returns

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CONTENTS

Make your functions return something meaningful, typed, and safe!

- Brings functional programming to Python land
- Provides a bunch of primitives to write declarative business logic
- Enforces better architecture
- Fully typed with annotations and checked with `mypy`, PEP561 compatible
- Adds emulated Higher Kinded Types support
- Provides type-safe interfaces to create your own data-types with enforced laws
- Has a bunch of helpers for better composition
- Pythonic and pleasant to write and to read
- Support functions and coroutines, framework agnostic
- Easy to start: has lots of docs, tests, and tutorials

Quickstart right now!

CHAPTER

ONE

INSTALLATION

```
pip install returns
```

You are also required to configure `mypy` correctly and install our plugin to fix this existing issue:

```
# In setup.cfg or mypy.ini:
[mypy]
plugins =
  returns.contrib.mypy.returns_plugin
```

We also recommend to use the same `mypy` settings we use.

Make sure you know how to get started, check out our docs! Try our demo.

CHAPTER

TWO

CONTENTS

- *Maybe container* that allows you to write `None`-free code
- *RequiresContext container* that allows you to use typed functional dependency injection
- *Result container* that let's you to get rid of exceptions
- *IO container* and *IOResult* that marks all impure operations and structures them
- *Future container* and *FutureResult* to work with `async` code
- Write your own container! You would still have all the features for your own types (including full existing code reuse and type-safety)

CHAPTER

THREE

MAYBE CONTAINER

`None` is called the worst mistake in the history of Computer Science.

So, what can we do to check for `None` in our programs? You can use builtin Optional type and write a lot of `if some is not None:` conditions. But, **having ``null`` checks here and there makes your code unreadable**.

```
user: Optional[User]
discount_program: Optional['DiscountProgram'] = None

if user is not None:
    balance = user.get_balance()
    if balance is not None:
        credit = balance.credit_amount()
        if credit is not None and credit > 0:
            discount_program = choose_discount(credit)
```

Or you can use Maybe container! It consists of `Some` and `Nothing` types, representing existing state and empty (instead of `None`) state respectively.

```
from typing import Optional
from returns.maybe import Maybe, maybe

@maybe  # decorator to convert existing Optional[int] to Maybe[int]
def bad_function() -> Optional[int]:
    ...

maybe_number: Maybe[float] = bad_function().bind_optional(
    lambda number: number / 2,
)
# => Maybe will return Some[float] only if there's a non-None value
#    Otherwise, will return Nothing
```

You can be sure that `.bind_optional()` method won't be called for `Nothing`. Forget about `None`-related errors forever!

We can also bind a `Optional`-returning function over a container. To achieve this, we are going to use `.bind_optional` method.

And that's how your initial refactored code will look like:

```
user: Optional[User]

# Type hint here is optional, it only helps the reader here:
```

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```
discount_program: Maybe['DiscountProgram'] = Maybe.from_optional(
    user,
).bind_optional(  # This won't be called if `user is None`
    lambda real_user: real_user.get_balance(),
).bind_optional(  # This won't be called if `real_user.get_balance()` is None
    lambda balance: balance.credit_amount(),
).bind_optional(  # And so on!
    lambda credit: choose_discount(credit) if credit > 0 else None,
)
```

Much better, isn't it?

CHAPTER

FOUR

REQUIRESCONTEXT CONTAINER

Many developers do use some kind of dependency injection in Python. And usually it is based on the idea that there's some kind of a container and assembly process.

Functional approach is much simpler!

Imagine that you have a `django` based game, where you award users with points for each guessed letter in a word (unguessed letters are marked as `'.'`):

```
from django.http import HttpRequest, HttpResponse
from words_app.logic import calculate_points

def view(request: HttpRequest) -> HttpResponse:
    user_word: str = request.POST['word']  # just an example
    points = calculate_points(user_word)
    ...  # later you show the result to user somehow

# Somewhere in your `words_app/logic.py`:

def calculate_points(word: str) -> int:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)

def _award_points_for_letters(guessed: int) -> int:
    return 0 if guessed < 5 else guessed  # minimum 6 points possible!
```

Awesome! It works, users are happy, your logic is pure and awesome. But, later you decide to make the game more fun: let's make the minimal accountable letters threshold configurable for an extra challenge.

You can just do it directly:

```
def _award_points_for_letters(guessed: int, threshold: int) -> int:
    return 0 if guessed < threshold else guessed
```

The problem is that `_award_points_for_letters` is deeply nested. And then you have to pass `threshold` through the whole callstack, including `calculate_points` and all other functions that might be on the way. All of them will have to accept `threshold` as a parameter! This is not useful at all! Large code bases will struggle a lot from this change.

Ok, you can directly use `django.settings` (or similar) in your `_award_points_for_letters` function. And **ruin your pure logic with framework specific details**. That's ugly!

Or you can use `RequiresContext` container. Let's see how our code changes:

```python
from django.conf import settings
from django.http import HttpRequest, HttpResponse
from words_app.logic import calculate_points

def view(request: HttpRequest) -> HttpResponse:
    user_word: str = request.POST['word']  # just an example
    points = calculate_points(user_words)(settings)  # passing the dependencies
    ...  # later you show the result to user somehow

# Somewhere in your `words_app/logic.py`:

from typing_extensions import Protocol
from returns.context import RequiresContext

class _Deps(Protocol):  # we rely on abstractions, not direct values or types
    WORD_THRESHOLD: int

def calculate_points(word: str) -> RequiresContext[int, _Deps]:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)

def _award_points_for_letters(guessed: int) -> RequiresContext[int, _Deps]:
    return RequiresContext(
        lambda deps: 0 if guessed < deps.WORD_THRESHOLD else guessed,
    )
```

And now you can pass your dependencies in a really direct and explicit way. And have the type-safety to check what you pass to cover your back. Check out RequiresContext docs for more. There you will learn how to make `'.'` also configurable.

We also have RequiresContextResult for context-related operations that might fail. And also RequiresContextIOResult and RequiresContextFutureResult.

CHAPTER

FIVE

RESULT CONTAINER

Please, make sure that you are also aware of Railway Oriented Programming.

5.1 Straight-forward approach

Consider this code that you can find in **any** python project.

```
import requests

def fetch_user_profile(user_id: int) -> 'UserProfile':
    """Fetches UserProfile dict from foreign API."""
    response = requests.get('/api/users/{0}'.format(user_id))
    response.raise_for_status()
    return response.json()
```

Seems legit, does it not? It also seems like a pretty straightforward code to test. All you need is to mock `requests.get` to return the structure you need.

But, there are hidden problems in this tiny code sample that are almost impossible to spot at the first glance.

5.2 Hidden problems

Let's have a look at the exact same code, but with the all hidden problems explained.

```
import requests

def fetch_user_profile(user_id: int) -> 'UserProfile':
    """Fetches UserProfile dict from foreign API."""
    response = requests.get('/api/users/{0}'.format(user_id))

    # What if we try to find user that does not exist?
    # Or network will go down? Or the server will return 500?
    # In this case the next line will fail with an exception.
    # We need to handle all possible errors in this function
    # and do not return corrupt data to consumers.
    response.raise_for_status()

    # What if we have received invalid JSON?
```

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```
    # Next line will raise an exception!
    return response.json()
```

Now, all (probably all?) problems are clear. How can we be sure that this function will be safe to use inside our complex business logic?

We really cannot be sure! We will have to create **lots** of `try` and `except` cases just to catch the expected exceptions. Our code will become complex and unreadable with all this mess!

Or we can go with the top level `except Exception:` case to catch literally everything. And this way we would end up with catching unwanted ones. This approach can hide serious problems from us for a long time.

5.3 Pipe example

```
import requests
from returns.result import Result, safe
from returns.pipeline import flow
from returns.pointfree import bind

def fetch_user_profile(user_id: int) -> Result['UserProfile', Exception]:
    """Fetches `UserProfile` TypedDict from foreign API."""
    return flow(
        user_id,
        _make_request,
        bind(_parse_json),
    )

@safe
def _make_request(user_id: int) -> requests.Response:
    # TODO: we are not yet done with this example, read more about `IO`:
    response = requests.get('/api/users/{0}'.format(user_id))
    response.raise_for_status()
    return response

@safe
def _parse_json(response: requests.Response) -> 'UserProfile':
    return response.json()
```

Now we have a clean and a safe and declarative way to express our business needs:

- We start from making a request, that might fail at any moment,
- Then parsing the response if the request was successful,
- And then return the result.

Now, instead of returning regular values we return values wrapped inside a special container thanks to the @safe decorator. It will return Success[YourType] or Failure[Exception]. And will never throw exception at us!

We also use flow and bind functions for handy and declarative composition.

This way we can be sure that our code won't break in random places due to some implicit exception. Now we control all parts and are prepared for the explicit errors.

We are not yet done with this example, let's continue to improve it in the next chapter.

CHAPTER

SIX

IO CONTAINER

Let's look at our example from another angle. All its functions look like regular ones: it is impossible to tell whether they are pure or impure from the first sight.

It leads to a very important consequence: *we start to mix pure and impure code together*. We should not do that!

When these two concepts are mixed we suffer really bad when testing or reusing it. Almost everything should be pure by default. And we should explicitly mark impure parts of the program.

That's why we have created `IO` container to mark impure functions that never fail.

These impure functions use `random`, current datetime, environment, or console:

```
import random
import datetime as dt

from returns.io import IO

def get_random_number() -> IO[int]:  # or use `@impure` decorator
    return IO(random.randint(1, 10))  # isn't pure, because random

now: Callable[[], IO[dt.datetime]] = impure(dt.datetime.now)

@impure
def return_and_show_next_number(previous: int) -> int:
    next_number = previous + 1
    print(next_number)  # isn't pure, because does IO
    return next_number
```

Now we can clearly see which functions are pure and which ones are impure. This helps us a lot in building large applications, unit testing you code, and composing business logic together.

6.1 Troublesome IO

As it was already said, we use `IO` when we handle functions that do not fail.

What if our function can fail and is impure? Like `requests.get()` we had earlier in our example.

Then we have to use a special `IOResult` type instead of a regular `Result`. Let's find the difference:

- Our `_parse_json` function always returns the same result (hopefully) for the same input: you can either parse valid `json` or fail on invalid one. That's why we return pure `Result`, there's no `IO` inside

- Our `_make_request` function is impure and can fail. Try to send two similar requests with and without internet connection. The result will be different for the same input. That's why we must use `IOResult` here: it can fail and has `IO`

So, in order to fulfill our requirement and separate pure code from impure one, we have to refactor our example.

6.2 Explicit IO

Let's make our IO explicit!

```
import requests
from returns.io import IOResult, impure_safe
from returns.result import safe
from returns.pipeline import flow
from returns.pointfree import bind_result

def fetch_user_profile(user_id: int) -> IOResult['UserProfile', Exception]:
    """Fetches `UserProfile` TypedDict from foreign API."""
    return flow(
        user_id,
        _make_request,
        # before: def (Response) -> UserProfile
        # after safe: def (Response) -> ResultE[UserProfile]
        # after bind_result: def (IOResultE[Response]) -> IOResultE[UserProfile]
        bind_result(_parse_json),
    )

@impure_safe
def _make_request(user_id: int) -> requests.Response:
    response = requests.get('/api/users/{0}'.format(user_id))
    response.raise_for_status()
    return response

@safe
def _parse_json(response: requests.Response) -> 'UserProfile':
    return response.json()
```

And later we can use unsafe_perform_io somewhere at the top level of our program to get the pure (or "real") value.

As a result of this refactoring session, we know everything about our code:

- Which parts can fail,
- Which parts are impure,
- How to compose them in a smart, readable, and typesafe manner.

CHAPTER

SEVEN

FUTURE CONTAINER

There are several issues with `async` code in Python:

1. You cannot call `async` function from a sync one
2. Any unexpectedly thrown exception can ruin your whole event loop
3. Ugly composition with lots of `await` statements

`Future` and `FutureResult` containers solve these issues!

7.1 Mixing sync and async code

The main feature of Future is that it allows to run async code while maintaining sync context. Let's see an example.

Let's say we have two functions, the `first` one returns a number and the `second` one increments it:

```
async def first() -> int:
    return 1

def second():  # How can we call `first()` from here?
    return first() + 1  # Boom! Don't do this. We illustrate a problem here.
```

If we try to just run `first()`, we will just create an unawaited coroutine. It won't return the value we want.

But, if we would try to run `await first()`, then we would need to change `second` to be `async`. And sometimes it is not possible for various reasons.

However, with `Future` we can "pretend" to call async code from sync code:

```
from returns.future import Future

def second() -> Future[int]:
    return Future(first()).map(lambda num: num + 1)
```

Without touching our `first` async function or making `second` async we have achieved our goal. Now, our async value is incremented inside a sync function.

However, `Future` still requires to be executed inside a proper eventloop:

```
import anyio  # or asyncio, or any other lib

# We can then pass our `Future` to any library: asyncio, trio, curio.
# And use any event loop: regular, uvloop, even a custom one, etc
assert anyio.run(second().awaitable) == 2
```

As you can see `Future` allows you to work with async functions from a sync context. And to mix these two realms together. Use raw `Future` for operations that cannot fail or raise exceptions. Pretty much the same logic we had with our `IO` container.

7.2 Async code without exceptions

We have already covered how ``*Result*` <#result-container>`_ works for both pure and impure code. The main idea is: we don't raise exceptions, we return them. It is **especially** critical in async code, because a single exception can ruin all our coroutines running in a single eventloop.

We have a handy combination of `Future` and `Result` containers: `FutureResult`. Again, this is exactly like `IOResult`, but for impure async code. Use it when your `Future` might have problems: like HTTP requests or filesystem operations.

You can easily turn any wild throwing coroutine into a calm `FutureResult`:

```
import anyio
from returns.future import future_safe
from returns.io import IOFailure

@future_safe
async def raising():
    raise ValueError('Not so fast!')

ioresult = anyio.run(raising.awaitable)  # all `Future`s return IO containers
assert ioresult == IOFailure(ValueError('Not so fast!'))  # True
```

Using `FutureResult` will keep your code safe from exceptions. You can always `await` or execute inside an eventloop any `FutureResult` to get sync `IOResult` instance to work with it in a sync manner.

7.3 Better async composition

Previously, you had to do quite a lot of `await`ing while writing `async` code:

```
async def fetch_user(user_id: int) -> 'User':
    ...

async def get_user_permissions(user: 'User') -> 'Permissions':
    ...

async def ensure_allowed(permissions: 'Permissions') -> bool:
    ...

async def main(user_id: int) -> bool:
    # Also, don't forget to handle all possible errors with `try / except`!
    user = await fetch_user(user_id)  # We will await each time we use a coro!
    permissions = await get_user_permissions(user)
    return await ensure_allowed(permissions)
```

Some people are ok with it, but some people don't like this imperative style. The problem is that there was no choice.

But now, you can do the same thing in functional style! With the help of `Future` and `FutureResult` containers:

```python
import anyio
from returns.future import FutureResultE, future_safe
from returns.io import IOSuccess, IOFailure

@future_safe
async def fetch_user(user_id: int) -> 'User':
    ...

@future_safe
async def get_user_permissions(user: 'User') -> 'Permissions':
    ...

@future_safe
async def ensure_allowed(permissions: 'Permissions') -> bool:
    ...

def main(user_id: int) -> FutureResultE[bool]:
    # We can now turn `main` into a sync function, it does not `await` at all.
    # We also don't care about exceptions anymore, they are already handled.
    return fetch_user(user_id).bind(get_user_permissions).bind(ensure_allowed)

correct_user_id: int  # has required permissions
banned_user_id: int  # does not have required permissions
wrong_user_id: int  # does not exist

# We can have correct business results:
assert anyio.run(main(correct_user_id).awaitable) == IOSuccess(True)
assert anyio.run(main(banned_user_id).awaitable) == IOSuccess(False)

# Or we can have errors along the way:
assert anyio.run(main(wrong_user_id).awaitable) == IOFailure(
    UserDoesNotExistError(...),
)
```

Or even something really fancy:

```python
from returns.pointfree import bind
from returns.pipeline import flow

def main(user_id: int) -> FutureResultE[bool]:
    return flow(
        fetch_user(user_id),
        bind(get_user_permissions),
        bind(ensure_allowed),
    )
```

Later we can also refactor our logical functions to be sync and to return `FutureResult`.

Lovely, isn't it?

CHAPTER

EIGHT

MORE!

Want more? Go to the docs! Or read these articles:

- Python exceptions considered an anti-pattern
- Enforcing Single Responsibility Principle in Python
- Typed functional Dependency Injection in Python
- How Async Should Have Been
- Higher Kinded Types in Python
- Make Tests a Part of Your App

Do you have an article to submit? Feel free to open a pull request!

CHAPTER

NINE

CONTENTS

9.1 Quickstart

Starting is really fast! You can intergrate `returns` into any project at any stage. You can use it fully or partially. With or without types.

`returns` is a very flexible library!

You can even just start using it without any deep theory around this project. But, you can always address our learning materials which will unravel all parts of functional programming with useful examples and simple terms.

9.1.1 Why

One of the most frequent questions Python developers ask: why would we need this?

Basically, the answer is that `returns` provides useful abstractions that solve some problems every developer has:

1. *`Maybe`* helps to work with `None` in a type-safe way
2. *`Result`* helps to work with exceptions in a type-safe way
3. *`IO`* helps to separate pure code from impure code to make your architecture better
4. *`Future`* helps to write `await` free code
5. *`RequiresContext`* helps to inject dependencies in a very readable, explicit, type-safe, and clean way
6. *Pipelines* can be used independently or together with the types above to create complex, declarative, and type-safe data pipelines

On top of that we provide useful interfaces that allows you to switch implementation on the fly. For example, you can write code that works the same way for sync and async execution flows. While being fully type-safe at the same time.

And you can write your own primitives that will solve any other problem you can possible have based on our existing or your custom interfaces.

In other words, `returns` unlocks insane powers of typed-functional programming to a regular Python developer.

9.1.2 Installation

`returns` is a pure Python library. Install it as usual:

```
pip install returns  # or better use poetry
```

9.1.3 Typechecking and other integrations

This step is optional. If you use `mypy` for type-checking, than you will need to configure it. We really recommend using `mypy` with this project though. Because we have put a lot of efforts into the typing part.

Check out our docs on *mypy*.

We also have built-in integrations with *pytest* and *hypothesis*. Also, there is *developer tooling* you might enjoy.

9.1.4 Theory

Do you want to learn new awesome concepts? Then, start reading our "Userguide"!

It has everything you need! Reading order matters.

However, this is optional. You can still use `returns` without a deep-dive into theory.

9.1.5 Building your own stuff

You can extend `returns` and build your own stuff! Particullary, you can add new interfaces, new containers, and new integrations. See *this guide*.

Join our chat to get help or advice.

9.2 Container: the concept

Container is a concept that allows you to write code around the existing wrapped values while maintaining the execution context.

List of supported containers:

- *Maybe* to handle `None` cases
- *Result* to handle possible exceptions
- *IO* to mark explicit `IO` actions
- *Future* to work with `async` code
- *RequiresContext* to pass context to your functions (DI and similar)

There are also some combintations like *IOResult*, *FutureResult*, *RequiresContextResult*, *RequiresContextIOResult* and *RequiresContextFutureResult*.

We will show you container's simple API of one attribute and several simple methods.

9.2.1 Basics

The main idea behind a container is that it wraps some internal state. That's what `._inner_value` is used for.

And we have several functions to create new containers based on the previous state. And we can see how this state is evolving during the execution.

Fig. 1: State evolution.

9.2.2 Working with a container

We use two methods to create a new container from the previous one. `bind` and `map`.

The difference is simple:

- `map` works with functions that return regular value
- `bind` works with functions that return new container of the same type

We have *returns.interfaces.mappable.MappableN.map()* to compose containers with regular functions.

Here's how it looks:

Fig. 2: Illustration of `map` method.

```
>>> from typing import Any
>>> from returns.result import Success, Result

>>> def double(state: int) -> int:
...     return state * 2

>>> result: Result[int, Any] = Success(1).map(double)
>>> assert str(result) == '<Success: 2>'

>>> result: Result[int, Any] = result.map(lambda state: state + 1)
>>> assert str(result) == '<Success: 3>'
```

The same works with built-in functions as well:

```
>>> from returns.io import IO

>>> io = IO('bytes').map(list)
>>> str(io)
"<IO: ['b', 'y', 't', 'e', 's']>"
```

The second method is `bind`. It is a bit different. We pass a function that returns another container to it. *returns.interfaces.bindable.BindableN.bind()* is used to literally bind two different containers together.

Here's how it looks:

Fig. 3: Illustration of `bind` method.

```
from returns.result import Result, Success

def may_fail(user_id: int) -> Result[float, str]:
    ...

value: Result[int, str] = Success(1)
# Can be assumed as either Success[float] or Failure[str]:
result: Result[float, str] = value.bind(may_fail)
```

Note: All containers support these methods. Because all containers implement *returns.interfaces.mappable.MappableN* and *returns.interfaces.bindable.BindableN*.

You can read more about methods that some other containers support and *interfaces* behind them.

9.2.3 Instantiating a container

All *returns.interfaces.applicative.ApplicativeN* containers support special `.from_value` method to construct a new container from a raw value.

```
>>> from returns.result import Result
>>> assert str(Result.from_value(1)) == '<Success: 1>'
```

There are also other methods in other interfaces. For example, here are some of them:

- *returns.interfaces.specific.maybe.MaybeLikeN.from_optional()* creates a value from `Optional` value

```
>>> from returns.maybe import Maybe, Some, Nothing
>>> assert Maybe.from_optional(1) == Some(1)
>>> assert Maybe.from_optional(None) == Nothing
```

- *returns.interfaces.failable.DiverseFailableN.from_failure()* creates a failing container from a value

```
>>> from returns.result import Result, Failure
>>> assert Result.from_failure(1) == Failure(1)
```

There are many other constructors! Check out concrete types and their interfaces.

9.2.4 Working with multiple containers

Multiple container arguments

We have already seen how we can work with one container and functions that receive a single argument.

Let's say you have a function of two arguments and two containers:

```
>>> def sum_two_numbers(first: int, second: int) -> int:
...     return first + second
```

And here are our two containers:

```
>>> from returns.io import IO

>>> one = IO(1)
>>> two = IO(2)
```

The naive approach to compose two `IO` containers and a function would be too hard to show here. Luckily, we support partial application and the `.apply()` method.

Here are the required steps:

0. We make `sum_two_numbers` to receive *partial arguments*
1. We create a new container that wraps `sum_two_numbers` function as a value
2. We then call `.apply()` twice to pass each value

It can be done like so:

```
>>> from returns.curry import curry
>>> from returns.io import IO

>>> @curry
... def sum_two_numbers(first: int, second: int) -> int:
...     return first + second

>>> one = IO(1)
>>> two = IO(2)
>>> assert two.apply(one.apply(IO(sum_two_numbers))) == IO(3)
```

But, there are other ways to make `sum_two_numbers` partial. One can use `partial` as well:

```
>>> from returns.curry import partial

>>> one = IO(1)
>>> two = IO(2)
>>> assert two.apply(one.apply(
...     IO(lambda x: partial(sum_two_numbers, x)),
... )) == IO(3)
```

Or even native `lambda` functions:

```
>>> one = IO(1)
>>> two = IO(2)
>>> assert two.apply(one.apply(
...     IO(lambda x: lambda y: sum_two_numbers(x, y)),
... )) == IO(3)
```

It would be faster, but not as elegant (and type-safe).

Working with iterable of containers

Imagine that you have two take 10 random numbers and then sum they to get the final result.

So, here's how your code will look like:

```
>>> import random
>>> from returns.io import IO

>>> def random_number() -> IO[int]:
...     return IO(2)  # Example, basically alias of ``random.randint(1, 5)``

>>> numbers = [random_number() for _ in range(10)]
>>> assert len(numbers) == 10
>>> assert all(isinstance(number, IO) for number in numbers)
```

So, how to sum these random values into a single `IO[int]` value? That's where *`Fold.loop`* really helps!

```
>>> from typing import Callable
>>> from returns.iterables import Fold

>>> def sum_two_numbers(first: int) -> Callable[[int], int]:
...     return lambda second: first + second

>>> assert Fold.loop(
...     numbers,  # let's loop on our ``IO`` values
...     IO(0),  # starting from ``0`` value
...     sum_two_numbers,  # and getting the sum of each two numbers in a loop
... ) == IO(20)
```

We can also change the initial element to some other value:

```
>>> assert Fold.loop(
...     numbers,
...     IO(5),  # now we will start from ``5``, not ``0`
...     sum_two_numbers,
... ) == IO(25)
```

`Fold.loop` is eager. It will be executed for all items in your iterable.

Collecting an iterable of containers into a single container

You might end up with an iterable of containers:

```
>>> from typing import List
>>> from returns.maybe import Maybe, Some, Nothing, maybe

>>> source = {'a': 1, 'b': 2}
>>> fetched_values: List[Maybe[int]] = [
...     maybe(source.get)(key)
...     for key in ('a', 'b')
... ]
```

To work with iterable of containers, it is recommended to cast it into a container with the iterable inside using the *`Fold.collect`* method:

```
>>> from returns.iterables import Fold

>>> assert Fold.collect(fetched_values, Some(())) == Some((1, 2))
```

Any falsy values will result in a falsy result (pun intended):

```
>>> fetched_values: List[Maybe[int]] = [
...     maybe(source.get)(key)
...     for key in ('a', 'c')  # 'c' is missing!
... ]
>>> assert Fold.collect(fetched_values, Some(())) == Nothing
```

You can also use a different strategy to fetch values you need, to do just that we have *Fold.collect_all* method:

```
>>> fetched_values: Maybe[int] = [
...     maybe(source.get)(key)
...     for key in ('a', 'c')  # 'c' is missing!
... ]
>>> assert Fold.collect_all(fetched_values, Some(())) == Some((1,))
```

We support any `Iterable[T]` input type and return a `Container[Sequence[T]]`.

You can subclass `Fold` type to change how any of these methods work.

9.2.5 Immutability

We like to think of `returns` as *immutable* structures. You cannot mutate the inner state of the created container, because we redefine `__setattr__` and `__delattr__` magic methods.

You cannot also set new attributes to container instances, since we are using `__slots__` for better performance and strictness.

Well, nothing is **really** immutable in python, but you were warned.

We also provide *returns.primitives.types.Immutable* mixin that users can use to quickly make their classes immutable.

9.2.6 Type safety

We try to make our containers optionally type safe.

What does it mean?

1. It is still good old `python`, do whatever you want without `mypy`
2. If you are using `mypy` you will be notified about type violations

We also ship PEP561 compatible `.pyi` files together with the source code. In this case these types will be available to users when they install our application.

We also ship custom `mypy` plugins to overcome some existing problems, please make sure to use them, since they increase your developer experience and type-safety level:

Check out our docs on using our *mypy plugins*.

9.2.7 Further reading

- *Railway oriented programming*

9.2.8 API Reference

`BaseContainer` is a base class for all other containers. It defines some basic things like representation, hashing, pickling, etc.

class BaseContainer(*inner_value*)

Bases: *returns.primitives.types.Immutable*

Utility class to provide all needed magic methods to the context.

__slots__ = ('_inner_value',)

__init__(*inner_value*)

Wraps the given value in the Container.

'value' is any arbitrary value of any type including functions.

__repr__()

Used to display details of object.

Return type `str`

__eq__(*other*)

Used to compare two 'Container' objects.

Parameters **other** (`Any`) –

Return type `bool`

__hash__()

Used to use this value as a key.

Return type `int`

__getstate__()

That's how this object will be pickled.

Return type `Any`

__setstate__(*state*)

Loading state from pickled data.

Parameters **state** (`Any`) –

Return type `None`

__abstractmethods__ = frozenset({})

__annotations__ = {'_inner_value': typing.Any}

__module__ = 'returns.primitives.container'

container_equality(*self*, *other*)

Function to compare similar containers.

Compares both their types and their inner values.

Parameters

- **self** (*KindN*[~_EqualType, `Any`, `Any`, `Any`]) –

- **other** (*KindN*[~_EqualType, Any, Any, Any]) –

Return type bool

9.3 Railway oriented programming

Containers can serve many different purposes (while still serving the main one: composition) for example, some of them (*Result* and *Maybe*) are used to work with different types of errors starting with `NullPointerException` to arbitrary user-defined ones.

9.3.1 Error handling

When talking about error handling we use a concept of Railway oriented programming. It means that flow of our program has two tracks:

1. Successful one: where everything goes perfectly: HTTP requests work, database is always serving us data, parsing values does not fail
2. Failed one: where something went wrong

We can switch from track to track: we can fail something or we can fix the situation.

Fig. 4: Railway oriented programming.

Returning execution to the right track

We also support two special methods to work with "failed" values:

- *returns.interfaces.altable.AltableN.alt()* transforms error to another error that works only when container is in failed state, is the opposite of *returns.interfaces.mappable.MappableN.map()* method
- *returns.interfaces.lashable.LashableN.lash()* is the opposite of *returns.interfaces.bindable.BindableN.bind()* method that works only when container is in failed state

Let's start from the first one: `alt` method allows to change your error type.

Fig. 5: Illustration of `alt` method.

```
>>> from returns.result import Failure
>>> assert Failure(1).alt(str) == Failure('1')
```

The second method is `lash`. It is a bit different. We pass a function that returns another container to it. *returns.interfaces.lashable.LashableN.lash()* is used to literally bind two different containers together. It can also lash your flow and get on the successful track again:

Fig. 6: Illustration of `lash` method.

```
>>> from returns.result import Result, Failure, Success

>>> def tolerate_exception(state: Exception) -> Result[int, Exception]:
...     if isinstance(state, ZeroDivisionError):
```

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```
...         return Success(0)
...     return Failure(state)

>>> value: Result[int, Exception] = Failure(ZeroDivisionError())
>>> result: Result[int, Exception] = value.lash(tolerate_exception)
>>> assert result == Success(0)

>>> value2: Result[int, Exception] = Failure(ValueError())
>>> result2: Result[int, Exception] = value2.lash(tolerate_exception)
>>> # => Failure(ValueError())
```

From typing perspective `.alt` and `.lash` are exactly the same as `.map` and `.bind` but only work with the second type argument instead of the first one:

```
from returns.result import Result

first: Result[int, int]
second: Result[int, int]

reveal_type(first.map(str))
# => Result[str, int]

reveal_type(second.alt(str))
# => Result[int, str]
```

Note: Not all containers support these methods, only containers that implement *returns.interfaces.lashable.LashableN* and *returns.interfaces.altable.AltableN* For example, *IO* based containers and *RequiresContext* cannot be alted or lashed.

9.3.2 Unwrapping values

And we have two more functions to unwrap inner state of containers into a regular types:

- `.unwrap` returns a value if it is possible, raises *returns.primitives.exceptions.UnwrapFailedError* otherwise

```
>>> from returns.result import Failure, Success
>>> from returns.maybe import Some, Nothing

>>> assert Success(1).value_or(None) == 1
>>> assert Some(0).unwrap() == 0
```

```
>>> Failure(1).unwrap()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError

>>> Nothing.unwrap()
Traceback (most recent call last):
```

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```
  ...
returns.primitives.exceptions.UnwrapFailedError
```

For failing containers you can use `returns.interfaces.unwrappable.Unwrapable.failure()` to unwrap the failed state:

```
>>> assert Failure(1).failure() == 1
>>> Success(1).failure()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Be careful, since this method will raise an exception when you try to `.failure()` a successful container.

Note: Not all containers support these methods, only containers that implement *returns.interfaces.unwrappable.Unwrappable*. For example, *IO* based containers and *RequiresContext* cannot be unwrapped.

Note: Some containers also have `.value_or()` helper method. Example:

```
>>> from returns.result import Success, Failure
>>> assert Success(1).value_or(None) == 1
>>> assert Failure(1).value_or(None) is None
```

9.3.3 Further reading

- Railway oriented programming in F#
- Against Railway-Oriented Programming

9.4 Higher Kinded Types

Higher Kinded Types is a new concept for Python developers. But, it is totally not new in general!

So, let's start with the detailed explanation: what Higher Kinded Types are?

9.4.1 Regular types

We can start with the very basic example. Let's say we have a function that transforms type `A` into a type `B`. These types `A` and `B` can be some specific ones, for example:

```
>>> def from_a_to_b(arg: int) -> str:
...     return str(arg)

>>> assert from_a_to_b(1) == '1'
```

That's what we already know and use. Let's scale things up!

9.4.2 Generics

The next thing we can do with types is to write generic types. What are generic types? Basically, they are some types that contain other types inside. Like `List[int]` is a list of integers: `[1, 2, 3]`. We know that `List[int]` has a shape of a `list` and contents of `int`.

We can also write functions that work with generics:

```
>>> from typing import List

>>> def all_to_str(arg: List[int]) -> List[str]:
...     return [str(item) for item in arg]

>>> assert all_to_str([1, 2]) == ['1', '2']
```

There's one more thing about generics we want to notice at this point. Different generics do have different numbers of type arguments:

- `List` has a single type argument: `List[Value]` or `Maybe[Value]`
- `Dict` has two type arguments: `Dict[Key, Value]` or `Result[Value, Error]`
- `Generator` has three type arguments: `Generator[Yield, Send, Return]` or `RequiresContextResult[Value, Error, Env]`

That's what we call a kind. So, `List` and `Maybe` have a kind of `1`, `Dict` and `Result` have kind of `2`, `Generator` and `RequiresContextResult` have a kind of `3`.

So, let's go one level further.

9.4.3 Operations on generics

Let's say you have a function that copies all values of a passed argument. We can define this function as:

```
>>> from typing import TypeVar
>>> ValueType = TypeVar('ValueType')

>>> def copy(arg: ValueType) -> ValueType:
...     ...
```

This function can work with any type. It receives something and then returns the same value back. That's the whole point of copying!

But, there are different functions, that do different things with types. For example, we can write a function that converts a value inside any *Container1* (a base class for all our containers) from `int` to `str`:

We can also write functions that work with generics:

```
>>> from returns.interfaces.container import Container1

>>> def to_str(container: Container1[int]) -> Container1[str]:
...     return container.map(str)
```

And here's how it can be used:

```
>>> from returns.maybe import Maybe
>>> from returns.io import IO

>>> assert to_str(Maybe.from_value(1)) == Maybe.from_value('1')
>>> assert to_str(IO.from_value(1)) == IO.from_value('1')
```

It works just fine! But! It has a very important thing inside. All calls to `to_str` will return `Container1` type, not something specific:

```
reveal_type(to_str(Maybe.from_value(1)))  # Container1[str]
reveal_type(to_str(IO.from_value(1)))     # Container1[str]
```

But, we know that this is not true. When we pass a `Maybe` in - we get the `Maybe` back. When we pass a `IO` in - we get the `IO` back.

How can we fix this problem? With `@overload`!

```
>>> from typing import overload
>>> from returns.maybe import Maybe
>>> from returns.io import IO

>>> @overload
... def to_str(arg: Maybe[int]) -> Maybe[str]:
...     ...

>>> @overload
... def to_str(arg: IO[int]) -> IO[str]:
...     ...
```

We kinda fixed it! Now, our calls will reveal the correct types for these three examples:

```
reveal_type(to_str(Maybe.from_value(1)))  # Maybe[str]
reveal_type(to_str(IO.from_value(1)))     # IO[str]
```

But, there's an important limitation with this solution: no other types are allowed in this function anymore. So, you will try to use it with any other type, it won't be possible.

9.4.4 Current limitations

To overcome current `@overload` decorators limitations, we can imagine a syntax like this:

```
from typing import TypeVar
from returns.interfaces.container import Container1

T = TypeVar('T', bound=Container1)

def all_to_str(arg: T[int]) -> T[str]:
    ...
```

Sadly, this does not work. Because `TypeVar` cannot be used with `[]`. We have to find some other way.

9.4.5 Higher Kinded Types

So, that's where `returns` saves the day!

Note: Technical note: this feature requires *mypy plugin*.

The main idea is that we can rewrite `T[int]` as `Kind1[T, int]`. Let's see how it works:

```
>>> from returns.primitives.hkt import Kind1
>>> from returns.interfaces.container import Container1
>>> from typing import TypeVar

>>> T = TypeVar('T', bound=Container1)

>>> def to_str(arg: Kind1[T, int]) -> Kind1[T, str]:
...   ...
```

Now, this will work almost correctly! Why almost? Because the revealed type will be `Kind1`.

```
reveal_type(to_str(Maybe.from_value(1)))  # Kind1[Maybe, str]
reveal_type(to_str(IO.from_value(1)))     # Kind1[IO, str]
```

That's not something we want. We don't need `Kind1`, we need real `Maybe` or `IO` values.

The final solution is to decorate `to_str` with `@kinded`:

```
>>> from returns.primitives.hkt import kinded

>>> @kinded
... def to_str(arg: Kind1[T, int]) -> Kind1[T, str]:
...   ...
```

Now, it will be fully working:

```
reveal_type(to_str(Maybe.from_value(1)))  # Maybe[str]
reveal_type(to_str(IO.from_value(1)))     # IO[str]
```

And the thing about this approach is that it will be:

1. Fully type-safe. It works with correct interface `Container1`, returns the correct type, has correct type transformation
2. Is opened for further extension and even custom types

9.4.6 Kinds

As it was said `Maybe[int]`, `Result[str, int]`, and `RequiresContextResult[str, int, bool]` are different in terms of a number of type arguments. We support different kinds:

- `Kind1[Maybe, int]` is similar to `Maybe[int]`
- `Kind2[Result, str, int]` is similar to `Result[str, int]`
- `Kind3[RequiresContextResult, str, int, bool]` is similar to `RequiresContextResult[str, int, bool]`

You can use any of them freely.

Later you will learn how to *create your own types* that support kinds!

9.4.7 Further reading

- Higher Kinded Types in Python

9.4.8 FAQ

Which types you can use with KindN?

The first position in all `KindN` types can be occupied by either `Instance` type or `TypeVar` with `bound=`.

Let's see an example:

```
>>> from typing import TypeVar
>>> from returns.primitives.hkt import KindN, kinded
>>> from returns.interfaces.mappable import MappableN

>>> _FirstType = TypeVar('_FirstType')
>>> _SecondType = TypeVar('_SecondType')
>>> _ThirdType = TypeVar('_ThirdType')
>>> _MappableKind = TypeVar('_MappableKind', bound=MappableN)

>>> @kinded
... def works_with_interface(
...     container: KindN[_MappableKind, _FirstType, _SecondType, _ThirdType],
... ) -> KindN[_MappableKind, str, _SecondType, _ThirdType]:
...     return container.map(str)
```

This version of `works_with_interface` will work with any subtype of `MappableN`. Because we use `_MappableKind` in its definition. And `_MappableKind` is a `TypeVar` bound to `MappableN`. Arguments of non `MappableN` subtypes will be rejected by a type-checker:

```
>>> from returns.maybe import Maybe
>>> from returns.io import IO
>>> from returns.result import Success

>>> assert works_with_interface(Maybe.from_value(1)) == Maybe.from_value('1')
>>> assert works_with_interface(IO.from_value(1)) == IO.from_value('1')
>>> assert works_with_interface(Success(1)) == Success('1')
```

In contrast, we can work directly with some specific type, let's say `Maybe` container:

```
>>> from returns.maybe import Maybe

>>> @kinded
... def works_with_maybe(
...     container: KindN[Maybe, _FirstType, _SecondType, _ThirdType],
... ) -> KindN[Maybe, str, _SecondType, _ThirdType]:
...     return container.map(str)
```

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```
>>> assert works_with_maybe(Maybe.from_value(1)) == Maybe.from_value('1')
```

Function `works_with_maybe` will work correctly with `Maybe` instance. Other types will be rejected.

So, choose wisely which mechanism you need.

9.4.9 API Reference

class KindN(**args*, ***kwds*)

Bases: `Generic[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, returns.primitives.hkt._TypeArgType3]`

Emulation support for Higher Kinded Types.

Consider `KindN` to be an alias of `Generic` type. But with some extra goodies.

`KindN` is the top-most type for other `Kind` types like `Kind1`, `Kind2`, `Kind3`, etc.

The only difference between them is how many type arguments they can hold. `Kind1` can hold just two type arguments: `Kind1[IO, int]` which is almost equals to `IO[int]`. `Kind2` can hold just two type arguments: `Kind2[IOResult, int, str]` which is almost equals to `IOResult[int, str]`. And so on.

The idea behind `KindN` is that one cannot write this code:

```
from typing import TypeVar

T = TypeVar('T')
V = TypeVar('V')

def impossible(generic: T, value: V) -> T[V]:
    return generic(value)
```

But, with `KindN` this becomes possible in a form of `Kind1[T, V]`.

Note: To make sure it works correctly, your type has to be a subtype of `KindN`.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this.

We use "emulated Higher Kinded Types" concept. Read the whitepaper: https://bit.ly/2ABACx2

`KindN` does not exist in runtime. It is used just for typing. There are (and must be) no instances of this type directly.

Implementation details

We didn't use `ABCMeta` to disallow its creation, because we don't want to have a possible metaclass conflict with other metaclasses. Current API allows you to mix `KindN` anywhere.

We allow `_InstanceType` of `KindN` to be `Instance` type or `TypeVarType` with `bound=...`.

See also:

- https://arrow-kt.io/docs/0.10/patterns/glossary/#higher-kinds
- https://github.com/gcanti/fp-ts/blob/master/docs/guides/HKT.md
- https://bow-swift.io/docs/fp-concepts/higher-kinded-types
- https://github.com/pelotom/hkts

Kind1

Type alias for kinds with one type argument.

alias of *returns.primitives.hkt.KindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, Any, Any]

Kind2

Type alias for kinds with two type arguments.

alias of *returns.primitives.hkt.KindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, Any]

Kind3

Type alias for kinds with three type arguments.

alias of *returns.primitives.hkt.KindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, returns.primitives.hkt._TypeArgType3]

class SupportsKindN(**args*, ***kwds*)

Bases: *returns.primitives.hkt.KindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, returns.primitives.hkt._TypeArgType3]

Base class for your containers.

Notice, that we use `KindN` / `Kind1` to annotate values, but we use `SupportsKindN` / `SupportsKind1` to inherit from.

Implementation details

The only thing this class does is: making sure that the resulting classes won't have `__getattr__` available during the typechecking phase.

Needless to say, that `__getattr__` during runtime - never exists at all.

SupportsKind1

Type alias used for inheritance with one type argument.

alias of *returns.primitives.hkt.SupportsKindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, NoReturn, NoReturn]

SupportsKind2
Type alias used for inheritance with two type arguments.

alias of *returns.primitives.hkt.SupportsKindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, NoReturn]

SupportsKind3
Type alias used for inheritance with three type arguments.

alias of *returns.primitives.hkt.SupportsKindN*[returns.primitives.hkt._InstanceType, returns.primitives.hkt._TypeArgType1, returns.primitives.hkt._TypeArgType2, returns.primitives.hkt._TypeArgType3]

dekind(*kind*)
Turns `Kind1[IO, int]` type into real `IO[int]` type.

Should be used when you are left with accidental `KindN` instance when you really want to have the real type.

Works with type arguments of any length.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this.

In runtime it just returns the passed argument, nothing really happens:

```
>>> from returns.io import IO
>>> from returns.primitives.hkt import Kind1

>>> container: Kind1[IO, int] = IO(1)
>>> assert dekind(container) is container
```

However, please, do not use this function unless you know exactly what you are doing and why do you need it.

Parameters **kind** (*KindN*[+_InstanceType, +_TypeArgType1, +_TypeArgType2, +_TypeArgType3]) –

Return type +_InstanceType

class Kinded(**args*, ***kwds*)
Bases: `typing_extensions.Protocol[returns.primitives.hkt._FunctionDefType]`

Protocol that tracks kinded functions calls.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this.

kinded(*function*)
Decorator to be used when you want to dekind the function's return type.

Does nothing in runtime, just returns its argument.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this.

Here's an example of how it should be used:

```
>>> from typing import TypeVar
>>> from returns.primitives.hkt import KindN, kinded
>>> from returns.interfaces.bindable import BindableN

>>> _Binds = TypeVar('_Binds', bound=BindableN)  # just an example
>>> _Type1 = TypeVar('_Type1')
```

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```
>>> _Type2 = TypeVar('_Type2')
>>> _Type3 = TypeVar('_Type3')

>>> @kinded
... def bindable_identity(
...     container: KindN[_Binds, _Type1, _Type2, _Type3],
... ) -> KindN[_Binds, _Type1, _Type2, _Type3]:
...     return container  # just do nothing
```

As you can see, here we annotate our return type as `-> KindN[_Binds, _Type1, _Type2, _Type3]`, it would be true without `@kinded` decorator.

But, `@kinded` decorator dekinds the return type and infers the real type behind it:

```
>>> from returns.io import IO, IOResult

>>> assert bindable_identity(IO(1)) == IO(1)
>>> # => Revealed type: 'IO[int]'

>>> iores: IOResult[int, str] = IOResult.from_value(1)
>>> assert bindable_identity(iores) == iores
>>> # => Revealed type: 'IOResult[int, str]'
```

The difference is very clear in `methods` modules, like:

- Raw `returns.methods.bind.internal_bind()` that returns `KindN` instance
- User-facing `returns.methods.bind.bind()` that returns the container type

You must use this decorator for your own kinded functions as well.

Parameters **function** (*~_FunctionType*) –

Return type *Kinded*[~_FunctionType]

9.5 Interfaces

We provide a lot of generic interfaces to write our bundled and your own custom types.

These interfaces are designed:

1. To be subclassed
2. To provide abstract methods to implement in your own types
3. To enforce correctness on final types
4. To attach critical laws to be checked

We use *Higher Kinded Types* to define abstract methods.

Reading about interfaces will be the most useful if you plan to *create your own containers*.

9.5.1 General information

All the non-specific interfaces (e.g. MappableN, BindableN, ApplicativeN) can have **Nth** types, at the maximum of three possible types. What does this mean?

MappableN interface, for example, can have one, two or three possible types. See the example below:

```
>>> from typing import NoReturn

>>> from returns.interfaces.mappable import (
...     MappableN, Mappable1, Mappable2, Mappable3,
... )

>>> one_type: MappableN[int, NoReturn, NoReturn]
>>> two_types: MappableN[int, str, NoReturn]
>>> three_types: MappableN[int, str, bool]

>>> # We have a shortcut for each amount of arguments to reduce the boilerplate
>>> one_type: Mappable1[int]
>>> two_types: Mappable2[int, str]
>>> three_type: Mappable3[int, str, bool]
```

Note: Useful links before you start here:

- Functors, Applicatives, And Monads In Pictures
- Understanding Functor and Monad With a Bag of Peanuts
- Variance of generic types
- If you know map, I will teach you monads

Naming convention

We follow a very specific naming convention in our interface names.

If interface does not depend on the number of types it works with and is always the same, we name it as is. For example, `Equable` is always the same and does not depend on the number of type arguments. We use adjectives to name these interfaces.

Secondly, if interface depends on the number of type arguments, it is named with `N` suffix in the end. It would always have numeric aliases for each number of arguments supported. For example, `MappableN`, `Mappable1`, `Mappable2`, and `Mappable3`.

The last criteria we have to decided on naming is "whether this interface always the same or it can have slight variations"? That's why we have `ResultLikeN` and `ResultBasedN` interfaces. Because `ResultBasedN` has two extra methods compared to `ResultLikeN`. We use `Like` suffix for interfaces that describes some similar types. We use `Based` suffix for interfaces that descire almost concrete types.

Laws

Some interfaces define its laws as values. These laws can be viewed as tests that are attached to the specific interface.

We are able to check them of any type that implements a given interfaces with laws by our own *check_all_laws hypothesis plugin*.

In this docs we are going to describe each general interface and its laws.

9.5.2 Mappable

Something is considered mappable if we can `map` it using a function, generally `map` is a method that accepts a function.

An example in this library is *Maybe*, that implements the `Mappable` interface:

```
>>> from returns.maybe import Maybe, Some

>>> def can_be_mapped(string: str) -> str:
...     return string + '!'

>>> maybe_str: Maybe[str] = Some('example')
>>> assert maybe_str.map(can_be_mapped) == Some('example!')
```

MappableN interface helps us to create our own mappable container like *Maybe*.

```
>>> from typing import Callable, TypeVar

>>> from returns.interfaces.mappable import Mappable1
>>> from returns.primitives.hkt import SupportsKind1
>>> from returns.primitives.container import BaseContainer

>>> _NumberType = TypeVar('_NumberType')
>>> _NewNumberType = TypeVar('_NewNumberType')

>>> class Number(
...     BaseContainer,
...     SupportsKind1['Number', _NumberType],
...     Mappable1[_NumberType],
... ):
...     def __init__(self, inner_value: _NumberType) -> None:
...         super().__init__(inner_value)
...
...     def map(  # This method is required by Mappable
...         self,
...         function: Callable[[_NumberType], _NewNumberType]
...     ) -> 'Number[_NewNumberType]':
...         return Number(function(self._inner_value))
```

With our `Number` mappable class we can compose easily math functions with it.

```
>>> def my_math_function(number: int) -> int:
...     return number - 1

>>> number: Number[int] = Number(-41)
>>> assert number.map(my_math_function).map(abs) == Number(42)
```

Laws

To make sure your `Mappable` implementation is right, you can apply the `Mappable` laws on it to test.

1. *Identity Law*: When we pass the identity function to the `map` method, the `Mappable` instance has to be the same, unchanged.

```
>>> from returns.functions import identity

>>> mappable_number: Number[int] = Number(1)
>>> assert mappable_number.map(identity) == Number(1)
```

2. *Associative Law*: Given two functions, `x` and `y`, calling the map method with `x` function and after that calling with `y` function must have the same result if we compose them together.

```
>>> from returns.functions import compose

>>> def add_one(number: int) -> int:
...     return number + 1

>>> def multiply_by_ten(number: int) -> int:
...     return number * 10

>>> mappable_number: Number[int] = Number(9)
>>> assert mappable_number.map(
...     add_one,
... ).map(
...     multiply_by_ten,
... ) == mappable_number.map(
...     compose(add_one, multiply_by_ten),
... )
```

9.5.3 Bindable

Bindable is something that we can bind with a function. Like *Maybe*, so *BindableN* interface will help us to create our custom bindable.

```
>>> from typing import Callable, TypeVar

>>> from returns.interfaces.bindable import Bindable1
>>> from returns.primitives.hkt import SupportsKind1, Kind1, dekind
>>> from returns.primitives.container import BaseContainer

>>> _NumberType = TypeVar('_NumberType')
>>> _NewNumberType = TypeVar('_NewNumberType')

>>> class Number(
...     BaseContainer,
...     SupportsKind1['Number', _NumberType],
...     Bindable1[_NumberType],
... ):
...     def __init__(self, inner_value: _NumberType) -> None:
...         super().__init__(inner_value)
```

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```
...
...     def bind(  # This method is required by Bindable
...         self,
...         function: Kind1[
...             'Number',
...             Callable[[_NumberType], 'Number[_NewNumberType]'],
...         ],
...     ) -> 'Number[_NewNumberType]':
...         return dekind(function(self._inner_value))
```

And here's how we can use it:

```
>>> def double(arg: int) -> Number[int]:
...     return Number(arg * 2)

>>> number = Number(5)
>>> assert number.bind(double) == Number(10)
```

9.5.4 Applicative

Something is considered applicative if it is a functor already and, moreover, we can `apply` another container to it and construct a new value with `.from_value` method.

An example in this library is *Maybe*, that implements the `Mappable` and `Applicative` interfaces:

```
>>> from returns.maybe import Maybe, Some

>>> maybe_str = Maybe.from_value('example')
>>> maybe_func = Maybe.from_value(len)  # we use function as a value!

>>> assert maybe_str.apply(maybe_func) == Some(7)
```

As you see, `apply` takes a container with a function inside and applies it to the current value inside the container.

This way we really execute `Maybe.from_value(len('example'))`.

ApplicativeN which is a subtype of *MappableN* interface helps us to create our own applicative container like *Maybe*.

```
>>> from typing import Callable, TypeVar

>>> from returns.interfaces.applicative import Applicative1
>>> from returns.primitives.hkt import SupportsKind1, Kind1, dekind
>>> from returns.primitives.container import BaseContainer

>>> _NumberType = TypeVar('_NumberType')
>>> _NewNumberType = TypeVar('_NewNumberType')

>>> class Number(
...     BaseContainer,
...     SupportsKind1['Number', _NumberType],
...     Applicative1[_NumberType],
... ):
...     def __init__(self, inner_value: _NumberType) -> None:
```

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```
...         super().__init__(inner_value)
...
...     def map(  # This method is required by Mappable
...         self,
...         function: Callable[[_NumberType], _NewNumberType]
...     ) -> 'Number[_NewNumberType]':
...         return Number(function(self._inner_value))
...
...     def apply(  # This method is required by Applicative
...         self,
...         container: Kind1[
...             'Number',
...             Callable[[_NumberType], _NewNumberType],
...         ],
...     ) -> 'Number[_NewNumberType]':
...         return Number.from_value(
...             dekind(container._inner_value(self._inner_value)),
...         )
...
...     @classmethod
...     def from_value(  # This method is required by Applicative
...         cls,
...         inner_value: _NewNumberType,
...     ) -> 'Number[_NewNumberType]':
...         return Number(inner_value)
```

With our `Number` mappable class we can compose easily math functions with it.

```
>>> def my_math_function(number: int) -> int:
...     return number - 1

>>> number = Number(3)
>>> number_function = Number.from_value(my_math_function)

>>> assert number.apply(number_function) == Number(2)
```

Laws

To make sure your `Applicative` implementation is right, you can apply the `Applicative` laws on it to test.

1. *Identity Law*: When we pass an applicative instance with wrapped identity function to the `apply` method, the `Applicative` has to be the same, unchanged.

```
>>> from returns.functions import identity

>>> applicative_number: Number[int] = Number(1)
>>> assert applicative_number.apply(
...     applicative_number.from_value(identity),
... ) == Number(1)
```

2. *Interchange Law*: We can start our composition with both raw value and a function.

```
>>> def function(arg: int) -> int:
...     return arg + 1

>>> raw_value = 5

>>> assert Number.from_value(raw_value).apply(
...     Number.from_value(function),
... ) == Number.from_value(function).apply(
...     Number.from_value(lambda inner: inner(raw_value)),
... )
```

3. *Homomorphism Law*: The homomorphism law says that applying a wrapped function to a wrapped value is the same as applying the function to the value in the normal way and then using `.from_value` on the result.

```
>>> def function(arg: int) -> int:
...     return arg + 1

>>> raw_value = 5

>>> assert Number.from_value(
...     function(raw_value),
... ) == Number.from_value(raw_value).apply(
...     Number.from_value(function),
... )
```

4. *Composition Law*: Applying two functions twice is the same as applying their composition once.

```
>>> from returns.functions import compose

>>> def first(arg: int) -> int:
...     return arg * 2

>>> def second(arg: int) -> int:
...     return arg + 1

>>> instance = Number(5)
>>> assert instance.apply(
...     Number.from_value(compose(first, second)),
... ) == instance.apply(
...     Number.from_value(first),
... ).apply(
...     Number.from_value(second),
... )
```

Plus all laws from `MappableN` interface.

9.5.5 Container

ContainerN is a central piece of our library. It is an interface that combines *ApplicativeN* and *BindableN* together.

So, in other words: `Container` is an `Apllicative` that you can `bind`!

```
>>> from typing import Callable, TypeVar

>>> from returns.interfaces.container import Container1
>>> from returns.primitives.hkt import SupportsKind1, Kind1, dekind
>>> from returns.primitives.container import BaseContainer

>>> _NumberType = TypeVar('_NumberType')
>>> _NewNumberType = TypeVar('_NewNumberType')

>>> class Number(
...     BaseContainer,
...     SupportsKind1['Number', _NumberType],
...     Container1[_NumberType],
... ):
...     def __init__(self, inner_value: _NumberType) -> None:
...         super().__init__(inner_value)
...
...     def map(  # This method is required by Mappable
...         self,
...         function: Callable[[_NumberType], _NewNumberType]
...     ) -> 'Number[_NewNumberType]':
...         return Number(function(self._inner_value))
...
...     def bind(  # This method is required by Bindable
...         self,
...         function: Kind1[
...             'Number',
...             Callable[[_NumberType], 'Number[_NewNumberType]'],
...         ],
...     ) -> 'Number[_NewNumberType]':
...         return dekind(function(self._inner_value))
...
...     def apply(  # This method is required by Applicative
...         self,
...         container: Kind1[
...             'Number',
...             Callable[[_NumberType], _NewNumberType],
...         ],
...     ) -> 'Number[_NewNumberType]':
...         return Number.from_value(
...             container._inner_value(self._inner_value),
...         )
...
...     @classmethod
...     def from_value(  # This method is required by Applicative
...         cls,
...         inner_value: _NewNumberType,
...     ) -> 'Number[_NewNumberType]':
```

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```
...         return Number(inner_value)
```

This code gives us an opportunity to use `Number` with `map`, `apply`, and `bind` as we already did in the examples above.

Laws

To make sure other people will be able to use your implementation, it should respect three new laws.

1. *Left Identity*: If we `bind` a function to our bindable must have to be the same result as passing the value directly to the function.

```
>>> def can_be_bound(value: int) -> Number[int]:
...     return Number(value)

>>> assert Number.from_value(5).bind(can_be_bound) == can_be_bound(5)
```

2. *Right Identity*: If we pass the bindable constructor through `bind` must have to be the same result as instantiating the bindable on our own.

```
>>> number = Number(2)
>>> assert number.bind(Number) == Number(2)
```

3. *Associative Law*: Given two functions, `x` and `y`, calling the bind method with `x` function and after that calling with `y` function must have the same result if we bind with a function that passes the value to `x` and then bind the result with `y`.

```
>>> def minus_one(arg: int) -> Number[int]:
...     return Number(arg - 1)

>>> def half(arg: int) -> Number[int]:
...     return Number(arg // 2)

>>> number = Number(9)
>>> assert number.bind(minus_one).bind(half) == number.bind(
...     lambda value: minus_one(value).bind(half),
... )
```

Plus all laws from `MappableN` and `ApplicativeN` interfaces.

9.5.6 More!

We have way more interfaces with different features! We have covered all of them in the technical docs.

So, use them to enforce type-safety of your own containers.

Specific interfaces

We also have a whole package of different specific interfaces that will help you to create containers based on our internal types, like `Result`.

9.5.7 FAQ

Why do you have general and specific interfaces?

We have `.interfaces.*` types that can be applied to any possible type. There's nothing they know about other types or `returns` package.

We also have a special `.interfaces.specific` package where we have types that know about other types in `returns`.

For example, `MappableN` from `.interfaces` only knows about `.map` method. It does not require anything else.

But, `ResultLikeN` from `.interfaces.specific.result` does require to have `.bind_result` method which relies on our *Result* type.

That's the only difference. Build your own types with any of those interfaces.

Why some interfaces do not have type alias for 1 or 2 type arguments?

Some types like *ResultLikeN* do not have type aliases for one type argument in a form of `ResultLike1`.

Why does `Mappable1` exists and `ResultLike1` does not?

Because `Mappable1` does make sense. But, `ResultLike1` requiers at least two (value and error) types to exist. The same applies for `ReaderLike1` and `ReaderResultLike1` and `ReaderResultLike2`.

We don't support type aliases for types that won't make sense.

What's the difference between `MappableN` and `BindableN`?

While `MappableN` you have to pass a pure function, like:

```
>>> def can_be_mapped(string: str) -> str:
...     return string
```

with Bindable we have to pass a function that returns another container:

```
>>> from returns.maybe import Maybe

>>> def can_be_bound(string: str) -> Maybe[str]:
...     return Some(string + '!')
```

The main difference is the return type. The consequence of this is big! `BindableN` allows to change the container type. While `MappableN` cannot do that.

So, `Some.bind(function)` can be evaluated to both `Some` and `Nothing`. While `Some.map(function)` will always stay as `Some`.

What is the difference between ResultLikeN and ResultBasedN?

`ResultLikeN` is just an intention of having a result (e.g. *`FutureResult`*), it's not the result yet. While `ResultBasedN` is a concrete result (e.g. *`IOResult`*), it has the desired result value.

Because of this difference between them is why we can't unwrap a `ResultLikeN` container, it does not have the real result yet.

See the example below using `FutureResult` to get a `IOResult`:

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.interfaces.specific.future_result import FutureResultBasedN
>>> from returns.interfaces.specific.ioresult import (
...     IOResultBasedN,
...     IOResultLikeN,
... )
>>> from returns.interfaces.specific.result import ResultLikeN, ResultBasedN
>>> from returns.io import IOSuccess, IOResult
>>> from returns.result import Success, Result

>>> async def coro(arg: int) -> Result[int, str]:
...     return Success(arg + 1)

>>> # `result_like` does not have the result we want (Result[int, str])
>>> # it's just the intention of having one,
>>> # we have to await it to get the real result
>>> result_like: FutureResult[int, str] = FutureResult(coro(1))
>>> assert isinstance(result_like, FutureResultBasedN)
>>> assert isinstance(result_like, IOResultLikeN)
>>> assert isinstance(result_like, ResultLikeN)

>>> # `anyio.run(...)` will await our coroutine and give the real result to us
>>> result: IOResult[int, str] = anyio.run(result_like.awaitable)
>>> assert isinstance(result, IOResultBasedN)
>>> assert isinstance(result, ResultLikeN)

>>> # Compare it with the real result:
>>> assert isinstance(Success(1), ResultBasedN)
```

Note: The same difference applies to all *`ResultLikeN` vs *`ResultBasedN` (e.g. *`IOResultLikeN`* and *`IOResultBasedN`*)

9.5.8 API Reference

Overview

Here's a full overview of all our interfaces:

Let's review it one by one.

Equable

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Equality laws.

Description: https://bit.ly/34D40iT

static reflexive_law(*first*)

Value should be equal to itself.

Parameters **first** (*~_EqualType*) –

Return type None

static symmetry_law(*first*, *second*)

If `A == B` then `B == A`.

Parameters

- **first** (*~_EqualType*) –
- **second** (*~_EqualType*) –

Return type None

static transitivity_law(*first*, *second*, *third*)

If `A == B` and `B == C` then `A == C`.

Parameters

- **first** (*~_EqualType*) –
- **second** (*~_EqualType*) –
- **third** (*~_EqualType*) –

Return type None

class Equable(**args*, ***kwds*)

Bases: *returns.primitives.laws.Lawful*[*Equable*]

Interface for types that can be compared with real values.

Not all types can, because some don't have the value at a time: - `Future` has to be awaited to get the value - `Reader` has to be called to get the value

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law1 object>, <returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

abstract equals(*other*)

Type-safe equality check for values of the same type.

Parameters

- **self** (*~_EqualType*) –
- **other** (*~_EqualType*) –

Return type bool

Mappable

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Mappable or functor laws.

https://en.wikibooks.org/wiki/Haskell/The_Functor_class#The_functor_laws

static identity_law(*mappable*)

Mapping identity over a value must return the value unchanged.

Parameters **mappable** (*MappableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

Return type None

static associative_law(*mappable*, *first*, *second*)

Mapping twice or mapping a composition is the same thing.

Parameters

- **mappable** (*MappableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **first** (Callable[[~_FirstType], ~_NewType1]) –
- **second** (Callable[[~_NewType1], ~_NewType2]) –

Return type None

class MappableN(**args*, ***kwds*)

Bases: Generic[returns.interfaces.mappable._FirstType, returns.interfaces.mappable._SecondType, returns.interfaces.mappable._ThirdType], *returns.primitives.laws.Lawful*[MappableN[_FirstType, _SecondType, _ThirdType]]

Allows to chain wrapped values in containers with regular functions.

Behaves like a functor.

See also:

- https://en.wikipedia.org/wiki/Functor

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law1 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

abstract map(*function*)

Allows to run a pure function over a container.

Parameters

- **self** (*~_MappableType*) –
- **function** (Callable[[~_FirstType], ~_UpdatedType]) –

Return type *KindN*[~_MappableType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

Mappable1
Type alias for kinds with one type argument.

alias of *returns.interfaces.mappable.MappableN*[returns.interfaces.mappable._FirstType, NoReturn, NoReturn]

Mappable2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.mappable.MappableN*[returns.interfaces.mappable._FirstType, returns.interfaces.mappable._SecondType, NoReturn]

Mappable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.mappable.MappableN*[returns.interfaces.mappable._FirstType, returns.interfaces.mappable._SecondType, returns.interfaces.mappable._ThirdType]

Bindable

class BindableN(**args*, ***kwds*)
Bases: Generic[returns.interfaces.bindable._FirstType, returns.interfaces.bindable._SecondType, returns.interfaces.bindable._ThirdType]

Represents a "context" in which calculations can be executed.

Bindable allows you to bind together a series of calculations while maintaining the context of that specific container.

In contrast to *returns.interfaces.lashable.LashableN*, works with the first type argument.

abstract bind(*function*)
Applies 'function' to the result of a previous calculation.

And returns a new container.

Parameters

- **self** (*~_BindableType*) –
- **function** (Callable[[~_FirstType], *KindN*[~_BindableType, ~_UpdatedType, ~_SecondType, ~_ThirdType]]) –

Return type *KindN*[~_BindableType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

Bindable1
Type alias for kinds with one type argument.

alias of *returns.interfaces.bindable.BindableN*[returns.interfaces.bindable._FirstType, NoReturn, NoReturn]

Bindable2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.bindable.BindableN*[returns.interfaces.bindable._FirstType, returns.interfaces.bindable._SecondType, NoReturn]

Bindable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.bindable.BindableN*[returns.interfaces.bindable._FirstType, returns.interfaces.bindable._SecondType, returns.interfaces.bindable._ThirdType]

Applicative

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Applicative mappable laws.

Definition: https://bit.ly/3hC8F8E Discussion: https://bit.ly/3jffz3L

static identity_law(*container*)

Identity law.

If we apply wrapped `identity` function to a container, nothing happens.

Parameters **container** (*ApplicativeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

Return type None

static interchange_law(*raw_value*, *container*, *function*)

Interchange law.

Basically we check that we can start our composition with both `raw_value` and `function`.

Great explanation: https://stackoverflow.com/q/27285918/4842742

Parameters

- **raw_value** (*~_FirstType*) –
- **container** (*ApplicativeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewType1]) –

Return type None

static homomorphism_law(*raw_value*, *container*, *function*)

Homomorphism law.

The homomorphism law says that applying a wrapped function to a wrapped value is the same as applying the function to the value in the normal way and then using `.from_value` on the result.

Parameters

- **raw_value** (*~_FirstType*) –
- **container** (*ApplicativeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewType1]) –

Return type None

static composition_law(*container*, *first*, *second*)

Composition law.

Applying two functions twice is the same as applying their composition once.

Parameters

- **container** (*ApplicativeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **first** (Callable[[~_FirstType], ~_NewType1]) –
- **second** (Callable[[~_NewType1], ~_NewType2]) –

Return type None

class ApplicativeN(*args, **kwds)

Bases: returns.interfaces.mappable.MappableN[returns.interfaces.applicative._FirstType, returns.interfaces.applicative._SecondType, returns.interfaces.applicative._ThirdType], returns.primitives.laws.Lawful[ApplicativeN[_FirstType, _SecondType, _ThirdType]]

Allows to create unit containers from raw values and to apply wrapped funcs.

See also:

- https://en.wikipedia.org/wiki/Applicative_functor
- http://learnyouahaskell.com/functors-applicative-functors-and-monoids

_laws: ClassVar[Sequence[returns.primitives.laws.Law]] = (<returns.primitives.laws.Law1 object>, <returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

abstract apply(*container*)

Allows to apply a wrapped function over a container.

Parameters

- **self** (*~_ApplicativeType*) –
- **container** (*KindN*[~_ApplicativeType, Callable[[~_FirstType], ~_UpdatedType], ~_SecondType, ~_ThirdType]) –

Return type *KindN*[~_ApplicativeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_value(*inner_value*)

Unit method to create new containers from any raw value.

Parameters

- **cls** (Type[~_ApplicativeType]) –
- **inner_value** (*~_UpdatedType*) –

Return type *KindN*[~_ApplicativeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

Applicative1

Type alias for kinds with one type argument.

alias of returns.interfaces.applicative.ApplicativeN[returns.interfaces.applicative._FirstType, NoReturn, NoReturn]

Applicative2

Type alias for kinds with two type arguments.

alias of returns.interfaces.applicative.ApplicativeN[returns.interfaces.applicative._FirstType, returns.interfaces.applicative._SecondType, NoReturn]

Applicative3

Type alias for kinds with three type arguments.

alias of returns.interfaces.applicative.ApplicativeN[returns.interfaces.applicative._FirstType, returns.interfaces.applicative._SecondType, returns.interfaces.applicative._ThirdType]

Altable

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Mappable or functor laws.

https://en.wikibooks.org/wiki/Haskell/The_Functor_class#The_functor_laws

static identity_law(*altable*)

Mapping identity over a value must return the value unchanged.

Parameters **altable** (*AltableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

Return type None

static associative_law(*altable*, *first*, *second*)

Mapping twice or mapping a composition is the same thing.

Parameters

- **altable** (*AltableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **first** (Callable[[~_SecondType], ~_NewType1]) –
- **second** (Callable[[~_NewType1], ~_NewType2]) –

Return type None

class AltableN(**args*, ***kwds*)

Bases: Generic[returns.interfaces.altable._FirstType, returns.interfaces.altable._SecondType, returns.interfaces.altable._ThirdType], *returns.primitives.laws.Lawful*[AltableN[_FirstType, _SecondType, _ThirdType]]

Modifies the second type argument with a pure function.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law1 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

abstract alt(*function*)

Allows to run a pure function over a container.

Parameters

- **self** (*~_AltableType*) –
- **function** (Callable[[~_SecondType], ~_UpdatedType]) –

Return type *KindN*[~_AltableType, ~_FirstType, ~_UpdatedType, ~_ThirdType]

Altable2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.altable.AltableN*[returns.interfaces.altable._FirstType, returns.interfaces.altable._SecondType, NoReturn]

Altable3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.altable.AltableN*[returns.interfaces.altable._FirstType, returns.interfaces.altable._SecondType, returns.interfaces.altable._ThirdType]

BiMappable

class BiMappableN(**args*, ***kwds*)

Bases: *returns.interfaces.mappable.MappableN*[returns.interfaces.bimappable._FirstType, returns.interfaces.bimappable._SecondType, returns.interfaces.bimappable._ThirdType], *returns.interfaces.altable.AltableN*[returns.interfaces.bimappable._FirstType, returns.interfaces.bimappable._SecondType, returns.interfaces.bimappable._ThirdType]

Allows to change both types of a container at the same time.

Uses `.map` to change first type and `.alt` to change second type.

See also:

- https://typelevel.org/cats/typeclasses/bifunctor.html

BiMappable2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.bimappable.BiMappableN*[returns.interfaces.bimappable._FirstType, returns.interfaces.bimappable._SecondType, NoReturn]

BiMappable3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.bimappable.BiMappableN*[returns.interfaces.bimappable._FirstType, returns.interfaces.bimappable._SecondType, returns.interfaces.bimappable._ThirdType]

Swappable

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Laws for *SwappableN* type.

static double_swap_law(*container*)

Swaaping container twice.

It ensure that we get the initial value back. In other words, swapping twice does nothing.

Parameters **container** (*SwappableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

Return type None

class SwappableN(**args*, ***kwds*)

Bases: *returns.interfaces.bimappable.BiMappableN*[returns.interfaces.swappable._FirstType, returns.interfaces.swappable._SecondType, returns.interfaces.swappable._ThirdType], *returns.primitives.laws.Lawful*[SwappableN[_FirstType, _SecondType, _ThirdType]]

Interface that allows swapping first and second type values.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law1 object>,)

Some classes and interfaces might have laws, some might not have any.

abstract swap()

Swaps first and second types in SwappableN.

Parameters **self** (*~_SwappableType*) –

Return type *KindN*[~_SwappableType, ~_SecondType, ~_FirstType, ~_ThirdType]

Swappable2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.swappable.SwappableN*[returns.interfaces.swappable._FirstType, returns.interfaces.swappable._SecondType, NoReturn]

Swappable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.swappable.SwappableN*[returns.interfaces.swappable._FirstType, returns.interfaces.swappable._SecondType, returns.interfaces.swappable._ThirdType]

Lashable

class LashableN(**args*, ***kwds*)
Bases: Generic[returns.interfaces.lashable._FirstType, returns.interfaces.lashable._SecondType, returns.interfaces.lashable._ThirdType]

Represents a "context" in which calculations can be executed.

Rescueable allows you to bind together a series of calculations while maintaining the context of that specific container.

In contrast to returns.interfaces.bindable.BinbdaleN, works with the second type value.

abstract lash(*function*)
Applies 'function' to the result of a previous calculation.

And returns a new container.

Parameters

- **self** (*~_LashableType*) –
- **function** (Callable[[~_SecondType], *KindN*[~_LashableType, ~_FirstType, ~_UpdatedType, ~_ThirdType]]) –

Return type *KindN*[~_LashableType, ~_FirstType, ~_UpdatedType, ~_ThirdType]

Lashable2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.lashable.LashableN*[returns.interfaces.lashable._FirstType, returns.interfaces.lashable._SecondType, NoReturn]

Lashable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.lashable.LashableN*[returns.interfaces.lashable._FirstType, returns.interfaces.lashable._SecondType, returns.interfaces.lashable._ThirdType]

Unwrappable

class Unwrappable(*args, **kwds)
Bases: Generic[returns.interfaces.unwrappable._FirstType, returns.interfaces.unwrappable._SecondType]

Represents containers that can unwrap and return its wrapped value.

There are no aliases or UnwrappableN for Unwrappable interface. Because it always uses two and just two types.

Not all types can be Unwrappable because we do require to raise UnwrapFailedError if unwrap is not possible.

abstract unwrap()
Custom magic method to unwrap inner value from container.

Should be redefined for ones that actually have values. And for ones that raise an exception for no values.

Note: As a part of the contract, failed unwrap calls must raise *returns.primitives.exceptions.UnwrapFailedError* exception.

This method is the opposite of failure().

Parameters self (*~_UnwrappableType*) –

Return type ~_FirstType

abstract failure()
Custom magic method to unwrap inner value from the failed container.

Note: As a part of the contract, failed failure calls must raise *returns.primitives.exceptions.UnwrapFailedError* exception.

This method is the opposite of unwrap().

Parameters self (*~_UnwrappableType*) –

Return type ~_SecondType

Container

class _LawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Container laws.

Definition: https://wiki.haskell.org/Monad_laws Good explanation: https://bit.ly/2Qsi5re

static left_identity_law(*raw_value*, *container*, *function*)
Left identity.

The first law states that if we take a value, put it in a default context with return and then feed it to a function by using bind, it's the same as just taking the value and applying the function to it.

Parameters

- **raw_value** (*~_FirstType*) –
- **container** (*ContainerN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

- **function** (Callable[[~_FirstType], *KindN*[*ContainerN*, ~_NewType1, ~_SecondType, ~_ThirdType]]) –

Return type None

static right_identity_law(*container*)

Right identity.

The second law states that if we have a container value and we use bind to feed it to .from_value, the result is our original container value.

Parameters **container** (*ContainerN*[~_FirstType, ~_SecondType, ~_ThirdType]) –

Return type None

static associative_law(*container*, *first*, *second*)

Associativity law.

The final monad law says that when we have a chain of container functions applications with bind, it shouldn't matter how they're nested.

Parameters

- **container** (*ContainerN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **first** (Callable[[~_FirstType], *KindN*[*ContainerN*, ~_NewType1, ~_SecondType, ~_ThirdType]]) –
- **second** (Callable[[~_NewType1], *KindN*[*ContainerN*, ~_NewType2, ~_SecondType, ~_ThirdType]]) –

Return type None

class ContainerN(**args*, ***kwds*)

Bases: *returns.interfaces.applicative.ApplicativeN*[returns.interfaces.container._FirstType, returns.interfaces.container._SecondType, returns.interfaces.container._ThirdType], *returns.interfaces.bindable.BindableN*[returns.interfaces.container._FirstType, returns.interfaces.container._SecondType, returns.interfaces.container._ThirdType], *returns.primitives.laws.Lawful*[ContainerN[_FirstType, _SecondType, _ThirdType]]

Handy alias for types with .bind, .map, and .apply methods.

Should be a base class for almost any containers you write.

See also:

- https://bit.ly/2CTEVov

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law1 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

Container1

Type alias for kinds with one type argument.

alias of *returns.interfaces.container.ContainerN*[returns.interfaces.container._FirstType, NoReturn, NoReturn]

Container2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.container.ContainerN*[returns.interfaces.container._FirstType, returns.interfaces.container._SecondType, NoReturn]

Container3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.container.ContainerN*[returns.interfaces.container._FirstType, returns.interfaces.container._SecondType, returns.interfaces.container._ThirdType]

Failable

class _FailableLawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Failable laws.

We need to be sure that `.lash` won't lash success types.

static lash_short_circuit_law(*raw_value*, *container*, *function*)
Ensures that you cannot lash a success.

Parameters

- **raw_value** (*~_FirstType*) –
- **container** (*FailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_SecondType], *KindN*[*FailableN*, ~_FirstType, ~_NewFirstType, ~_ThirdType]]) –

Return type None

class FailableN(**args*, ***kwds*)
Bases: *returns.interfaces.container.ContainerN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType], *returns.interfaces.lashable.LashableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType], *returns.primitives.laws.Lawful*[FailableN[_FirstType, _SecondType, _ThirdType]]

Base type for types that can fail.

It is a raw type and should not be used directly. Use `SingleFailableN` and `DiverseFailableN` instead.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law3 object>,)
Some classes and interfaces might have laws, some might not have any.

Failable2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.failable.FailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, NoReturn]

Failable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.failable.FailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType]

class _SingleFailableLawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Single Failable laws.

We need to be sure that `.map` and `.bind` works correctly for `empty` property.

static map_short_circuit_law(*container*, *function*)
Ensures that you cannot map from the *empty* property.

Parameters

- **container** (*SingleFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewFirstType]) –

Return type None

static bind_short_circuit_law(*container*, *function*)
Ensures that you cannot bind from the *empty* property.

Parameters

- **container** (*SingleFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], *KindN*[*SingleFailableN*, ~_NewFirstType, ~_SecondType, ~_ThirdType]]) –

Return type None

static apply_short_circuit_law(*container*, *function*)
Ensures that you cannot apply from the *empty* property.

Parameters

- **container** (*SingleFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewFirstType]) –

Return type None

class SingleFailableN(**args*, ***kwds*)
Bases: *returns.interfaces.failable.FailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType]

Base type for types that have just only one failed value.

Like `Maybe` types where the only failed value is `Nothing`.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>)
Some classes and interfaces might have laws, some might not have any.

abstract property empty: *returns.interfaces.failable.SingleFailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType]
This property represents the failed value. :param self: :type self: ~_SingleFailableType

Return type *SingleFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]

SingleFailable2
Type alias for kinds with two types arguments.

alias of *returns.interfaces.failable.SingleFailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, NoReturn]

SingleFailable3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.failable.SingleFailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType]

class _DiverseFailableLawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Diverse Failable laws.

We need to be sure that `.map`, `.bind`, `.apply` and `.alt` works correctly for both success and failure types.

static map_short_circuit_law(*raw_value*, *container*, *function*)

Ensures that you cannot map a failure.

Parameters

- **raw_value** (*~_SecondType*) –
- **container** (*DiverseFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewFirstType]) –

Return type None

static bind_short_circuit_law(*raw_value*, *container*, *function*)

Ensures that you cannot bind a failure.

See: https://wiki.haskell.org/Typeclassopedia#MonadFail

Parameters

- **raw_value** (*~_SecondType*) –
- **container** (*DiverseFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], *KindN*[*DiverseFailableN*, ~_NewFirstType, ~_SecondType, ~_ThirdType]]) –

Return type None

static apply_short_circuit_law(*raw_value*, *container*, *function*)

Ensures that you cannot apply a failure.

Parameters

- **raw_value** (*~_SecondType*) –
- **container** (*DiverseFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewFirstType]) –

Return type None

static alt_short_circuit_law(*raw_value*, *container*, *function*)

Ensures that you cannot alt a success.

Parameters

- **raw_value** (*~_SecondType*) –
- **container** (*DiverseFailableN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_SecondType], ~_NewFirstType]) –

Return type None

class DiverseFailableN(**args*, ***kwds*)

Bases: *returns.interfaces.failable.FailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType], *returns.interfaces.swappable.SwappableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType], *returns.primitives.laws.Lawful*[DiverseFailableN[_FirstType, _SecondType, _ThirdType]]

Base type for types that have any failed value.

Like `Result` types.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law3 object>)

Some classes and interfaces might have laws, some might not have any.

abstract classmethod from_failure(*inner_value*)

Unit method to create new containers from any raw value.

Parameters

- **cls** (Type[~_DiverseFailableType]) –
- **inner_value** (*~_UpdatedType*) –

Return type *KindN*[~_DiverseFailableType, ~_FirstType, ~_UpdatedType, ~_ThirdType]

DiverseFailable2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.failable.DiverseFailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, NoReturn]

DiverseFailable3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.failable.DiverseFailableN*[returns.interfaces.failable._FirstType, returns.interfaces.failable._SecondType, returns.interfaces.failable._ThirdType]

Maybe specific

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Maybe laws.

We need to be sure that `.map`, `.bind`, `.bind_optional`, and `.lash` works correctly for both successful and failed types.

static map_short_circuit_law(*container*, *function*)

Ensures that you cannot map from failures.

Parameters

- **container** (*MaybeLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], ~_NewType1]) –

Return type None

static bind_short_circuit_law(*container*, *function*)

Ensures that you cannot bind from failures.

Parameters

- **container** (*MaybeLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], *KindN*[*MaybeLikeN*, ~_NewType1, ~_SecondType, ~_ThirdType]]) –

Return type None

static bind_optional_short_circuit_law(*container*, *function*)
Ensures that you cannot bind from failures.

Parameters

- **container** (*MaybeLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], Optional[~_NewType1]]) –

Return type None

static lash_short_circuit_law(*raw_value*, *container*, *function*)
Ensures that you cannot lash a success.

Parameters

- **raw_value** (*~_FirstType*) –
- **container** (*MaybeLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_SecondType], *KindN*[*MaybeLikeN*, ~_FirstType, ~_NewType1, ~_ThirdType]]) –

Return type None

static unit_structure_law(*container*, *function*)
Ensures None is treated specially.

Parameters

- **container** (*MaybeLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **function** (Callable[[~_FirstType], None]) –

Return type None

class MaybeLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.failable.SingleFailableN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, returns.interfaces.specific.maybe._ThirdType], *returns.primitives.laws.Lawful*[MaybeLikeN[_FirstType, _SecondType, _ThirdType]]

Type for values that do look like a Maybe.

For example, RequiresContextMaybe should be created from this interface. Cannot be unwrapped or compared.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law3 object>, <returns.primitives.laws.Law2 object>)
Some classes and interfaces might have laws, some might not have any.

abstract bind_optional(*function*)
Binds a function that returns Optional values.

Parameters

- **self** (*~_MaybeLikeType*) –
- **function** (Callable[[~_FirstType], Optional[~_UpdatedType]]) –

Return type *KindN*[~_MaybeLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_optional(*inner_value*)
Unit method to create containers from Optional value.

Parameters

- **cls** (Type[~_MaybeLikeType]) –
- **inner_value** (Optional[~_ValueType]) –

Return type *KindN*[~_MaybeLikeType, ~_ValueType, ~_SecondType, ~_ThirdType]

MaybeLike2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.maybe.MaybeLikeN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, NoReturn]

MaybeLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.maybe.MaybeLikeN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, returns.interfaces.specific.maybe._ThirdType]

class MaybeBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.maybe.MaybeLikeN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, returns.interfaces.specific.maybe._ThirdType], *returns.interfaces.unwrappable.Unwrappable*[returns.interfaces.specific.maybe._FirstType, None], *returns.interfaces.equable.Equable*

Concrete interface for Maybe type.

Can be unwrapped and compared.

abstract or_else_call(*function*)
Calls a function in case there nothing to unwrap.

Parameters **function** (Callable[[], ~_ValueType]) –

Return type Union[~_FirstType, ~_ValueType]

MaybeBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.maybe.MaybeBasedN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, NoReturn]

MaybeBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.maybe.MaybeBasedN*[returns.interfaces.specific.maybe._FirstType, returns.interfaces.specific.maybe._SecondType, returns.interfaces.specific.maybe._ThirdType]

Result specific

An interface that represents a pure computation result.

For impure result see *returns.interfaces.specific.ioresult.IOResultLikeN* type.

class ResultLikeN(**args*, ***kwds*)

Bases: *returns.interfaces.failable.DiverseFailableN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, returns.interfaces.specific.result._ThirdType]

Base types for types that looks like `Result` but cannot be unwrapped.

Like `RequiresContextResult` or `FutureResult`.

abstract bind_result(*function*)

Runs `Result` returning function over a container.

Parameters

- **self** (*~_ResultLikeType*) –
- **function** (`Callable`[[~_FirstType], `ForwardRef`]) –

Return type *KindN*[~_ResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_result(*inner_value*)

Unit method to create new containers from any raw value.

Parameters

- **cls** (`Type`[~_ResultLikeType]) –
- **inner_value** (`ForwardRef`) –

Return type *KindN*[~_ResultLikeType, ~_ValueType, ~_ErrorType, ~_ThirdType]

ResultLike2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.result.ResultLikeN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, `NoReturn`]

ResultLike3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.result.ResultLikeN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, returns.interfaces.specific.result._ThirdType]

class UnwrappableResult(**args*, ***kwds*)

Bases: *returns.interfaces.specific.result.ResultLikeN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, returns.interfaces.specific.result._ThirdType], *returns.interfaces.unwrappable.Unwrappable*[returns.interfaces.specific.result._FirstUnwrappableType, returns.interfaces.specific.result._SecondUnwrappableType], *returns.interfaces.equable.Equable*

Intermediate type with 5 type arguments that represents unwrappable result.

It is a raw type and should not be used directly. Use `ResultBasedN` and `IOResultBasedN` instead.

class ResultBasedN(**args*, ***kwds*)

Bases: *returns.interfaces.specific.result.UnwrappableResult*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, returns.

interfaces.specific.result._ThirdType, returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType]

Base type for real Result types.

Can be unwrapped.

ResultBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.result.ResultBasedN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, NoReturn]

ResultBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.result.ResultBasedN*[returns.interfaces.specific.result._FirstType, returns.interfaces.specific.result._SecondType, returns.interfaces.specific.result._ThirdType]

IO specific

class IOLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.container.ContainerN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, returns.interfaces.specific.io._ThirdType]

Represents interface for types that looks like fearless IO.

This type means that IO cannot fail. Like random numbers, date, etc. Don't use this type for IO that can. Instead, use *returns.interfaces.specific.ioresult.IOResultBasedN* type.

abstract bind_io(*function*)
Allows to apply a wrapped function over a container.

Parameters

- **self** (*~_IOLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_IOLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_io(*inner_value*)
Unit method to create new containers from successful IO.

Parameters

- **cls** (Type[~_IOLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_IOLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

IOLike1
Type alias for kinds with one type argument.

alias of *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.io._FirstType, NoReturn, NoReturn]

IOLike2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, NoReturn]

IOLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, returns.interfaces.specific.io._ThirdType]

class IOBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, returns.interfaces.specific.io._ThirdType], *returns.interfaces.equable.Equable*

Represents the base interface for types that do fearless IO.

This type means that IO cannot fail. Like random numbers, date, etc. Don't use this type for IO that can. Instead, use *returns.interfaces.specific.ioresult.IOResultBasedN* type.

This interface also supports direct comparison of two values. While IOLikeN is different. It can be lazy and cannot be compared.

IOBased1
Type alias for kinds with one type argument.

alias of *returns.interfaces.specific.io.IOBasedN*[returns.interfaces.specific.io._FirstType, NoReturn, NoReturn]

IOBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.io.IOBasedN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, NoReturn]

IOBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.io.IOBasedN*[returns.interfaces.specific.io._FirstType, returns.interfaces.specific.io._SecondType, returns.interfaces.specific.io._ThirdType]

IOResult specific

An interface for types that do IO and can fail.

It is a base interface for both sync and async IO stacks.

class IOResultLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType], *returns.interfaces.specific.result.ResultLikeN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType]

Base type for types that look like IOResult but cannot be unwrapped.

Like FutureResult or RequiresContextIOResult.

abstract bind_ioresult(*function*)
Runs IOResult returning function over a container.

Parameters

- **self** (*~_IOResultLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_IOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract compose_result(*function*)

Allows to compose the underlying Result with a function.

Parameters

- **self** (*~_IOResultLikeType*) –
- **function** (Callable[[ForwardRef], *KindN*[~_IOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]]) –

Return type *KindN*[~_IOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_ioresult(*inner_value*)

Unit method to create new containers from IOResult type.

Parameters

- **cls** (Type[~_IOResultLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_IOResultLikeType, ~_ValueType, ~_ErrorType, ~_ThirdType]

abstract classmethod from_failed_io(*inner_value*)

Unit method to create new containers from failed IO.

Parameters

- **cls** (Type[~_IOResultLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_IOResultLikeType, ~_FirstType, ~_ErrorType, ~_ThirdType]

IOResultLike2

Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.ioresult.IOResultLikeN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, NoReturn]

IOResultLike3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.ioresult.IOResultLikeN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType]

class IOResultBasedN(**args*, ***kwds*)

Bases: *returns.interfaces.specific.ioresult.IOResultLikeN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType], *returns.interfaces.specific.io.IOBasedN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType], *returns.interfaces.specific.result.UnwrappableResult*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType, IO[_FirstType], IO[_SecondType]]

Base type for real IOResult types.

Can be unwrapped.

IOResultBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.ioresult.IOResultBasedN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, NoReturn]

IOResultBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.ioresult.IOResultBasedN*[returns.interfaces.specific.ioresult._FirstType, returns.interfaces.specific.ioresult._SecondType, returns.interfaces.specific.ioresult._ThirdType]

Future specific

Represents the base interfaces for types that do fearless async operations.

This type means that `Future` cannot fail. Don't use this type for async that can. Instead, use *returns.interfaces.specific.future_result.FutureResultBasedN* type.

class FutureLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.io.IOLikeN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

Base type for ones that does look like `Future`.

But at the time this is not a real `Future` and cannot be awaited.

abstract bind_future(*function*)
Allows to bind `Future` returning function over a container.

Parameters

- **self** (*~_FutureLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract bind_async_future(*function*)
Allows to bind async `Future` returning function over container.

Parameters

- **self** (*~_FutureLikeType*) –
- **function** (Callable[[~_FirstType], Awaitable[ForwardRef]]) –

Return type *KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract bind_async(*function*)
Binds async function returning the same type of container.

Parameters

- **self** (*~_FutureLikeType*) –
- **function** (Callable[[~_FirstType], Awaitable[*KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]) –

Return type *KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract bind_awaitable(*function*)
Allows to bind async function over container.

Parameters

- **self** (*~_FutureLikeType*) –
- **function** (Callable[[~_FirstType], Awaitable[~_UpdatedType]]) –

Return type *KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_future(*inner_value*)
Unit method to create new containers from successful Future.

Parameters

- **cls** (Type[~_FutureLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_FutureLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

FutureLike1
Type alias for kinds with one type argument.

alias of *returns.interfaces.specific.future.FutureLikeN*[returns.interfaces.specific.future._FirstType, NoReturn, NoReturn]

FutureLike2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.future.FutureLikeN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, NoReturn]

FutureLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.future.FutureLikeN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

class AwaitableFutureN(**args*, ***kwds*)
Bases: Generic[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

Type that provides the required API for Future to be async.

Should not be used directly. Use FutureBasedN instead.

abstract async awaitable()
Underling logic under await expression.

Parameters **self** (*~_AsyncFutureType*) –

Return type *IOLikeN*[~_FirstType, ~_SecondType, ~_ThirdType]

AsyncFuture1
Type alias for kinds with one type argument.

alias of *returns.interfaces.specific.future.AwaitableFutureN*[returns.interfaces.specific.future._FirstType, NoReturn, NoReturn]

AsyncFuture2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.future.AwaitableFutureN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, NoReturn]

AsyncFuture3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.future.AwaitableFutureN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

class FutureBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.future.FutureLikeN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType], *returns.interfaces.specific.future.AwaitableFutureN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

Base type for real `Future` objects.

They can be awaited.

FutureBased1
Type alias for kinds with one type argument.

alias of *returns.interfaces.specific.future.FutureBasedN*[returns.interfaces.specific.future._FirstType, NoReturn, NoReturn]

FutureBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.future.FutureBasedN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, NoReturn]

FutureBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.future.FutureBasedN*[returns.interfaces.specific.future._FirstType, returns.interfaces.specific.future._SecondType, returns.interfaces.specific.future._ThirdType]

FutureResult specific

Represents the base interfaces for types that do fear-some async operations.

This type means that `FutureResult` can (and will!) fail with exceptions.

Use this type to mark that this specific async opetaion can fail.

class FutureResultLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.future.FutureLikeN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType], *returns.interfaces.specific.ioresult.IOResultLikeN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType]

Base type for ones that does look like `FutureResult`.

But at the time this is not a real `Future` and cannot be awaited. It is also cannot be unwrapped, because it is not a real `IOResult`.

abstract bind_future_result(*function*)
Allows to bind FutureResult functions over a container.

Parameters

- **self** (*~_FutureResultLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_FutureResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract bind_async_future_result(*function*)
Allows to bind async FutureResult functions over container.

Parameters

- **self** (*~_FutureResultLikeType*) –
- **function** (Callable[[~_FirstType], Awaitable[ForwardRef]]) –

Return type *KindN*[~_FutureResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_failed_future(*inner_value*)
Creates new container from a failed Future.

Parameters

- **cls** (Type[~_FutureResultLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_FutureResultLikeType, ~_FirstType, ~_ErrorType, ~_ThirdType]

classmethod from_future_result(*inner_value*)
Creates container from FutureResult instance.

Parameters

- **cls** (Type[~_FutureResultLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_FutureResultLikeType, ~_ValueType, ~_ErrorType, ~_ThirdType]

FutureResultLike2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.future_result.FutureResultLikeN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, NoReturn]

FutureResultLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.future_result.FutureResultLikeN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType]

class FutureResultBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.future.FutureBasedN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType], *returns.interfaces.specific.future_result.FutureResultLikeN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType]

Base type for real `FutureResult` objects.

They can be awaited. Still cannot be unwrapped.

FutureResultBased2
Type alias for kinds with two type arguments.

alias of *returns.interfaces.specific.future_result.FutureResultBasedN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, NoReturn]

FutureResultBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.future_result.FutureResultBasedN*[returns.interfaces.specific.future_result._FirstType, returns.interfaces.specific.future_result._SecondType, returns.interfaces.specific.future_result._ThirdType]

Reader specific

This module is special.

`Reader` does not produce `ReaderLikeN` interface as other containers.

Because `Reader` can be used with two or three type arguments: - `RequiresContext[value, env]` - `RequiresContextResult[value, error, env]`

Because the second type argument changes its meaning based on the used `KindN` instance, we need to have two separate interfaces for two separate use-cases: - `ReaderLike2` is used for types where the second type argument is `env` - `ReaderLike3` is used for types where the third type argument is `env`

We also have two methods and two poinfree helpers for `bind_context` composition: one for each interface.

Furthermore, `Reader` cannot have `ReaderLike1` type, because we need both `value` and `env` types at all cases.

See also:

- https://github.com/dry-python/returns/issues/485

class Contextable(**args*, ***kwds*)
Bases: `Generic`[returns.interfaces.specific.reader._ValueType, returns.interfaces.specific.reader._EnvType]

Special type we use as a base one for all callble `Reader` instances.

It only has a single method. And is a base type for every single one of them.

But, each `Reader` defines the return type differently. For example:

- `Reader` has just `_ReturnType`
- `ReaderResult` has `Result[_FirstType, _SecondType]`
- `ReaderIOResult` has `IOResult[_FirstType, _SecondType]`

And so on.

class ReaderLike2(**args*, ***kwds*)
Bases: *returns.interfaces.container.ContainerN*[returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType, NoReturn]

Reader interface for `Kind2` based types.

It has two type arguments and treats the second type argument as env type.

abstract property no_args: NoDeps
Is required to call Reader with no explicit arguments. :param self: :type self: ~_ReaderLike2Type

Return type ForwardRef

abstract bind_context(*function*)
Allows to apply a wrapped function over a Reader container.

Parameters

- **self** (*~_ReaderLike2Type*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_ReaderLike2Type, ~_UpdatedType, ~_SecondType, Any]

abstract modify_env(*function*)
Transforms the environment before calling the container.

Parameters

- **self** (*~_ReaderLike2Type*) –
- **function** (Callable[[~_UpdatedType], ~_SecondType]) –

Return type *KindN*[~_ReaderLike2Type, ~_FirstType, ~_UpdatedType, Any]

abstract classmethod ask()
Returns the dependencies inside the container.

Parameters **cls** (Type[~_ReaderLike2Type]) –

Return type *KindN*[~_ReaderLike2Type, ~_SecondType, ~_SecondType, Any]

abstract classmethod from_context(*inner_value*)
Unit method to create new containers from successful Reader.

Parameters

- **cls** (Type[~_ReaderLike2Type]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_ReaderLike2Type, ~_ValueType, ~_EnvType, Any]

class CallableReader2(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader.ReaderLike2*[returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType], *returns.interfaces.specific.reader.Contextable*[returns.interfaces.specific.reader._ValueType, returns.interfaces.specific.reader._EnvType]

Intermediate interface for ReaderLike2 + __call__ method.

Has 4 type variables to type Reader and __call__ independently. Since, we don't have any other fancy ways of doing it.

Should not be used directly other than defining your own Reader interfaces.

class ReaderLike3(**args*, ***kwds*)
Bases: *returns.interfaces.container.ContainerN*[returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType, returns.interfaces.specific.reader._ThirdType]

Reader interface for Kind3 based types.

It has three type arguments and treats the third type argument as env type. The second type argument is not used here.

abstract property no_args: NoDeps
Is required to call Reader with no explicit arguments. :param self: :type self: ~_ReaderLike3Type

Return type ForwardRef

abstract bind_context(*function*)
Allows to apply a wrapped function over a Reader container.

Parameters

- **self** (*~_ReaderLike3Type*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_ReaderLike3Type, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract modify_env(*function*)
Transforms the environment before calling the container.

Parameters

- **self** (*~_ReaderLike3Type*) –
- **function** (Callable[[~_UpdatedType], ~_ThirdType]) –

Return type *KindN*[~_ReaderLike3Type, ~_FirstType, ~_SecondType, ~_UpdatedType]

abstract classmethod ask()
Returns the dependencies inside the container.

Parameters **cls** (Type[~_ReaderLike3Type]) –

Return type *KindN*[~_ReaderLike3Type, ~_ThirdType, ~_SecondType, ~_ThirdType]

abstract classmethod from_context(*inner_value*)
Unit method to create new containers from successful Reader.

Parameters

- **cls** (Type[~_ReaderLike3Type]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_ReaderLike3Type, ~_ValueType, ~_SecondType, ~_EnvType]

class CallableReader3(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader.ReaderLike3*[returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType, returns.interfaces.specific.reader._ThirdType], *returns.interfaces.specific.reader.Contextable*[returns.interfaces.specific.reader._ValueType, returns.interfaces.specific.reader._EnvType]

Intermediate interface for ReaderLike3 + __call__ method.

Has 5 type variables to type Reader and __call__ independently. Since, we don't have any other fancy ways of doing it.

Should not be used directly other than defining your own Reader interfaces.

class _LawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Concrete laws for ReaderBased2.

See: https://github.com/haskell/mtl/pull/61/files

static purity_law(*container*, *env*)
Calling a Reader twice has the same result with the same env.

Parameters

- **container** (*ReaderBased2*[~_FirstType, ~_SecondType]) –
- **env** (*~_SecondType*) –

Return type None

static asking_law(*container*, *env*)
Asking for an env, always returns the env.

Parameters

- **container** (*ReaderBased2*[~_FirstType, ~_SecondType]) –
- **env** (*~_SecondType*) –

Return type None

class ReaderBased2(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader.CallableReader2*[returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType, returns.interfaces.specific.reader._FirstType, returns.interfaces.specific.reader._SecondType], *returns.primitives.laws.Lawful*[ReaderBased2[_FirstType, _SecondType]]

This interface is very specific to our Reader type.

The only thing that differs from ReaderLike2 is that we know the specific types for its __call__ method.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>)
Some classes and interfaces might have laws, some might not have any.

ReaderResult specific

class ReaderResultLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader.ReaderLike3*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType], *returns.interfaces.specific.result.ResultLikeN*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType]

Base interface for all types that do look like ReaderResult instance.

Cannot be called.

abstract bind_context_result(*function*)
Binds a ReaderResult returning function over a container.

Parameters

- **self** (*~_ReaderResultLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_ReaderResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_failed_context(*inner_value*)
Unit method to create new containers from failed Reader.

Parameters

- **cls** (Type[~_ReaderResultLikeType]) –

- **inner_value** (ForwardRef) –

Return type *KindN*[~_ReaderResultLikeType, ~_FirstType, ~_ErrorType, ~_EnvType]

abstract classmethod from_result_context(*inner_value*)
Unit method to create new containers from ReaderResult.

Parameters

- **cls** (Type[~_ReaderResultLikeType]) –
- **inner_value** (ForwardRef) –

Return type *KindN*[~_ReaderResultLikeType, ~_ValueType, ~_ErrorType, ~_EnvType]

ReaderResultLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_result.ReaderResultLikeN*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType]

class _LawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Concrete laws for ReaderResulBasedN.

See: https://github.com/haskell/mtl/pull/61/files

static purity_law(*container*, *env*)
Calling a Reader twice has the same result with the same env.

Parameters

- **container** (*ReaderResultBasedN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **env** (*~_ThirdType*) –

Return type None

static asking_law(*container*, *env*)
Asking for an env, always returns the env.

Parameters

- **container** (*ReaderResultBasedN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **env** (*~_ThirdType*) –

Return type None

class ReaderResultBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader_result.ReaderResultLikeN*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType], *returns.interfaces.specific.reader.CallableReader3*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType, Result[_FirstType, _SecondType], returns.interfaces.specific.reader_result._ThirdType], *returns.primitives.laws.Lawful*[ReaderResultBasedN[_FirstType, _SecondType, _ThirdType]]

This interface is very specific to our ReaderResult type.

The only thing that differs from ReaderResultLikeN is that we know the specific types for its __call__ method.

In this case the return type of `__call__` is `Result`.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>, <returns.primitives.laws.Law2 object>)

Some classes and interfaces might have laws, some might not have any.

ReaderResultBased3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_result.ReaderResultBasedN*[returns.interfaces.specific.reader_result._FirstType, returns.interfaces.specific.reader_result._SecondType, returns.interfaces.specific.reader_result._ThirdType]

ReaderIOResult specific

class ReaderIOResultLikeN(**args*, ***kwds*)

Bases: *returns.interfaces.specific.reader_result.ReaderResultLikeN*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType], *returns.interfaces.specific.ioresult.IOResultLikeN*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType]

Base interface for all types that do look like `ReaderIOResult` instance.

Cannot be called.

abstract bind_context_ioresult(*function*)

Binds a `ReaderIOResult` returning function over a container.

Parameters

- **self** (*~_ReaderIOResultLikeType*) –
- **function** (`Callable`[[~_FirstType], `ForwardRef`]) –

Return type *KindN*[~_ReaderIOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_ioresult_context(*inner_value*)

Unit method to create new containers from `ReaderIOResult`.

Parameters

- **cls** (`Type`[~_ReaderIOResultLikeType]) –
- **inner_value** (`ForwardRef`) –

Return type *KindN*[~_ReaderIOResultLikeType, ~_ValueType, ~_ErrorType, ~_EnvType]

ReaderIOResultLike3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_ioresult.ReaderIOResultLikeN*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType]

class _LawSpec

Bases: *returns.primitives.laws.LawSpecDef*

Concrete laws for `ReaderIOResultBasedN`.

See: https://github.com/haskell/mtl/pull/61/files

static asking_law(*container*, *env*)
Asking for an env, always returns the env.

Parameters

- **container** (*ReaderIOResultBasedN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **env** (*~_ThirdType*) –

Return type None

class ReaderIOResultBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader_ioresult.ReaderIOResultLikeN*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType], *returns.interfaces.specific.reader.CallableReader3*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType, IOResult[_FirstType, _SecondType], returns.interfaces.specific.reader_ioresult._ThirdType], *returns.primitives.laws.Lawful*[ReaderIOResultBasedN[_FirstType, _SecondType, _ThirdType]]

This interface is very specific to our ReaderIOResult type.

The only thing that differs from ReaderIOResultLikeN is that we know the specific types for its __call__ method.

In this case the return type of __call__ is IOResult.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>,)
Some classes and interfaces might have laws, some might not have any.

ReaderIOResultBased3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_ioresult.ReaderIOResultBasedN*[returns.interfaces.specific.reader_ioresult._FirstType, returns.interfaces.specific.reader_ioresult._SecondType, returns.interfaces.specific.reader_ioresult._ThirdType]

ReaderFutureResult specific

class ReaderFutureResultLikeN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader_ioresult.ReaderIOResultLikeN*[returns.interfaces.specific.reader_future_result._FirstType, returns.interfaces.specific.reader_future_result._SecondType, returns.interfaces.specific.reader_future_result._ThirdType], *returns.interfaces.specific.future_result.FutureResultLikeN*[returns.interfaces.specific.reader_future_result._FirstType, returns.interfaces.specific.reader_future_result._SecondType, returns.interfaces.specific.reader_future_result._ThirdType]

Interface for all types that do look like ReaderFutureResult instance.

Cannot be called.

abstract bind_context_future_result(*function*)
Bind a ReaderFutureResult returning function over a container.

Parameters

- **self** (*~_ReaderFutureResultLikeType*) –
- **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *KindN*[~_ReaderFutureResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract bind_async_context_future_result(*function*)
Bind async `ReaderFutureResult` function.

Parameters

- **self** (*~_ReaderFutureResultLikeType*) –
- **function** (`Callable`[[~_FirstType], `Awaitable`[`ForwardRef`]]) –

Return type *KindN*[~_ReaderFutureResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]

abstract classmethod from_future_result_context(*inner_value*)
Unit method to create new containers from `ReaderFutureResult`.

Parameters

- **cls** (`Type`[~_ReaderFutureResultLikeType]) –
- **inner_value** (`ForwardRef`) –

Return type *KindN*[~_ReaderFutureResultLikeType, ~_ValueType, ~_ErrorType, ~_EnvType]

ReaderFutureResultLike3
Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_future_result.ReaderFutureResultLikeN*[`returns.interfaces.specific.reader_future_result._FirstType`, `returns.interfaces.specific.reader_future_result._SecondType`, `returns.interfaces.specific.reader_future_result._ThirdType`]

class _LawSpec
Bases: *returns.primitives.laws.LawSpecDef*

Concrete laws for `ReaderFutureResultBasedN`.

See: https://github.com/haskell/mtl/pull/61/files

static asking_law(*container*, *env*)
Asking for an env, always returns the env.

Parameters

- **container** (*ReaderFutureResultBasedN*[~_FirstType, ~_SecondType, ~_ThirdType]) –
- **env** (*~_ThirdType*) –

Return type `None`

class ReaderFutureResultBasedN(**args*, ***kwds*)
Bases: *returns.interfaces.specific.reader_future_result.ReaderFutureResultLikeN*[`returns.interfaces.specific.reader_future_result._FirstType`, `returns.interfaces.specific.reader_future_result._SecondType`, `returns.interfaces.specific.reader_future_result._ThirdType`], *returns.interfaces.specific.reader.CallableReader3*[`returns.interfaces.specific.reader_future_result._FirstType`, `returns.interfaces.specific.reader_future_result._SecondType`, `returns.interfaces.specific.reader_future_result._ThirdType`, `FutureResult[_FirstType, _SecondType]`, `returns.interfaces.specific.reader_future_result._ThirdType`], *returns.primitives.laws.Lawful*[`ReaderFutureResultBasedN[_FirstType, _SecondType, _ThirdType]`]

This interface is very specific to our `ReaderFutureResult` type.

The only thing that differs from `ReaderFutureResultLikeN` is that we know the specific types for its `__call__` method.

In this case the return type of `__call__` is `FutureResult`.

_laws: ClassVar[Sequence[*returns.primitives.laws.Law*]] = (<returns.primitives.laws.Law2 object>,)

Some classes and interfaces might have laws, some might not have any.

ReaderFutureResultBased3

Type alias for kinds with three type arguments.

alias of *returns.interfaces.specific.reader_future_result.ReaderFutureResultBasedN*[returns.interfaces.specific.reader_future_result._FirstType, returns.interfaces.specific.reader_future_result._SecondType, returns.interfaces.specific.reader_future_result._ThirdType]

9.6 Maybe

The `Maybe` container is used when a series of computations could return `None` at any point.

9.6.1 Maybe container

`Maybe` consist of two types: `Some` and `Nothing`. We have a convenient method to create different `Maybe` types based on just a single value:

```
>>> from returns.maybe import Maybe

>>> assert str(Maybe.from_optional(1)) == '<Some: 1>'
>>> assert str(Maybe.from_optional(None)) == '<Nothing>'
```

We also have another method called `.from_value` that behaves a bit differently:

```
>>> from returns.maybe import Maybe

>>> assert str(Maybe.from_value(1)) == '<Some: 1>'
>>> assert str(Maybe.from_value(None)) == '<Some: None>'
```

Usage

It might be very useful for complex operations like the following one:

```
>>> from attr import dataclass
>>> from typing import Optional
>>> from returns.maybe import Maybe, Nothing

>>> @dataclass
... class Address(object):
...     street: Optional[str]

>>> @dataclass
... class User(object):
```

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```
...     address: Optional[Address]

>>> @dataclass
... class Order(object):
...     user: Optional[User]

>>> def get_street_address(order: Order) -> Maybe[str]:
...     return Maybe.from_optional(order.user).bind_optional(
...         lambda user: user.address,
...     ).bind_optional(
...         lambda address: address.street,
...     )

>>> with_address = Order(User(Address('Some street')))
>>> empty_user = Order(None)
>>> empty_address = Order(User(None))
>>> empty_street = Order(User(Address(None)))

>>> str(get_street_address(with_address))  # all fields are not None
'<Some: Some street>'

>>> assert get_street_address(empty_user) == Nothing
>>> assert get_street_address(empty_address) == Nothing
>>> assert get_street_address(empty_street) == Nothing
```

Optional type

One may ask: "How is that different to the `Optional[]` type?" That's a really good question!

Consider the same code to get the street name without `Maybe` and using raw `Optional` values:

```
order: Order  # some existing Order instance
street: Optional[str] = None
if order.user is not None:
    if order.user.address is not None:
        street = order.user.address.street
```

It looks way uglier and can grow even more uglier and complex when new logic will be introduced.

9.6.2 Pattern Matching

`Maybe` values can be matched using the new feature of Python 3.10, Structural Pattern Matching, see the example below:

```
from dataclasses import dataclass
from typing import Final

from returns.maybe import Maybe, Nothing, Some


@dataclass
```

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```
class _Book(object):
    book_id: int
    name: str


_BOOK_LIST: Final = (
    _Book(book_id=1, name='Category Theory for Programmers'),
    _Book(book_id=2, name='Fluent Python'),
    _Book(book_id=3, name='Learn You Some Erlang for Great Good'),
    _Book(book_id=4, name='Learn You a Haskell for Great Good'),
)


def _find_book(book_id: int) -> Maybe[_Book]:
    for book in _BOOK_LIST:
        if book.book_id == book_id:
            return Some(book)
    return Nothing


if __name__ == '__main__':
    desired_book = _find_book(2)
    match desired_book:
        # Matches any `Some` instance that contains a book named `Fluent Python`
        case Some(_Book(name='Fluent Python')):
            print('"Fluent Python" was found')

        # Matches any `Some` instance and binds its value to the `book` variable
        case Some(book):
            print('Book found: {0}'.format(book.name))

        # Matches `Nothing` instance
        case Maybe.empty:
            print('Not found the desired book!')
```

9.6.3 Decorators

Limitations

Typing will only work correctly if *our mypy plugin* is used. This happens due to mypy issue.

maybe

Sometimes we have to deal with functions that dears to return `Optional` values!

We have to work with it the carefully and write `if x is not None:` everywhere. Luckily, we have your back! `maybe` function decorates any other function that returns `Optional` and converts it to return `Maybe` instead:

```
>>> from typing import Optional
>>> from returns.maybe import Maybe, Some, maybe

>>> @maybe
... def number(num: int) -> Optional[int]:
...     if num > 0:
...         return num
...     return None

>>> result: Maybe[int] = number(1)
>>> assert result == Some(1)
```

9.6.4 FAQ

How can I turn Maybe into Optional again?

When working with regular Python, you might need regular `Optional[a]` values.

You can easily get one from your `Maybe` container at any point in time:

```
>>> from returns.maybe import Maybe
>>> assert Maybe.from_optional(1).value_or(None) == 1
>>> assert Maybe.from_optional(None).value_or(None) == None
```

As you can see, revealed type of `.value_or(None)` is `Optional[a]`. Use it a fallback.

How to model absence of value vs presence of None value?

Let's say you have this `dict`: `values = {'a': 1, 'b': None}` So, you can have two types of `None` here:

- `values.get('b')`
- `values.get('c')`

But, they are different! The first has explicit `None` value, the second one has no given key and `None` is used as a default. You might need to know exactly which case you are dealing with. For example, in validation.

So, the first thing to remember is that:

```
>>> assert Some(None) != Nothing
```

There's a special way to work with a type like this:

```
>>> values = {'a': 1, 'b': None}

>>> assert Maybe.from_value(values).map(lambda d: d.get('a')) == Some(1)
>>> assert Maybe.from_value(values).map(lambda d: d.get('b')) == Some(None)
```

In contrast, you can ignore both `None` values easily:

```
>>> assert Maybe.from_value(values).bind_optional(
...     lambda d: d.get('a'),
... ) == Some(1)

>>> assert Maybe.from_value(values).bind_optional(
...     lambda d: d.get('b'),
... ) == Nothing
```

So, how to write a complete check for a value: both present and missing?

```
>>> from typing import Optional, Dict, TypeVar
>>> from returns.maybe import Maybe, Some, Nothing

>>> _Key = TypeVar('_Key')
>>> _Value = TypeVar('_Value')

>>> def check_key(
...    heystack: Dict[_Key, _Value],
...    needle: _Key,
... ) -> Maybe[_Value]:
...     if needle not in heystack:
...         return Nothing
...     return Maybe.from_value(heystack[needle])  # try with `.from_optional`

>>> real_values = {'a': 1}
>>> opt_values = {'a': 1, 'b': None}

>>> assert check_key(real_values, 'a') == Some(1)
>>> assert check_key(real_values, 'b') == Nothing
>>> # Type revealed: returns.maybe.Maybe[builtins.int]

>>> assert check_key(opt_values, 'a') == Some(1)
>>> assert check_key(opt_values, 'b') == Some(None)
>>> assert check_key(opt_values, 'c') == Nothing
>>> # Type revealed: returns.maybe.Maybe[Union[builtins.int, None]]
```

Choose wisely between `.from_value` and `.map`, and `.from_optional` and `.bind_optional`. They are similar, but do different things.

See the original issue about Some(None) for more details and the full history.

Why there's no IOMaybe?

We do have `IOResult`, but we don't have `IOMaybe`. Why? Because when dealing with `IO` there are a lot of possible errors. And `Maybe` represents just `None` and the value.

It is not useful for `IO` related tasks. So, use `Result` instead, which can represent what happened to your `IO`.

You can convert `Maybe` to `Result` and back again with special *Converters*.

Why Maybe does not have alt method?

Well, because `Maybe` only has a single failed value: `Nothing` and it cannot be altered.

But, `Maybe` has *returns.maybe.Maybe.or_else_call()* method to call a passed callback function with zero argument on failed container:

```
>>> from returns.maybe import Some, Nothing

>>> assert Some(1).or_else_call(lambda: 2) == 1
>>> assert Nothing.or_else_call(lambda: 2) == 2
```

This method is unique to `Maybe` container.

9.6.5 Further reading

- Option Monads in Rust
- Option overview in TypeScript
- Maybe not - Rich Hickey

9.6.6 API Reference

class Maybe(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*Maybe*, returns.maybe._ValueType, NoReturn, NoReturn], *returns.interfaces.specific.maybe.MaybeBasedN*[returns.maybe._ValueType, None, NoReturn]

Represents a result of a series of computations that can return `None`.

An alternative to using exceptions or constant `is None` checks. `Maybe` is an abstract type and should not be instantiated directly. Instead use `Some` and `Nothing`.

See also:

- https://github.com/gcanti/fp-ts/blob/master/docs/modules/Option.ts.md

empty: ClassVar[*Maybe*[Any]] = <Nothing>

Alias for *Nothing*

success_type

Success type that is used to represent the successful computation.

Parameters **inner_value** (*+_ValueType*) –

alias of *returns.maybe.Some*

failure_type

Failure type that is used to represent the failed computation.

Parameters **inner_value** (None) –

alias of returns.maybe._Nothing

equals(*other*)

Typesafe equality comparison with other *Result* objects.

Parameters

- **self** (*KindN*[~_EqualType, Any, Any, Any]) –
- **other** (*KindN*[~_EqualType, Any, Any, Any]) –

Return type bool

map(*function*)

Composes successful container with a pure function.

```
>>> from returns.maybe import Some, Nothing
>>> def mappable(string: str) -> str:
...     return string + 'b'

>>> assert Some('a').map(mappable) == Some('ab')
>>> assert Nothing.map(mappable) == Nothing
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *Maybe*[~_NewValueType]

apply(*function*)

Calls a wrapped function in a container on this container.

```
>>> from returns.maybe import Some, Nothing

>>> def appliable(string: str) -> str:
...     return string + 'b'

>>> assert Some('a').apply(Some(appliable)) == Some('ab')
>>> assert Some('a').apply(Nothing) == Nothing
>>> assert Nothing.apply(Some(appliable)) == Nothing
>>> assert Nothing.apply(Nothing) == Nothing
```

Parameters **function** (*KindN*[*Maybe*, Callable[[+_ValueType], ~_NewValueType], Any, Any]) –

Return type *Maybe*[~_NewValueType]

bind(*function*)

Composes successful container with a function that returns a container.

```
>>> from returns.maybe import Nothing, Maybe, Some
>>> def bindable(string: str) -> Maybe[str]:
...     return Some(string + 'b')

>>> assert Some('a').bind(bindable) == Some('ab')
>>> assert Nothing.bind(bindable) == Nothing
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*Maybe*, ~_NewValueType, Any, Any]]) –

Return type *Maybe*[~_NewValueType]

bind_optional(*function*)

Binds a function returning an optional value over a container.

```
>>> from returns.maybe import Some, Nothing
>>> from typing import Optional

>>> def bindable(arg: str) -> Optional[int]:
...     return len(arg) if arg else None

>>> assert Some('a').bind_optional(bindable) == Some(1)
>>> assert Some('').bind_optional(bindable) == Nothing
```

Parameters **function** (Callable[[+_ValueType], Optional[~_NewValueType]]) –

Return type *Maybe*[~_NewValueType]

lash(*function*)

Composes failed container with a function that returns a container.

```
>>> from returns.maybe import Maybe, Some, Nothing

>>> def lashable(arg=None) -> Maybe[str]:
...      return Some('b')

>>> assert Some('a').lash(lashable) == Some('a')
>>> assert Nothing.lash(lashable) == Some('b')
```

We need this feature to make `Maybe` compatible with different `Result` like operations.

Parameters **function** (Callable[[Any], *KindN*[*Maybe*, +_ValueType, Any, Any]]) –

Return type *Maybe*[+_ValueType]

value_or(*default_value*)

Get value from successful container or default value from failed one.

```
>>> from returns.maybe import Nothing, Some
>>> assert Some(0).value_or(1) == 0
>>> assert Nothing.value_or(1) == 1
```

Parameters **default_value** (*~_NewValueType*) –

Return type Union[+_ValueType, ~_NewValueType]

or_else_call(*function*)

Get value from successful container or default value from failed one.

Really close to *value_or()* but works with lazy values. This method is unique to `Maybe` container, because other containers do have `.alt` method.

But, `Maybe` does not have this method. There's nothing to `alt` in `Nothing`.

Instead, it has this method to execute some function if called on a failed container:

```
>>> from returns.maybe import Some, Nothing
>>> assert Some(1).or_else_call(lambda: 2) == 1
>>> assert Nothing.or_else_call(lambda: 2) == 2
```

It might be useful to work with exceptions as well:

```
>>> def fallback() -> NoReturn:
...     raise ValueError('Nothing!')

>>> Nothing.or_else_call(fallback)
Traceback (most recent call last):
  ...
ValueError: Nothing!
```

Parameters **function** (Callable[[], ~_NewValueType]) –

Return type Union[+_ValueType, ~_NewValueType]

unwrap()

Get value from successful container or raise exception for failed one.

```
>>> from returns.maybe import Nothing, Some
>>> assert Some(1).unwrap() == 1

>>> Nothing.unwrap()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type +_ValueType

failure()

Get failed value from failed container or raise exception from success.

```
>>> from returns.maybe import Nothing, Some
>>> assert Nothing.failure() is None

>>> Some(1).failure()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type None

classmethod from_value(*inner_value*)

Creates new instance of Maybe container based on a value.

```
>>> from returns.maybe import Maybe, Some
>>> assert Maybe.from_value(1) == Some(1)
>>> assert Maybe.from_value(None) == Some(None)
```

Parameters **inner_value** (*~_NewValueType*) –

Return type *Maybe*[~_NewValueType]

classmethod from_optional(*inner_value*)

Creates new instance of Maybe container based on an optional value.

```
>>> from returns.maybe import Maybe, Some, Nothing
>>> assert Maybe.from_optional(1) == Some(1)
>>> assert Maybe.from_optional(None) == Nothing
```

Parameters **inner_value** (Optional[~_NewValueType]) –

Return type *Maybe*[~_NewValueType]

class Some(*inner_value*)

Bases: *returns.maybe.Maybe*[returns.maybe._ValueType]

Represents a calculation which has succeeded and contains the value.

Quite similar to Success type.

Parameters **inner_value** (*+_ValueType*) –

bind(*function*)

Binds current container to a function that returns container.

bind_optional(*function*)

Binds a function returning an optional value over a container.

unwrap()

Returns inner value for successful container.

map(*function*)

Composes current container with a pure function.

apply(*container*)

Calls a wrapped function in a container on this container.

lash(*function*)

Does nothing for Some.

value_or(*default_value*)

Returns inner value for successful container.

or_else_call(*function*)

Returns inner value for successful container.

failure()

Raises exception for successful container.

Nothing: *returns.maybe.Maybe*[NoReturn] = <Nothing>

Public unit value of protected _Nothing type.

maybe(*function*)

Decorator to convert None-returning function to Maybe container.

This decorator works with sync functions only. Example:

```
>>> from typing import Optional
>>> from returns.maybe import Nothing, Some, maybe

>>> @maybe
... def might_be_none(arg: int) -> Optional[int]:
...     if arg == 0:
...         return None
...     return 1 / arg
```

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```
>>> assert might_be_none(0) == Nothing
>>> assert might_be_none(1) == Some(1.0)
```

Requires our *mypy plugin*.

Parameters **function** (Callable[..., Optional[+_ValueType]]) –

Return type Callable[..., *Maybe*[+_ValueType]]

9.7 Result

Make sure to get familiar with *Railway oriented programming*.

`Result` is obviously a result of some series of computations. It might succeed with some resulting value. Or it might return an error with some extra details.

`Result` consist of two types: `Success` and `Failure`. `Success` represents successful operation result and `Failure` indicates that something has failed.

```
from returns.result import Result, Success, Failure

def find_user(user_id: int) -> Result['User', str]:
    user = User.objects.filter(id=user_id)
    if user.exists():
        return Success(user[0])
    return Failure('User was not found')

user_search_result = find_user(1)
# => Success(User{id: 1, ...})

user_search_result = find_user(0)  # id 0 does not exist!
# => Failure('User was not found')
```

When is it useful? When you do not want to use exceptions to break your execution scope. Or when you do not want to use `None` to represent empty values, since it will raise `TypeError` somewhere and other `None` exception-friends.

9.7.1 Composition

Make sure to check out how to compose container with `flow` or *pipe*! Read more about them if you want to compose your containers easily.

9.7.2 Pattern Matching

`Result` values can be matched using the new feature of Python 3.10, Structural Pattern Matching, see the example below:

```
from returns.result import Failure, Success, safe


@safe
def div(first_number: int, second_number: int) -> int:
    return first_number // second_number


match div(1, 0):
    # Matches if the result stored inside `Success` is `10`
    case Success(10):
        print('Result is "10"')

    # Matches any `Success` instance and binds its value to the `value` variable
    case Success(value):
        print('Result is "{0}"'.format(value))

    # Matches if the result stored inside `Failure` is `ZeroDivisionError`
    case Failure(ZeroDivisionError):
        print('"ZeroDivisionError" was raised')

    # Matches any `Failure` instance
    case Failure(_):
        print('The division was a failure')
```

9.7.3 Aliases

There are several useful alises for `Result` type with some common values:

- *returns.result.ResultE* is an alias for `Result[... Exception]`, just use it when you want to work with `Result` containers that use exceptions as error type. It is named `ResultE` because it is `ResultException` and `ResultError` at the same time.

9.7.4 Decorators

Limitations

Typing will only work correctly if *our mypy plugin* is used. This happens due to mypy issue.

safe

safe is used to convert regular functions that can throw exceptions to functions that return *Result* type.

Supports only regular functions. If you need to mark `async` functions as `safe`, use *future_safe* instead.

```
>>> from returns.result import Success, safe

>>> @safe  # Will convert type to: Callable[[int], Result[float, Exception]]
... def divide(number: int) -> float:
...     return number / number

>>> assert divide(1) == Success(1.0)
>>> str(divide(0))
'<Failure: division by zero>'
```

9.7.5 FAQ

How to create unit objects?

Use `Success` or `Failure`. Alternatively *returns.result.Result.from_value()* or *returns.result.Result.from_failure()*.

It might be a good idea to use unit functions together with the explicit annotation. Python's type system does not allow us to do much, so this is required:

```
>>> from returns.result import Result, Success

>>> def callback(arg: int) -> Result[float, int]:
...     return Success(float(arg))

>>> first: Result[int, int] = Success(1)
>>> assert first.bind(callback) == Success(1.0)
```

Otherwise `first` will have `Result[int, Any]` type. Which is okay in some situations.

How to compose error types?

You might want to sometimes use `unify` *Pointfree* functions instead of `.bind` to compose error types together. While `.bind` enforces error type to stay the same, `unify` is designed to return a `Union` of a revious error type and a new one.

It gives an extra flexibility, but also provokes more thinking and can be problematic in some cases.

Like so:

```
>>> from returns.result import Result, Success, Failure
>>> from returns.pointfree import unify

>>> def div(number: int) -> Result[float, ZeroDivisionError]:
...     if number:
...         return Success(1 / number)
...     return Failure(ZeroDivisionError('division by zero'))

>>> container: Result[int, ValueError] = Success(1)
>>> assert unify(div)(container) == Success(1.0)
>>> # => Revealed type is:
>>> # Result[float, Union[ValueError, ZeroDivisionError]]
```

So, that's a way to go, if you need this composition.

map vs bind

We use the `map` method when we're working with pure functions, a function is pure if it doesn't produce any side-effect (e.g. Exceptions). On the other hand, we use the `bind` method if a function returns a `Result` instance which translates its potential side-effect into a raw value. See the example below:

```
>>> import json
>>> from typing import Dict

>>> from returns.result import Failure, Result, Success, safe

>>> # `cast_to_bool` doesn't produce any side-effect
>>> def cast_to_bool(arg: int) -> bool:
...     return bool(arg)

>>> # `parse_json` can produce Exceptions, so we use the `safe` decorator
>>> # to prevent any kind of exceptions
>>> @safe
... def parse_json(arg: str) -> Dict[str, str]:
...     return json.loads(arg)

>>> assert Success(1).map(cast_to_bool) == Success(True)
>>> assert Success('{"example": "example"}').bind(parse_json) == Success({"example":
↪"example"})
>>> assert Success('').bind(parse_json).alt(str) == Failure('Expecting value: line 1␣
↪column 1 (char 0)')
```

9.7.6 Further reading

- Railway Oriented Programming
- Recoverable Errors with Result in Rust
- Either overview in TypeScript

9.7.7 API Reference

class Result(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*Result*, returns.result._ValueType, returns.result._ErrorType, NoReturn], *returns.interfaces.specific.result.ResultBasedN*[returns.result._ValueType, returns.result._ErrorType, NoReturn]

Base class for *Failure* and *Success*.

Result does not have a public constructor. Use *Success()* and *Failure()* to construct the needed values.

See also:

- https://bit.ly/361qQhi
- https://hackernoon.com/the-throw-keyword-was-a-mistake-l9e532di

success_type

Success type that is used to represent the successful computation.

Parameters **inner_value** (*+_ValueType*) –

alias of *returns.result.Success*

failure_type

Failure type that is used to represent the failed computation.

Parameters **inner_value** (*+_ErrorType*) –

alias of *returns.result.Failure*

equals(*other*)

Typesafe equality comparison with other *Result* objects.

Parameters

- **self** (*KindN*[~_EqualType, Any, Any, Any]) –
- **other** (*KindN*[~_EqualType, Any, Any, Any]) –

Return type bool

property trace: Optional[List[inspect.FrameInfo]]

Returns a list with stack trace when *Failure()* was called.

Return type Optional[List[FrameInfo]]

swap()

Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of .bind_ related methods and only a single .lash - it is easier to work with values.

```
>>> from returns.result import Success, Failure
>>> assert Success(1).swap() == Failure(1)
>>> assert Failure(1).swap() == Success(1)
```

Return type *Result*[+_ErrorType, +_ValueType]

map(*function*)

Composes successful container with a pure function.

```
>>> from returns.result import Failure, Success

>>> def mappable(string: str) -> str:
...     return string + 'b'

>>> assert Success('a').map(mappable) == Success('ab')
>>> assert Failure('a').map(mappable) == Failure('a')
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *Result*[~_NewValueType, +_ErrorType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> from returns.result import Failure, Success

>>> def appliable(string: str) -> str:
...     return string + 'b'

>>> assert Success('a').apply(Success(appliable)) == Success('ab')
>>> assert Failure('a').apply(Success(appliable)) == Failure('a')

>>> assert Success('a').apply(Failure(1)) == Failure(1)
>>> assert Failure(1).apply(Failure(2)) == Failure(1)
```

Parameters **container** (*KindN*[*Result*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, Any]) –

Return type *Result*[~_NewValueType, +_ErrorType]

bind(*function*)

Composes successful container with a function that returns a container.

```
>>> from returns.result import Result, Success, Failure

>>> def bindable(arg: str) -> Result[str, str]:
...     if len(arg) > 1:
...         return Success(arg + 'b')
...     return Failure(arg + 'c')

>>> assert Success('aa').bind(bindable) == Success('aab')
>>> assert Success('a').bind(bindable) == Failure('ac')
>>> assert Failure('a').bind(bindable) == Failure('a')
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*Result*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *Result*[~_NewValueType, +_ErrorType]

bind_result(*function*)

Alias for *bind_result* method, it is the same as *bind* here.

Parameters **function** (Callable[[+_ValueType], *KindN*[*Result*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *Result*[~_NewValueType, +_ErrorType]

alt(*function*)

Composes failed container with a pure function to modify failure.

```
>>> from returns.result import Failure, Success

>>> def altable(arg: str) -> str:
...     return arg + 'b'

>>> assert Success('a').alt(altable) == Success('a')
>>> assert Failure('a').alt(altable) == Failure('ab')
```

Parameters **function** (Callable[[+_ErrorType], ~_NewErrorType]) –

Return type *Result*[+_ValueType, ~_NewErrorType]

lash(*function*)

Composes failed container with a function that returns a container.

```
>>> from returns.result import Result, Success, Failure

>>> def lashable(arg: str) -> Result[str, str]:
...     if len(arg) > 1:
...         return Success(arg + 'b')
...     return Failure(arg + 'c')

>>> assert Success('a').lash(lashable) == Success('a')
>>> assert Failure('a').lash(lashable) == Failure('ac')
>>> assert Failure('aa').lash(lashable) == Success('aab')
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*Result*, +_ValueType, ~_NewErrorType, Any]]) –

Return type *Result*[+_ValueType, ~_NewErrorType]

value_or(*default_value*)

Get value or default value.

```
>>> from returns.result import Failure, Success
>>> assert Success(1).value_or(2) == 1
>>> assert Failure(1).value_or(2) == 2
```

Parameters **default_value** (*~_NewValueType*) –

Return type Union[+_ValueType, ~_NewValueType]

unwrap()

Get value or raise exception.

```
>>> from returns.result import Failure, Success
>>> assert Success(1).unwrap() == 1

>>> Failure(1).unwrap()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type +_ValueType

failure()
Get failed value or raise exception.

```
>>> from returns.result import Failure, Success
>>> assert Failure(1).failure() == 1

>>> Success(1).failure()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type +_ErrorType

classmethod from_value(*inner_value*)
One more value to create success unit values.

It is useful as a united way to create a new value from any container.

```
>>> from returns.result import Result, Success
>>> assert Result.from_value(1) == Success(1)
```

You can use this method or *Success()*, choose the most convenient for you.

Parameters **inner_value** (*~_NewValueType*) –

Return type *Result*[~_NewValueType, Any]

classmethod from_failure(*inner_value*)
One more value to create failure unit values.

It is useful as a united way to create a new value from any container.

```
>>> from returns.result import Result, Failure
>>> assert Result.from_failure(1) == Failure(1)
```

You can use this method or *Failure()*, choose the most convenient for you.

Parameters **inner_value** (*~_NewErrorType*) –

Return type *Result*[Any, ~_NewErrorType]

classmethod from_result(*inner_value*)
Creates a new Result instance from existing Result instance.

```
>>> from returns.result import Result, Failure, Success
>>> assert Result.from_result(Success(1)) == Success(1)
>>> assert Result.from_result(Failure(1)) == Failure(1)
```

This is a part of *returns.interfaces.specific.result.ResultBasedN* interface.

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *Result*[~_NewValueType, ~_NewErrorType]

class Failure(*inner_value*)

Bases: *returns.result.Result*[Any, returns.result._ErrorType]

Represents a calculation which has failed.

It should contain an error code or message.

Parameters **inner_value** (*+_ErrorType*) –

alt(*function*)

Composes failed container with a pure function to modify failure.

map(*function*)

Does nothing for Failure.

bind(*function*)

Does nothing for Failure.

bind_result(*function*)

Alias for *bind* method. Part of the *ResultBasedN* interface.

lash(*function*)

Composes this container with a function returning container.

apply(*container*)

Does nothing for Failure.

value_or(*default_value*)

Returns default value for failed container.

swap()

Failures swap to *Success*.

unwrap()

Raises an exception, since it does not have a value inside.

Return type NoReturn

failure()

Returns failed value.

Return type +_ErrorType

class Success(*inner_value*)

Bases: *returns.result.Result*[returns.result._ValueType, Any]

Represents a calculation which has succeeded and contains the result.

Contains the computation value.

Parameters **inner_value** (*+_ValueType*) –

alt(*function*)

Does nothing for Success.

map(*function*)

Composes current container with a pure function.

bind(*function*)

Binds current container to a function that returns container.

bind_result(*function*)
Alias for *bind* method. Part of the *ResultBasedN* interface.

lash(*function*)
Does nothing for `Success`.

apply(*container*)
Calls a wrapped function in a container on this container.

value_or(*default_value*)
Returns the value for successful container.

swap()
Successes swap to *Failure*.

unwrap()
Returns the unwrapped value from successful container.

Return type +_ValueType

failure()
Raises an exception for successful container.

Return type `NoReturn`

ResultE
Alias for a popular case when `Result` has `Exception` as error type.

alias of *returns.result.Result*[`returns.result._ValueType`, `Exception`]

safe(*function*)
Decorator to convert exception-throwing function to `Result` container.

Should be used with care, since it only catches `Exception` subclasses. It does not catch `BaseException` subclasses.

If you need to mark `async` function as `safe`, use *returns.future.future_safe()* instead. This decorator only works with sync functions. Example:

```
>>> from returns.result import Result, Success, safe

>>> @safe
... def might_raise(arg: int) -> float:
...     return 1 / arg

>>> assert might_raise(1) == Success(1.0)
>>> assert isinstance(might_raise(0), Result.failure_type)
```

Similar to *returns.io.impure_safe()* and *returns.future.future_safe()* decorators.

Requires our *mypy plugin*.

Parameters **function** (`Callable`[..., +_ValueType]) –

Return type `Callable`[..., *Result*[+_ValueType, `Exception`]]

9.8 IO

Mathematicians dream in pure functions. Each of them only relies on its arguments and always produces the same result for the same input.

That's not how a useful program works. We need to rely on the environment and we need to do side effects.

Furthermore, there are several types of `IO` in our programs:

- Some `IO` never fails, like: getting current date and time, random number, or OS name
- Some `IO` might fail, like: sending network requests, accessing filesystem, or database

There's a solution.

9.8.1 IO container

Once you have an `IO` operation you can mark it appropriately. We can use a simple class *returns.io.IO* to mark impure parts of the program that do not fail.

```
>>> import random
>>> from returns.io import IO
>>> def get_random_number() -> IO[int]:
...     return IO(random.randint(1, 10))
...
>>> assert isinstance(get_random_number(), IO)
```

And later we can work inside this `IO` context and do not break into our pure part of the program:

```
>>> assert get_random_number().map(lambda number: number / number) == IO(1.0)
```

And it infects all other functions that call it.

```
>>> def modify_number(number: int) -> IO[float]:
...     return get_random_number().map(lambda rnd: number / rnd)
...
>>> assert isinstance(modify_number(1), IO)
```

It is good enough to indicate that you are aware of side effects of the function.

9.8.2 IOResult

On the other hand, we can have `IO` parts of the program that do fail.

Imagine we have this beautiful pure function:

```
def can_book_seats(
    number_of_seats: int,
    reservation: 'Reservation',
) -> bool:
    return reservation.capacity >= number_of_seats + reservation.booked
```

What's good about it? We can test it easily. Even without setting up any testing framework, simple doctests will be enough.

This code is **beautiful**, because it is **simple**.

We can later use its result to process the result of the booking request:

```
def process_booking_result(is_successful: bool) -> 'ProcessID':
    ...

process_booking_result(is_successful)  # works just fine!
```

At this point we don't have `IO` in our program.

Impure functions

But, imagine that our requirements had changed. And now we have to grab the number of already booked tickets from some other microservice and fetch the maximum capacity from the database:

```
import requests
import db

def can_book_seats(
    number_of_seats: int,
    place_id: int,
) -> bool:
    capacity = db.get_place_capacity(place_id)  # sql query
    booked = requests('https://partner.com/api').json()['booked']  # http req
    return capacity >= number_of_seats + booked
```

Now testing this code will become a nightmare! It will require to setup:

- real database and tables
- fixture data
- `requests` mocks for different outcomes
- and the whole Universe!

Our complexity has sky-rocketed! And the most annoying part is that all other functions that call `can_book_seats` now also have to do the same setup. It seams like `IO` is indelible mark (some people also call it "effect").

And at some point it time we will start to mix pure and impure code together. Let's not forget that all of these operations can fail too!

Separating two worlds

Well, `IO` mark is indeed indelible and should be respected.

And then impurity becomes explicit:

```
import requests
import db
from returns.io import IOResultE

def can_book_seats(
    number_of_seats: int,
    place_id: int,
) -> IOResultE[bool]:
    ...
```

Now this function returns `IOResultE[bool]` instead of a regular `bool`. It means, that it cannot be used where regular `bool` can be:

```
def process_booking_result(is_successful: bool) -> 'ProcessID':
    ...

is_successful: IOResultE[bool] = can_book_seats(number_of_seats, place_id)
process_booking_result(is_successful)  # Boom!
# => Argument 1 has incompatible type "IOResultE[bool]"; expected "bool"
```

See? It is now impossible for a pure function to use `IOResultE[bool]`. It is impossible to unwrap or get a raw value from this container. Once it is marked as `IO` it will never return to the pure state (well, there's a hack actually: *unsafe_perform_io*).

Now we have to work inside the `IO` context:

```
message_id: IOResultE['ProcessID'] = can_book_seats(
    number_of_seats,
    place_id,
).map(
    process_booking_result,
)
```

Or it can be annotated to work with impure results:

```
def process_booking_result(
    is_successful: IOResultE[bool],
) -> IOResultE['ProcessID']:
    ...

is_successful: IOResult[bool] = can_book_seats(number_of_seats, place_id)
process_booking_result(is_successful)  # Works!
```

Now, all our impurity is explicit. We can track it, we can fight it, we can design it better. By saying that, it is assumed that you have a functional core and imperative shell.

Lifting

You can also lift regular functions into one that works with `IO` or `IOResult` on both ends. It really helps you with the composition!

```
>>> from returns.io import IO
>>> from returns.pointfree import map_

>>> def regular_function(arg: int) -> float:
...     return arg / 2  # not an `IO` operation

>>> container = IO(1)
>>> # When we need to compose `regular_function` with `IO`,
>>> # we have two ways of doing it:
>>> io = container.map(regular_function)
>>> assert io == IO(0.5)

>>> # or, it is the same as:
```

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```
>>> io = map_(regular_function)(container)
>>> assert io == IO(0.5)
```

`IOResult` can lift both regular functions and ones that return `Result`:

```
>>> from returns.io import IOResult, IOSuccess
>>> from returns.pointfree import map_

>>> def regular_function(arg: int) -> float:
...     return arg / 2  # not an `IO` operation

>>> container: IOResult[int, str] = IOSuccess(1)
>>> # When we need to compose `regular_function` with `IOResult`,
>>> # we have two ways of doing it:
>>> io = container.map(regular_function)
>>> assert io == IOSuccess(0.5)

>>> # or, it is the same as:
>>> io = map_(regular_function)(container)
>>> assert io == IOSuccess(0.5)
```

And `Result` based functions:

```
>>> from returns.io import IOResult, IOSuccess
>>> from returns.result import Result, Success, Failure
>>> from returns.pointfree import bind_result

>>> def regular_function(arg: int) -> Result[float, str]:
...     if arg > 0:
...         return Success(arg / 2)
...     return Failure('zero')

>>> assert bind_result(regular_function)(
...     IOSuccess(1),
... ) == IOResult.from_result(regular_function(1))
```

Lifting is useful when using *returns.pipeline.pipe()* and other different declarative tools.

9.8.3 Pattern Matching

`IOResult` values can be matched using the new feature of Python 3.10, Structural Pattern Matching, see the example below:

```
from returns.io import IOFailure, IOResult, IOSuccess
from returns.result import Success

container: IOResult[int, str] = IOSuccess(42)
match container:
    # Matches if the result stored inside `IOSuccess` is `42`
    # We need to use `Success` until the custom matching protocol
    # is released. For more information, please visit:
    # https://www.python.org/dev/peps/pep-0622/#custom-matching-protocol
```

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```
    case IOSuccess(Success(42)):
        print('Result is "42"')

    # Matches any `IOSuccess` instance
    # and binds its value to the `value` variable
    case IOSuccess(value):
        print('Result is "{0}"'.format(value))

    # Matches any `IOFailure` instance
    case IOFailure(_):
        print('A failure was occurred')
```

9.8.4 Aliases

There are several useful alises for `IOResult` type with some common values:

- *returns.io.IOResultE* is an alias for `IOResult[... Exception]`, just use it when you want to work with `IOResult` containers that use exceptions as error type. It is named `IOResultE` because it is `IOResultException` and `IOResultError` at the same time.

9.8.5 Decorators

Limitations

Typing will only work correctly if *our mypy plugin* is used. This happens due to mypy issue.

impure

We also have this handy decorator to help you with the existing impure things in Python:

```
from returns.io import impure

name: IO[str] = impure(input)('What is your name?')
```

You can also decorate your own functions with `@impure` for better readability and clearness:

```
import random
from returns.io import impure

@impure
def get_user() -> 'User':
    return random.randint(1, 5)
```

impure_safe

Similar to `impure` and `safe` decorators. Once applied, it transforms the return type to be `IOResultE`:

```
from returns.io import IOResultE, impure_safe

@impure_safe
def http_get(path: str) -> 'Response':
    return requests.get(path)

container: IOResultE['Response'] = http_get('/home')
```

Use for impure operations that might fail.

9.8.6 Helpers

Don't forget to check out *Converters*.

unsafe_perform_io

Sometimes you really need to get the raw value from `IO` container. For example:

```
def index_view(request, user_id):
    user: IO[User] = get_user(user_id)
    return render('index.html', {'user': user})  # ???
```

In this case your web-framework will not render your user correctly. Since it does not expect it to be wrapped inside `IO` containers. And we obviously cannot `map` or `bind` this function.

What to do? Use *unsafe_perform_io*:

```
from returns.unsafe import unsafe_perform_io

def index_view(request, user_id):
    user: IO[User] = get_user(user_id)
    return render('index.html', {'user': unsafe_perform_io(user)})  # Ok
```

We need it as an escape and compatibility mechanism for our imperative shell.

In other words:

```
>>> from returns.unsafe import unsafe_perform_io
>>> from returns.io import IO

>>> assert unsafe_perform_io(IO('abc')) == 'abc'
```

It is recommended to use import-linter to restrict imports from `returns.unsafe` expect the top-level modules.

Inspired by Haskell's unsafePerformIO

9.8.7 FAQ

Why aren't IO lazy?

Please, note that our `IO` implementation is not lazy by design. This way when you mark something as `@impure` it will work as previously. The only thing that changes is the return type.

Instead we offer to use *unsafe_perform_io* to work with `IO` and simulate laziness.

But, you can always make your `IO` lazy:

```
>>> from returns.io import IO
>>> lazy = lambda: IO(1)
>>> assert lazy() == IO(1)
```

We have decided that it would be better and more familiar for Python devs.

What is the difference between IO[T] and T?

What kind of input parameter should my function accept `IO[T]` or simple `T`?

It really depends on your domain / context. If the value is pure, than use raw unwrapped values. If the value is fetched, input, received, selected, than use `IO` or `IOResult` container: first one for operations that never fail, second one for operations that might fail.

Most web applications are just fully covered with `IO`.

Why can't we use IO[Result] instead of IOResult?

We actually can! But, it is harder to write. And `IOResult` is actually the very same thing as `IO[Result]`, but has nicer API:

```
x: IO[Result[int, str]]
x.map(lambda io: io.map(lambda number: number + 1))

# Is the same as:

y: IOResult[int, str]
y.map(lambda number: number + 1)
```

The second one looks better, doesn't it?

How to create unit objects for IOResult?

TLDR: you need to use `IOSuccess` and `IOFailure` functions or `IOResult.from_value` and `IOResult.from_failure` methods:

```
>>> from returns.io import IOResult, IOSuccess, IOFailure

>>> first: IOResult[int, str] = IOSuccess(1)
>>> second: IOResult[float, int] = IOFailure(1)

>>> assert IOResult.from_value(1) == IOSuccess(1)
>>> assert IOResult.from_failure(2) == IOFailure(2)
```

You can also annotate your variables properly. Otherwise, `mypy` will treat `IOSuccess(1)` as `IOSuccess[int, Any]`. You can narrow the type in advance.

See *How to create unit objects?* for more details.

9.8.8 Further reading

- Functional core, imperative shell
- Functional architecture is Ports and Adapters
- IO effect in Scala
- Getting started with fp-ts: IO
- IOEither
- Effect Tracking Is Commercially Worthless

9.8.9 API Reference

class `IO`(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*IO*, returns.io._ValueType, NoReturn, NoReturn], *returns.interfaces.specific.io.IOLikeN*[returns.io._ValueType, NoReturn, NoReturn]

Explicit container for impure function results.

We also sometimes call it "marker" since once it is marked, it cannot be ever unmarked. There's no way to directly get its internal value.

Note that `IO` represents a computation that never fails.

Examples of such computations are:

- read / write to localStorage
- get the current time
- write to the console
- get a random number

Use `IOResult[...]` for operations that might fail. Like DB access or network operations.

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-io-36p6
- https://gist.github.com/chris-taylor/4745921

Parameters **inner_value** (*+_ValueType*) –

equals(*other*)

Typesafe equality comparison with other *Result* objects.

Parameters

- **self** (*KindN*[~_EqualType, Any, Any, Any]) –
- **other** (*KindN*[~_EqualType, Any, Any, Any]) –

Return type bool

map(*function*)
Applies function to the inner value.

Applies 'function' to the contents of the IO instance and returns a new IO object containing the result. 'function' should accept a single "normal" (non-container) argument and return a non-container result.

```
>>> def mappable(string: str) -> str:
...     return string + 'b'

>>> assert IO('a').map(mappable) == IO('ab')
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *IO*[~_NewValueType]

apply(*container*)
Calls a wrapped function in a container on this container.

```
>>> from returns.io import IO
>>> assert IO('a').apply(IO(lambda inner: inner + 'b')) == IO('ab')
```

Or more complex example that shows how we can work with regular functions and multiple `IO` arguments:

```
>>> from returns.curry import curry

>>> @curry
... def appliable(first: str, second: str) -> str:
...     return first + second

>>> assert IO('b').apply(IO('a').apply(IO(appliable))) == IO('ab')
```

Parameters **container** (*KindN*[*IO*, Callable[[+_ValueType], ~_NewValueType], Any, Any]) –

Return type *IO*[~_NewValueType]

bind(*function*)
Applies 'function' to the result of a previous calculation.

'function' should accept a single "normal" (non-container) argument and return `IO` type object.

```
>>> def bindable(string: str) -> IO[str]:
...     return IO(string + 'b')

>>> assert IO('a').bind(bindable) == IO('ab')
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*IO*, ~_NewValueType, Any, Any]]) –

Return type *IO*[~_NewValueType]

bind_io(*function*)
Alias for *bind* method. Part of the *IOLikeN* interface.

Parameters **function** (Callable[[+_ValueType], *KindN*[*IO*, ~_NewValueType, Any, Any]]) –

Return type *IO*[~_NewValueType]

classmethod from_value(*inner_value*)
Unit function to construct new `IO` values.

Is the same as regular constructor:

```
>>> from returns.io import IO
>>> assert IO(1) == IO.from_value(1)
```

Part of the *returns.interfaces.applicative.ApplicativeN* interface.

Parameters **inner_value** (*~_NewValueType*) –

Return type *IO*[~_NewValueType]

classmethod from_io(*inner_value*)
Unit function to construct new `IO` values from existing `IO`.

```
>>> from returns.io import IO
>>> assert IO(1) == IO.from_io(IO(1))
```

Part of the `returns.interfaces.specific.IO.IOLikeN` interface.

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *IO*[~_NewValueType]

classmethod from_ioresult(*inner_value*)
Converts `IOResult[a, b]` back to `IO[Result[a, b]]`.

Can be really helpful for composition.

```
>>> from returns.io import IO, IOSuccess
>>> from returns.result import Success
>>> assert IO.from_ioresult(IOSuccess(1)) == IO(Success(1))
```

Is the reverse of *returns.io.IOResult.from_typecast()*.

Parameters **inner_value** (*IOResult*[~_NewValueType, ~_NewErrorType]) –

Return type *IO*[*Result*[~_NewValueType, ~_NewErrorType]]

impure(*function*)
Decorator to mark function that it returns *IO* container.

If you need to mark `async` function as impure, use *returns.future.future()* instead. This decorator only works with sync functions. Example:

```
>>> from returns.io import IO, impure

>>> @impure
... def function(arg: int) -> int:
...     return arg + 1  # this action is pure, just an example
...

>>> assert function(1) == IO(2)
```

Requires our *mypy plugin*.

Parameters **function** (`Callable[..., ~_NewValueType]`) –

Return type Callable[..., *IO*[~_NewValueType]]

class IOResult(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*IOResult*, returns.io._ValueType, returns.io._ErrorType, NoReturn], *returns.interfaces.specific.ioresult.IOResultBasedN*[returns.io._ValueType, returns.io._ErrorType, NoReturn]

Explicit container for impure function results that might fail.

Definition

This type is similar to *returns.result.Result*. This basically a more useful version of IO[Result[a, b]]. Use this type for IO computations that might fail. Examples of IO computations that might fail are:

- access database
- access network
- access filesystem

Use *IO* for operations that do IO but do not fail.

Note, that even methods like unwrap`()` and *value_or()* return values wrapped in IO.

IOResult is a complex compound value that consists of:

- raw value
- Result
- IO

This is why it has so many helper and factory methods:

- You can construct IOResult from raw values with *IOSuccess()* and *IOFailure()* public type constructors
- You can construct IOResult from IO values with *from_failed_io()* and *IOResult.from_io()*
- You can construct IOResult from Result values with *from_result()*

We also have a lot of utility methods for better function composition like:

- *bind_result()* to work with functions which return Result
- *from_typecast()* to work with IO[Result[...]] values

See also:

https://github.com/gcanti/fp-ts/blob/master/docs/modules/IOEither.ts.md

Implementation

This class contains all the methods that can be delegated to Result. But, some methods are not implemented which means that we have to use special _IOSuccess and _IOFailure implementation details to correctly handle these callbacks.

Do not rely on them! Use public functions and types instead.

Parameters **inner_value** (*Result*[+_ValueType, +_ErrorType]) –

success_type

Success type that is used to represent the successful computation.

Parameters **inner_value** (*+_ValueType*) –

alias of *returns.io.IOSuccess*

failure_type
Failure type that is used to represent the failed computation.

Parameters **inner_value** (*+_ErrorType*) –

alias of *returns.io.IOFailure*

equals(*other*)
Typesafe equality comparison with other *IOResult* objects.

Parameters

- **self** (*KindN*[~_EqualType, Any, Any, Any]) –
- **other** (*KindN*[~_EqualType, Any, Any, Any]) –

Return type bool

property trace: Optional[List[inspect.FrameInfo]]
Returns a stack trace when *IOFailure()* was called.

Return type Optional[List[FrameInfo]]

swap()
Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of .bind_ related methods and only a single .lash - it is easier to work with values.

```
>>> from returns.io import IOSuccess, IOFailure
>>> assert IOSuccess(1).swap() == IOFailure(1)
>>> assert IOFailure(1).swap() == IOSuccess(1)
```

Return type *IOResult*[+_ErrorType, +_ValueType]

map(*function*)
Composes successful container with a pure function.

```
>>> from returns.io import IOSuccess
>>> assert IOSuccess(1).map(lambda num: num + 1) == IOSuccess(2)
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

apply(*container*)
Calls a wrapped function in a container on this container.

```
>>> from returns.io import IOSuccess, IOFailure

>>> def appliable(first: str) -> str:
...     return first + 'b'

>>> assert IOSuccess('a').apply(
...     IOSuccess(appliable),
```

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```
... ) == IOSuccess('ab')
>>> assert IOFailure('a').apply(
...     IOSuccess(appliable),
... ) == IOFailure('a')

>>> assert IOSuccess('a').apply(IOFailure(1)) == IOFailure(1)
>>> assert IOFailure('a').apply(IOFailure('b')) == IOFailure('a')
```

Parameters **container** (*KindN*[*IOResult*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, Any]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

bind(*function*)

Composes successful container with a function that returns a container.

```
>>> from returns.io import IOResult, IOFailure, IOSuccess
>>> def bindable(string: str) -> IOResult[str, str]:
...     if len(string) > 1:
...         return IOSuccess(string + 'b')
...     return IOFailure(string + 'c')

>>> assert IOSuccess('aa').bind(bindable) == IOSuccess('aab')
>>> assert IOSuccess('a').bind(bindable) == IOFailure('ac')
>>> assert IOFailure('a').bind(bindable) == IOFailure('a')
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*IOResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

bind_ioresult(*function*)

Alias for *bind_ioresult* method. Part of the *IOResultBasedN* interface.

Parameters **function** (Callable[[+_ValueType], *KindN*[*IOResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

bind_result(*function*)

Composes successful container with a function that returns a container.

Similar to *bind()*, but works with containers that return *returns.result.Result* instead of *IOResult*.

```
>>> from returns.io import IOFailure, IOSuccess
>>> from returns.result import Result, Success

>>> def bindable(string: str) -> Result[str, str]:
...     if len(string) > 1:
...         return Success(string + 'b')
...     return Failure(string + 'c')

>>> assert IOSuccess('aa').bind_result(bindable) == IOSuccess('aab')
>>> assert IOSuccess('a').bind_result(bindable) == IOFailure('ac')
>>> assert IOFailure('a').bind_result(bindable) == IOFailure('a')
```

Parameters **function** (Callable[[+_ValueType], *Result*[~_NewValueType, +_ErrorType]]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

bind_io(*function*)

Composes successful container with a function that returns a container.

Similar to *bind()*, but works with containers that return *returns.io.IO* instead of *IOResult*.

```
>>> from returns.io import IO, IOFailure, IOSuccess

>>> def bindable(string: str) -> IO[str]:
...     return IO(string + 'z')

>>> assert IOSuccess('a').bind_io(bindable) == IOSuccess('az')
>>> assert IOFailure('a').bind_io(bindable) == IOFailure('a')
```

Parameters **function** (Callable[[+_ValueType], *IO*[~_NewValueType]]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

alt(*function*)

Composes failed container with a pure function to modify failure.

```
>>> from returns.io import IOFailure
>>> assert IOFailure(1).alt(float) == IOFailure(1.0)
```

Parameters **function** (Callable[[+_ErrorType], ~_NewErrorType]) –

Return type *IOResult*[+_ValueType, ~_NewErrorType]

lash(*function*)

Composes failed container with a function that returns a container.

```
>>> from returns.io import IOFailure, IOSuccess, IOResult
>>> def lashable(state: str) -> IOResult[int, str]:
...     if len(state) > 1:
...         return IOSuccess(len(state))
...     return IOFailure('oops')

>>> assert IOFailure('a').lash(lashable) == IOFailure('oops')
>>> assert IOFailure('abc').lash(lashable) == IOSuccess(3)
>>> assert IOSuccess('a').lash(lashable) == IOSuccess('a')
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*IOResult*, +_ValueType, ~_NewErrorType, Any]]) –

Return type *IOResult*[+_ValueType, ~_NewErrorType]

value_or(*default_value*)

Get value from successful container or default value from failed one.

```
>>> from returns.io import IO, IOFailure, IOSuccess
>>> assert IOSuccess(1).value_or(None) == IO(1)
>>> assert IOFailure(1).value_or(None) == IO(None)
```

Parameters **default_value** (*~_NewValueType*) –

Return type *IO*[Union[+_ValueType, ~_NewValueType]]

unwrap()

Get value from successful container or raise exception for failed one.

```
>>> from returns.io import IO, IOFailure, IOSuccess
>>> assert IOSuccess(1).unwrap() == IO(1)

>>> IOFailure(1).unwrap()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type *IO*[+_ValueType]

failure()

Get failed value from failed container or raise exception from success.

```
>>> from returns.io import IO, IOFailure, IOSuccess
>>> assert IOFailure(1).failure() == IO(1)

>>> IOSuccess(1).failure()
Traceback (most recent call last):
  ...
returns.primitives.exceptions.UnwrapFailedError
```

Return type *IO*[+_ErrorType]

compose_result(*function*)

Composes inner `Result` with `IOResult` returning function.

Can be useful when you need an access to both states of the result.

```
>>> from returns.io import IOResult, IOSuccess, IOFailure
>>> from returns.result import Result

>>> def count(container: Result[int, int]) -> IOResult[int, int]:
...     return IOResult.from_result(
...         container.map(lambda x: x + 1).alt(abs),
...     )

>>> assert IOSuccess(1).compose_result(count) == IOSuccess(2)
>>> assert IOFailure(-1).compose_result(count) == IOFailure(1)
```

Parameters **function** (Callable[[*Result*[+_ValueType, +_ErrorType]], *KindN*[*IOResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *IOResult*[~_NewValueType, +_ErrorType]

classmethod from_typecast(*inner_value*)
Converts `IO[Result[_ValueType, _ErrorType]]` to `IOResult`.

Also prevails the type of `Result` to `IOResult`, so: `IO[Result[_ValueType, _ErrorType]]` would become `IOResult[_ValueType, _ErrorType]`.

```
>>> from returns.result import Success
>>> from returns.io import IO, IOResult, IOSuccess
>>> container = IO(Success(1))
>>> assert IOResult.from_typecast(container) == IOSuccess(1)
```

Can be reverted via *returns.io.IO.from_ioresult()* method.

Parameters **inner_value** (*IO*[*Result*[~_NewValueType, ~_NewErrorType]]) –

Return type *IOResult*[~_NewValueType, ~_NewErrorType]

classmethod from_failed_io(*inner_value*)
Creates new `IOResult` from "failed" `IO` container.

```
>>> from returns.io import IO, IOResult, IOFailure
>>> container = IO(1)
>>> assert IOResult.from_failed_io(container) == IOFailure(1)
```

Parameters **inner_value** (*IO*[~_NewErrorType]) –

Return type *IOResult*[Any, ~_NewErrorType]

classmethod from_io(*inner_value*)
Creates new `IOResult` from "successful" `IO` container.

```
>>> from returns.io import IO, IOResult, IOSuccess
>>> container = IO(1)
>>> assert IOResult.from_io(container) == IOSuccess(1)
```

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *IOResult*[~_NewValueType, Any]

classmethod from_result(*inner_value*)
Creates `IOResult` from `Result` value.

```
>>> from returns.io import IOResult, IOSuccess, IOFailure
>>> from returns.result import Success, Failure

>>> assert IOResult.from_result(Success(1)) == IOSuccess(1)
>>> assert IOResult.from_result(Failure(2)) == IOFailure(2)
```

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *IOResult*[~_NewValueType, ~_NewErrorType]

classmethod from_ioresult(*inner_value*)
Creates `IOResult` from existing `IOResult` value.

```
>>> from returns.io import IOResult, IOSuccess, IOFailure

>>> assert IOResult.from_ioresult(IOSuccess(1)) == IOSuccess(1)
>>> assert IOResult.from_ioresult(IOFailure(2)) == IOFailure(2)
```

Parameters **inner_value** (*IOResult*[~_NewValueType, ~_NewErrorType]) –

Return type *IOResult*[~_NewValueType, ~_NewErrorType]

classmethod from_value(*inner_value*)
One more value to create success unit values.

It is useful as a united way to create a new value from any container.

```
>>> from returns.io import IOResult, IOSuccess
>>> assert IOResult.from_value(1) == IOSuccess(1)
```

You can use this method or *IOSuccess()*, choose the most convenient for you.

Parameters **inner_value** (*~_NewValueType*) –

Return type *IOResult*[~_NewValueType, Any]

classmethod from_failure(*inner_value*)
One more value to create failure unit values.

It is useful as a united way to create a new value from any container.

```
>>> from returns.io import IOResult, IOFailure
>>> assert IOResult.from_failure(1) == IOFailure(1)
```

You can use this method or *IOFailure()*, choose the most convenient for you.

Parameters **inner_value** (*~_NewErrorType*) –

Return type *IOResult*[Any, ~_NewErrorType]

class IOFailure(*inner_value*)
Bases: *returns.io.IOResult*[Any, returns.io._ErrorType]

IOFailure representation.

Parameters **inner_value** (*+_ErrorType*) –

bind(*function*)
Does nothing for IOFailure.

bind_ioresult(*function*)
Alias for *bind_ioresult* method. Part of the *IOResultBasedN* interface. # noqa: E501

bind_result(*function*)
Does nothing for IOFailure.

bind_io(*function*)
Does nothing for IOFailure.

lash(*function*)
Composes this container with a function returning IOResult.

class IOSuccess(*inner_value*)
Bases: *returns.io.IOResult*[returns.io._ValueType, Any]

IOSuccess representation.

Parameters **inner_value** (*+_ValueType*) –

bind(*function*)
Composes this container with a function returning IOResult.

bind_ioresult(*function*)
Alias for *bind_ioresult* method. Part of the *IOResultBasedN* interface. # noqa: E501

bind_result(*function*)
Binds Result returning function to current container.

bind_io(*function*)
Binds IO returning function to current container.

lash(*function*)
Does nothing for IOSuccess.

IOResultE
Alias for a popular case when IOResult has Exception as error type.

alias of *returns.io.IOResult*[returns.io._ValueType, Exception]

impure_safe(*function*)
Decorator to mark function that it returns *IOResult* container.

Should be used with care, since it only catches Exception subclasses. It does not catch BaseException subclasses.

If you need to mark async function as impure, use *returns.future.future_safe()* instead. This decorator only works with sync functions. Example:

```
>>> from returns.io import IOSuccess, impure_safe

>>> @impure_safe
... def function(arg: int) -> float:
...     return 1 / arg
...

>>> assert function(1) == IOSuccess(1.0)
>>> assert function(0).failure()
```

Similar to *returns.future.future_safe()* and *returns.result.safe()* decorators.

Requires our *mypy plugin*.

Parameters **function** (Callable[..., ~_NewValueType]) –

Return type Callable[..., *IOResult*[~_NewValueType, Exception]]

unsafe_perform_io(*wrapped_in_io*)
Compatibility utility and escape mechanism from IO world.

Just unwraps the internal value from *returns.io.IO* container. Should be used with caution! Since it might be overused by lazy and ignorant developers.

It is recommended to have only one place (module / file) in your program where you allow unsafe operations.

We recommend to use import-linter to enforce this rule.

```
>>> from returns.io import IO
>>> assert unsafe_perform_io(IO(1)) == 1
```

See also:

- https://github.com/seddonym/import-linter

Parameters **wrapped_in_io** (*IO*[~_ValueType]) –

Return type ~_ValueType

9.9 Future

A set of primitives to work with `async` functions.

Can be used with `asyncio`, `trio`, and `curio`. And any event-loop!

Tested with anyio.

What problems do we solve with these containers? Basically these ones:

1. You cannot call async function from a sync one
2. Any unexpectedly thrown exception can ruin your whole event loop
3. Ugly composition with lots of *await* statements

9.9.1 Future container

Without `Future` container it is impossible to compose two functions: sync and async one.

You simply cannot `await` coroutines inside a sync context. It is even a `SyntaxError`.

```
def test():
    await some()
# SyntaxError: 'await' outside async function
```

So, you have to turn you function into async one. And all callers of this function in async functions. And all their callers.

This is really hard to model. When you code has two types of uncomposable functions you increase your mental complexity by extreme levels.

Instead, you can use `Future` container, it allows you to model async interactions in a sync manner:

```
>>> from returns.future import Future

>>> async def first() -> int:
...     return 1

>>> async def second(arg: int) -> int:
...     return arg + 1

>>> def main() -> Future[int]:  # sync function!
...     return Future(first()).bind_awaitable(second)
```

Now we can compose async functions and maintaining a sync context! It is also possible run a `Future` with regular tools like `asyncio.run` or `anyio.run`:

```
>>> import anyio
>>> from returns.io import IO

>>> assert anyio.run(main().awaitable) == IO(2)
```

One more very useful thing `Future` does behind the scenes is converting its result to `IO`-based containers. This helps a lot when separating pure and impure (async functions are impure) code inside your app.

9.9.2 FutureResult

This container becomes very useful when working with `async` function that can fail.

It works the similar way regular `Result` does. And is literally a wrapper around `Future[Result[_V, _E]]` type.

Let's see how it can be used in a real program:

```
import asyncio  # we use `asyncio` only as an example, you can use any io lib
from typing import Sequence, cast

import httpx  # you would need to `pip install httpx`
from typing_extensions import Final, TypedDict

from returns.future import FutureResultE, future_safe
from returns.io import IOResultE
from returns.iterables import Fold

_URL: Final = 'https://jsonplaceholder.typicode.com/posts/{0}'
_Post = TypedDict('_Post', {
    'id': int,
    'userId': int,
    'title': str,
    'body': str,
})


@future_safe
async def _fetch_post(post_id: int) -> _Post:
    # Ideally, we can use `ReaderFutureResult` to provide `client` from deps.
    async with httpx.AsyncClient(timeout=5) as client:
        response = await client.get(_URL.format(post_id))
        response.raise_for_status()
        return cast(_Post, response.json())  # or validate the response


def _show_titles(number_of_posts: int) -> Sequence[FutureResultE[str]]:
    def factory(post: _Post) -> str:
        return post['title']

    return [
        # Notice how easily we compose async and sync functions:
        _fetch_post(post_id).map(factory)
        # TODO: try `for post_id in (2, 1, 0):` to see how async errors work
        for post_id in range(1, number_of_posts + 1)
```

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```
    ]


async def main() -> IOResultE[Sequence[str]]:
    """
    Main entrypoint for the async world.

    Let's fetch 3 titles of posts asynchronously.
    We use `gather` to run requests in "parallel".
    """
    futures: Sequence[IOResultE[str]] = await asyncio.gather(*_show_titles(3))
    return Fold.collect(futures, IOResultE.from_value(()))


if __name__ == '__main__':
    print(asyncio.run(main()))  # noqa: WPS421
    # <IOResult: <Success: (
    #    'sunt aut facere repellat provident occaecati ...',
    #    'qui est esse',
    #    'ea molestias quasi exercitationem repellat qui ipsa sit aut',
    # )>>
```

What is different?

1. We can now easily make `show_titles` sync, we can also make `_fetch_post` sync, but we would need to use `ReaderFutureResult` container with proper dependencies in this case
2. We now don't care about errors at all. In this example any error will cancel the whole pipeline
3. We now have `.map` method to easily compose sync and async functions

You can see the next example with *RequiresContextFutureResult* and without a single `async/await`. That example illustrates the whole point of our actions: writing sync code that executes asynchronously without any magic at all.

9.9.3 Aliases

There are several useful alises for `FutureResult` type with some common values:

- *returns.future.FutureResultE* is an alias for `FutureResult[... Exception]`, just use it when you want to work with `FutureResult` containers that use exceptions as error type. It is named `FutureResultE` because it is `FutureResultException` and `FutureResultError` at the same time.

9.9.4 Decorators

future

This decorator helps to easily transform `async def` into `Future`:

```
>>> import anyio
>>> from returns.future import future, Future
>>> from returns.io import IO

>>> @future
```

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```
... async def test(arg: int) -> float:
...     return arg / 2

>>> future_instance = test(1)
>>> assert isinstance(future_instance, Future)
>>> assert anyio.run(future_instance.awaitable) == IO(0.5)
```

Make sure that you decorate with `@future` only coroutines that do not throw exceptions. For ones that do, use `future_safe`.

future_safe

This decorator converts `async def` into `FutureResult`, which means that it becomes:

1. Full featured `Future` like container
2. Safe from any exceptions

Let's dig into it:

```
>>> import anyio
>>> from returns.future import future_safe, FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> @future_safe
... async def test(arg: int) -> float:
...     return 1 / arg

>>> future_instance = test(2)
>>> assert isinstance(future_instance, FutureResult)
>>> assert anyio.run(future_instance.awaitable) == IOSuccess(0.5)

>>> str(anyio.run(test(0).awaitable))  # this will fail
'<IOResult: <Failure: division by zero>>'
```

Never miss exceptions ever again!

asyncify

Helper decorator to transform regular sync function into `async` ones.

```
>>> import anyio
>>> from inspect import iscoroutinefunction
>>> from returns.future import asyncify

>>> @asyncify
... def your_function(x: int) -> int:
...     return x + 1

>>> assert iscoroutinefunction(your_function) is True
>>> assert anyio.run(your_function, 1) == 2
```

Very important node: making your function `async` does not mean it will work asynchronously. It can still block if it uses blocking calls. Here's an example of how you **must not** do:

```
import requests
from returns.future import asyncify

@asyncify
def please_do_not_do_that():
    return requests.get('...')  # this will still block!
```

Do not overuse this decorator. It is only useful for some basic composition with `Future` and `FutureResult`.

9.9.5 FAQ

Is it somehow related to Future object from asyncio?

Nope, we just use the same naming there are in other languages and platforms. Python happens to have its own meaning for this word.

In our worldview, these two `Future` entities should never meet each other in a single codebase.

It is also not related to concurrent.Future.

How to create unit objects?

For `Future` container:

- `from_value` when you have a raw value
- `from_io` when you have existing `IO` container
- `from_future_result` when you have existing `FutureResult`

For `FutureResult` container:

- `from_value` when you want to mark some raw value as a `Success`
- `from_failure` when you want to mark some raw value as a `Failure`
- `from_result` when you already have `Result` container
- `from_io` when you have successful `IO`
- `from_failed_io` when you have failed `IO`
- `from_future` when you have successful `Future`
- `from_failed_future` when you have failed `Future`
- `from_typecast` when you have existing `Future[Result]`

What is the difference between Future[Result[a, b]] and FutureResult[a, b]?

There's almost none.

The only difference is that `FutureResult[a, b]` is a handy wrapper around `Future[Result[a, b]]`, so you won't need to use methods like `.map` and `.bind` twice.

You can always convert it with methods like `.from_typecast` and `.from_future_result`.

9.9.6 Further reading

- How Async Should Have Been
- What Color is Your Function?
- From Promises to Futures

9.9.7 API Reference

async async_identity(*instance*)

Async function that returns its argument.

```
>>> import anyio
>>> from returns.future import async_identity
>>> assert anyio.run(async_identity, 1) == 1
```

See *returns.functions.identity()* for sync version of this function and more docs and examples.

Parameters **instance** (*~_FirstType*) –

Return type ~_FirstType

class Future(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*Future*, returns.future._ValueType, NoReturn, NoReturn], *returns.interfaces.specific.future.FutureBasedN*[returns.future._ValueType, NoReturn, NoReturn]

Container to easily compose `async` functions.

Represents a better abstraction over a simple coroutine.

Is framework, event-loop, and IO-library agnostics. Works with `asyncio`, `curio`, `trio`, or any other tool. Internally we use `anyio` to test that it works as expected for any io stack.

Note that `Future[a]` represents a computation that never fails and returns `IO[a]` type. Use `FutureResult[a, b]` for operations that might fail. Like DB access or network operations.

Is not related to `asyncio.Future` in any kind.

Tradeoffs

Due to possible performance issues we move all coroutines definitions to a separate module.

See also:

- https://gcanti.github.io/fp-ts/modules/Task.ts.html
- https://zio.dev/docs/overview/overview_basic_concurrency

Parameters **inner_value** (Awaitable[+_ValueType]) –

async **awaitable**()

Transforms Future[a] to Awaitable[IO[a]].

Use this method when you need a real coroutine. Like for asyncio.run calls.

Note, that returned value will be wrapped in *returns.io.IO* container.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO
>>> assert anyio.run(Future.from_value(1).awaitable) == IO(1)
```

Return type *IO*[+_ValueType]

map(*function*)

Applies function to the inner value.

Applies 'function' to the contents of the IO instance and returns a new Future object containing the result. 'function' should accept a single "normal" (non-container) argument and return a non-container result.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> def mappable(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     Future.from_value(1).map(mappable).awaitable,
... ) == IO(2)
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *Future*[~_NewValueType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> import anyio
>>> from returns.future import Future

>>> def transform(arg: int) -> str:
...     return str(arg) + 'b'
```

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```
>>> assert anyio.run(
...     Future.from_value(1).apply(
...         Future.from_value(transform),
...     ).awaitable,
... ) == IO('1b')
```

Parameters **container** (*KindN*[*Future*, Callable[[+_ValueType], ~_NewValueType], Any, Any]) –

Return type *Future*[~_NewValueType]

bind(*function*)

Applies 'function' to the result of a previous calculation.

'function' should accept a single "normal" (non-container) argument and return `Future` type object.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> def bindable(x: int) -> Future[int]:
...     return Future.from_value(x + 1)

>>> assert anyio.run(
...     Future.from_value(1).bind(bindable).awaitable,
... ) == IO(2)
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*Future*, ~_NewValueType, Any, Any]]) –

Return type *Future*[~_NewValueType]

bind_future(*function*)

Alias for *bind* method. Part of the *FutureBasedN* interface.

Parameters **function** (Callable[[+_ValueType], *KindN*[*Future*, ~_NewValueType, Any, Any]]) –

Return type *Future*[~_NewValueType]

bind_async(*function*)

Compose a container and `async` function returning a container.

This function should return a container value. See *bind_awaitable()* to bind `async` function that returns a plain value.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> async def coroutine(x: int) -> Future[str]:
...     return Future.from_value(str(x + 1))

>>> assert anyio.run(
```

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```
...     Future.from_value(1).bind_async(coroutine).awaitable,
... ) == IO('2')
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*Future*, ~_NewValueType, Any, Any]]]) –

Return type *Future*[~_NewValueType]

bind_async_future(*function*)

Alias for *bind_async* method. Part of the *FutureBasedN* interface.

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*Future*, ~_NewValueType, Any, Any]]]) –

Return type *Future*[~_NewValueType]

bind_awaitable(*function*)

Allows to compose a container and a regular `async` function.

This function should return plain, non-container value. See *bind_async()* to bind `async` function that returns a container.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> async def coroutine(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     Future.from_value(1).bind_awaitable(coroutine).awaitable,
... ) == IO(2)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[~_NewValueType]]) –

Return type *Future*[~_NewValueType]

bind_io(*function*)

Applies 'function' to the result of a previous calculation.

'function' should accept a single "normal" (non-container) argument and return `IO` type object.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> def bindable(x: int) -> IO[int]:
...     return IO(x + 1)

>>> assert anyio.run(
...     Future.from_value(1).bind_io(bindable).awaitable,
... ) == IO(2)
```

Parameters **function** (Callable[[+_ValueType], *IO*[~_NewValueType]]) –

Return type *Future*[~_NewValueType]

classmethod from_value(*inner_value*)
Allows to create a `Future` from a plain value.

The resulting `Future` will just return the given value wrapped in *returns.io.IO* container when awaited.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> async def main() -> bool:
...     return (await Future.from_value(1)) == IO(1)

>>> assert anyio.run(main) is True
```

Parameters **inner_value** (*~_NewValueType*) –

Return type *Future*[~_NewValueType]

classmethod from_future(*inner_value*)
Creates a new `Future` from the existing one.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> future = Future.from_value(1)
>>> assert anyio.run(Future.from_future(future).awaitable) == IO(1)
```

Part of the `FutureBasedN` interface.

Parameters **inner_value** (*Future*[~_NewValueType]) –

Return type *Future*[~_NewValueType]

classmethod from_io(*inner_value*)
Allows to create a `Future` from `IO` container.

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO

>>> async def main() -> bool:
...     return (await Future.from_io(IO(1))) == IO(1)

>>> assert anyio.run(main) is True
```

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *Future*[~_NewValueType]

classmethod from_future_result(*inner_value*)
Creates `Future[Result[a, b]]` instance from `FutureResult[a, b]`.

This method is the inverse of *from_typecast()*.

```
>>> import anyio
>>> from returns.future import Future, FutureResult
>>> from returns.io import IO
>>> from returns.result import Success

>>> container = Future.from_future_result(FutureResult.from_value(1))
>>> assert anyio.run(container.awaitable) == IO(Success(1))
```

Parameters **inner_value** (*FutureResult*[~_NewValueType, ~_NewErrorType]) –

Return type *Future*[*Result*[~_NewValueType, ~_NewErrorType]]

future(*function*)

Decorator to turn a coroutine definition into `Future` container.

```
>>> import anyio
>>> from returns.io import IO
>>> from returns.future import future

>>> @future
... async def test(x: int) -> int:
...     return x + 1

>>> assert anyio.run(test(1).awaitable) == IO(2)
```

Requires our *mypy plugin*.

Parameters **function** (`Callable`[..., `Coroutine`[~_FirstType, ~_SecondType, +_ValueType]]) –

Return type `Callable`[..., *Future*[+_ValueType]]

asyncify(*function*)

Decorator to turn a common function into an asynchronous function.

This decorator is useful for composition with `Future` and `FutureResult` containers.

Warning: This function will not your sync function **run** like async one. It will still be a blocking function that looks like async one. We recommend to only use this decorator with functions that do not access network or filesystem. It is only a composition helper, not a transformer.

Usage example:

```
>>> import anyio
>>> from returns.future import asyncify

>>> @asyncify
... def test(x: int) -> int:
...     return x + 1

>>> assert anyio.run(test, 1) == 2
```

Requires our *mypy plugin*.

Read more about async and sync functions: https://journal.stuffwithstuff.com/2015/02/01/what-color-is-your-function/

Parameters **function** (Callable[..., +_ValueType]) –

Return type Callable[..., Coroutine[Any, Any, +_ValueType]]

class FutureResult(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*FutureResult*, returns.future._ValueType, returns.future._ErrorType, NoReturn], *returns.interfaces.specific.future_result.FutureResultBasedN*[returns.future._ValueType, returns.future._ErrorType, NoReturn]

Container to easily compose `async` functions.

Represents a better abstraction over a simple coroutine.

Is framework, event-loop, and IO-library agnostics. Works with `asyncio`, `curio`, `trio`, or any other tool. Internally we use `anyio` to test that it works as expected for any io stack.

Note that `FutureResult[a, b]` represents a computation that can fail and returns `IOResult[a, b]` type. Use `Future[a]` for operations that cannot fail.

This is a `Future` that returns `Result` type. By providing this utility type we make developers' lives easier. `FutureResult` has a lot of composition helpers to turn complex nested operations into a one function calls.

Tradeoffs

Due to possible performance issues we move all coroutines definitions to a separate module.

See also:

- https://gcanti.github.io/fp-ts/modules/TaskEither.ts.html
- https://zio.dev/docs/overview/overview_basic_concurrency

Parameters **inner_value** (Awaitable[*Result*[+_ValueType, +_ErrorType]]) –

async awaitable()

Transforms `FutureResult[a, b]` to `Awaitable[IOResult[a, b]]`.

Use this method when you need a real coroutine. Like for `asyncio.run` calls.

Note, that returned value will be wrapped in *returns.io.IOResult* container.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess
>>> assert anyio.run(
...     FutureResult.from_value(1).awaitable,
... ) == IOSuccess(1)
```

Return type *IOResult*[+_ValueType, +_ErrorType]

swap()

Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of `.bind_` related methods and only a single `.lash`. It is easier to work with values than with errors.

```
>>> import anyio
>>> from returns.future import FutureSuccess, FutureFailure
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(FutureSuccess(1).swap) == IOFailure(1)
>>> assert anyio.run(FutureFailure(1).swap) == IOSuccess(1)
```

Return type *FutureResult*[+_ErrorType, +_ValueType]

map(*function*)

Applies function to the inner value.

Applies 'function' to the contents of the IO instance and returns a new `FutureResult` object containing the result. 'function' should accept a single "normal" (non-container) argument and return a non-container result.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def mappable(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     FutureResult.from_value(1).map(mappable).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure(1).map(mappable).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (`Callable`[[+_ValueType], ~_NewValueType]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def appliable(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     FutureResult.from_value(1).apply(
...         FutureResult.from_value(appliable),
...     ).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure(1).apply(
...         FutureResult.from_value(appliable),
...     ).awaitable,
```

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```
... ) == IOFailure(1)

>>> assert anyio.run(
...     FutureResult.from_value(1).apply(
...         FutureResult.from_failure(2),
...     ).awaitable,
... ) == IOFailure(2)
>>> assert anyio.run(
...     FutureResult.from_failure(1).apply(
...         FutureResult.from_failure(2),
...     ).awaitable,
... ) == IOFailure(1)
```

Parameters **container** (*KindN*[*FutureResult*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, Any]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind(*function*)

Applies 'function' to the result of a previous calculation.

'function' should accept a single "normal" (non-container) argument and return `Future` type object.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def bindable(x: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(x + 1)

>>> assert anyio.run(
...     FutureResult.from_value(1).bind(bindable).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind(bindable).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*FutureResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_future_result(*function*)

Alias for *bind* method. Part of the *FutureResultBasedN* interface.

Parameters **function** (Callable[[+_ValueType], *KindN*[*FutureResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_async(*function*)

Composes a container and `async` function returning container.

This function should return a container value. See *bind_awaitable()* to bind `async` function that returns a plain value.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def coroutine(x: int) -> FutureResult[str, int]:
...     return FutureResult.from_value(str(x + 1))

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_async(coroutine).awaitable,
... ) == IOSuccess('2')
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind_async(coroutine).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*FutureResult*, ~_NewValueType, +_ErrorType, Any]]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_async_future_result(*function*)

Alias for *bind_async* method. Part of the *FutureResultBasedN* interface.

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*FutureResult*, ~_NewValueType, +_ErrorType, Any]]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_awaitable(*function*)

Allows to compose a container and a regular `async` function.

This function should return plain, non-container value. See *bind_async()* to bind `async` function that returns a container.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def coro(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_awaitable(coro).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind_awaitable(coro).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[~_NewValueType]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_result(*function*)

Binds a function returning `Result[a, b]` container.

```
>>> import anyio
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Result, Success
>>> from returns.future import FutureResult

>>> def bind(inner_value: int) -> Result[int, str]:
...     return Success(inner_value + 1)

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_result(bind).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure('a').bind_result(bind).awaitable,
... ) == IOFailure('a')
```

Parameters **function** (Callable[[+_ValueType], *Result*[~_NewValueType, +_ErrorType]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_ioresult(*function*)

Binds a function returning `IOResult[a, b]` container.

```
>>> import anyio
>>> from returns.io import IOResult, IOSuccess, IOFailure
>>> from returns.future import FutureResult

>>> def bind(inner_value: int) -> IOResult[int, str]:
...     return IOSuccess(inner_value + 1)

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_ioresult(bind).awaitable,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure('a').bind_ioresult(bind).awaitable,
... ) == IOFailure('a')
```

Parameters **function** (Callable[[+_ValueType], *IOResult*[~_NewValueType, +_ErrorType]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_io(*function*)

Binds a function returning `IO[a]` container.

```
>>> import anyio
>>> from returns.io import IO, IOSuccess, IOFailure
>>> from returns.future import FutureResult

>>> def bind(inner_value: int) -> IO[float]:
...     return IO(inner_value + 0.5)

>>> assert anyio.run(
```

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```
...     FutureResult.from_value(1).bind_io(bind).awaitable,
... ) == IOSuccess(1.5)
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind_io(bind).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], *IO*[~_NewValueType]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_future(*function*)

Binds a function returning `Future[a]` container.

```
>>> import anyio
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.future import Future, FutureResult

>>> def bind(inner_value: int) -> Future[float]:
...     return Future.from_value(inner_value + 0.5)

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_future(bind).awaitable,
... ) == IOSuccess(1.5)
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind_future(bind).awaitable,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], *Future*[~_NewValueType]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

bind_async_future(*function*)

Composes a container and `async` function returning `Future`.

Similar to *bind_future()* but works with async functions.

```
>>> import anyio
>>> from returns.future import Future, FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def coroutine(x: int) -> Future[str]:
...     return Future.from_value(str(x + 1))

>>> assert anyio.run(
...     FutureResult.from_value(1).bind_async_future,
...     coroutine,
... ) == IOSuccess('2')
>>> assert anyio.run(
...     FutureResult.from_failure(1).bind_async,
...     coroutine,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*Future*[~_NewValueType]]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

alt(*function*)

Composes failed container with a pure function to modify failure.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def altable(arg: int) -> int:
...     return arg + 1

>>> assert anyio.run(
...     FutureResult.from_value(1).alt(altable).awaitable,
... ) == IOSuccess(1)
>>> assert anyio.run(
...     FutureResult.from_failure(1).alt(altable).awaitable,
... ) == IOFailure(2)
```

Parameters **function** (Callable[[+_ErrorType], ~_NewErrorType]) –

Return type *FutureResult*[+_ValueType, ~_NewErrorType]

lash(*function*)

Composes failed container with a function that returns a container.

```
>>> import anyio
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess

>>> def lashable(x: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(x + 1)

>>> assert anyio.run(
...     FutureResult.from_value(1).lash(lashable).awaitable,
... ) == IOSuccess(1)
>>> assert anyio.run(
...     FutureResult.from_failure(1).lash(lashable).awaitable,
... ) == IOSuccess(2)
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*FutureResult*, +_ValueType, ~_NewErrorType, Any]]) –

Return type *FutureResult*[+_ValueType, ~_NewErrorType]

compose_result(*function*)

Composes inner `Result` with `FutureResult` returning function.

Can be useful when you need an access to both states of the result.

```
>>> import anyio
>>> from returns.future import FutureResult
```

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```
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Result

>>> def count(container: Result[int, int]) -> FutureResult[int, int]:
...     return FutureResult.from_result(
...         container.map(lambda x: x + 1).alt(abs),
...     )

>>> assert anyio.run(
...     FutureResult.from_value(1).compose_result, count,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     FutureResult.from_failure(-1).compose_result, count,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[*Result*[+_ValueType, +_ErrorType]], *KindN*[*FutureResult*, ~_NewValueType, +_ErrorType, Any]]) –

Return type *FutureResult*[~_NewValueType, +_ErrorType]

classmethod from_typecast(*inner_value*)

Creates `FutureResult[a, b]` from `Future[Result[a, b]]`.

```
>>> import anyio
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Success, Failure
>>> from returns.future import Future, FutureResult

>>> async def main():
...     assert await FutureResult.from_typecast(
...         Future.from_value(Success(1)),
...     ) == IOSuccess(1)
...     assert await FutureResult.from_typecast(
...         Future.from_value(Failure(1)),
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*Future*[*Result*[~_NewValueType, ~_NewErrorType]]) –

Return type *FutureResult*[~_NewValueType, ~_NewErrorType]

classmethod from_future(*inner_value*)

Creates `FutureResult` from successful `Future` value.

```
>>> import anyio
>>> from returns.io import IOSuccess
>>> from returns.future import Future, FutureResult

>>> async def main():
...     assert await FutureResult.from_future(
...         Future.from_value(1),
```

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```
...     ) == IOSuccess(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*Future*[~_NewValueType]) –

Return type *FutureResult*[~_NewValueType, Any]

classmethod from_failed_future(*inner_value*)

Creates FutureResult from failed Future value.

```
>>> import anyio
>>> from returns.io import IOFailure
>>> from returns.future import Future, FutureResult

>>> async def main():
...     assert await FutureResult.from_failed_future(
...         Future.from_value(1),
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*Future*[~_NewErrorType]) –

Return type *FutureResult*[Any, ~_NewErrorType]

classmethod from_future_result(*inner_value*)

Creates new FutureResult from existing one.

```
>>> import anyio
>>> from returns.io import IOSuccess
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_future_result(
...         FutureResult.from_value(1),
...     ) == IOSuccess(1)

>>> anyio.run(main)
```

Part of the FutureResultLikeN interface.

Parameters **inner_value** (*FutureResult*[~_NewValueType, ~_NewErrorType]) –

Return type *FutureResult*[~_NewValueType, ~_NewErrorType]

classmethod from_io(*inner_value*)

Creates FutureResult from successful IO value.

```
>>> import anyio
>>> from returns.io import IO, IOSuccess
>>> from returns.future import FutureResult

>>> async def main():
```

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```
...     assert await FutureResult.from_io(
...         IO(1),
...     ) == IOSuccess(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *FutureResult*[~_NewValueType, Any]

classmethod from_failed_io(*inner_value*)

Creates FutureResult from failed IO value.

```
>>> import anyio
>>> from returns.io import IO, IOFailure
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_failed_io(
...         IO(1),
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*IO*[~_NewErrorType]) –

Return type *FutureResult*[Any, ~_NewErrorType]

classmethod from_ioresult(*inner_value*)

Creates FutureResult from IOResult value.

```
>>> import anyio
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_ioresult(
...         IOSuccess(1),
...     ) == IOSuccess(1)
...     assert await FutureResult.from_ioresult(
...         IOFailure(1),
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*IOResult*[~_NewValueType, ~_NewErrorType]) –

Return type *FutureResult*[~_NewValueType, ~_NewErrorType]

classmethod from_result(*inner_value*)

Creates FutureResult from Result value.

```
>>> import anyio
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Success, Failure
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_result(
...         Success(1),
...     ) == IOSuccess(1)
...     assert await FutureResult.from_result(
...         Failure(1),
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *FutureResult*[~_NewValueType, ~_NewErrorType]

classmethod **from_value**(*inner_value*)

Creates `FutureResult` from successful value.

```
>>> import anyio
>>> from returns.io import IOSuccess
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_value(
...         1,
...     ) == IOSuccess(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*~_NewValueType*) –

Return type *FutureResult*[~_NewValueType, Any]

classmethod **from_failure**(*inner_value*)

Creates `FutureResult` from failed value.

```
>>> import anyio
>>> from returns.io import IOFailure
>>> from returns.future import FutureResult

>>> async def main():
...     assert await FutureResult.from_failure(
...         1,
...     ) == IOFailure(1)

>>> anyio.run(main)
```

Parameters **inner_value** (*~_NewErrorType*) –

Return type *FutureResult*[Any, ~_NewErrorType]

FutureSuccess(*inner_value*)
Public unit function to create successful `FutureResult` objects.

Is the same as *from_value()*.

```
>>> import anyio
>>> from returns.future import FutureResult, FutureSuccess

>>> assert anyio.run(FutureSuccess(1).awaitable) == anyio.run(
...     FutureResult.from_value(1).awaitable,
... )
```

Parameters **inner_value** (*~_NewValueType*) –

Return type *FutureResult*[~_NewValueType, Any]

FutureFailure(*inner_value*)
Public unit function to create failed `FutureResult` objects.

Is the same as *from_failure()*.

```
>>> import anyio
>>> from returns.future import FutureResult, FutureFailure

>>> assert anyio.run(FutureFailure(1).awaitable) == anyio.run(
...     FutureResult.from_failure(1).awaitable,
... )
```

Parameters **inner_value** (*~_NewErrorType*) –

Return type *FutureResult*[Any, ~_NewErrorType]

FutureResultE
Alias for a popular case when `Result` has `Exception` as error type.

alias of *returns.future.FutureResult*[returns.future._ValueType, Exception]

future_safe(*function*)
Decorator to convert exception-throwing coroutine to `FutureResult`.

Should be used with care, since it only catches `Exception` subclasses. It does not catch `BaseException` subclasses.

If you need to mark sync function as `safe`, use *returns.future.future_safe()* instead. This decorator only works with `async` functions. Example:

```
>>> import anyio
>>> from returns.future import future_safe
>>> from returns.io import IOSuccess, IOResult

>>> @future_safe
... async def might_raise(arg: int) -> float:
...     return 1 / arg
...

>>> assert anyio.run(might_raise(2).awaitable) == IOSuccess(0.5)
>>> assert isinstance(
```

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```
...     anyio.run(might_raise(0).awaitable),
...     IOResult.failure_type,
... )
```

Similar to *returns.io.impure_safe()* and *returns.result.safe()* decorators, but works with `async` functions.

Requires our *mypy plugin*.

Parameters **function** (`Callable[..., Coroutine[~_FirstType, ~_SecondType, +_ValueType]]`) –

Return type `Callable[..., FutureResult[+_ValueType, Exception]]`

9.10 Context

Dependency injection is a popular software architecture pattern.

It's main idea is that you provide Inversion of Control and can pass different things into your logic instead of hardcoding you stuff. And by doing this you are on your way to achieve Single Responsibility for your functions and objects.

9.10.1 Using the context

A lot of programs we write rely on the context implicitly or explicitly. We can rely on configuration, env variables, stubs, logical dependencies, etc.

Let's look at the example.

Simple app

One of the most popular errors Python developers do in `Django` is that they overuse `settings` object inside the business logic. This makes your logic framework-oriented and hard to reason about in large projects.

Because values just pop out of nowhere in a deeply nested functions. And can be changed from the outside, from the context of your app.

Imagine that you have a `django` based game, where you award users with points for each guessed letter in a word (unguessed letters are marked as `'.'`):

```
from django.http import HttpRequest, HttpResponse
from words_app.logic import calculate_points

def view(request: HttpRequest) -> HttpResponse:
    user_word: str = request.POST['word']  # just an example
    points = calculate_points(user_word)
    ...  # later you show the result to user somehow
```

```
# Somewhere in your `words_app/logic.py`:

def calculate_points(word: str) -> int:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)
```

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```
def _award_points_for_letters(guessed: int) -> int:
    return 0 if guessed < 5 else guessed  # minimum 6 points possible!
```

Straight and simple!

Adding configuration

But, later you decide to make the game more fun: let's make the minimal accoutable letters threshold configurable for an extra challenge.

You can just do it directly:

```
def _award_points_for_letters(guessed: int, threshold: int) -> int:
    return 0 if guessed < threshold else guessed
```

And now your code won't simply type-check. Because that's how our caller looks like:

```
def calculate_points(word: str) -> int:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)
```

To fix this `calculate_points` function (and all other upper caller functions) will have to accept `threshold: int` as a parameter and pass it to `_award_points_for_letters`.

Imagine that your large project has multiple things to configure in multiple functions. What a mess it would be!

Ok, you can directly use `django.settings` (or similar) in your `_award_points_for_letters` function. And ruin your pure logic with framework-specific details. That's ugly!

Explicitly reling on context

We have learned that this tiny change showed us that it is not so easy to rely on implicit app context.

And instead of passing parameters for all callstack or using dirty framework specific magic you can use `RequiresContext` container. That was built just for this case.

Let's see how our code changes:

```
from django.conf import settings
from django.http import HttpRequest, HttpResponse
from words_app.logic import calculate_points

def view(request: HttpRequest) -> HttpResponse:
    user_word: str = request.POST['word']  # just an example
    points = calculate_points(user_words)(settings)  # passing the dependencies
    ...  # later you show the result to user somehow
```

```
# Somewhere in your `words_app/logic.py`:

from typing_extensions import Protocol
from returns.context import RequiresContext

class _Deps(Protocol):  # we rely on abstractions, not direct values or types
```

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```
    WORD_THRESHOLD: int

def calculate_points(word: str) -> RequiresContext[int, _Deps]:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)

def _award_points_for_letters(guessed: int) -> RequiresContext[int, _Deps]:
    return RequiresContext(
        lambda deps: 0 if guessed < deps.WORD_THRESHOLD else guessed,
    )
```

And now you can pass your dependencies in a really direct and explicit way.

ask

Let's try to configure how we mark our unguessed letters (previously unguessed letters were marked as `'.'`). Let's say, we want to change this to be `_`.

How can we do that with our existing function?

```
def calculate_points(word: str) -> RequiresContext[int, _Deps]:
    guessed_letters_count = len([letter for letter in word if letter != '.'])
    return _award_points_for_letters(guessed_letters_count)
```

We are already using `RequiresContext`, but its dependencies are just hidden from us! We have a special helper for this case: `.ask()`, which returns us current dependencies.

The only thing we need to is to properly annotate the type for our case: `RequiresContext[int, _Deps].ask()` Sadly, currently `mypy` is not able to infer the dependency type out of the context and we need to explicitly provide it.

Let's see the final result:

```
from returns.context import RequiresContext, RequiresContext

class _Deps(Protocol):  # we rely on abstractions, not direct values or types
    WORD_THRESHOLD: int
    UNGUESSED_CHAR: str

def calculate_points(word: str) -> RequiresContext[int, _Deps]:
    def factory(deps: _Deps) -> RequiresContext[int, _Deps]:
        guessed_letters_count = len([
            letter for letter in word if letter != deps.UNGUESSED_CHAR
        ])
        return _award_points_for_letters(guessed_letters_count)

    return RequiresContext[int, _Deps].ask().bind(factory)
```

And now we access the current context from any place in our callstack. Isn't it convenient?

Warning: `RequiresContext` and similar types are not recursion safe. If you would have nesting of more than `sys.getrecursionlimit()` you will end up with `RecursionError`. Will this ever happen to you? Probably not.

9.10.2 RequiresContext container

The concept behind *RequiresContext* container is really simple. It is a container around `Callable[[EnvType], ReturnType]` function.

By its definition it works with pure functions that never fails.

It can be illustrated as a simple nested function:

```
>>> from typing import Callable
>>> def first(limit: int) -> Callable[[str], bool]:
...     def inner(deps: str) -> bool:
...         return len(deps) > limit
...     return inner

>>> assert first(2)('abc')  # first(limit)(deps)
>>> assert not first(5)('abc')  # first(limit)(deps)
```

That's basically enough to make dependency injection possible. But how would you compose `first` function? Let's say with the following function:

```
>>> def bool_to_str(arg: bool) -> str:
...     return 'ok' if arg else 'nope'
```

It would be hard, knowing that it returns another function to be called later when the context is known.

We can wrap it in `RequiresContext` container to allow better composition!

```
>>> from returns.context import RequiresContext

>>> def first(limit: int) -> RequiresContext[bool, str]:
...     def inner(deps: str) -> bool:
...         return len(deps) > limit
...     return RequiresContext(inner)  # wrapping function here!

>>> assert first(1).map(bool_to_str)('abc') == 'ok'
>>> assert first(5).map(bool_to_str)('abc') == 'nope'
```

There's how execution flows:

Fig. 7: RequiresContext execution flow.

The rule is: the dependencies are injected at the very last moment in time. And then normal logical execution happens.

9.10.3 RequiresContextResult container

RequiresContextResult container is a combination of `RequiresContext[Result[a, b], env]`. Which means that it is a wrapper around pure function that might fail.

We also added a lot of useful methods for this container, so you can work easily with it:

- *bind_result()* allows to bind functions that return `Result` with just one call
- *bind_context()* allows to bind functions that return `RequiresContext` easily
- There are also several useful constructors from any possible type

Use it when you work with pure context-related functions that might fail.

9.10.4 RequiresContextIOResult container

RequiresContextIOResult container is a combination of `RequiresContext[IOResult[a, b], env]`. Which means that it is a wrapper around impure function that might fail.

We also added a lot of useful methods for this container, so you can work easily with it:

- *bind_result()* allows to bind functions that return `Result` with just one call
- *bind_io()* allows to bind functions that return `IO` with just one call
- *bind_ioresult()* allows to bind functions that return `IOResult` with just one call
- *bind_context()* allows to bind functions that return `RequiresContext` easily
- *bind_context_result()* allows to bind functions that return `RequiresContextResult` easily
- There are also several useful constructors from any possible type

Use it when you work with impure context-related functions that might fail. This is basically **the main type** that is going to be used in most apps.

9.10.5 RequiresContextFutureResult container

RequiresContextFutureResult container is a combination of `RequiresContext[FutureResult[a, b], env]`. Which means that it is a wrapper around impure async function that might fail.

Here's how it should be used:

```
from typing import Sequence, cast

import anyio  # you would need to `pip install anyio`
import httpx  # you would need to `pip install httpx`
from typing_extensions import Final, TypedDict

from returns.context import RequiresContextFutureResultE
from returns.functions import tap
from returns.future import FutureResultE, future_safe
from returns.iterables import Fold
from returns.pipeline import managed
from returns.result import ResultE, safe

_URL: Final = 'https://jsonplaceholder.typicode.com/posts/{0}'
_Post = TypedDict('_Post', {
    'id': int,
    'userId': int,
    'title': str,
    'body': str,
})


def _close(
    client: httpx.AsyncClient,
    raw_value: ResultE[Sequence[str]],
) -> FutureResultE[None]:
    return future_safe(client.aclose)()

```

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```python

def _fetch_post(
    post_id: int,
) -> RequiresContextFutureResultE[_Post, httpx.AsyncClient]:
    context: RequiresContextFutureResultE[
        httpx.AsyncClient,
        httpx.AsyncClient,
    ] = RequiresContextFutureResultE.ask()

    return context.bind_future_result(
        lambda client: future_safe(client.get)(_URL.format(post_id)),
    ).bind_result(
        safe(tap(httpx.Response.raise_for_status)),
    ).map(
        lambda response: cast(_Post, response.json()),  # or validate it
    )


def _show_titles(
    number_of_posts: int,
) -> RequiresContextFutureResultE[Sequence[str], httpx.AsyncClient]:
    def factory(post: _Post) -> str:
        return post['title']

    titles = [
        # Notice how easily we compose async and sync functions:
        _fetch_post(post_id).map(factory)
        # TODO: try `for post_id in (2, 1, 0):` to see how errors work
        for post_id in range(1, number_of_posts + 1)
    ]
    return Fold.collect(titles, RequiresContextFutureResultE.from_value(()))


if __name__ == '__main__':
    # Let's fetch 3 titles of posts one-by-one, but with async client,
    # because we want to highlight `managed` in this example:
    managed_httpx = managed(_show_titles(3), _close)
    future_result = managed_httpx(
        FutureResultE.from_value(httpx.AsyncClient(timeout=5)),
    )
    print(anyio.run(future_result.awaitable))  # noqa: WPS421
    # <IOResult: <Success: (
    #    'sunt aut facere repellat provident occaecati ...',
    #    'qui est esse',
    #    'ea molestias quasi exercitationem repellat qui ipsa sit aut',
    # )>>
```

This example illustrates the whole point of our actions: writing sync code that executes asynchronously without any magic at all!

We also added a lot of useful methods for this container, so you can work easily with it.

These methods are identical with `RequiresContextIOResult`:

- *bind_result()* allows to bind functions that return `Result` with just one call
- *bind_io()* allows to bind functions that return `IO` with just one call
- *bind_ioresult()* allows to bind functions that return `IOResult` with just one call
- *bind_future_result()* allows to bind functions that return `FutureResult` with just one call
- *bind_context()* allows to bind functions that return `RequiresContext` easily
- *bind_context_result()* allows to bind functions that return `RequiresContextResult` easily

There are new ones:

- *bind_future()* allows to bind functions that return `Future` container
- *bind_future_result()* allows to bind functions that return `FutureResult` container
- *bind_async_future()* allows to bind async functions that return `Future` container
- *bind_async_future_result()* allows to bind async functions that return `FutureResult` container
- *bind_context_ioresult()* allows to bind functions that return `RequiresContextIOResult`
- *bind_async()* allows to bind async functions that return `RequiresContextFutureResult` container
- *bind_awaitable()* allows to bind async function that return raw values

Use it when you work with impure context-related functions that might fail. This is basically **the main type** that is going to be used in most apps.

9.10.6 Aliases

There are several useful aliases for `RequiresContext` and friends with some common values:

- *Reader* is an alias for `RequiresContext[...]` to save you some typing. Uses `Reader` because it is a native name for this concept from Haskell.
- *RequiresContextResultE* is an alias for `RequiresContextResult[..., Exception]`, just use it when you want to work with `RequiresContextResult` containers that use exceptions as error type. It is named `ResultE` because it is `ResultException` and `ResultError` at the same time.
- *ReaderResult* is an alias for `RequiresContextResult[...]` to save you some typing.
- *ReaderResultE* is an alias for `RequiresContextResult[..., Exception]`
- *RequiresContextIOResultE* is an alias for `RequiresContextIOResult[..., Exception]`
- *ReaderIOResult* is an alias for `RequiresContextIOResult[...]` to save you some typing.
- *ReaderIOResultE* is an alias for `RequiresContextIOResult[..., Exception]`
- *RequiresContextFutureResultE* is an alias for `RequiresContextFutureResult[..., Exception]`
- *ReaderFutureResult* is an alias for `RequiresContextFutureResult[...]` to save you some typing.
- *ReaderFutureResultE* is an alias for `RequiresContextFutureResult[..., Exception]`

9.10.7 FAQ

How to create unit objects?

`RequiresContext` requires you to use one of the following methods:

- `from_value` when you have a raw value
- `from_requires_context_result` when you have `RequiresContextResult`
- `from_requires_context_ioresult` when you have `RequiresContextIOResult`

`RequiresContextResult` requires you to use one of the following methods:

- `from_value` when you want to mark some raw value as a `Success`
- `from_failure` when you want to mark some raw value as a `Failure`
- `from_result` when you already have `Result` container
- `from_context` when you have successful `RequiresContext`
- `from_failed_context` when you have failed `RequiresContext`
- `from_typecast` when you have `RequiresContext[..., Result]`

`RequiresContextIOResult` requires you to use one of the following methods:

- `from_value` when you want to mark some raw value as a `Success`
- `from_failure` when you want to mark some raw value as a `Failure`
- `from_result` when you already have `Result` container
- `from_io` when you have successful `IO` container
- `from_failed_io` when you have failed `IO` container
- `from_ioresult` when you already have `IOResult` container
- `from_context` when you have successful `RequiresContext` container
- `from_failed_context` when you have failed `RequiresContext` container
- `from_result_context` when you have `RequiresContextResult` container
- `from_typecast` when you have `RequiresContext[..., IOResult]`

`RequiresContextFutureResult` requires you to use one of the following methods:

- `from_value` when you want to mark some raw value as a `Success`
- `from_failure` when you want to mark some raw value as a `Failure`
- `from_result` when you already have `Result` container
- `from_io` when you have successful `IO` container
- `from_failed_io` when you have failed `IO` container
- `from_ioresult` when you already have `IOResult` container
- `from_future` when you already have successful `Future` container
- `from_failed_future` when you already have failed `Future` container
- `from_future_result` when you already have `FutureResult` container
- `from_context` when you have successful `RequiresContext`

- `from_failed_context` when you have failed `RequiresContext`
- `from_result_context` when you have `RequiresContextResult` container
- `from_ioresult_context` when you have `RequiresContextIOResult` container
- `from_typecast` when you have `RequiresContext[..., IOResult]`

How can I access dependencies inside the context?

Use `.ask()` method!

See *this guide*.

RequiresContext looks like a decorator with arguments

Yes, this container might remind a traditional decorator with arguments, let see an example:

```
>>> def example(print_result: bool):
...     def decorator(function):
...         def factory(*args, **kwargs):
...             original = function(*args, **kwargs)
...             if print_result:
...                 print(original)
...             return original
...         return factory
...     return decorator
```

And it can be used like so:

```
>>> @example(print_result=True)
... def my_function(first: int, second: int) -> int:
...     return first + second

>>> assert my_function(2, 3) == 5
5
```

We can model the similar idea with `RequiresContext`:

```
>>> from returns.context import RequiresContext

>>> def my_function(first: int, second: int) -> RequiresContext[int, bool]:
...     def factory(print_result: bool) -> int:
...         original = first + second
...         if print_result:
...             print(original)
...         return original
...     return RequiresContext(factory)

>>> assert my_function(2, 3)(False) == 5
>>> assert my_function(2, 3)(True) == 5
5
```

As you can see, it is easier to change the behaviour of a function with `RequiresContext`. While decorator with arguments glues values to a function forever. Decide when you need which behaviour carefully.

Why can't we use RequiresContext[Result, e] instead of RequiresContextResult?

We actually can! But, it is harder to write. And `RequiresContextResult` is actually the very same thing as `RequiresContext[Result, e]`, but has nicer API:

```
x: RequiresContext[Result[int, str], int]
x.map(lambda result: result.map(lambda number: number + 1))

# Is the same as:

y: RequiresContextResult[int, str, int]
y.map(lambda number: number + 1)
```

The second one looks better, doesn't it? The same applies for `RequiresContextIOResult` and `RequiresContextFutureResult` as well.

Why do I have to use explicit type annotation for ask method?

Because `mypy` cannot possibly know the type of current context. This is hard even for a plugin.

So, using this technique is better:

```
from returns.context import RequiresContext

def some_context(*args, **kwargs) -> RequiresContext[str, int]:
    def factory(deps: int) -> RequiresContext[str, int]:
        ...
    return RequiresContext[str, int].ask().bind(factory)
```

What is the difference between DI and RequiresContext?

Dependency Injection pattern and Inversion of Control principle forms a lot of ideas and tooling that do pretty much the same as `RequiresContext` container.

What is the difference? Why do we need each of them?

Let's find out! Tools like dependencies or punq tries to:

1. Inspect (by name or type respectively) function or class that needs dependencies
2. Build the required dependency tree from the source defined in the service container

There are other tools like `inject` that also invades your code with `@inject` decorator.

`RequiresContext` works completely different. It respects your code and does not try to inspect in any manner. It also does not care about building dependencies at all.

All it does is: provides simple API to compose functions that need additional context (or dependencies) to run.

You can even use them together: `RequiresContext` will pass dependencies built by `punq` (or any other tool of your choice) as a `deps` parameter to `RequiresContext` instance.

When to use which? Let's dig into it!

- `RequiresContext` offers explicit context passing for the whole function stack inside your program. This means two things: you will have to pass it through all your code and use it everywhere inside your program explicitly, when you need to access the environment and dependencies

- Traditional `DI` allows to leave a lot of code unaware of dependency injection. Because you don't have to maintain the context everywhere. You just need to adjust your API to meet the dependency injector requirements. On the other hand, you lose explicitness here.

So when to use `RequiresContext`?

1. When you write pure functional code
2. When you want to know which code relies on context and which is free from it, `RequiresContext` makes this explicit and typed
3. When you rely on types inside your program
4. When you want to rely on functions rather than magic

When not to use `RequiresContext` and use traditional DI?

1. When you already have a lot of code written in a different approach: in OOP and/or imperative styles
2. When you need to pass dependencies into a very deep level of your call stack implicitly (without modifying the whole stack), this is called magic
3. When you not rely on types for dependencies. There are cases when DI is made by names or tags

Here's an example that might give you a better understanding of how `RequiresContext` is used on real and rather big projects:

```
from typing import Callable, Dict, Protocol, final
from returns.io import IOResultE
from returns.context import ReaderIOResultE

@final
class _SyncPermissionsDeps(Protocol):
    fetch_metadata: Callable[[], IOResultE['Metadata']]
    get_user_permissions: Callable[['Metadata'], Dict[int, str]]  # pure
    update_bi_permissions: Callable[[Dict[int, str]], IOResultE['Payload']]

def sync_permissions() -> ReaderIOResultE[_SyncPermissionsDeps, 'Payload']:
    """
    This functions runs a scheduled task once a day.

    It syncs permissions from the metadata storage to our BI system.
    """
    def factory(deps: _SyncPermissionsDeps) -> IOResultE['Payload']:
        return deps.fetch_metadata().map(
            deps.get_user_permissions,
        ).bind_ioresult(
            deps.update_bi_permissions,
        )
    return ReaderIOResult(factory)
```

And then it is called like so:

```
# tasks.py
from celery import shared_task
from returns.functions import raise_exception

from logic.usecases.sync_permissions import sync_permissions
from infrastructure.implemented import Container
```

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```
from infrastructure.services import bi
from infrastructure.repositories import db

@shared_task(autoretry_for=(ConnectionError,), max_retries=3)
def queue_sync_permissions():
    # Building the container with dependencies to pass it into the context.
    # We also make sure that we don't forget to raise internal exceptions
    # and trigger celery retries.
    return sync_permissions().alt(raise_exception)(Container(
        fetch_metadata=db.select_user_metadata,
        get_user_permissions=bi.permissions_from_user,
        update_bi_permissions=bi.put_user_permissions,
    ))
```

9.10.8 Further reading

- Enforcing Single Responsibility Principle in Python
- Typed functional Dependency Injection in Python
- Three-Useful-Monads: Reader
- Getting started with fp-ts: Reader
- Reader & Constructor-based Dependency Injection in Scala - friend or foe?

9.10.9 API Reference

RequiresContext

NoDeps = typing.Any

Sometimes `RequiresContext` and other similar types might be used with no explicit dependencies so we need to have this type alias for Any.

class RequiresContext(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*RequiresContext*, returns.context.requires_context._ReturnType, returns.context.requires_context._EnvType, NoReturn], *returns.interfaces.specific.reader.ReaderBased2*[returns.context.requires_context._ReturnType, returns.context.requires_context._EnvType]

The `RequiresContext` container.

It's main purpose is to wrap some specific function and to provide tools to compose other functions around it without actually calling it.

The `RequiresContext` container passes the state you want to share between functions. Functions may read that state, but can't change it. The `RequiresContext` container lets us access shared immutable state within a specific context.

It can be used for lazy evaluation and typed dependency injection.

`RequiresContext` is used with functions that never fail. If you want to use `RequiresContext` with returns `Result` then consider using `RequiresContextResult` instead.

Note: This container does not wrap ANY value. It wraps only functions. You won't be able to supply arbitrary types!

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-reader-1ie5
- https://en.wikipedia.org/wiki/Lazy_evaluation
- https://bit.ly/2R8l4WK

Parameters **inner_value** (Callable[[-_EnvType], +_ReturnType]) –

no_args: ClassVar[*NoDeps*] = <object object>

A convenient placeholder to call methods created by *.from_value()*:

map(*function*)

Allows to compose functions inside the wrapped container.

Here's how it works:

```
>>> from returns.context import RequiresContext
>>> def first(lg: bool) -> RequiresContext[int, float]:
...     # `deps` has `float` type here:
...     return RequiresContext(
...         lambda deps: deps if lg else -deps,
...     )

>>> assert first(True).map(lambda number: number * 10)(2.5) == 25.0
>>> assert first(False).map(lambda number: number * 10)(0.1) -1.0
```

Parameters **function** (Callable[[+_ReturnType], ~_NewReturnType]) –

Return type *RequiresContext*[~_NewReturnType, -_EnvType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> from returns.context import RequiresContext
>>> assert RequiresContext.from_value('a').apply(
...     RequiresContext.from_value(lambda inner: inner + 'b')
... )(...) == 'ab'
```

Parameters **container** (*KindN*[ForwardRef, Callable[[+_ReturnType], ~_NewReturnType], -_EnvType, Any]) –

Return type *RequiresContext*[~_NewReturnType, -_EnvType]

bind(*function*)

Composes a container with a function returning another container.

This is useful when you do several computations that rely on the same context.

```
>>> from returns.context import RequiresContext

>>> def first(lg: bool) -> RequiresContext[int, float]:
...     # `deps` has `float` type here:
...     return RequiresContext(
...         lambda deps: deps if lg else -deps,
...     )

>>> def second(number: int) -> RequiresContext[str, float]:
...     # `deps` has `float` type here:
...     return RequiresContext(
...         lambda deps: '>=' if number >= deps else '<',
...     )

>>> assert first(True).bind(second)(1) == '>='
>>> assert first(False).bind(second)(2) == '<'
```

Parameters **function** (Callable[[+_ReturnType], *KindN*[ForwardRef, ~_NewReturnType, -_EnvType, Any]]) –

Return type *RequiresContext*[~_NewReturnType, -_EnvType]

bind_context(*function*)

Alias for *bind_context* method, it is the same as *bind* here.

Parameters **function** (Callable[[+_ReturnType], *KindN*[ForwardRef, ~_NewReturnType, -_EnvType, Any]]) –

Return type *RequiresContext*[~_NewReturnType, -_EnvType]

modify_env(*function*)

Allows to modify the environment type.

```
>>> from returns.context import RequiresContext

>>> def mul(arg: int) -> RequiresContext[float, int]:
...     return RequiresContext(lambda deps: arg * deps)

>>> assert mul(3).modify_env(int)('2') == 6
```

Parameters **function** (Callable[[~_NewEnvType], -_EnvType]) –

Return type *RequiresContext*[+_ReturnType, ~_NewEnvType]

classmethod ask()

Get current context to use the dependencies.

It is a common scenario when you need to use the environment. For example, you want to do some context-related computation, but you don't have the context instance at your disposal. That's where `.ask()` becomes useful!

```
>>> from typing_extensions import TypedDict
>>> class Deps(TypedDict):
...     message: str
```

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```
>>> def first(lg: bool) -> RequiresContext[int, Deps]:
...     # `deps` has `Deps` type here:
...     return RequiresContext(
...         lambda deps: deps['message'] if lg else 'error',
...     )

>>> def second(text: str) -> RequiresContext[int, int]:
...     return first(len(text) > 3)

>>> assert second('abc')({'message': 'ok'}) == 'error'
>>> assert second('abcd')({'message': 'ok'}) == 'ok'
```

And now imagine that you have to change this 3 limit. And you want to be able to set it via environment as well. Ok, let's fix it with the power of `RequiresContext.ask()`!

```
>>> from typing_extensions import TypedDict
>>> class Deps(TypedDict):
...     message: str
...     limit: int   # note this new field!

>>> def new_first(lg: bool) -> RequiresContext[int, Deps]:
...     # `deps` has `Deps` type here:
...     return RequiresContext(
...         lambda deps: deps['message'] if lg else 'err',
...     )

>>> def new_second(text: str) -> RequiresContext[int, int]:
...     return RequiresContext[int, Deps].ask().bind(
...         lambda deps: new_first(len(text) > deps.get('limit', 3)),
...     )

>>> assert new_second('abc')({'message': 'ok', 'limit': 2}) == 'ok'
>>> assert new_second('abcd')({'message': 'ok'}) == 'ok'
>>> assert new_second('abcd')({'message': 'ok', 'limit': 5}) == 'err'
```

That's how `ask` works.

This class contains methods that require to explicitly set type annotations. Why? Because it is impossible to figure out the type without them. So, here's how you should use them:

```
RequiresContext[int, Dict[str, str]].ask()
```

Otherwise, your `.ask()` method will return `RequiresContext[<nothing>, <nothing>]`, which is unusable:

```
env = RequiresContext.ask()
env(some_deps)
```

And `mypy` will warn you: `error:  Need type annotation for '...'`

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-reader-1ie5

Return type *RequiresContext*[-_EnvType, -_EnvType]

classmethod from_value(*inner_value*)
Used to return some specific value from the container.

Consider this method as some kind of factory. Passed value will be a return type. Make sure to use *no_args* for getting the unit value.

```
>>> from returns.context import RequiresContext
>>> unit = RequiresContext.from_value(5)
>>> assert unit(RequiresContext.no_args) == 5
```

Might be used with or without direct type hint.

Parameters **inner_value** (*~_FirstType*) –

Return type *RequiresContext*[~_FirstType, Any]

classmethod from_context(*inner_value*)
Used to create new containers from existing ones.

Used as a part of `ReaderBased2` interface.

```
>>> from returns.context import RequiresContext
>>> unit = RequiresContext.from_value(5)
>>> assert RequiresContext.from_context(unit)(...) == unit(...)
```

Parameters **inner_value** (*RequiresContext*[~_NewReturnType, ~_NewEnvType]) –

Return type *RequiresContext*[~_NewReturnType, ~_NewEnvType]

classmethod from_requires_context_result(*inner_value*)
Typecasts `RequiresContextResult` to `RequiresContext` instance.

Breaks `RequiresContextResult[a, b, e]` into `RequiresContext[Result[a, b], e]`.

```
>>> from returns.context import RequiresContext
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success
>>> assert RequiresContext.from_requires_context_result(
...     RequiresContextResult.from_value(1),
... )(...) == Success(1)
```

Can be reverted with `RequiresContextResult.from_typecast`.

Parameters **inner_value** (`ForwardRef`) –

Return type *RequiresContext*[*Result*[~_ValueType, ~_ErrorType], -_EnvType]

classmethod from_requires_context_ioresult(*inner_value*)
Typecasts `RequiresContextIOResult` to `RequiresContext` instance.

Breaks `RequiresContextIOResult[a, b, e]` into `RequiresContext[IOResult[a, b], e]`.

```
>>> from returns.context import RequiresContext
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess
>>> assert RequiresContext.from_requires_context_ioresult(
```

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```
...     RequiresContextIOResult.from_value(1),
... )(...) == IOSuccess(1)
```

Can be reverted with `RequiresContextIOResult.from_typecast`.

Parameters **inner_value** (`ForwardRef`) –

Return type *RequiresContext*[*IOResult*[~_ValueType, ~_ErrorType], -_EnvType]

classmethod from_requires_context_future_result(*inner_value*)

Typecasts `RequiresContextIOResult` to `RequiresContext` instance.

Breaks `RequiresContextIOResult[a, b, e]` into `RequiresContext[IOResult[a, b], e]`.

```
>>> import anyio
>>> from returns.context import RequiresContext
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess

>>> container = RequiresContext.from_requires_context_future_result(
...     RequiresContextFutureResult.from_value(1),
... )
>>> assert anyio.run(
...     container, RequiresContext.no_args,
... ) == IOSuccess(1)
```

Can be reverted with `RequiresContextFutureResult.from_typecast`.

Parameters **inner_value** (`ForwardRef`) –

Return type *RequiresContext*[*FutureResult*[~_ValueType, ~_ErrorType], -_EnvType]

Reader

Sometimes *RequiresContext* is too long to type.

Parameters **inner_value** (`Callable`[[-_EnvType], +_ReturnType]) –

RequiresContextResult

class RequiresContextResult(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*RequiresContextResult*, returns.context.requires_context_result._ValueType, returns.context.requires_context_result._ErrorType, returns.context.requires_context_result._EnvType], *returns.interfaces.specific.reader_result.ReaderResultBasedN*[returns.context.requires_context_result._ValueType, returns.context.requires_context_result._ErrorType, returns.context.requires_context_result._EnvType]

The `RequiresContextResult` combinator.

See *returns.context.requires_context.RequiresContext* for more docs.

This is just a handy wrapper around `RequiresContext[Result[a, b], env]` which represents a context-dependent pure operation that might fail and return *returns.result.Result*.

It has several important differences from the regular `Result` classes. It does not have `Success` and `Failure` subclasses. Because, the computation is not yet performed. And we cannot know the type in advance.

So, this is a thin wrapper, without any changes in logic.

Why do we need this wrapper? That's just for better usability!

```
>>> from returns.context import RequiresContext
>>> from returns.result import Success, Result

>>> def function(arg: int) -> Result[int, str]:
...     return Success(arg + 1)

>>> # Without wrapper:
>>> assert RequiresContext.from_value(Success(1)).map(
...     lambda result: result.bind(function),
... )(...) == Success(2)

>>> # With wrapper:
>>> assert RequiresContextResult.from_value(1).bind_result(
...     function,
... )(...) == Success(2)
```

This way `RequiresContextResult` allows to simply work with:

- raw values and pure functions
- `RequiresContext` values and pure functions returning it
- `Result` and functions returning it

Important implementation details

Due it is meaning, `RequiresContextResult` cannot have `Success` and `Failure` subclasses.

We only have just one type. That's by design.

Different converters are also not supported for this type. Use converters inside the `RequiresContext` context, not outside.

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-reader-1ie5
- https://en.wikipedia.org/wiki/Lazy_evaluation
- https://bit.ly/2R8l4WK
- https://bit.ly/2RwP4fp

Parameters **inner_value** (Callable[[-_EnvType], *Result*[+_ValueType, +_ErrorType]]) –

no_args: ClassVar[NoDeps] = <object object>
A convenient placeholder to call methods created by *.from_value()*.

swap()
Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of `.bind_` related methods and only a single `.lash` - it is easier to work with values.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Failure, Success

>>> success = RequiresContextResult.from_value(1)
>>> failure = RequiresContextResult.from_failure(1)

>>> assert success.swap()(...) == Failure(1)
>>> assert failure.swap()(...) == Success(1)
```

Return type *RequiresContextResult*[+_ErrorType, +_ValueType, -_EnvType]

map(*function*)

Composes successful container with a pure function.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure

>>> assert RequiresContextResult.from_value(1).map(
...     lambda x: x + 1,
... )(...) == Success(2)

>>> assert RequiresContextResult.from_failure(1).map(
...     lambda x: x + 1,
... )(...) == Failure(1)
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure, Result

>>> def transform(arg: str) -> str:
...     return arg + 'b'

>>> assert RequiresContextResult.from_value('a').apply(
...     RequiresContextResult.from_value(transform),
... )(...) == Success('ab')

>>> assert RequiresContextResult.from_failure('a').apply(
...     RequiresContextResult.from_value(transform),
... )(...) == Failure('a')

>>> assert isinstance(RequiresContextResult.from_value('a').apply(
...     RequiresContextResult.from_failure(transform),
... )(...), Result.failure_type) is True
```

Parameters **container** (*KindN*[*RequiresContextResult*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, -_EnvType]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind(*function*)

Composes this container with a function returning the same type.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure

>>> def first(lg: bool) -> RequiresContextResult[int, int, float]:
...     # `deps` has `float` type here:
...     return RequiresContextResult(
...         lambda deps: Success(deps) if lg else Failure(-deps),
...     )

>>> def second(
...     number: int,
... ) -> RequiresContextResult[str, int, float]:
...     # `deps` has `float` type here:
...     return RequiresContextResult(
...         lambda deps: Success('>=' if number >= deps else '<'),
...     )

>>> assert first(True).bind(second)(1) == Success('>=')
>>> assert first(False).bind(second)(2) == Failure(-2)
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_result(*function*)

Alias for *bind_context_result* method, it is the same as *bind* here.

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_result(*function*)

Binds `Result` returning function to current container.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure, Result

>>> def function(num: int) -> Result[str, int]:
...     return Success(num + 1) if num > 0 else Failure('<0')

>>> assert RequiresContextResult.from_value(1).bind_result(
...     function,
... )(RequiresContextResult.no_args) == Success(2)

>>> assert RequiresContextResult.from_value(0).bind_result(
...     function,
... )(RequiresContextResult.no_args) == Failure('<0')
```

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```
>>> assert RequiresContextResult.from_failure(':(').bind_result(
...     function,
... )(RequiresContextResult.no_args) == Failure(':(')
```

Parameters **function** (Callable[[+_ValueType], *Result*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context(*function*)

Binds RequiresContext returning function to current container.

```
>>> from returns.context import RequiresContext
>>> from returns.result import Success, Failure

>>> def function(arg: int) -> RequiresContext[int, str]:
...     return RequiresContext(lambda deps: len(deps) + arg)

>>> assert function(2)('abc') == 5

>>> assert RequiresContextResult.from_value(2).bind_context(
...     function,
... )('abc') == Success(5)

>>> assert RequiresContextResult.from_failure(2).bind_context(
...     function,
... )('abc') == Failure(2)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextResult*[~_NewValueType, +_ErrorType, -_EnvType]

alt(*function*)

Composes failed container with a pure function.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure

>>> assert RequiresContextResult.from_value(1).alt(
...     lambda x: x + 1,
... )(...) == Success(1)

>>> assert RequiresContextResult.from_failure(1).alt(
...     lambda x: x + 1,
... )(...) == Failure(2)
```

Parameters **function** (Callable[[+_ErrorType], ~_NewErrorType]) –

Return type *RequiresContextResult*[+_ValueType, ~_NewErrorType, -_EnvType]

lash(*function*)

Composes this container with a function returning the same type.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure

>>> def lashable(arg: str) -> RequiresContextResult[str, str, str]:
...     if len(arg) > 1:
...         return RequiresContextResult(
...             lambda deps: Success(deps + arg),
...         )
...     return RequiresContextResult(
...         lambda deps: Failure(arg + deps),
...     )

>>> assert RequiresContextResult.from_value('a').lash(
...     lashable,
... )('c') == Success('a')
>>> assert RequiresContextResult.from_failure('a').lash(
...     lashable,
... )('c') == Failure('ac')
>>> assert RequiresContextResult.from_failure('aa').lash(
...     lashable,
... )('b') == Success('baa')
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*RequiresContextResult*, +_ValueType, ~_NewErrorType, -_EnvType]]) –

Return type *RequiresContextResult*[+_ValueType, ~_NewErrorType, -_EnvType]

modify_env(*function*)

Allows to modify the environment type.

```
>>> from returns.context import RequiresContextResultE
>>> from returns.result import Success, safe

>>> def div(arg: int) -> RequiresContextResultE[float, int]:
...     return RequiresContextResultE(
...         safe(lambda deps: arg / deps),
...     )

>>> assert div(3).modify_env(int)('2') == Success(1.5)
>>> assert div(3).modify_env(int)('0').failure()
```

Parameters **function** (Callable[[~_NewEnvType], -_EnvType]) –

Return type *RequiresContextResult*[+_ValueType, +_ErrorType, ~_NewEnvType]

classmethod ask()

Is used to get the current dependencies inside the call stack.

Similar to *returns.context.requires_context.RequiresContext.ask()*, but returns `Result` instead of a regular value.

Please, refer to the docs there to learn how to use it.

One important note that is worth duplicating here: you might need to provide `_EnvType` explicitly, so `mypy` will know about it statically.

```
>>> from returns.context import RequiresContextResultE
>>> from returns.result import Success
>>> assert RequiresContextResultE[int, int].ask().map(
...     str,
... )(1) == Success('1')
```

Return type *RequiresContextResult*[-_EnvType, +_ErrorType, -_EnvType]

classmethod from_result(*inner_value*)

Creates new container with `Result` as a unit value.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success, Failure
>>> deps = RequiresContextResult.no_args

>>> assert RequiresContextResult.from_result(
...     Success(1),
... )(deps) == Success(1)

>>> assert RequiresContextResult.from_result(
...     Failure(1),
... )(deps) == Failure(1)
```

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_typecast(*inner_value*)

You might end up with `RequiresContext[Result[...]]` as a value.

This method is designed to turn it into `RequiresContextResult`. It will save all the typing information.

It is just more useful!

```
>>> from returns.context import RequiresContext
>>> from returns.result import Success, Failure

>>> assert RequiresContextResult.from_typecast(
...     RequiresContext.from_value(Success(1)),
... )(RequiresContextResult.no_args) == Success(1)

>>> assert RequiresContextResult.from_typecast(
...     RequiresContext.from_value(Failure(1)),
... )(RequiresContextResult.no_args) == Failure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextResult*[~_NewValueType, ~_NewErrorType, -_EnvType]

classmethod from_context(*inner_value*)

Creates new container from `RequiresContext` as a success unit.

```
>>> from returns.context import RequiresContext
>>> from returns.result import Success
>>> assert RequiresContextResult.from_context(
...     RequiresContext.from_value(1),
... )(...) == Success(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextResult*[~_NewValueType, Any, ~_NewEnvType]

classmethod **from_failed_context**(*inner_value*)

Creates new container from `RequiresContext` as a failure unit.

```
>>> from returns.context import RequiresContext
>>> from returns.result import Failure
>>> assert RequiresContextResult.from_failed_context(
...     RequiresContext.from_value(1),
... )(...) == Failure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextResult*[Any, ~_NewValueType, ~_NewEnvType]

classmethod **from_result_context**(*inner_value*)

Creates `RequiresContextResult` from another instance of it.

```
>>> from returns.context import ReaderResult
>>> from returns.result import Success, Failure

>>> assert ReaderResult.from_result_context(
...     ReaderResult.from_value(1),
... )(...) == Success(1)

>>> assert ReaderResult.from_result_context(
...     ReaderResult.from_failure(1),
... )(...) == Failure(1)
```

Parameters **inner_value** (*RequiresContextResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]) –

Return type *RequiresContextResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod **from_value**(*inner_value*)

Creates new container with `Success(inner_value)` as a unit value.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Success
>>> assert RequiresContextResult.from_value(1)(...) == Success(1)
```

Parameters **inner_value** (*~_FirstType*) –

Return type *RequiresContextResult*[~_FirstType, Any, Any]

classmethod from_failure(*inner_value*)

Creates new container with `Failure(inner_value)` as a unit value.

```
>>> from returns.context import RequiresContextResult
>>> from returns.result import Failure
>>> assert RequiresContextResult.from_failure(1)(...) == Failure(1)
```

Parameters **inner_value** (*~_FirstType*) –

Return type *RequiresContextResult*[Any, ~_FirstType, Any]

RequiresContextResultE

Alias for a popular case when `Result` has `Exception` as error type.

alias of *returns.context.requires_context_result.RequiresContextResult*[returns.context.requires_context_result._ValueType, Exception, returns.context.requires_context_result._EnvType]

ReaderResult

Alias to save you some typing. Uses original name from Haskell.

Parameters **inner_value** (Callable[[-_EnvType], *Result*[+_ValueType, +_ErrorType]]) –

ReaderResultE

Alias to save you some typing. Has `Exception` as error type.

alias of *returns.context.requires_context_result.RequiresContextResult*[returns.context.requires_context_result._ValueType, Exception, returns.context.requires_context_result._EnvType]

RequiresContextIOResult

class RequiresContextIOResult(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*RequiresContextIOResult*, returns.context.requires_context_ioresult._ValueType, returns.context.requires_context_ioresult._ErrorType, returns.context.requires_context_ioresult._EnvType], *returns.interfaces.specific.reader_ioresult.ReaderIOResultBasedN*[returns.context.requires_context_ioresult._ValueType, returns.context.requires_context_ioresult._ErrorType, returns.context.requires_context_ioresult._EnvType]

The `RequiresContextIOResult` combinator.

See *returns.context.requires_context.RequiresContext* and *returns.context.requires_context_result.RequiresContextResult* for more docs.

This is just a handy wrapper around `RequiresContext[IOResult[a, b], env]` which represents a context-dependent impure operation that might fail.

It has several important differences from the regular `Result` classes. It does not have `Success` and `Failure` subclasses. Because, the computation is not yet performed. And we cannot know the type in advance.

So, this is a thin wrapper, without any changes in logic.

Why do we need this wrapper? That's just for better usability!

```
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess, IOResult
```

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```
>>> def function(arg: int) -> IOResult[int, str]:
...     return IOSuccess(arg + 1)

>>> # Without wrapper:
>>> assert RequiresContext.from_value(IOSuccess(1)).map(
...     lambda ioresult: ioresult.bind(function),
... )(...) == IOSuccess(2)

>>> # With wrapper:
>>> assert RequiresContextIOResult.from_value(1).bind_ioresult(
...     function,
... )(...) == IOSuccess(2)
```

This way `RequiresContextIOResult` allows to simply work with:

- raw values and pure functions
- `RequiresContext` values and pure functions returning it
- `RequiresContextResult` values and pure functions returning it
- `Result` and pure functions returning it
- `IOResult` and functions returning it
- other `RequiresContextIOResult` related functions and values

This is a complex type for complex tasks!

Important implementation details

Due it is meaning, `RequiresContextIOResult` cannot have `Success` and `Failure` subclasses.

We only have just one type. That's by design.

Different converters are also not supported for this type. Use converters inside the `RequiresContext` context, not outside.

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-reader-1ie5
- https://en.wikipedia.org/wiki/Lazy_evaluation
- https://bit.ly/2R8l4WK
- https://bit.ly/2RwP4fp

Parameters **inner_value** (Callable[[-_EnvType], *IOResult*[+_ValueType, +_ErrorType]]) –

no_args: ClassVar[NoDeps] = <object object>
A convenient placeholder to call methods created by *.from_value()*.

swap()
Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of `.bind_` related methods and only a single `.lash` - it is easier to work with values.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> success = RequiresContextIOResult.from_value(1)
>>> failure = RequiresContextIOResult.from_failure(1)

>>> assert success.swap()(...) == IOFailure(1)
>>> assert failure.swap()(...) == IOSuccess(1)
```

Return type *RequiresContextIOResult*[+_ErrorType, +_ValueType, -_EnvType]

map(*function*)

Composes successful container with a pure function.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert RequiresContextIOResult.from_value(1).map(
...     lambda x: x + 1,
... )(...) == IOSuccess(2)

>>> assert RequiresContextIOResult.from_failure(1).map(
...     lambda x: x + 1,
... )(...) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> def transform(arg: str) -> str:
...     return arg + 'b'

>>> assert RequiresContextIOResult.from_value('a').apply(
...     RequiresContextIOResult.from_value(transform),
... )(...) == IOSuccess('ab')

>>> assert RequiresContextIOResult.from_value('a').apply(
...     RequiresContextIOResult.from_failure(1),
... )(...) == IOFailure(1)

>>> assert RequiresContextIOResult.from_failure('a').apply(
...     RequiresContextIOResult.from_value(transform),
... )(...) == IOFailure('a')
```

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```
>>> assert RequiresContextIOResult.from_failure('a').apply(
...     RequiresContextIOResult.from_failure('b'),
... )(...) == IOFailure('a')
```

Parameters **container** (*KindN*[*RequiresContextIOResult*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, -_EnvType]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind(*function*)

Composes this container with a function returning the same type.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> def first(lg: bool) -> RequiresContextIOResult[int, int, float]:
...     # `deps` has `float` type here:
...     return RequiresContextIOResult(
...         lambda deps: IOSuccess(deps) if lg else IOFailure(-deps),
...     )

>>> def second(
...     number: int,
... ) -> RequiresContextIOResult[str, int, float]:
...     # `deps` has `float` type here:
...     return RequiresContextIOResult(
...         lambda deps: IOSuccess('>=' if number >= deps else '<'),
...     )

>>> assert first(True).bind(second)(1) == IOSuccess('>=')
>>> assert first(False).bind(second)(2) == IOFailure(-2)
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextIOResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_ioresult(*function*)

Alias for *bind_context_ioresult* method, it is the same as *bind* here.

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextIOResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_result(*function*)

Binds `Result` returning function to the current container.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.result import Success, Failure, Result
>>> from returns.io import IOSuccess, IOFailure

>>> def function(num: int) -> Result[int, str]:
```

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```
...     return Success(num + 1) if num > 0 else Failure('<0')

>>> assert RequiresContextIOResult.from_value(1).bind_result(
...     function,
... )(RequiresContextIOResult.no_args) == IOSuccess(2)

>>> assert RequiresContextIOResult.from_value(0).bind_result(
...     function,
... )(RequiresContextIOResult.no_args) == IOFailure('<0')

>>> assert RequiresContextIOResult.from_failure(':(').bind_result(
...     function,
... )(RequiresContextIOResult.no_args) == IOFailure(':(')
```

Parameters **function** (Callable[[+_ValueType], *Result*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context(*function*)

Binds RequiresContext returning function to current container.

```
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess, IOFailure

>>> def function(arg: int) -> RequiresContext[int, str]:
...     return RequiresContext(lambda deps: len(deps) + arg)

>>> assert function(2)('abc') == 5

>>> assert RequiresContextIOResult.from_value(2).bind_context(
...     function,
... )('abc') == IOSuccess(5)

>>> assert RequiresContextIOResult.from_failure(2).bind_context(
...     function,
... )('abc') == IOFailure(2)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_result(*function*)

Binds RequiresContextResult returning function to the current one.

```
>>> from returns.context import RequiresContextResult
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Success, Failure

>>> def function(arg: int) -> RequiresContextResult[int, int, str]:
...     if arg > 0:
...         return RequiresContextResult(
```

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```
...             lambda deps: Success(len(deps) + arg),
...         )
...     return RequiresContextResult(
...         lambda deps: Failure(len(deps) + arg),
...     )

>>> assert function(2)('abc') == Success(5)
>>> assert function(-1)('abc') == Failure(2)

>>> assert RequiresContextIOResult.from_value(
...     2,
... ).bind_context_result(
...     function,
... )('abc') == IOSuccess(5)

>>> assert RequiresContextIOResult.from_value(
...     -1,
... ).bind_context_result(
...     function,
... )('abc') == IOFailure(2)

>>> assert RequiresContextIOResult.from_failure(
...     2,
... ).bind_context_result(
...     function,
... )('abc') == IOFailure(2)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_io(*function*)

Binds IO returning function to the current container.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IO, IOSuccess, IOFailure

>>> def function(number: int) -> IO[str]:
...     return IO(str(number))

>>> assert RequiresContextIOResult.from_value(1).bind_io(
...     function,
... )(RequiresContextIOResult.no_args) == IOSuccess('1')

>>> assert RequiresContextIOResult.from_failure(1).bind_io(
...     function,
... )(RequiresContextIOResult.no_args) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], *IO*[~_NewValueType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_ioresult(*function*)

Binds `IOResult` returning function to the current container.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOResult, IOSuccess, IOFailure

>>> def function(num: int) -> IOResult[int, str]:
...     return IOSuccess(num + 1) if num > 0 else IOFailure('<0')

>>> assert RequiresContextIOResult.from_value(1).bind_ioresult(
...     function,
... )(RequiresContextIOResult.no_args) == IOSuccess(2)

>>> assert RequiresContextIOResult.from_value(0).bind_ioresult(
...     function,
... )(RequiresContextIOResult.no_args) == IOFailure('<0')

>>> assert RequiresContextIOResult.from_failure(':(').bind_ioresult(
...     function,
... )(RequiresContextIOResult.no_args) == IOFailure(':(')
```

Parameters **function** (`Callable`[[+_ValueType], *IOResult*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

alt(*function*)

Composes failed container with a pure function.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert RequiresContextIOResult.from_value(1).alt(
...     lambda x: x + 1,
... )(...) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_failure(1).alt(
...     lambda x: x + 1,
... )(...) == IOFailure(2)
```

Parameters **function** (`Callable`[[+_ErrorType], ~_NewErrorType]) –

Return type *RequiresContextIOResult*[+_ValueType, ~_NewErrorType, -_EnvType]

lash(*function*)

Composes this container with a function returning the same type.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> def lashable(
...     arg: str,
... ) -> RequiresContextIOResult[str, str, str]:
...     if len(arg) > 1:
```

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```
...             return RequiresContextIOResult(
...                 lambda deps: IOSuccess(deps + arg),
...             )
...         return RequiresContextIOResult(
...             lambda deps: IOFailure(arg + deps),
...         )

>>> assert RequiresContextIOResult.from_value('a').lash(
...     lashable,
... )('c') == IOSuccess('a')
>>> assert RequiresContextIOResult.from_failure('a').lash(
...     lashable,
... )('c') == IOFailure('ac')
>>> assert RequiresContextIOResult.from_failure('aa').lash(
...     lashable,
... )('b') == IOSuccess('baa')
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*RequiresContextIOResult*, +_ValueType, ~_NewErrorType, -_EnvType]]) –

Return type *RequiresContextIOResult*[+_ValueType, ~_NewErrorType, -_EnvType]

compose_result(*function*)

Composes inner `Result` with `ReaderIOResult` returning function.

Can be useful when you need an access to both states of the result.

```
>>> from returns.context import ReaderIOResult, NoDeps
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Result

>>> def count(
...     container: Result[int, int],
... ) -> ReaderIOResult[int, int, NoDeps]:
...     return ReaderIOResult.from_result(
...         container.map(lambda x: x + 1).alt(abs),
...     )

>>> success = ReaderIOResult.from_value(1)
>>> failure = ReaderIOResult.from_failure(-1)
>>> assert success.compose_result(count)(...) == IOSuccess(2)
>>> assert failure.compose_result(count)(...) == IOFailure(1)
```

Parameters **function** (Callable[[*Result*[+_ValueType, +_ErrorType]], *KindN*[*RequiresContextIOResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextIOResult*[~_NewValueType, +_ErrorType, -_EnvType]

modify_env(*function*)

Allows to modify the environment type.

```
>>> from returns.context import RequiresContextIOResultE
>>> from returns.io import IOSuccess, impure_safe

>>> def div(arg: int) -> RequiresContextIOResultE[float, int]:
...     return RequiresContextIOResultE(
...         impure_safe(lambda deps: arg / deps),
...     )

>>> assert div(3).modify_env(int)('2') == IOSuccess(1.5)
>>> assert div(3).modify_env(int)('0').failure()
```

Parameters **function** (Callable[[~_NewEnvType], -_EnvType]) –

Return type *RequiresContextIOResult*[+_ValueType, +_ErrorType, ~_NewEnvType]

classmethod ask()

Is used to get the current dependencies inside the call stack.

Similar to *returns.context.requires_context.RequiresContext.ask()*, but returns IOResult instead of a regular value.

Please, refer to the docs there to learn how to use it.

One important note that is worth duplicating here: you might need to provide _EnvType explicitly, so mypy will know about it statically.

```
>>> from returns.context import RequiresContextIOResultE
>>> from returns.io import IOSuccess
>>> assert RequiresContextIOResultE[int, int].ask().map(
...     str,
... )(1) == IOSuccess('1')
```

Return type *RequiresContextIOResult*[-_EnvType, +_ErrorType, -_EnvType]

classmethod from_result(*inner_value*)

Creates new container with Result as a unit value.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.result import Success, Failure
>>> from returns.io import IOSuccess, IOFailure
>>> deps = RequiresContextIOResult.no_args

>>> assert RequiresContextIOResult.from_result(
...     Success(1),
... )(deps) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_result(
...     Failure(1),
... )(deps) == IOFailure(1)
```

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_io(*inner_value*)
Creates new container from successful `IO` value.

```
>>> from returns.io import IO, IOSuccess
>>> from returns.context import RequiresContextIOResult

>>> assert RequiresContextIOResult.from_io(IO(1))(
...     RequiresContextIOResult.no_args,
... ) == IOSuccess(1)
```

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *RequiresContextIOResult*[~_NewValueType, Any, Any]

classmethod from_failed_io(*inner_value*)
Creates a new container from failed `IO` value.

```
>>> from returns.io import IO, IOFailure
>>> from returns.context import RequiresContextIOResult

>>> assert RequiresContextIOResult.from_failed_io(IO(1))(
...     RequiresContextIOResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*IO*[~_NewErrorType]) –

Return type *RequiresContextIOResult*[Any, ~_NewErrorType, Any]

classmethod from_ioresult(*inner_value*)
Creates new container with `IOResult` as a unit value.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure
>>> deps = RequiresContextIOResult.no_args

>>> assert RequiresContextIOResult.from_ioresult(
...     IOSuccess(1),
... )(deps) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_ioresult(
...     IOFailure(1),
... )(deps) == IOFailure(1)
```

Parameters **inner_value** (*IOResult*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_ioresult_context(*inner_value*)
Creates new container with `ReaderIOResult` as a unit value.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert RequiresContextIOResult.from_ioresult_context(
```

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```
...     RequiresContextIOResult.from_value(1),
... )(...) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_ioresult_context(
...     RequiresContextIOResult.from_failure(1),
... )(...) == IOFailure(1)
```

Parameters **inner_value** (*RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]) –

Return type *RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod from_typecast(*inner_value*)

You might end up with `RequiresContext[IOResult]` as a value.

This method is designed to turn it into `RequiresContextIOResult`. It will save all the typing information.

It is just more useful!

```
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess, IOFailure

>>> assert RequiresContextIOResult.from_typecast(
...     RequiresContext.from_value(IOSuccess(1)),
... )(RequiresContextIOResult.no_args) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_typecast(
...     RequiresContext.from_value(IOFailure(1)),
... )(RequiresContextIOResult.no_args) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, -_EnvType]

classmethod from_context(*inner_value*)

Creates new container from `RequiresContext` as a success unit.

```
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess

>>> assert RequiresContextIOResult.from_context(
...     RequiresContext.from_value(1),
... )(...) == IOSuccess(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextIOResult*[~_NewValueType, Any, ~_NewEnvType]

classmethod from_failed_context(*inner_value*)

Creates new container from `RequiresContext` as a failure unit.

```
>>> from returns.context import RequiresContext
>>> from returns.io import IOFailure

>>> assert RequiresContextIOResult.from_failed_context(
...     RequiresContext.from_value(1),
... )(...) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextIOResult*[Any, ~_NewValueType, ~_NewEnvType]

classmethod **from_result_context**(*inner_value*)

Creates new container from `RequiresContextResult` as a unit value.

```
>>> from returns.context import RequiresContextResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert RequiresContextIOResult.from_result_context(
...     RequiresContextResult.from_value(1),
... )(...) == IOSuccess(1)

>>> assert RequiresContextIOResult.from_result_context(
...     RequiresContextResult.from_failure(1),
... )(...) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextIOResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod **from_value**(*inner_value*)

Creates new container with `IOSuccess(inner_value)` as a unit value.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess

>>> assert RequiresContextIOResult.from_value(1)(
...     RequiresContextIOResult.no_args,
... ) == IOSuccess(1)
```

Parameters **inner_value** (*~_NewValueType*) –

Return type *RequiresContextIOResult*[~_NewValueType, Any, Any]

classmethod **from_failure**(*inner_value*)

Creates new container with `IOFailure(inner_value)` as a unit value.

```
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOFailure

>>> assert RequiresContextIOResult.from_failure(1)(
...     RequiresContextIOResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*~_NewErrorType*) –

Return type *RequiresContextIOResult*[Any, ~_NewErrorType, Any]

RequiresContextIOResultE

Alias for a popular case when Result has Exception as error type.

alias of *returns.context.requires_context_ioresult.RequiresContextIOResult*[returns.context.requires_context_ioresult._ValueType, Exception, returns.context.requires_context_ioresult._EnvType]

ReaderIOResult

Alias to save you some typing. Uses original name from Haskell.

Parameters **inner_value** (Callable[[-_EnvType], *IOResult*[+_ValueType, +_ErrorType]]) –

ReaderIOResultE

Alias to save you some typing. Uses Exception as error type.

alias of *returns.context.requires_context_ioresult.RequiresContextIOResult*[returns.context.requires_context_ioresult._ValueType, Exception, returns.context.requires_context_ioresult._EnvType]

RequiresContextFutureResult

class RequiresContextFutureResult(*inner_value*)

Bases: *returns.primitives.container.BaseContainer*, *returns.primitives.hkt.SupportsKindN*[*RequiresContextFutureResult*, returns.context.requires_context_future_result._ValueType, returns.context.requires_context_future_result._ErrorType, returns.context.requires_context_future_result._EnvType], *returns.interfaces.specific.reader_future_result.ReaderFutureResultBasedN*[returns.context.requires_context_future_result._ValueType, returns.context.requires_context_future_result._ErrorType, returns.context.requires_context_future_result._EnvType], *returns.interfaces.specific.future_result.FutureResultLikeN*[returns.context.requires_context_future_result._ValueType, returns.context.requires_context_future_result._ErrorType, returns.context.requires_context_future_result._EnvType]

The RequiresContextFutureResult combinator.

This probably the main type people are going to use in async programs.

See *returns.context.requires_context.RequiresContext*, *returns.context.requires_context_result.RequiresContextResult*, and returns.context.requires_context_result.RequiresContextIOResult for more docs.

This is just a handy wrapper around RequiresContext[FutureResult[a, b], env] which represents a context-dependent impure async operation that might fail.

So, this is a thin wrapper, without any changes in logic. Why do we need this wrapper? That's just for better usability!

This way RequiresContextIOResult allows to simply work with:

- raw values and pure functions
- RequiresContext values and pure functions returning it
- RequiresContextResult values and pure functions returning it
- RequiresContextIOResult values and pure functions returning it

- `Result` and pure functions returning it
- `IOResult` and functions returning it
- `FutureResult` and functions returning it
- other `RequiresContextFutureResult` related functions and values

This is a complex type for complex tasks!

Important implementation details

Due it is meaning, `RequiresContextFutureResult` cannot have `Success` and `Failure` subclasses.

We only have just one type. That's by design.

Different converters are also not supported for this type. Use converters inside the `RequiresContext` context, not outside.

See also:

- https://dev.to/gcanti/getting-started-with-fp-ts-reader-1ie5
- https://en.wikipedia.org/wiki/Lazy_evaluation
- https://bit.ly/2R8l4WK
- https://bit.ly/2RwP4fp

Parameters **inner_value** (Callable[[-_EnvType], *FutureResult*[+_ValueType, +_ErrorType]]) –

no_args: ClassVar[NoDeps] = <object object>
A convenient placeholder to call methods created by *.from_value()*.

swap()
Swaps value and error types.

So, values become errors and errors become values. It is useful when you have to work with errors a lot. And since we have a lot of `.bind_` related methods and only a single `.lash` - it is easier to work with values.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> success = RequiresContextFutureResult.from_value(1)
>>> failure = RequiresContextFutureResult.from_failure(1)

>>> assert anyio.run(success.swap(), ...) == IOFailure(1)
>>> assert anyio.run(failure.swap(), ...) == IOSuccess(1)
```

Return type *RequiresContextFutureResult*[+_ErrorType, +_ValueType, -_EnvType]

map(*function*)
Composes successful container with a pure function.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(RequiresContextFutureResult.from_value(1).map(
...     lambda x: x + 1,
... )(...).awaitable) == IOSuccess(2)

>>> assert anyio.run(RequiresContextFutureResult.from_failure(1).map(
...     lambda x: x + 1,
... )(...).awaitable) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], ~_NewValueType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

apply(*container*)

Calls a wrapped function in a container on this container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def transform(arg: str) -> str:
...     return arg + 'b'

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value('a').apply(
...         RequiresContextFutureResult.from_value(transform),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess('ab')

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure('a').apply(
...         RequiresContextFutureResult.from_value(transform),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure('a')
```

Parameters **container** (*KindN*[*RequiresContextFutureResult*, Callable[[+_ValueType], ~_NewValueType], +_ErrorType, -_EnvType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind(*function*)

Composes this container with a function returning the same type.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure
```

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```
>>> def function(
...     number: int,
... ) -> RequiresContextFutureResult[str, int, int]:
...     # `deps` has `int` type here:
...     return RequiresContextFutureResult(
...         lambda deps: FutureResult.from_value(str(number + deps)),
...     )

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(2).bind(function),
...     3,
... ) == IOSuccess('5')
>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(2).bind(function),
...     3,
... ) == IOFailure(2)
```

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextFutureResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_future_result(*function*)

Alias for *bind_context_future_result* method, it is the same as *bind* here.

Parameters **function** (Callable[[+_ValueType], *KindN*[*RequiresContextFutureResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_async(*function*)

Composes this container with a async function returning the same type.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def function(
...     number: int,
... ) -> RequiresContextFutureResult[str, int, int]:
...     return RequiresContextFutureResult.from_value(number + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_async(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(1).bind_async(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*RequiresContextFutureResult*, ~_NewValueType, +_ErrorType, -_EnvType]]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_async_context_future_result(*function*)

Alias for *bind_async_context_future_result* method, it is the same as *bind_async* here.

Parameters **function** (Callable[[+_ValueType], Awaitable[*KindN*[*RequiresContextFutureResult*, ~_NewValueType, +_ErrorType, -_EnvType]]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_awaitable(*function*)

Allows to compose a container and a regular `async` function.

This function should return plain, non-container value. See *bind_async()* to bind `async` function that returns a container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def coroutine(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_awaitable(
...         coroutine,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(1).bind_awaitable(
...         coroutine,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], Awaitable[~_NewValueType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_result(*function*)

Binds `Result` returning function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.result import Success, Result
>>> from returns.io import IOSuccess, IOFailure

>>> def function(num: int) -> Result[int, str]:
...     return Success(num + 1)

>>> assert anyio.run(
```

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```
...     RequiresContextFutureResult.from_value(1).bind_result(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(':(').bind_result(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (Callable[[+_ValueType], *Result*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context(*function*)

Binds RequiresContext returning function to current container.

```
>>> import anyio
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess, IOFailure

>>> def function(arg: int) -> RequiresContext[int, str]:
...     return RequiresContext(lambda deps: len(deps) + arg)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(2).bind_context(
...         function,
...     ),
...     'abc',
... ) == IOSuccess(5)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(0).bind_context(
...         function,
...     ),
...     'abc',
... ) == IOFailure(0)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_result(*function*)

Binds RequiresContextResult returning function to the current one.

```
>>> import anyio
>>> from returns.context import RequiresContextResult
>>> from returns.io import IOSuccess, IOFailure
```

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```
>>> from returns.result import Success

>>> def function(arg: int) -> RequiresContextResult[int, int, str]:
...     return RequiresContextResult(
...         lambda deps: Success(len(deps) + arg),
...     )

>>> instance = RequiresContextFutureResult.from_value(
...     2,
... ).bind_context_result(
...     function,
... )('abc')
>>> assert anyio.run(instance.awaitable) == IOSuccess(5)

>>> instance = RequiresContextFutureResult.from_failure(
...     2,
... ).bind_context_result(
...     function,
... )('abc')
>>> assert anyio.run(instance.awaitable) == IOFailure(2)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_context_ioresult(*function*)

Binds RequiresContextIOResult returning function to the current one.

```
>>> import anyio
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> def function(arg: int) -> RequiresContextIOResult[int, int, str]:
...     return RequiresContextIOResult(
...         lambda deps: IOSuccess(len(deps) + arg),
...     )

>>> instance = RequiresContextFutureResult.from_value(
...     2,
... ).bind_context_ioresult(
...     function,
... )('abc')
>>> assert anyio.run(instance.awaitable) == IOSuccess(5)

>>> instance = RequiresContextFutureResult.from_failure(
...     2,
... ).bind_context_ioresult(
...     function,
... )('abc')
>>> assert anyio.run(instance.awaitable) == IOFailure(2)
```

Parameters **function** (Callable[[+_ValueType], ForwardRef]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_io(*function*)

Binds IO returning function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IO, IOSuccess, IOFailure

>>> def do_io(number: int) -> IO[str]:
...     return IO(str(number))  # not IO operation actually

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_io(do_io),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess('1')

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(1).bind_io(do_io),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[+_ValueType], *IO*[~_NewValueType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_ioresult(*function*)

Binds IOResult returning function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOResult, IOSuccess, IOFailure

>>> def function(num: int) -> IOResult[int, str]:
...     return IOSuccess(num + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_ioresult(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(':(').bind_ioresult(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (Callable[[+_ValueType], *IOResult*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_future(*function*)

Binds `Future` returning function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import Future
>>> from returns.io import IOSuccess, IOFailure

>>> def function(num: int) -> Future[int]:
...     return Future.from_value(num + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_future(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> failed = RequiresContextFutureResult.from_failure(':(')
>>> assert anyio.run(
...     failed.bind_future(function),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (`Callable`[[+_ValueType], *Future*[~_NewValueType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_future_result(*function*)

Binds `FutureResult` returning function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def function(num: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(num + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_future_result(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> failed = RequiresContextFutureResult.from_failure(':(')
>>> assert anyio.run(
...     failed.bind_future_result(function),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (`Callable`[[+_ValueType], *FutureResult*[~_NewValueType, +_ErrorType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_async_future(*function*)

Binds Future returning async function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import Future
>>> from returns.io import IOSuccess, IOFailure

>>> async def function(num: int) -> Future[int]:
...     return Future.from_value(num + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).bind_async_future(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> failed = RequiresContextFutureResult.from_failure(':(')
>>> assert anyio.run(
...     failed.bind_async_future(function),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*Future*[~_NewValueType]]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

bind_async_future_result(*function*)

Bind FutureResult returning async function to the current container.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def function(num: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(num + 1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(
...         1,
...     ).bind_async_future_result(
...         function,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(2)

>>> failed = RequiresContextFutureResult.from_failure(':(')
>>> assert anyio.run(
...     failed.bind_async_future_result(function),
```

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```
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(':(')
```

Parameters **function** (Callable[[+_ValueType], Awaitable[*FutureResult*[~_NewValueType, +_ErrorType]]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

alt(*function*)

Composes failed container with a pure function.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value(1).alt(
...         lambda x: x + 1,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure(1).alt(
...         lambda x: x + 1,
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(2)
```

Parameters **function** (Callable[[+_ErrorType], ~_NewErrorType]) –

Return type *RequiresContextFutureResult*[+_ValueType, ~_NewErrorType, -_EnvType]

lash(*function*)

Composes this container with a function returning the same type.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess

>>> def lashable(
...     arg: str,
... ) -> RequiresContextFutureResult[str, str, str]:
...     return RequiresContextFutureResult(
...         lambda deps: FutureResult.from_value(
...             deps + arg,
...         ),
...     )

>>> assert anyio.run(
...     RequiresContextFutureResult.from_value('a').lash(lashable),
```

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```
...     'c',
... ) == IOSuccess('a')

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failure('aa').lash(
...         lashable,
...     ),
...     'b',
... ) == IOSuccess('baa')
```

Parameters **function** (Callable[[+_ErrorType], *KindN*[*RequiresContextFutureResult*, +_ValueType, ~_NewErrorType, -_EnvType]]) –

Return type *RequiresContextFutureResult*[+_ValueType, ~_NewErrorType, -_EnvType]

compose_result(*function*)

Composes inner `Result` with `ReaderFutureResult` returning func.

Can be useful when you need an access to both states of the result.

```
>>> import anyio
>>> from returns.context import ReaderFutureResult, NoDeps
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.result import Result

>>> def count(
...     container: Result[int, int],
... ) -> ReaderFutureResult[int, int, NoDeps]:
...     return ReaderFutureResult.from_result(
...         container.map(lambda x: x + 1).alt(abs),
...     )

>>> success = ReaderFutureResult.from_value(1)
>>> failure = ReaderFutureResult.from_failure(-1)

>>> assert anyio.run(
...     success.compose_result(count), ReaderFutureResult.no_args,
... ) == IOSuccess(2)
>>> assert anyio.run(
...     failure.compose_result(count), ReaderFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **function** (Callable[[*Result*[+_ValueType, +_ErrorType]], *KindN*[*RequiresContextFutureResult*, ~_NewValueType, +_ErrorType, -_EnvType]]) –

Return type *RequiresContextFutureResult*[~_NewValueType, +_ErrorType, -_EnvType]

modify_env(*function*)

Allows to modify the environment type.

```
>>> import anyio
>>> from returns.future import future_safe, asyncify
```

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```
>>> from returns.context import RequiresContextFutureResultE
>>> from returns.io import IOSuccess

>>> def div(arg: int) -> RequiresContextFutureResultE[float, int]:
...     return RequiresContextFutureResultE(
...         future_safe(asyncify(lambda deps: arg / deps)),
...     )

>>> assert anyio.run(div(3).modify_env(int), '2') == IOSuccess(1.5)
>>> assert anyio.run(div(3).modify_env(int), '0').failure()
```

Parameters **function** (Callable[[~_NewEnvType], -_EnvType]) –

Return type *RequiresContextFutureResult*[+_ValueType, +_ErrorType, ~_NewEnvType]

classmethod ask()

Is used to get the current dependencies inside the call stack.

Similar to *returns.context.requires_context.RequiresContext.ask()*, but returns `FutureResult` instead of a regular value.

Please, refer to the docs there to learn how to use it.

One important note that is worth duplicating here: you might need to provide type annotations explicitly, so `mypy` will know about it statically.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResultE
>>> from returns.io import IOSuccess

>>> assert anyio.run(
...     RequiresContextFutureResultE[int, int].ask().map(str),
...     1,
... ) == IOSuccess('1')
```

Return type *RequiresContextFutureResult*[-_EnvType, +_ErrorType, -_EnvType]

classmethod from_result(*inner_value*)

Creates new container with `Result` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.result import Success, Failure
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...    RequiresContextFutureResult.from_result(Success(1)),
...    RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...    RequiresContextFutureResult.from_result(Failure(1)),
...    RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*Result*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_io(*inner_value*)

Creates new container from successful IO value.

```
>>> import anyio
>>> from returns.io import IO, IOSuccess
>>> from returns.context import RequiresContextFutureResult

>>> assert anyio.run(
...     RequiresContextFutureResult.from_io(IO(1)),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)
```

Parameters **inner_value** (*IO*[~_NewValueType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, Any, Any]

classmethod from_failed_io(*inner_value*)

Creates a new container from failed IO value.

```
>>> import anyio
>>> from returns.io import IO, IOFailure
>>> from returns.context import RequiresContextFutureResult

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failed_io(IO(1)),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*IO*[~_NewErrorType]) –

Return type *RequiresContextFutureResult*[Any, ~_NewErrorType, Any]

classmethod from_ioresult(*inner_value*)

Creates new container with IOResult as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_ioresult(IOSuccess(1)),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_ioresult(IOFailure(1)),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*IOResult*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_future(*inner_value*)

Creates new container with successful `Future` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import Future
>>> from returns.io import IOSuccess

>>> assert anyio.run(
...     RequiresContextFutureResult.from_future(Future.from_value(1)),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)
```

Parameters **inner_value** (*Future*[~_NewValueType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, Any, Any]

classmethod from_failed_future(*inner_value*)

Creates new container with failed `Future` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import Future
>>> from returns.io import IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failed_future(
...         Future.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*Future*[~_NewErrorType]) –

Return type *RequiresContextFutureResult*[Any, ~_NewErrorType, Any]

classmethod from_future_result_context(*inner_value*)

Creates new container with `ReaderFutureResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_future_result_context(
...         RequiresContextFutureResult.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_future_result_context(
```

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```
...         RequiresContextFutureResult.from_failure(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod from_future_result(*inner_value*)

Creates new container with `FutureResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_future_result(
...         FutureResult.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_future_result(
...         FutureResult.from_failure(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (*FutureResult*[~_NewValueType, ~_NewErrorType]) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, Any]

classmethod from_typecast(*inner_value*)

You might end up with `RequiresContext[FutureResult]` as a value.

This method is designed to turn it into `RequiresContextFutureResult`. It will save all the typing information.

It is just more useful!

```
>>> import anyio
>>> from returns.context import RequiresContext
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_typecast(
...         RequiresContext.from_value(FutureResult.from_value(1)),
```

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```
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_typecast(
...         RequiresContext.from_value(FutureResult.from_failure(1)),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, ~_EnvType]

classmethod **from_context**(*inner_value*)

Creates new container from RequiresContext as a success unit.

```
>>> import anyio
>>> from returns.context import RequiresContext
>>> from returns.io import IOSuccess

>>> assert anyio.run(
...     RequiresContextFutureResult.from_context(
...         RequiresContext.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextFutureResult*[~_NewValueType, Any, ~_NewEnvType]

classmethod **from_failed_context**(*inner_value*)

Creates new container from RequiresContext as a failure unit.

```
>>> import anyio
>>> from returns.context import RequiresContext
>>> from returns.io import IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_failed_context(
...         RequiresContext.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextFutureResult*[Any, ~_NewValueType, ~_NewEnvType]

classmethod from_result_context(*inner_value*)

Creates new container from `RequiresContextResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_result_context(
...         RequiresContextResult.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_result_context(
...         RequiresContextResult.from_failure(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod from_ioresult_context(*inner_value*)

Creates new container from `RequiresContextIOResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextIOResult
>>> from returns.io import IOSuccess, IOFailure

>>> assert anyio.run(
...     RequiresContextFutureResult.from_ioresult_context(
...         RequiresContextIOResult.from_value(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOSuccess(1)

>>> assert anyio.run(
...     RequiresContextFutureResult.from_ioresult_context(
...         RequiresContextIOResult.from_failure(1),
...     ),
...     RequiresContextFutureResult.no_args,
... ) == IOFailure(1)
```

Parameters **inner_value** (ForwardRef) –

Return type *RequiresContextFutureResult*[~_NewValueType, ~_NewErrorType, ~_NewEnvType]

classmethod from_value(*inner_value*)

Creates new container with successful `FutureResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOSuccess

>>> assert anyio.run(RequiresContextFutureResult.from_value(1)(
...     RequiresContextFutureResult.no_args,
... ).awaitable) == IOSuccess(1)
```

Parameters **inner_value** (*~_FirstType*) –

Return type *RequiresContextFutureResult*[~_FirstType, Any, Any]

classmethod from_failure(*inner_value*)

Creates new container with failed `FutureResult` as a unit value.

```
>>> import anyio
>>> from returns.context import RequiresContextFutureResult
>>> from returns.io import IOFailure

>>> assert anyio.run(RequiresContextFutureResult.from_failure(1)(
...     RequiresContextFutureResult.no_args,
... ).awaitable) == IOFailure(1)
```

Parameters **inner_value** (*~_FirstType*) –

Return type *RequiresContextFutureResult*[Any, ~_FirstType, Any]

RequiresContextFutureResultE

Alias for a popular case when `Result` has `Exception` as error type.

alias of *returns.context.requires_context_future_result.RequiresContextFutureResult*[returns.context.requires_context_future_result._ValueType, Exception, returns.context.requires_context_future_result._EnvType]

ReaderFutureResult

Sometimes *RequiresContextFutureResult* is too long to type.

Parameters **inner_value** (Callable[[-_EnvType], *FutureResult*[+_ValueType, +_ErrorType]]) –

ReaderFutureResultE

Alias to save you some typing. Uses `Exception` as error type.

alias of *returns.context.requires_context_future_result.RequiresContextFutureResult*[returns.context.requires_context_future_result._ValueType, Exception, returns.context.requires_context_future_result._EnvType]

9.11 Create your own container

This tutorial will guide you through the process of creating your own containers.

9.11.1 Step 0: Motivation

First things first, why would anyone want to create a custom containers?

The great idea about "containers" in functional programming is that it can be literally anything. There are endless use-cases.

You can create your own primitives for working with some language-or-framework specific problem, or just model your business domain.

You can copy ideas from other languages or just compose existing containers for better usability (like `IOResult` is the composition of `IO` and `Result`).

Example

We are going to implement a `Pair` container for this example. What is a `Pair`? Well, it is literally a pair of two values. No more, no less. Similar to a `Tuple[FirstType, SecondType]`. But with extra goodies.

Note: You can find all code samples here.

9.11.2 Step 1: Choosing right interfaces

After you came up with the idea, you will need to make a decision: what capabilities my container must have?

Basically, you should decide what *Interfaces* you will subtype and what methods and laws will be present in your type. You can create just a *returns.interfaces.mappable.MappableN* or choose a full featured *returns.interfaces.container.ContainerN*.

You can also choose some specific interfaces to use, like *returns.interfaces.specific.result.ResultLikeN* or any other.

Summing up, decide what laws and methods you need to solve your problem. And then subtype the interfaces that provide these methods and laws.

Example

What interfaces a `Pair` type needs?

- *returns.interfaces.equable.Equable*, because two `Pair` instances can be compared
- *returns.interfaces.mappable.MappableN*, because the first type can be composed with pure functions
- *returns.interfaces.bindable.BindableN*, because a `Pair` can be bound to a function returning a new `Pair` based on the first type
- *returns.interfaces.altable.AltableN*, because the second type can be composed with pure functions
- *returns.interfaces.lashable.LashableN*, because a `Pair` can be bound to a function returning a new `Pair` based on the second type

Now, after we know about all interfaces we would need, let's find pre-defined aliases we can reuse.

Turns out, there are some of them!

- *returns.interfaces.bimappable.BiMappableN* which combines `MappableN` and `AltableN`
- *returns.interfaces.swappable.SwappableN* is an alias for `BiMappableN` with a new method called `.swap` to change values order

Let's look at the result:

Note: A special note on *returns.primitives.container.BaseContainer*. It is a very useful class with lots of pre-defined feaatures, like: immutability, better cloning, serialization, and comparison.

You can skip it if you wish, but it is highlighly recommended.

Later we will talk about an actual implementation of all required methods.

9.11.3 Step 2: Initial implementation

So, let's start writing some code!

We would need to implement all interface methods, otherwise `mypy` won't be happy. That's what it currently says on our type definition:

```
error: Final class test_pair1.Pair has abstract attributes "alt", "bind", "equals", "lash
↪", "map", "swap"
```

Looks like it already knows what methods should be there!

Ok, let's drop some initial and straight forward implementation. We will later make it more complex step by step.

```
from typing import Callable, Tuple, TypeVar

from typing_extensions import final

from returns.interfaces import bindable, equable, lashable, swappable
from returns.primitives.container import BaseContainer, container_equality
from returns.primitives.hkt import Kind2, SupportsKind2, dekind

_FirstType = TypeVar('_FirstType')
_SecondType = TypeVar('_SecondType')

_NewFirstType = TypeVar('_NewFirstType')
_NewSecondType = TypeVar('_NewSecondType')


@final
class Pair(
    BaseContainer,
    SupportsKind2['Pair', _FirstType, _SecondType],
    bindable.Bindable2[_FirstType, _SecondType],
    swappable.Swappable2[_FirstType, _SecondType],
    lashable.Lashable2[_FirstType, _SecondType],
    equable.Equable,
```

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```
):
    """
    A type that represents a pair of something.

    Like to coordinates ``(x, y)`` or two best friends.
    Or a question and an answer.

    """

    def __init__(
        self,
        inner_value: Tuple[_FirstType, _SecondType],
    ) -> None:
        """Saves passed tuple as ``._inner_value`` inside this instance."""
        super().__init__(inner_value)

    # `Equable` part:

    equals = container_equality  # we already have this defined for all types

    # `Mappable` part via `BiMappable`:

    def map(
        self,
        function: Callable[[_FirstType], _NewFirstType],
    ) -> 'Pair[_NewFirstType, _SecondType]':
        return Pair((function(self._inner_value[0]), self._inner_value[1]))

    # `BindableN` part:

    def bind(
        self,
        function: Callable[
            [_FirstType],
            Kind2['Pair', _NewFirstType, _SecondType],
        ],
    ) -> 'Pair[_NewFirstType, _SecondType]':
        return dekind(function(self._inner_value[0]))

    # `AltableN` part via `BiMappableN`:

    def alt(
        self,
        function: Callable[[_SecondType], _NewSecondType],
    ) -> 'Pair[_FirstType, _NewSecondType]':
        return Pair((self._inner_value[0], function(self._inner_value[1])))

    # `LashableN` part:

    def lash(
        self,
        function: Callable[
```

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```
            [_SecondType],
            Kind2['Pair', _FirstType, _NewSecondType],
        ],
    ) -> 'Pair[_FirstType, _NewSecondType]':
        return dekind(function(self._inner_value[1]))

    # `SwappableN` part:

    def swap(self) -> 'Pair[_SecondType, _FirstType]':
        return Pair((self._inner_value[1], self._inner_value[0]))
```

You can check our resulting source with `mypy`. It would be happy this time.

9.11.4 Step 3: New interfaces

As you can see our existing interfaces do not cover everything. We can potentially want several extra things:

1. A method that takes two arguments and returns a new `Pair` instance
2. A named constructor to create a `Pair` from a single value
3. A named constructor to create a `Pair` from two values

We can define an interface just for this! It would be also nice to add all other interfaces there as supertypes.

That's how it is going to look:

```
class PairLikeN(
    bindable.BindableN[_FirstType, _SecondType, _ThirdType],
    swappable.SwappableN[_FirstType, _SecondType, _ThirdType],
    lashable.LashableN[_FirstType, _SecondType, _ThirdType],
    equable.Equable,
):
    """Special interface for types that look like a ``Pair``."""

    @abstractmethod
    def pair(
        self: _PairLikeKind,
        function: Callable[
            [_FirstType, _SecondType],
            KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType],
        ],
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to work with both arguments at the same time."""

    @classmethod
    @abstractmethod
    def from_paired(
        cls: Type[_PairLikeKind],
        first: _NewFirstType,
        second: _NewSecondType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to create a PairLikeN from just two values."""

```

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```
    @classmethod
    @abstractmethod
    def from_unpaired(
        cls: Type[_PairLikeKind],
        inner_value: _NewFirstType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewFirstType, _ThirdType]:
        """Allows to create a PairLikeN from just a single object."""
```

Awesome! Now we have a new interface to implement. Let's do that!

```
    def pair(
        self,
        function: Callable[
            [_FirstType, _SecondType],
            Kind2['Pair', _NewFirstType, _NewSecondType],
        ],
    ) -> 'Pair[_NewFirstType, _NewSecondType]':
        return dekind(function(self._inner_value[0], self._inner_value[1]))
```

```
    @classmethod
    def from_unpaired(
        cls,
        inner_value: _NewFirstType,
    ) -> 'Pair[_NewFirstType, _NewFirstType]':
        return Pair((inner_value, inner_value))
```

Looks like we are done!

9.11.5 Step 4: Writing tests and docs

The best part about this type is that it is pure. So, we can write our tests inside docs!

We are going to use doctests builtin module for that.

This gives us several key benefits:

- All our docs has usage examples
- All our examples are correct, because they are executed and tested
- We don't need to write regular boring tests

Let's add docs and doctests! Let's use `map` method as a short example:

```
    def map(
        self,
        function: Callable[[_FirstType], _NewFirstType],
    ) -> 'Pair[_NewFirstType, _SecondType]':
        """
        Changes the first type with a pure function.

        >>> assert Pair((1, 2)).map(str) == Pair(('1', 2))

        """
        return Pair((function(self._inner_value[0]), self._inner_value[1]))
```

By adding these simple tests we would already have 100% coverage. But, what if we can completely skip writing tests, but still have 100%?

Let's discuss how we can achieve that with "Laws as values".

9.11.6 Step 5: Checking laws

We already ship lots of laws with our interfaces. See our docs on *laws and checking them*.

Moreover, you can also define your own laws! Let's add them to our `PairLikeN` interface.

Let's start with laws definition:

```
class _LawSpec(LawSpecDef):
    @law_definition
    def pair_equality_law(
        raw_value: _FirstType,
        container: 'PairLikeN[_FirstType, _SecondType, _ThirdType]',
    ) -> None:
        """Ensures that unpaired and paired constructors work fine."""
        assert_equal(
            container.from_unpaired(raw_value),
            container.from_paired(raw_value, raw_value),
        )

    @law_definition
    def pair_left_identity_law(
        pair: Tuple[_FirstType, _SecondType],
        container: 'PairLikeN[_FirstType, _SecondType, _ThirdType]',
        function: Callable[
            [_FirstType, _SecondType],
            KindN['PairLikeN', _NewFirstType, _NewSecondType, _ThirdType],
        ],
    ) -> None:
        """Ensures that unpaired and paired constructors work fine."""
        assert_equal(
            container.from_paired(*pair).pair(function),
            function(*pair),
        )
```

And them let's add them to our `PairLikeN` interface:

```
class PairLikeN(
    bindable.BindableN[_FirstType, _SecondType, _ThirdType],
    swappable.SwappableN[_FirstType, _SecondType, _ThirdType],
    lashable.LashableN[_FirstType, _SecondType, _ThirdType],
    equable.Equable,
):
    """Special interface for types that look like a ``Pair``."""

    _laws: ClassVar[Sequence[Law]] = (
        Law2(_LawSpec.pair_equality_law),
        Law3(_LawSpec.pair_left_identity_law),
    )
```

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```
    @abstractmethod
    def pair(
        self: _PairLikeKind,
        function: Callable[
            [_FirstType, _SecondType],
            KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType],
        ],
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to work with both arguments at the same time."""

    @classmethod
    @abstractmethod
    def from_paired(
        cls: Type[_PairLikeKind],
        first: _NewFirstType,
        second: _NewSecondType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to create a PairLikeN from just two values."""

    @classmethod
    @abstractmethod
    def from_unpaired(
        cls: Type[_PairLikeKind],
        inner_value: _NewFirstType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewFirstType, _ThirdType]:
        """Allows to create a PairLikeN from just a single object."""
```

The last to do is to call `check_all_laws(Pair, use_init=True)` to generate 10 `hypothesis` test cases with hundreds real test cases inside.

Here's the final result of our brand new `Pair` type:

```
from abc import abstractmethod
from typing import Callable, ClassVar, NoReturn, Sequence, Tuple, Type, TypeVar

from typing_extensions import final

from returns.contrib.hypothesis.laws import check_all_laws
from returns.interfaces import bindable, equable, lashable, swappable
from returns.primitives.asserts import assert_equal
from returns.primitives.container import BaseContainer, container_equality
from returns.primitives.hkt import Kind2, KindN, SupportsKind2, dekind
from returns.primitives.laws import Law, Law2, Law3, LawSpecDef, law_definition

_FirstType = TypeVar('_FirstType')
_SecondType = TypeVar('_SecondType')
_ThirdType = TypeVar('_ThirdType')

_NewFirstType = TypeVar('_NewFirstType')
_NewSecondType = TypeVar('_NewSecondType')

_PairLikeKind = TypeVar('_PairLikeKind', bound='PairLikeN')
```

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```


class _LawSpec(LawSpecDef):
    @law_definition
    def pair_equality_law(
        raw_value: _FirstType,
        container: 'PairLikeN[_FirstType, _SecondType, _ThirdType]',
    ) -> None:
        """Ensures that unpaired and paired constructors work fine."""
        assert_equal(
            container.from_unpaired(raw_value),
            container.from_paired(raw_value, raw_value),
        )

    @law_definition
    def pair_left_identity_law(
        pair: Tuple[_FirstType, _SecondType],
        container: 'PairLikeN[_FirstType, _SecondType, _ThirdType]',
        function: Callable[
            [_FirstType, _SecondType],
            KindN['PairLikeN', _NewFirstType, _NewSecondType, _ThirdType],
        ],
    ) -> None:
        """Ensures that unpaired and paired constructors work fine."""
        assert_equal(
            container.from_paired(*pair).pair(function),
            function(*pair),
        )


class PairLikeN(
    bindable.BindableN[_FirstType, _SecondType, _ThirdType],
    swappable.SwappableN[_FirstType, _SecondType, _ThirdType],
    lashable.LashableN[_FirstType, _SecondType, _ThirdType],
    equable.Equable,
):
    """Special interface for types that look like a ``Pair``."""

    _laws: ClassVar[Sequence[Law]] = (
        Law2(_LawSpec.pair_equality_law),
        Law3(_LawSpec.pair_left_identity_law),
    )

    @abstractmethod
    def pair(
        self: _PairLikeKind,
        function: Callable[
            [_FirstType, _SecondType],
            KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType],
        ],
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to work with both arguments at the same time."""
```

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```
    @classmethod
    @abstractmethod
    def from_paired(
        cls: Type[_PairLikeKind],
        first: _NewFirstType,
        second: _NewSecondType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewSecondType, _ThirdType]:
        """Allows to create a PairLikeN from just two values."""

    @classmethod
    @abstractmethod
    def from_unpaired(
        cls: Type[_PairLikeKind],
        inner_value: _NewFirstType,
    ) -> KindN[_PairLikeKind, _NewFirstType, _NewFirstType, _ThirdType]:
        """Allows to create a PairLikeN from just a single object."""


PairLike2 = PairLikeN[_FirstType, _SecondType, NoReturn]
PairLike3 = PairLikeN[_FirstType, _SecondType, _ThirdType]


@final
class Pair(
    BaseContainer,
    SupportsKind2['Pair', _FirstType, _SecondType],
    PairLike2[_FirstType, _SecondType],
):
    """
    A type that represents a pair of something.

    Like to coordinates ``(x, y)`` or two best friends.
    Or a question and an answer.

    """

    def __init__(
        self,
        inner_value: Tuple[_FirstType, _SecondType],
    ) -> None:
        """Saves passed tuple as ``._inner_value`` inside this instance."""
        super().__init__(inner_value)

    # `Equable` part:

    equals = container_equality  # we already have this defined for all types

    # `Mappable` part via `BiMappable`:

    def map(
        self,
```

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```
        function: Callable[[_FirstType], _NewFirstType],
    ) -> 'Pair[_NewFirstType, _SecondType]':
        """
        Changes the first type with a pure function.

        >>> assert Pair((1, 2)).map(str) == Pair(('1', 2))

        """
        return Pair((function(self._inner_value[0]), self._inner_value[1]))

    # `BindableN` part:

    def bind(
        self,
        function: Callable[
            [_FirstType],
            Kind2['Pair', _NewFirstType, _SecondType],
        ],
    ) -> 'Pair[_NewFirstType, _SecondType]':
        """
        Changes the first type with a function returning another ``Pair``.

        >>> def bindable(first: int) -> Pair[str, str]:
        ...     return Pair((str(first), ''))

        >>> assert Pair((1, 'b')).bind(bindable) == Pair(('1', ''))

        """
        return dekind(function(self._inner_value[0]))

    # `AltableN` part via `BiMappableN`:

    def alt(
        self,
        function: Callable[[_SecondType], _NewSecondType],
    ) -> 'Pair[_FirstType, _NewSecondType]':
        """
        Changes the second type with a pure function.

        >>> assert Pair((1, 2)).alt(str) == Pair((1, '2'))

        """
        return Pair((self._inner_value[0], function(self._inner_value[1])))

    # `LashableN` part:

    def lash(
        self,
        function: Callable[
            [_SecondType],
            Kind2['Pair', _FirstType, _NewSecondType],
        ],
```

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```
    ) -> 'Pair[_FirstType, _NewSecondType]':
        """
        Changes the second type with a function returning ``Pair``.

        >>> def lashable(second: int) -> Pair[str, str]:
        ...     return Pair(('', str(second)))

        >>> assert Pair(('a', 2)).lash(lashable) == Pair(('', '2'))

        """
        return dekind(function(self._inner_value[1]))

    # `SwappableN` part:

    def swap(self) -> 'Pair[_SecondType, _FirstType]':
        """
        Swaps ``Pair`` elements.

        >>> assert Pair((1, 2)).swap() == Pair((2, 1))

        """
        return Pair((self._inner_value[1], self._inner_value[0]))

    # `PairLikeN` part:

    def pair(
        self,
        function: Callable[
            [_FirstType, _SecondType],
            Kind2['Pair', _NewFirstType, _NewSecondType],
        ],
    ) -> 'Pair[_NewFirstType, _NewSecondType]':
        """
        Creates a new ``Pair`` from an existing one via a passed function.

        >>> def min_max(first: int, second: int) -> Pair[int, int]:
        ...     return Pair((min(first, second), max(first, second)))

        >>> assert Pair((2, 1)).pair(min_max) == Pair((1, 2))
        >>> assert Pair((1, 2)).pair(min_max) == Pair((1, 2))

        """
        return dekind(function(self._inner_value[0], self._inner_value[1]))

    @classmethod
    def from_paired(
        cls,
        first: _NewFirstType,
        second: _NewSecondType,
    ) -> 'Pair[_NewFirstType, _NewSecondType]':
        """
        Creates a new pair from two values.
```

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```
        >>> assert Pair.from_paired(1, 2) == Pair((1, 2))

        """
        return Pair((first, second))

    @classmethod
    def from_unpaired(
        cls,
        inner_value: _NewFirstType,
    ) -> 'Pair[_NewFirstType, _NewFirstType]':
        """
        Creates a new pair from a single value.

        >>> assert Pair.from_unpaired(1) == Pair((1, 1))

        """
        return Pair((inner_value, inner_value))


# Running hypothesis auto-generated tests:
check_all_laws(Pair, use_init=True)
```

9.11.7 Step 6: Writing type-tests

Note: You can find all type-tests here.

The next thing we want is to write a type-test!

What is a type-test? This is a special type of tests for your typing. We run `mypy` on top of tests and use snapshots to assert the result.

We recommend to use pytest-mypy-plugins. Read more about how to use it.

Let's start with a simple test to make sure our `.pair` function works correctly:

Warning: Please, don't use `env:` property the way we do here. We need it since we store our example in `tests/` folder. And we have to tell `mypy` how to find it.

```
- case: test_pair_type
  disable_cache: false
  env:
    # We only need this because we store this example in `tests/`
    # and not in our source code. Please, do not copy this line!
    - MYPYPATH=./tests/test_examples/test_your_container
  main: |
    # Let's import our `Pair` type we defined earlier:
    from test_pair4 import Pair

```

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```
    def function(first: int, second: str) -> Pair[float, bool]:
        ...

    my_pair: Pair[int, str] = Pair.from_paired(1, 'a')
    reveal_type(my_pair.pair(function))
  out: |
    main:8: note: Revealed type is "test_pair4.Pair[builtins.float*, builtins.bool*]"
```

Ok, now, let's try to raise an error by using it incorrectly:

```
- case: test_pair_error
  disable_cache: false
  env:
    # We only need this because we store this example in `tests/`
    # and not in our source code. Please, do not copy this line!
    - MYPYPATH=./tests/test_examples/test_your_container
  main: |
    # Let's import our `Pair` type we defined earlier:
    from test_pair4 import Pair

    # Oups! This function has first and second types swapped!
    def function(first: str, second: int) -> Pair[float, bool]:
        ...

    my_pair = Pair.from_paired(1, 'a')
    my_pair.pair(function)  # this should and will error
  out: |
    main:9: error: Argument 1 to "pair" of "Pair" has incompatible type "Callable[[str,␣
↪int], Pair[float, bool]]"; expected "Callable[[int, str], KindN[Pair[Any, Any], float,␣
↪bool, Any]]"
```

9.11.8 Step 7: Reusing code

The last (but not the least!) thing you need to know is that you can reuse all code we already have for this new `Pair` type.

This is because of our *Higher Kinded Types* feature.

So, let's say we want to use native `map_()` pointfree function with our new `Pair` type. Let's test that it will work correctly:

```
- case: test_pair_map
  disable_cache: false
  env:
    # We only need this because we store this example in `tests/`
    # and not in our source code. Please, do not copy this line!
    - MYPYPATH=./tests/test_examples/test_your_container
  main: |
    from test_pair4 import Pair
    from returns.pointfree import map_

    my_pair: Pair[int, int] = Pair.from_unpaired(1)
```

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```
    reveal_type(my_pair.map(str))
    reveal_type(map_(str)(my_pair))
  out: |
    main:5: note: Revealed type is "test_pair4.Pair[builtins.str*, builtins.int]"
    main:6: note: Revealed type is "test_pair4.Pair[builtins.str, builtins.int]"
```

Yes, it works!

Now you have fully working, typed, documented, lawful, and tested primitive. You can build any other primitive you need for your business logic or infrastructure.

9.12 Pipelines

The main idea behind functional programming is functional composition.

We provide several tools to make composition easy, readable, pythonic, and useful.

Note: Make sure you are familiar with our *Pointfree* tools, because pipelines and pointfree functions are best friends!

9.12.1 flow

`flow` allows to easily compose multiple functions together into a pipeline. It is useful when you already have an instance to compose functions with.

Note: `flow` is the recommended way to write your code with `returns`!

Let's see an example:

```
>>> from returns.pipeline import flow
>>> assert flow(
...     [1, 2, 3],
...     lambda collection: max(collection),
...     lambda max_number: -max_number,
... ) == -3
```

This allows you to write declarative steps that should be performed on an existing value.

Note: Technical note: `flow` has the best type inference mechanism among all other tools we provide here. This happens due to our *mypy plugins*.

You can also use `flow` with pointfree functions and containers:

```
>>> from returns.result import Result, Success, Failure
>>> from returns.pointfree import bind
>>> from returns.pipeline import flow

>>> def regular_function(arg: int) -> float:
```

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```
...     return float(arg)

>>> def returns_container(arg: float) -> Result[str, ValueError]:
...     if arg != 0:
...         return Success(str(arg))
...     return Failure(ValueError('Wrong arg'))

>>> def also_returns_container(arg: str) -> Result[str, ValueError]:
...     return Success(arg + '!')

>>> assert flow(
...     1,  # initial value
...     regular_function,  # composes easily
...     returns_container,  # also composes easily, but returns a container
...     # So we need to `bind` the next function to allow it to consume
...     # the container from the previous step.
...     bind(also_returns_container),
... ) == Success('1.0!')

>>> # And this will fail:
>>> assert flow(
...     0,  # initial value
...     regular_function,  # composes easily
...     returns_container,  # also composes easily, but returns a container
...     # So we need to `bind` the next function to allow it to consume
...     # the container from the previous step.
...     bind(also_returns_container),
... ).failure().args == ('Wrong arg', )
```

And now let's get to know `pipe`, it is very similar, but has different usage pattern.

9.12.2 pipe

`pipe` is an easy way to compose functions together. It is useful when you don't have an instance to compose functions with yet.

Note: `pipe` requires to use our *mypy plugins*.

Let's see an example.

```
>>> from returns.pipeline import pipe

>>> pipeline = pipe(str, lambda x: x + 'b', str.upper)
>>> assert pipeline(1) == '1B'
```

It might be later used with multiple values:

```
>>> assert pipeline(2) == '2B'
```

It is also might be useful to compose containers together:

```
>>> from returns.pipeline import pipe
>>> from returns.result import Result, Success, Failure
>>> from returns.pointfree import bind

>>> def regular_function(arg: int) -> float:
...     return float(arg)

>>> def returns_container(arg: float) -> Result[str, ValueError]:
...     if arg != 0:
...         return Success(str(arg))
...     return Failure(ValueError('Wrong arg'))

>>> def also_returns_container(arg: str) -> Result[str, ValueError]:
...     return Success(arg + '!')

>>> transaction = pipe(
...     regular_function,  # composes easily
...     returns_container,  # also composes easily, but returns a container
...     # So we need to `bind` the next function to allow it to consume
...     # the container from the previous step.
...     bind(also_returns_container),
... )
>>> result = transaction(1)  # running the pipeline
>>> assert result == Success('1.0!')
```

You might consider `pipe()` as *returns.functions.compose()* on steroids. The main difference is that `compose` takes strictly two arguments (or you might say that it has an arity of two), while `pipe` has infinite possible arguments.

9.12.3 managed

A really common task is to work with something stateful, like database connections or files.

First, you need to acquire some resource, then use it and do your thing, and clear things up and release the acquired resource.

There are several rules here:

1. If the acquiring failed, then do nothing: do not try to use the resource or release it
2. If the resource is acquired, then try to use it and then release it despite of the usage result

In other words, if you cannot open a file, then do nothing. If you opened it, then try to read it. And then always close it.

Let's say you have to read a file's contents:

```
>>> from typing import TextIO
>>> from returns.pipeline import managed, is_successful
>>> from returns.result import ResultE
>>> from returns.io import IOResultE, impure_safe

>>> def read_file(file_obj: TextIO) -> IOResultE[str]:
...     return impure_safe(file_obj.read)()  # this will be the final result

>>> def close_file(
...     file_obj: TextIO,
```

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```
...     file_contents: ResultE[str],
... ) -> IOResultE[None]:  # sometimes might require to use `untap`
...     return impure_safe(file_obj.close)()  # this value will be dropped

>>> managed_read = managed(read_file, close_file)

>>> read_result = managed_read(
...     impure_safe(lambda filename: open(filename, 'r'))('pyproject.toml'),
... )
>>> assert is_successful(read_result)  # file content is inside `IOSuccess`
```

And here's how we recommend to combine `managed` with other pipeline functions:

```
>>> import tomlkit
>>> from returns.pipeline import flow
>>> from returns.pointfree import bind_result
>>> from returns.result import safe
>>> from returns.io import IOSuccess

>>> @safe
... def parse_toml(file_contents: str) -> dict:
...     return tomlkit.parse(file_contents)

>>> @safe
... def get_project_name(parsed: dict) -> str:
...     return parsed['tool']['poetry']['name']

>>> pipeline_result = flow(
...     'pyproject.toml',  # filename we work with
...     impure_safe(lambda filename: open(filename, 'r')),
...     managed_read,
...     bind_result(parse_toml),
...     bind_result(get_project_name),
... )
>>> assert pipeline_result == IOSuccess('returns')
```

Notice a few tricks here:

1. We use `managed` with and without `flow` here, both are fine!
2. We have created a `managed_read` managed function, so we don't need to specify it every time we want to read a file in a functional way
3. We are using impure and pure operations inside the pipeline: this helps us to understand how our app works. Which parts do access the file system and which just work

However, you can still use the imperative approach with `with:` or `try/finally` wrapped into `@impure_safe` decorator, your choice! We don't recommend to mix these two. Stick to one you like the most.

`managed` can be used with:

- `IOResult`
- `FutureResult`
- `RequiresContextIOResult`

- RequiresContextFutureResult

9.12.4 is_successful

`is_successful` is used to tell whether or not your result is a success. We treat only three types that do not throw as successful ones, basically: *Success*, *IOSuccess*, and *Some*

```
>>> from returns.result import Success, Failure
>>> from returns.pipeline import is_successful

>>> assert is_successful(Success(1)) is True
>>> assert is_successful(Failure('text')) is False
```

9.12.5 Further reading

- fp-ts pipeable
- ZIO Managed

9.12.6 API Reference

flow(*instance*, **functions*)

Allows to compose a value and up to multiple functions that use this value.

All starts with the value itself. Each next function uses the previous result as an input parameter.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this function.

Currently, `flow` has a hard limit of 21 steps. Because, it is not possible to type it otherwise. We need a hard limit. See: https://github.com/dry-python/returns/issues/461

Here's how it should be used:

```
>>> from returns.pipeline import flow

>>> # => executes: str(float(int('1')))
>>> assert flow('1', int, float, str) == '1.0'
```

This function is closely related to `pipe`:

```
>>> from returns.pipeline import pipe
>>> assert flow('1', int, float, str) == pipe(int, float, str)('1')
```

See also:

- https://stackoverflow.com/a/41585450/4842742
- https://github.com/gcanti/fp-ts/blob/master/src/pipeable.ts

Requires our *mypy plugin*.

Parameters

- **instance** (*~_InstanceType*) –

- **functions** (*~_PipelineStepType*) –

Return type ~_ReturnType

pipe(**functions*)

Allows to compose a value and up to 7 functions that use this value.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this function.

Each next function uses the previous result as an input parameter. Here's how it should be used:

```
>>> from returns.pipeline import pipe

>>> # => executes: str(float(int('1')))
>>> assert pipe(int, float, str)('1') == '1.0'
```

This function is closely related to `pipe`:

```
>>> from returns.pipeline import flow
>>> assert pipe(int, float, str)('1') == flow('1', int, float, str)
```

See also:

- https://stackoverflow.com/a/41585450/4842742
- https://github.com/gcanti/fp-ts/blob/master/src/pipeable.ts

managed(*use*, *release*)

Allows to run managed computation.

Managed computations consist of three steps:

1. `acquire` when we get some initial resource to work with
2. `use` when the main logic is done
3. `release` when we release acquired resource

Let's look at the example:

1. We need to acquire an opened file to read it later
2. We need to use acquired file to read its content
3. We need to release the acquired file in the end

Here's a code example:

```
>>> from returns.pipeline import managed
>>> from returns.io import IOSuccess, IOFailure, impure_safe

>>> class Lock(object):
...     '''Example class to emulate state to acquire and release.'''
...     def __init__(self, default: bool = False) -> None:
...         self.set = default
...     def __eq__(self, lock) -> bool:  # we need this for testing
...         return self.set == lock.set
...     def release(self) -> None:
...         self.set = False
```

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```
>>> pipeline = managed(
...     lambda lock: IOSuccess(lock) if lock.set else IOFailure(False),
...     lambda lock, use_result: impure_safe(lock.release)(),
... )

>>> assert pipeline(IOSuccess(Lock(True))) == IOSuccess(Lock(False))
>>> assert pipeline(IOSuccess(Lock())) == IOFailure(False)
>>> assert pipeline(IOFailure('no lock')) == IOFailure('no lock')
```

See also:

- https://github.com/gcanti/fp-ts/blob/master/src/IOEither.ts
- https://zio.dev/docs/datatypes/datatypes_managed

Implementation

This class requires some explanation.

First of all, we modeled this function as a class, so it can be partially applied easily.

Secondly, we used imperative approach of programming inside this class. Functional approached was 2 times slower. And way more complex to read and understand.

Lastly, we try to hide these two things for the end user. We pretend that this is not a class, but a function. We also do not break a functional abstraction for the end user. It is just an implementation detail.

Type inference does not work so well with `lambda` functions. But, we do not recommend to use this function with `lambda` functions.

Parameters

- **use** (Callable[[~_FirstType], *KindN*[~_IOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]]) –
- **release** (Callable[[~_FirstType, *Result*[~_UpdatedType, ~_SecondType]], *KindN*[~_IOResultLikeType, None, ~_SecondType, ~_ThirdType]]) –

Return type *Kinded*[Callable[[*KindN*[~_IOResultLikeType, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_IOResultLikeType, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

is_successful(*container*)

Determines if a container was successful or not.

```
>>> from returns.maybe import Some, Nothing
>>> from returns.result import Failure, Success
>>> from returns.io import IOSuccess, IOFailure

>>> assert is_successful(Some(1))
>>> assert not is_successful(Nothing)

>>> assert is_successful(Success(1))
>>> assert not is_successful(Failure(1))

>>> assert is_successful(IOSuccess(1))
>>> assert not is_successful(IOFailure(1))
```

This function can work with containers that are instance of *returns.interfaces.unwrappable.Unwrappable*.

Parameters **container** (*Unwrappable*) –

Return type bool

9.13 Converters

We have several helpers to convert containers from one type to another and back again.

9.13.1 Maybe and Result

We have two converters to work with `Result <-> Maybe` transformations:

- *maybe_to_result()* that converts `Maybe` to `Result`
- *result_to_maybe()* that converts `Result` to `Maybe`

That's how they work:

```
>>> from returns.converters import maybe_to_result, result_to_maybe
>>> from returns.maybe import Maybe, Some
>>> from returns.result import Result, Success

>>> result: Result[int, Exception] = Success(1)
>>> maybe: Maybe[int] = result_to_maybe(result)
>>> assert maybe == Some(1)

>>> new_result: Result[int, None] = maybe_to_result(maybe)
>>> assert new_result == Success(1)
```

Take a note, that type changes. Also, take a note that `Success(None)` will be converted to `Nothing`.

9.13.2 flatten

You can also use *flatten* to merge nested containers together:

```
>>> from returns.converters import flatten
>>> from returns.maybe import Some
>>> from returns.result import Success
>>> from returns.io import IO

>>> assert flatten(IO(IO(1))) == IO(1)
>>> assert flatten(Some(Some(1))) == Some(1)
>>> assert flatten(Success(Success(1))) == Success(1)
```

9.13.3 API Reference

flatten(*container*)

Joins two nested containers together.

Please, note that it will not join two `Failure` for `Result` case or two `Nothing` for `Maybe` case (or basically any two error types) together.

```
>>> from returns.converters import flatten
>>> from returns.io import IO
>>> from returns.result import Failure, Success

>>> assert flatten(IO(IO(1))) == IO(1)

>>> assert flatten(Success(Success(1))) == Success(1)
>>> assert flatten(Failure(Failure(1))) == Failure(Failure(1))
```

See also:

- https://bit.ly/2sIviUr

Parameters **container** (*KindN*[~_BindableKind, *KindN*[~_BindableKind, ~_FirstType, ~_SecondType, ~_ThirdType], ~_SecondType, ~_ThirdType]) –

Return type *KindN*[~_BindableKind, ~_FirstType, ~_SecondType, ~_ThirdType]

result_to_maybe(*result_container*)

Converts `Result` container to `Maybe` container.

```
>>> from returns.maybe import Some, Nothing
>>> from returns.result import Failure, Success

>>> assert result_to_maybe(Success(1)) == Some(1)
>>> assert result_to_maybe(Success(None)) == Some(None)
>>> assert result_to_maybe(Failure(1)) == Nothing
>>> assert result_to_maybe(Failure(None)) == Nothing
```

Parameters **result_container** (*Result*[~_FirstType, ~_SecondType]) –

Return type *Maybe*[~_FirstType]

maybe_to_result(*maybe_container*)

Converts `Maybe` container to `Result` container.

```
>>> from returns.maybe import Some, Nothing
>>> from returns.result import Failure, Success

>>> assert maybe_to_result(Some(1)) == Success(1)
>>> assert maybe_to_result(Some(None)) == Success(None)
>>> assert maybe_to_result(Nothing) == Failure(None)
```

Parameters **maybe_container** (*Maybe*[~_FirstType]) –

Return type *Result*[~_FirstType, None]

9.14 Pointfree

This module provides a bunch of primitives to work with containers.

It is centered around the composition idea. Sometimes using methods on containers is not very helpful. Instead we can use functions that has the reverse semantics, but the same end result.

Why would anyone need these functions when you can use methods? To create pipelines!

Without pointfree functions you cannot easily work with containers inside pipelines. Because they do not compose well:

```
from returns.pipeline import pipe
from returns.result import ResultE

def returns_result(arg: int) -> ResultE[int]:
    ...

def works_with_result(arg: int) -> ResultE[int]:
    ...

def finish_work(arg: int) -> ResultE[int]:
    ...

pipe(
    returns_result,
    works_with_result,  # does not compose!
    finish_work,  # does not compose either!
)
```

In a normal situation you would probably write:

```
returns_result().bind(works_with_result).bind(notifies_user)
```

And you need a way to somehow do this in the pipeline. That's where pointfree functions become really useful.

9.14.1 map

Allows to compose containers and functions, but in a reverse manner.

```
>>> from returns.pointfree import map_
>>> from returns.maybe import Maybe, Some

>>> def mappable(arg: str) -> int:
...     return ord(arg)

>>> container: Maybe[str] = Some('a')
>>> # We now have two way of composining these entities.
>>> # 1. Via ``.map``:
>>> assert container.map(mappable) == Some(97)
>>> # 2. Or via ``bind`` function, the same but in the inverse way:
>>> assert map_(mappable)(container) == Some(97)
```

9.14.2 bind

Allows to bind a function that returns a container of the same type.

Without `bind()` function it would be very hard to declaratively compose two entities:

1. Existing containers
2. Existing functions that accept a regular value and return a container

We can compose these entities with `.bind` when calling it directly, but how can we do it inversely?

```
>>> from returns.pointfree import bind
>>> from returns.maybe import Maybe, Some

>>> def bindable(arg: str) -> Maybe[int]:
...     return Some(1)

>>> container: Maybe[str] = Some('a')
>>> # We now have two way of composing these entities.
>>> # 1. Via ``.bind``:
>>> assert container.bind(bindable) == Some(1)
>>> # 2. Or via ``bind`` function, the same but in the inverse way:
>>> assert bind(bindable)(container) == Some(1)
```

That's it!

We also have a long list of other `bind_*` functions, like:

- `bind_io` to bind functions returning `IO` container
- `bind_result` to bind functions returning `Result` container
- `bind_ioresult` to bind functions returning `IOResult` container
- `bind_future` to bind functions returning `Future` container
- `bind_async_future` to bind async functions returning `Future` container
- `bind_future_result` to bind functions returning `FutureResult` container
- `bind_async_future_result` to bind async functions returning `FutureResult` container
- `bind_context` to bind functions returning `RequiresContext` container
- `bind_context_result` to bind functions returning `RequiresContextResult` container
- `bind_context_ioresult` to bind functions returning `RequiresContextIOResult` container
- `bind_async` to bind async functions returning `Future` or `FutureResult`
- `bind_awaitable` to bind async non-container functions

9.14.3 lash

Pointfree `lash()` function is an alternative to `.lash()` container method. It is also required for better declarative programming.

```
>>> from returns.pointfree import lash
>>> from returns.result import Success, Failure, Result

>>> def function(arg: str) -> Result[int, str]:
...     return Success(1)

>>> container: Result[int, str] = Failure('a')
>>> # We now have two way of composing these entities.
>>> # 1. Via ``.lash``:
>>> assert container.lash(function) == Success(1)
>>> # 2. Or via ``lash`` function, the same but in the inverse way:
>>> assert lash(function)(container) == Success(1)
```

9.14.4 apply

Pointfree `apply` function allows to use `.apply()` container method like a function:

```
>>> from returns.pointfree import apply
>>> from returns.maybe import Some, Nothing

>>> def function(arg: int) -> str:
...     return chr(arg) + '!'

>>> assert apply(Some(function))(Some(97)) == Some('a!')
>>> assert apply(Some(function))(Some(98)) == Some('b!')
>>> assert apply(Some(function))(Nothing) == Nothing
>>> assert apply(Nothing)(Nothing) == Nothing
```

If you wish to use `apply` inside a pipeline that's how it would probably look like:

```
>>> from returns.pointfree import apply
>>> from returns.pipeline import flow
>>> from returns.maybe import Some

>>> def function(arg: int) -> str:
...     return chr(arg) + '!'

>>> assert flow(
...     Some(97),
...     apply(Some(function)),
... ) == Some('a!')
```

Or with function as the first parameter:

```
>>> from returns.pipeline import flow
>>> from returns.curry import curry
>>> from returns.maybe import Some
```

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```
>>> @curry
... def function(first: int, second: int) -> int:
...     return first + second

>>> assert flow(
...     Some(function),
...     Some(2).apply,
...     Some(3).apply,
... ) == Some(5)
```

9.14.5 compose_result

Sometimes we need to manipulate the inner `Result` of some containers like `IOResult` or `FutureResult`, with `compose_result` we're able to do this kind of manipulation.

```
>>> from returns.pointfree import compose_result
>>> from returns.io import IOResult, IOSuccess, IOFailure
>>> from returns.result import Result

>>> def cast_to_str(container: Result[float, int]) -> IOResult[str, int]:
...     return IOResult.from_result(container.map(str))

>>> assert compose_result(cast_to_str)(IOSuccess(42.0)) == IOSuccess('42.0')
>>> assert compose_result(cast_to_str)(IOFailure(1)) == IOFailure(1)
```

9.14.6 cond

Sometimes we need to create `SingleFailableN` or `DiverseFailableN` containers (e.g. `Maybe`, `ResultLikeN`) based on a boolean expression, `cond` can help us.

Consider `cond` to be a functional `if`.

See the example below:

```
>>> from returns.pipeline import flow
>>> from returns.pointfree import cond
>>> from returns.result import Result, Failure, Success

>>> def returns_boolean(arg: int) -> bool:
...     return bool(arg)

>>> assert flow(
...     returns_boolean(1),
...     cond(Result, 'success', 'failure')
... ) == Success('success')

>>> assert flow(
...     returns_boolean(0),
...     cond(Result, 'success', 'failure')
... ) == Failure('failure')
```

Example using cond with the Maybe container:

```
>>> from returns.pipeline import flow
>>> from returns.pointfree import cond
>>> from returns.maybe import Maybe, Some, Nothing

>>> assert flow(
...     returns_boolean(1),
...     cond(Maybe, 'success')
... ) == Some('success')

>>> assert flow(
...     returns_boolean(0),
...     cond(Maybe, 'success')
... ) == Nothing
```

9.14.7 Further reading

- Tacit programming or point-free style
- Pointfree in Haskell

9.14.8 API Reference

map_(*function*)

Lifts function to be wrapped in a container for better composition.

In other words, it modifies the function's signature from: `a -> b` to: `Container[a] -> Container[b]`

This is how it should be used:

```
>>> from returns.io import IO
>>> from returns.pointfree import map_

>>> def example(argument: int) -> float:
...     return argument / 2

>>> assert map_(example)(IO(1)) == IO(0.5)
```

Note, that this function works for all containers with `.map` method. See `returns.primitives.interfaces.mappable.MappableN` for more info.

See also:

- https://wiki.haskell.org/Lifting

Parameters **function** (Callable[[~_FirstType], ~_UpdatedType]) –

Return type *Kinded*[Callable[[*KindN*[~_MappableKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_MappableKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind(*function*)

Turns function's input parameter from a regular value to a container.

In other words, it modifies the function signature from: `a -> Container[b]` to: `Container[a] -> Container[b]`

Similar to *returns.pointfree.lash()*, but works for successful containers. This is how it should be used:

```
>>> from returns.pointfree import bind
>>> from returns.maybe import Maybe, Some, Nothing

>>> def example(argument: int) -> Maybe[int]:
...     return Some(argument + 1)

>>> assert bind(example)(Some(1)) == Some(2)
>>> assert bind(example)(Nothing) == Nothing
```

Note, that this function works for all containers with `.bind` method. See `returns.primitives.interfaces.bindable.BindableN` for more info.

Parameters **function** (`Callable[[~_FirstType], KindN[~_BindableKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]`) –

Return type *Kinded*[`Callable[[KindN[~_BindableKind, ~_FirstType, ~_SecondType, ~_ThirdType]], KindN[~_BindableKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]`]

bind_result(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> Result[b, c]` to: `Container[a, c] -> Container[b, c]`

```
>>> from returns.io import IOSuccess
>>> from returns.context import RequiresContextResult
>>> from returns.result import Result, Success
>>> from returns.pointfree import bind_result

>>> def returns_result(arg: int) -> Result[int, str]:
...     return Success(arg + 1)

>>> bound = bind_result(returns_result)
>>> assert bound(IOSuccess(1)) == IOSuccess(2)
>>> assert bound(RequiresContextResult.from_value(1))(...) == Success(2)
```

Parameters **function** (`Callable[[~_FirstType], ForwardRef]`) –

Return type *Kinded*[`Callable[[KindN[~_ResultLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], KindN[~_ResultLikeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]`]

bind_io(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> IO[b]` to: `Container[a, c] -> Container[b, c]`

```
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.io import IO
>>> from returns.pointfree import bind_io

>>> def returns_io(arg: int) -> IO[int]:
```

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```
...     return IO(arg + 1)

>>> bound = bind_io(returns_io)
>>> assert bound(IO(1)) == IO(2)
>>> assert bound(IOSuccess(1)) == IOSuccess(2)
>>> assert bound(IOFailure(1)) == IOFailure(1)
```

Parameters **function** (Callable[[-_FirstType], ForwardRef]) –

Return type *Kinded*[Callable[[*KindN*[~_IOLikeKind, -_FirstType, ~_SecondType, -_ThirdType]], *KindN*[~_IOLikeKind, +_UpdatedType, ~_SecondType, -_ThirdType]]]

bind_ioresult(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> IOResult[b, c]` to: `Container[a, c] -> Container[b, c]`

```
>>> from returns.io import IOResult, IOSuccess
>>> from returns.context import RequiresContextIOResult
>>> from returns.pointfree import bind_ioresult

>>> def returns_ioresult(arg: int) -> IOResult[int, str]:
...     return IOSuccess(arg + 1)

>>> bound = bind_ioresult(returns_ioresult)
>>> assert bound(IOSuccess(1)) == IOSuccess(2)
>>> assert bound(
...     RequiresContextIOResult.from_value(1),
... )(...) == IOSuccess(2)
```

Parameters **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *Kinded*[Callable[[*KindN*[~_IOResultLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_IOResultLikeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_future(*function*)

Compose a container and sync function returning `Future`.

In other words, it modifies the function signature from: `a -> Future[b]` to: `Container[a] -> Container[b]`

Similar to *returns.pointfree.lash()*, but works for successful containers. This is how it should be used:

```
>>> import anyio
>>> from returns.pointfree import bind_future
>>> from returns.future import Future
>>> from returns.io import IO

>>> def example(argument: int) -> Future[int]:
...     return Future.from_value(argument + 1)

>>> assert anyio.run(
```

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```
...     bind_future(example)(Future.from_value(1)).awaitable,
... ) == IO(2)
```

Note, that this function works for all containers with `.bind_future` method. See `returns.primitives.interfaces.specific.future.FutureLikeN` for more info.

Parameters **function** (`Callable[[~_FirstType], Future[~_UpdatedType]]`) –

Return type *Kinded*[`Callable[[KindN[~_FutureKind, ~_FirstType, ~_SecondType, ~_ThirdType]], KindN[~_FutureKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]`]

bind_async_future(*function*)

Compose a container and async function returning `Future`.

In other words, it modifies the function signature from: `a -> Awaitable[Future[b]]` to: `Container[a] -> Container[b]`

This is how it should be used:

```
>>> import anyio
>>> from returns.pointfree import bind_async_future
>>> from returns.future import Future
>>> from returns.io import IO

>>> async def example(argument: int) -> Future[int]:
...     return Future.from_value(argument + 1)

>>> assert anyio.run(
...     bind_async_future(example)(Future.from_value(1)).awaitable,
... ) == IO(2)
```

Note, that this function works for all containers with `.bind_async_future` method. See `returns.primitives.interfaces.specific.future.FutureLikeN` for more info.

Parameters **function** (`Callable[[~_FirstType], Awaitable[Future[~_UpdatedType]]]`) –

Return type *Kinded*[`Callable[[KindN[~_FutureKind, ~_FirstType, ~_SecondType, ~_ThirdType]], KindN[~_FutureKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]`]

bind_future_result(*function*)

Compose a container and async function returning `FutureResult`.

In other words, it modifies the function signature from: `a -> FutureResult[b, c]` to: `Container[a, c] -> Container[b, c]`

This is how it should be used:

```
>>> import anyio
>>> from returns.pointfree import bind_future_result
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> def example(argument: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(argument + 1)

>>> assert anyio.run(
...     bind_future_result(example)(
```

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```
...         FutureResult.from_value(1),
...     ).awaitable,
... ) == IOSuccess(2)

>>> assert anyio.run(
...     bind_future_result(example)(
...         FutureResult.from_failure('a'),
...     ).awaitable,
... ) == IOFailure('a')
```

Note, that this function works for all containers with `.bind_async_future` method. See `FutureResultLikeN` for more info.

Parameters **function** (Callable[[~_FirstType], *FutureResult*[~_UpdatedType, ~_SecondType]]) –

Return type *Kinded*[Callable[[*KindN*[~_FutureResultKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_FutureResultKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_async_future_result(*function*)

Compose a container and async function returning `FutureResult`.

In other words, it modifies the function signature from: `a -> Awaitable[FutureResult[b, c]]` to: `Container[a, c] -> Container[b, c]`

This is how it should be used:

```
>>> import anyio
>>> from returns.pointfree import bind_async_future_result
>>> from returns.future import FutureResult
>>> from returns.io import IOSuccess, IOFailure

>>> async def example(argument: int) -> FutureResult[int, str]:
...     return FutureResult.from_value(argument + 1)

>>> assert anyio.run(
...     bind_async_future_result(example)(
...         FutureResult.from_value(1),
...     ).awaitable,
... ) == IOSuccess(2)

>>> assert anyio.run(
...     bind_async_future_result(example)(
...         FutureResult.from_failure('a'),
...     ).awaitable,
... ) == IOFailure('a')
```

Note, that this function works for all containers with `.bind_async_future` method. See `FutureResultLikeN` for more info.

Parameters **function** (Callable[[~_FirstType], Awaitable[*FutureResult*[~_UpdatedType, ~_SecondType]]]) –

Return type *Kinded*[Callable[[*KindN*[~_FutureResultKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_FutureResultKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_context2(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> RequresContext[b, c]` to: `Container[a, c] -> Container[b, c]`

```
>>> from returns.pointfree import bind_context2
>>> from returns.context import Reader

>>> def example(argument: int) -> Reader[int, int]:
...     return Reader(lambda deps: argument + deps)

>>> assert bind_context2(example)(Reader.from_value(2))(3) == 5
```

Note, that this function works with only `Kind2` containers with `.bind_context` method. See `returns.primitives.interfaces.specific.reader.ReaderLike2` for more info.

Parameters **function** (`Callable[[~_FirstType], ForwardRef]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader2Kind, ~_FirstType, ~_SecondType, `Any`]], *KindN*[~_Reader2Kind, ~_UpdatedType, ~_SecondType, `Any`]]]

bind_context3(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> RequresContext[b, c]` to: `Container[a, c] -> Container[b, c]`

```
>>> from returns.context import RequiresContext, RequiresContextResult
>>> from returns.result import Success, Failure
>>> from returns.pointfree import bind_context

>>> def function(arg: int) -> RequiresContext[str, int]:
...     return RequiresContext(lambda deps: len(deps) + arg)

>>> assert bind_context(function)(
...     RequiresContextResult.from_value(2),
... )('abc') == Success(5)
>>> assert bind_context(function)(
...     RequiresContextResult.from_failure(0),
... )('abc') == Failure(0)
```

Note, that this function works with only `Kind3` containers with `.bind_context` method. See `returns.primitives.interfaces.specific.reader.ReaderLike3` for more info.

Parameters **function** (`Callable[[~_FirstType], ForwardRef]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_Reader3Kind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_context(*function*)

Useful alias for *bind_context3()*.

Parameters **function** (`Callable[[~_FirstType], ForwardRef]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_Reader3Kind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

modify_env2(*function*)

Modifies the second type argument of a `ReaderLike2`.

In other words, it modifies the function's signature from: `a -> b` to: `Container[x, a] -> Container[x, b]`

```
>>> from returns.pointfree import modify_env2
>>> from returns.context import RequiresContext

>>> def multiply(arg: int) -> RequiresContext[int, int]:
...     return RequiresContext(lambda deps: arg * deps)

>>> assert modify_env2(int)(multiply(3))('4') == 12
```

Note, that this function works with only `Kind2` containers with `.modify_env` method. See `returns.primitives.interfaces.specific.reader.ReaderLike2` for more info.

Parameters **function** (`Callable[[~_UpdatedType], ~_SecondType]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader2Kind, ~_FirstType, ~_SecondType, `Any`]], *KindN*[~_Reader2Kind, ~_FirstType, ~_UpdatedType, `Any`]]]

modify_env3(*function*)

Modifies the third type argument of a `ReaderLike3`.

In other words, it modifies the function's signature from: `a -> b` to: `Container[x, a] -> Container[x, b]`

```
>>> from returns.pointfree import modify_env
>>> from returns.context import RequiresContextResultE
>>> from returns.result import Success, safe

>>> def divide(arg: int) -> RequiresContextResultE[float, int]:
...     return RequiresContextResultE(safe(lambda deps: arg / deps))

>>> assert modify_env(int)(divide(3))('2') == Success(1.5)
>>> assert modify_env(int)(divide(3))('0').failure()
```

Note, that this function works with only `Kind3` containers with `.modify_env` method. See `returns.primitives.interfaces.specific.reader.ReaderLike3` for more info.

Parameters **function** (`Callable[[~_UpdatedType], ~_ThirdType]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_UpdatedType]]]

modify_env(*function*)

Useful alias for *modify_env3()*.

Parameters **function** (`Callable[[~_UpdatedType], ~_ThirdType]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_Reader3Kind, ~_FirstType, ~_SecondType, ~_UpdatedType]]]

bind_context_result(*function*)

Composes successful container with a function that returns a container.

In other words, it modifies the function's signature from: `a -> ReaderResult[b, c, e]` to: `Container[a, c, e] -> Container[b, c, e]`

```
>>> from returns.pointfree import bind_context_result
>>> from returns.context import ReaderIOResult, ReaderResult
```

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```
>>> from returns.io import IOSuccess, IOFailure

>>> def example(argument: int) -> ReaderResult[int, str, str]:
...     return ReaderResult.from_value(argument + 1)

>>> assert bind_context_result(example)(
...     ReaderIOResult.from_value(1),
... )(...) == IOSuccess(2)
>>> assert bind_context_result(example)(
...     ReaderIOResult.from_failure('a'),
... )(...) == IOFailure('a')
```

Parameters **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *Kinded*[Callable[[*KindN*[~_ReaderResultLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_ReaderResultLikeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_context_ioresult(*function*)

Lifts function from RequiresContextIOResult for better composition.

In other words, it modifies the function's signature from: a -> RequiresContextIOResult[env, b, c] to: Container[env, a, c] -> Container[env, b, c]

```
>>> import anyio
>>> from returns.context import (
...     RequiresContextFutureResult,
...     RequiresContextIOResult,
... )
>>> from returns.io import IOSuccess, IOFailure
>>> from returns.pointfree import bind_context_ioresult

>>> def function(arg: int) -> RequiresContextIOResult[str, int, str]:
...     return RequiresContextIOResult(
...         lambda deps: IOSuccess(len(deps) + arg),
...     )

>>> assert anyio.run(bind_context_ioresult(function)(
...     RequiresContextFutureResult.from_value(2),
... )('abc').awaitable) == IOSuccess(5)
>>> assert anyio.run(bind_context_ioresult(function)(
...     RequiresContextFutureResult.from_failure(0),
... )('abc').awaitable) == IOFailure(0)
```

Parameters **function** (Callable[[~_FirstType], ForwardRef]) –

Return type *Kinded*[Callable[[*KindN*[~_ReaderIOResultLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_ReaderIOResultLikeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

bind_async(*function*)

Compose a container and async function returning a container.

In other words, it modifies the function's signature from: `a -> Awaitable[Container[b]]` to: `Container[a] -> Container[b]`

This is how it should be used:

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO
>>> from returns.pointfree import bind_async

>>> async def coroutine(x: int) -> Future[str]:
...     return Future.from_value(str(x + 1))

>>> bound = bind_async(coroutine)(Future.from_value(1))
>>> assert anyio.run(bound.awaitable) == IO('2')
```

Note, that this function works for all containers with `.bind_async` method. See `returns.primitives.interfaces.specific.future.FutureLikeN` for more info.

Parameters **function** (`Callable[[~_FirstType], Awaitable[`*KindN*`[~_FutureKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]`) –

Return type *Kinded*`[Callable[[`*KindN*`[~_FutureKind, ~_FirstType, ~_SecondType, ~_ThirdType]], `*KindN*`[~_FutureKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]`

bind_awaitable(*function*)

Composes a container a regular `async` function.

This function should return plain, non-container value.

In other words, it modifies the function's signature from: `a -> Awaitable[b]` to: `Container[a] -> Container[b]`

This is how it should be used:

```
>>> import anyio
>>> from returns.future import Future
>>> from returns.io import IO
>>> from returns.pointfree import bind_awaitable

>>> async def coroutine(x: int) -> int:
...     return x + 1

>>> assert anyio.run(
...     bind_awaitable(coroutine)(Future.from_value(1)).awaitable,
... ) == IO(2)
```

Note, that this function works for all containers with `.bind_awaitable` method. See `returns.primitives.interfaces.specific.future.FutureLikeN` for more info.

Parameters **function** (`Callable[[~_FirstType], Awaitable[~_UpdatedType]]`) –

Return type *Kinded*`[Callable[[`*KindN*`[~_FutureKind, ~_FirstType, ~_SecondType, ~_ThirdType]], `*KindN*`[~_FutureKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]`

bind_optional(*function*)

Binds a function returning optional value over a container.

In other words, it modifies the function's signature from: `a -> Optional[b]` to: `Container[a] -> Container[b]`

```
>>> from typing import Optional
>>> from returns.pointfree import bind_optional
>>> from returns.maybe import Some, Nothing

>>> def example(argument: int) -> Optional[int]:
...     return argument + 1 if argument > 0 else None

>>> assert bind_optional(example)(Some(1)) == Some(2)
>>> assert bind_optional(example)(Some(0)) == Nothing
>>> assert bind_optional(example)(Nothing) == Nothing
```

Note, that this function works for all containers with `.bind_optional` method. See `returns.primitives.interfaces.specific.maybe._MaybeLikeKind` for more info.

Parameters **function** (`Callable[[~_FirstType], Optional[~_UpdatedType]]`) –

Return type *Kinded*[`Callable[[`*KindN*[~_MaybeLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_MaybeLikeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

compose_result(*function*)

Composes inner `Result` with `IOResultLike` returning function.

Can be useful when you need an access to both states of the result.

```
>>> from returns.io import IOResult, IOSuccess, IOFailure
>>> from returns.pointfree import compose_result
>>> from returns.result import Result

>>> def modify_string(container: Result[str, str]) -> IOResult[str, str]:
...     return IOResult.from_result(
...         container.map(str.upper).alt(str.lower),
...     )

>>> assert compose_result(modify_string)(
...     IOSuccess('success')
... ) == IOSuccess('SUCCESS')
>>> assert compose_result(modify_string)(
...     IOFailure('FAILURE')
... ) == IOFailure('failure')
```

Parameters **function** (`Callable[[`*Result*[~_FirstType, ~_SecondType]], *KindN*[~_IOResultLikeKind, ~_NewFirstType, ~_SecondType, ~_ThirdType]]) –

Return type *Kinded*[`Callable[[`*KindN*[~_IOResultLikeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_IOResultLikeKind, ~_NewFirstType, ~_SecondType, ~_ThirdType]]]

cond(*container_type: Type[returns.pointfree.cond._SingleFailableKind]*, *success_value: returns.pointfree.cond._ValueType*) → *returns.primitives.hkt.Kinded*[Callable[[bool], *returns.primitives.hkt.KindN*[returns.pointfree.cond._SingleFailableKind, returns.pointfree.cond._ValueType, returns.pointfree.cond._ErrorType, Any]]]

cond(*container_type: Type[returns.pointfree.cond._DiverseFailableKind]*, *success_value: returns.pointfree.cond._ValueType*, *error_value: returns.pointfree.cond._ErrorType*) → *returns.primitives.hkt.Kinded*[Callable[[bool], *returns.primitives.hkt.KindN*[returns.pointfree.cond._DiverseFailableKind, returns.pointfree.cond._ValueType, returns.pointfree.cond._ErrorType, Any]]]

Reduce the boilerplate when choosing paths.

Works with SingleFailableN (e.g. Maybe) and DiverseFailableN (e.g. Result).

Example using cond with the Result container:

```
>>> from returns.pointfree import cond
>>> from returns.result import Failure, Result, Success

>>> assert cond(Result, 'success', 'failure')(True) == Success('success')
>>> assert cond(Result, 'success', 'failure')(False) == Failure('failure')
```

Example using cond with the Maybe container:

```
>>> from returns.maybe import Maybe, Some, Nothing

>>> assert cond(Maybe, 10.0)(True) == Some(10.0)
>>> assert cond(Maybe, 10.0)(False) == Nothing
```

Parameters

- **container_type** (Union[Type[~_SingleFailableKind], Type[~_DiverseFailableKind]]) –
- **success_value** (*~_ValueType*) –
- **error_value** (Optional[~_ErrorType]) –

lash(*function*)

Turns function's input parameter from a regular value to a container.

In other words, it modifies the function signature from: `a -> Container[b]` to: `Container[a] -> Container[b]`

Similar to *returns.pointfree.bind()*, but works for failed containers.

This is how it should be used:

```
>>> from returns.pointfree import lash
>>> from returns.result import Success, Failure, Result

>>> def example(argument: int) -> Result[str, int]:
...     return Success(argument + 1)

>>> assert lash(example)(Success('a')) == Success('a')
>>> assert lash(example)(Failure(1)) == Success(2)
```

Note, that this function works for all containers with `.lash` method. See `returns.interfaces.lashable.Lashable` for more info.

Parameters **function** (Callable[[~_SecondType], *KindN*[~_LashableKind, ~_FirstType, ~_UpdatedType, ~_ThirdType]]) –

Return type *Kinded*[Callable[[*KindN*[~_LashableKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_LashableKind, ~_FirstType, ~_UpdatedType, ~_ThirdType]]]

unify(*function*)

Composes successful container with a function that returns a container.

Similar to *bind()* but has different type. It returns `Result[ValueType, Union[OldErrorType, NewErrorType]]` instead of `Result[ValueType, OldErrorType]`.

So, it can be more useful in some situations. Probably with specific exceptions.

```
>>> from returns.methods import cond
>>> from returns.pointfree import unify
>>> from returns.result import Result, Success, Failure

>>> def bindable(arg: int) -> Result[int, int]:
...     return cond(Result, arg % 2 == 0, arg + 1, arg - 1)

>>> assert unify(bindable)(Success(2)) == Success(3)
>>> assert unify(bindable)(Success(1)) == Failure(0)
>>> assert unify(bindable)(Failure(42)) == Failure(42)
```

Parameters **function** (Callable[[~_FirstType], *KindN*[~_DiverseFailableKind, ~_NewFirstType, ~_NewSecondType, ~_NewThirdType]]) –

Return type *Kinded*[Callable[[*KindN*[~_DiverseFailableKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_DiverseFailableKind, ~_NewFirstType, Union[~_SecondType, ~_NewSecondType], ~_NewThirdType]]]

apply(*container*)

Turns container containing a function into a callable.

In other words, it modifies the function signature from: `Container[a -> b]` to: `Container[a] -> Container[b]`

This is how it should be used:

```
>>> from returns.pointfree import apply
>>> from returns.maybe import Some, Nothing

>>> def example(argument: int) -> int:
...     return argument + 1

>>> assert apply(Some(example))(Some(1)) == Some(2)
>>> assert apply(Some(example))(Nothing) == Nothing
>>> assert apply(Nothing)(Some(1)) == Nothing
>>> assert apply(Nothing)(Nothing) == Nothing
```

Note, that this function works for all containers with `.apply` method. See *returns.interfaces.applicative.ApplicativeN* for more info.

Parameters **container** (*KindN*[~_ApplicativeKind, Callable[[~_FirstType], ~_UpdatedType], ~_SecondType, ~_ThirdType]) –

Return type *Kinded*[Callable[[*KindN*[~_ApplicativeKind, ~_FirstType, ~_SecondType, ~_ThirdType]], *KindN*[~_ApplicativeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]]]

9.15 Methods

The following useful methods can be used to interact with interfaces.

9.15.1 cond

Reduce the boilerplate when choosing paths with `DiverseFailableN`. Think of this method as a functional `if` alternative for successful or failed types.

So, this code:

```
>>> from returns.result import Failure, Result, Success

>>> def is_numeric(string: str) -> Result[str, str]:
...     if string.isnumeric():
...         return Success('It is a number')
...     return Failure('It is not a number')
```

Can be replaced with this:

```
>>> from returns.methods import cond
>>> from returns.result import Failure, Result, Success

>>> def is_numeric(string: str) -> Result[str, str]:
...     return cond(
...         Result,
...         string.isnumeric(),
...         'It is a number',
...         'It is not a number',
...     )

>>> assert is_numeric('42') == Success('It is a number')
>>> assert is_numeric('text') == Failure('It is not a number')
```

Why is it helpful? Because `cond` can be easily added into a *Pipelines* of functions.

9.15.2 unwrap_or_failure

Unwraps either a successful or failed value.

```
>>> from returns.io import IO, IOSuccess, IOFailure
>>> from returns.methods import unwrap_or_failure

>>> assert unwrap_or_failure(IOSuccess(1)) == IO(1)
>>> assert unwrap_or_failure(IOFailure('a')) == IO('a')
```

Useful when you have a `ResultLike` value with correctly handled error value, for example with `bimap()`. Here's a full example:

```
>>> from returns.result import Failure, Result, Success
>>> from returns.methods import unwrap_or_failure
>>> from returns.pointfree import bimap
```

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```
>>> instance: Result[int, str] = Success(1)
>>> error_handled = bimap(lambda inr: inr + 1, lambda _: 0)(instance)
>>> assert isinstance(unwrap_or_failure(error_handled), int)
```

9.15.3 API Reference

cond(*container_type*, *is_success*, *success_value*, *error_value=None*)

Kinded version of `internal_cond()`, use it to infer real return type.

Parameters

- **container_type** (Union[Type[~_SingleFailableKind], Type[~_DiverseFailableKind]]) –
- **is_success** (bool) –
- **success_value** (*~_ValueType*) –
- **error_value** (Optional[~_ErrorType]) –

unwrap_or_failure(*container*)

Unwraps either successful or failed value.

```
>>> from returns.io import IO, IOSuccess, IOFailure
>>> from returns.methods import unwrap_or_failure

>>> assert unwrap_or_failure(IOSuccess(1)) == IO(1)
>>> assert unwrap_or_failure(IOFailure('a')) == IO('a')
```

Parameters **container** (*Unwrappable*[~_FirstType, ~_SecondType]) –

Return type Union[~_FirstType, ~_SecondType]

9.16 Helper functions

We feature several helper functions to make your developer experience better.

9.16.1 compose

We also ship an utility function to compose two different functions together.

```
>>> from returns.functions import compose

>>> bool_after_int = compose(int, bool)
>>> assert bool_after_int('1') is True
>>> assert bool_after_int('0') is False
```

Composition is also type-safe. The only limitation is that we only support functions with one argument and one return to be composed.

Only works with regular functions (not async).

Warning: `compose` might fail to infer types for some functions. There are several problems: `lambda` and generic functions. In these cases `mypy` will fail to infer the types of the resulting function.

In this case, use `pipe` it does the same thing, but has pretty good type inference. Or use manual annotations with `Callable` type.

9.16.2 identity

We also ship *returns.functions.identity()* function to help you with the composition.

Identity function is a simple concept: it just returns its argument. If you wonder why do we need this function, please read below:

- Practical Usage of Identity Function (JS)
- Using Identity Functions (Scala)

9.16.3 tap and untap

We need `tap()` function to easily compose values with functions that does not return. For example you sometimes need to `print()` values inside your *pipe*:

```
>>> from returns.functions import tap

>>> result = tap(print)(1)  # will print and return 1
1
>>> assert result == 1
```

You can also use the `untap` function to turn any function's return type to `None` and still do its thing:

```
>>> from returns.functions import tap, untap

>>> result = untap(tap(print))(1)  # will print and return None
1
>>> assert result is None
```

This is also sometimes helpful for a typed function composition.

9.16.4 raise_exception

Sometimes you really want to reraise an exception from `Failure[Exception]` due to some existing API (or a dirty hack).

We allow you to do that with ease!

```
from returns.functions import raise_exception

def create_account_and_user(username: str) -> ...:
    """
    Creates new Account-User pair.

    Imagine, that you need to reraise ValidationErrors due to existing API.
```

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```
    """
    return _validate_user(
        username,
    ).alt(
        # What happens here is interesting, since you do not let your
        # unwrap to fail with UnwrapFailedError, but instead
        # allows you to reraise a wrapped exception.
        # In this case `ValidationError()` will be thrown
        # before `UnwrapFailedError`
        raise_exception,
    )

def _validate_user(username: str) -> Result['User', ValidationError]:
    ...
```

Use this with caution. We try to remove exceptions from our code base. Original proposal is here.

9.16.5 not_

With `not_` helper function we can easily deny a function returns. It supports functions with one or more arguments.

```
>>> from typing import List
>>> from returns.functions import compose, not_

>>> def is_even(number: int) -> bool:
...     return number % 2 == 0

>>> def number_is_in_list(number: int, list_: List[int]) -> bool:
...     return number in list_

>>> assert not_(is_even)(2) is False
>>> assert not_(number_is_in_list)(1, [2, 3, 4]) is True
>>> assert compose(int, not_(is_even))("1") is True
```

9.16.6 API Reference

identity(*instance*)

Function that returns its argument.

```
>>> assert identity(1) == 1
>>> assert identity([1, 2, 3]) == [1, 2, 3]
```

This function is really helpful for some composition. It is also useful for "do nothing" use-case.

See also:

- https://en.wikipedia.org/wiki/Identity_function
- https://stackoverflow.com/a/21506571/4842742

Parameters **instance** (*~_FirstType*) –

Return type ~_FirstType

compose(*first*, *second*)

Allows function composition.

Works as: `second . first` or `first() |> second()`. You can read it as "second after first".

```
>>> assert compose(float, int)('123.5') == 123
```

We can only compose functions with one argument and one return. Type checked.

Parameters

- **first** (Callable[[~_FirstType], ~_SecondType]) –
- **second** (Callable[[~_SecondType], ~_ThirdType]) –

Return type Callable[[~_FirstType], ~_ThirdType]

tap(*function*)

Allows to apply some function and return an argument, instead of a result.

Is useful for composing functions with side-effects like `print()`, `logger.log()`, etc.

```
>>> assert tap(print)(1) == 1
1
>>> assert tap(lambda _: 1)(2) == 2
```

See also:

- https://github.com/dry-python/returns/issues/145

Parameters **function** (Callable[[~_FirstType], Any]) –

Return type Callable[[~_FirstType], ~_FirstType]

untap(*function*)

Allows to apply some function and always return `None` as a result.

Is useful for composing functions that do some side effects and return some nosense.

Is the kind of a reverse of the `tap` function.

```
>>> def strange_log(arg: int) -> int:
...     print(arg)
...     return arg

>>> assert untap(strange_log)(2) is None
2
>>> assert untap(tap(lambda _: 1))(2) is None
```

See also:

- https://github.com/dry-python/returns/issues/145

Parameters **function** (Callable[[~_FirstType], Any]) –

Return type Callable[[~_FirstType], None]

raise_exception(*exception*)

Helper function to raise exceptions as a function.

It might be required as a compatibility tool for existing APIs. That's how it can be used:

```
>>> from returns.result import Failure, Result
>>> # Some operation result:
>>> user: Result[int, ValueError] = Failure(ValueError('boom'))

>>> # Here we unwrap internal exception and raise it:
>>> user.alt(raise_exception)
Traceback (most recent call last):
  ...
ValueError: boom
```

See also:

- https://github.com/dry-python/returns/issues/56

Parameters **exception** (Exception) –

Return type NoReturn

not_(*function*)

Denies the function returns.

```
>>> from returns.result import Result, Success, Failure

>>> def is_successful(result_container: Result[float, int]) -> bool:
...     return isinstance(result_container, Result.success_type)

>>> assert not_(is_successful)(Success(1.0)) is False
>>> assert not_(is_successful)(Failure(1)) is True
```

Parameters **function** (Callable[..., bool]) –

Return type Callable[..., bool]

9.17 Curry

This module is dedicated to partial application.

We support two types of partial application: `@curry` and `partial`.

`@curry` is a new concept for most Python developers, but Python already has a great tool to use partial application: functools.partial

The only problem with it is the lack of typing. Let's see what problems do we solve with this module.

Warning: This module requires *our mypy plugin* to be present. Without it we will fallback to the original behaviour.

9.17.1 Partial

Here's how typing works there:

```
from functools import partial

def some_function(first: int, second: int) -> float:
    return first / second

reveal_type(partial(some_function, 1))
# => functools.partial[builtins.float*]
# => Which is really: `def (*Any, **Any) -> builtins.float`
```

And compare it with out solution:

```
from returns.curry import partial

def some_function(first: int, second: int) -> float:
    return first / second

reveal_type(partial(some_function, 1))
# => def (second: builtins.int) -> builtins.float*
# => Which is fair!
```

Note: We still use `functools.partial` inside. We just improve the typings.

Generics

One more problem is generics support in `functools.partial`. Here's the comparison:

```
from functools import partial
from typing import List, TypeVar

T = TypeVar('T')

x: List[int]

def some_function(first: List[T], second: int) -> T:
    return first[second]

reveal_type(partial(some_function, x))
# => functools.partial[T`-1]
# => Which is broken!
```

And our solution works fine:

```
from returns.curry import partial

reveal_type(partial(some_function, x))
# => def (second: builtins.int) -> builtins.int*
```

We also work with complex generic with multiple arguments or with multiple generics.

The only known problem is that passing explicit generic like `[1, 2, 3]` will resolve in `List[Any]`. Because `mypy` won't be able to infer this type for some reason.

The reasonable work-around is to pass annotated variables like in the example above.

Types and Instances

We can also work with types and instances. Because they are callable too!

```
from returns.curry import partial

class Test(object):
    def __init__(self, arg: int) -> None:
        self.arg = arg

    def __call__(self, other: int) -> int:
        return self.arg + other

reveal_type(partial(Test, 1))  # N: Revealed type is 'def () -> ex.Test'
reveal_type(partial(Test(1), 1))  # N: Revealed type is 'def () -> builtins.int'
```

No differences with regular callables at all.

Overloads

We also support working with `@overload` definitions. It also looks the same way:

```
from typing import overload
from returns.curry import partial

@overload
def test(a: int, b: str) -> str:
    ...

@overload
def test(a: int) -> int:
    ...

@overload
def test(a: str) -> None:  # won't match!
    ...

def test(a, b=None):
    ...

reveal_type(partial(test, 1))  # N: Revealed type is 'Overload(def (b: builtins.str) ->␣
↪builtins.str, def () -> builtins.int)'
```

From this return type you can see that we work with all matching cases and discriminate unmatching ones.

9.17.2 @curry

`curry` allows to provide only a subset of arguments to a function. And it won't be called until all the required arguments are provided.

In contrast to `partial` which works on the calling stage, `@curry` works best when defining a new function.

```
>>> from returns.curry import curry

>>> @curry
... def function(first: int, second: str) -> bool:
...     return len(second) > first

>>> assert function(1)('a') is False
>>> assert function(1, 'a') is False
>>> assert function(2)('abc') is True
>>> assert function(2, 'abc') is True
```

Take a note, that providing invalid arguments will raise `TypeError`:

```
>>> function(1, 2, 3)
Traceback (most recent call last):
  ...
TypeError: too many positional arguments

>>> function(a=1)
Traceback (most recent call last):
  ...
TypeError: got an unexpected keyword argument 'a'
```

This is really helpful when working with `.apply()` method of containers.

Warning: We recommend using *partial* instead of `@curry` when possible because it's much faster.

Typing

`@curry` functions are also fully typed with our custom `mypy` plugin.

Let's see how types do look like for a curried function:

```
>>> from returns.curry import curry

>>> @curry
... def zero(a: int, b: float, *, kw: bool) -> str:
...     return str(a - b) if kw else ''

>>> assert zero(1)(0.3)(kw=True) == '0.7'
>>> assert zero(1)(0.3, kw=False) == ''

# If we will reveal the type it would be quite big:

reveal_type(zero)
```

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```
# Overload(
#   def (a: builtins.int) -> Overload(
#     def (b: builtins.float, *, kw: builtins.bool) -> builtins.str,
#     def (b: builtins.float) -> def (*, kw: builtins.bool) -> builtins.str
#   ),
#   def (a: builtins.int, b: builtins.float) -> def (*, kw: builtins.bool)
#     -> builtins.str,
#   def (a: builtins.int, b: builtins.float, *, kw: builtins.bool)
#     -> builtins.str
# )
```

It reveals to us that there are 4 possible way to call this function. And we type all of them with overload type.

When you provide any arguments, you discriminate some overloads and choose more specific path:

```
reveal_type(zero(1, 2.0))
# By providing this set of arguments we have chosen this path:
#
#   def (a: builtins.int, b: builtins.float) -> def (*, kw: builtins.bool)
#     -> builtins.str,
#
# And the revealed type would be:
#
#   def (*, kw: builtins.bool) -> builtins.str
#
```

It works with functions, instance, class, and static methods, including generics. See `Limitations` in the API Reference.

9.17.3 FAQ

Why don't you support * and ** arguments?

When you use `partial(some, *my_args)` or `partial(some, **my_args)` or both of them at the same time, we fallback to the default return type. The same happens with `curry`. Why?

There are several problems:

- Because `mypy` cannot not infer what arguments are there inside this `my_args` variable
- Because `curry` cannot know when to stop accepting `*args` and `**kwargs`
- And there are possibly other problems!

Our advice is not to use `*args` and `*kwargs` with `partial` and `curry`.

But, it is still possible, but in this case we will fallback to `Any`.

9.17.4 Further reading

- functools.partial
- Currying
- @curry decorator

9.17.5 API Reference

partial(*func*, **args*, ***kwargs*)

Typed partial application.

It is just a `functools.partial` wrapper with better typing support.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this function.

```
>>> from returns.curry import partial

>>> def sum_two_numbers(first: int, second: int) -> int:
...     return first + second

>>> sum_with_ten = partial(sum_two_numbers, 10)
>>> assert sum_with_ten(2) == 12
>>> assert sum_with_ten(-5) == 5
```

See also:

- https://docs.python.org/3/library/functools.html#functools.partial

Parameters

- **func** (`Callable`[..., ~_ReturnType]) –
- **args** (`Any`) –
- **kwargs** (`Any`) –

Return type `Callable`[..., ~_ReturnType]

curry(*function*)

Typed currying decorator.

Currying is a conception from functional languages that does partial applying. That means that if we pass one argument in a function that gets 2 or more arguments, we'll get a new function that remembers all previously passed arguments. Then we can pass remaining arguments, and the function will be executed.

partial() function does a similar thing, but it does partial application exactly once. `curry` is a bit smarter and will do partial application until enough arguments passed.

If wrong arguments are passed, `TypeError` will be raised immediately.

We use a custom `mypy` plugin to make sure types are correct. Otherwise, it is currently impossible to properly type this function.

```
>>> from returns.curry import curry

>>> @curry
... def divide(number: int, by: int) -> float:
...     return number / by

>>> divide(1)  # doesn't call the func and remembers arguments
<function divide at ...>
>>> assert divide(1)(by=10) == 0.1  # calls the func when possible
>>> assert divide(1)(10) == 0.1  # calls the func when possible
>>> assert divide(1, by=10) == 0.1  # or call the func like always
```

Here are several examples with wrong arguments:

```
>>> divide(1, 2, 3)
Traceback (most recent call last):
  ...
TypeError: too many positional arguments

>>> divide(a=1)
Traceback (most recent call last):
  ...
TypeError: got an unexpected keyword argument 'a'
```

Limitations:

- It is kinda slow. Like 100 times slower than a regular function call.
- It does not work with several builtins like `str`, `int`, and possibly other `C` defined callables
- `*args` and `**kwargs` are not supported and we use `Any` as a fallback
- Support of arguments with default values is very limited, because we cannot be totally sure which case we are using: with the default value or without it, be careful
- We use a custom `mypy` plugin to make types correct, otherwise, it is currently impossible
- It might not work as expected with curried `Klass().method`, it might generate invalid method signature (looks like a bug in `mypy`)
- It is probably a bad idea to `curry` a function with lots of arguments, because you will end up with lots of overload functions, that you won't be able to understand. It might also be slow during the typecheck
- Currying of `__init__` does not work because of the bug in `mypy`: https://github.com/python/mypy/issues/8801

We expect people to use this tool responsibly when they know that they are doing.

See also:

- https://en.wikipedia.org/wiki/Currying
- https://stackoverflow.com/questions/218025/

Parameters **function** (Callable[..., ~_ReturnType]) –

Return type Callable[..., ~_ReturnType]

9.18 Primitive types

We have several utility types that we use for our containers, that can also help end users as well.

9.18.1 Fold

You can use all power of declarative loops in your app with `Fold`.

```
>>> from returns.iterables import Fold
>>> from returns.io import IO

>>> items = [IO(1), IO(2), IO(3)]
>>> assert Fold.loop(
...     items,
...     IO(''),
...     lambda num: lambda text: text + str(num),
... ) == IO('123')
```

There are also other helpful methods as well. See *returns.iterables.AbstractFold*.

We also ship *AbstractFold*, where you can change how `loop` (or any other) method works. For example, for performance reasons.

Let's say you have a big number of *RequiresContext* instances and you want to do the same thing string concatenation we have shown above.

You might face recursion problems with it:

```
>>> import sys
>>> from returns.context import Reader
>>> from returns.iterables import Fold

>>> items = [Reader.from_value(num) for num in range(sys.getrecursionlimit())]
>>> Fold.loop(items, Reader.from_value(0), lambda x: lambda y: x + y)(...)
Traceback (most recent call last):
  ...
RecursionError: maximum recursion depth exceeded in comparison
```

So, let's change how it works for this specific type:

```
>>> from returns.iterables import AbstractFold

>>> class ContextAwareFold(AbstractFold):
...     @classmethod
...     def _loop(cls, iterable, acc, function, concat, deps=None):
...         wrapped = acc.from_value(function)
...         for current in iterable:
...             assert isinstance(current, Reader)
...             acc = Reader.from_value(concat(current, acc, wrapped)(deps))
...         return acc
```

Note: Don't forget to add typing annotations to your real code! This is just an example.

And now let's test that it works without recursion:

```
>>> items = [Reader.from_value(num) for num in range(sys.getrecursionlimit())]
>>> assert ContextAwareFold.loop(
...     items, Reader.from_value(0), lambda x: lambda y: x + y,
... )(...) == sum(range(sys.getrecursionlimit()))
```

And no error will be produced! We now don't use recursion inside. Consider this way of doing things as a respected hack.

9.18.2 Immutable

This class is useful when you need to make some instances immutable (like *our containers are immutable*).

9.18.3 API Reference

Iterables

class AbstractFold

Bases: `object`

A collection of different helpers to write declarative `Iterable` actions.

Allows to work with iterables.

Implementation

`AbstractFold` and `Fold` types are special. They have double definition for each method: public and protected ones. Why?

Because you cannot override `@kinded` method due to a `mypy` bug. So, there are two opportunities for us here:

1. Declare all method as `@final` and do not allow to change anything
2. Use delegation to protected unkinded methods

We have chosen the second way! Here's how it works:

1. Public methods are `@kinded` for better typing and cannot be overridden
2. Protected methods are unkinded and can be overridden in subtyping

Now, if you need to make a change into our implementation, then you can subclass `Fold` or `AbstractFold` and then change an implementation of any unkinded protected method.

classmethod loop(*iterable*, *acc*, *function*)

Allows to make declarative loops for any `ApplicativeN` subtypes.

Quick example:

```
>>> from typing import Callable
>>> from returns.maybe import Some
>>> from returns.iterables import Fold

>>> def sum_two(first: int) -> Callable[[int], int]:
...     return lambda second: first + second
```

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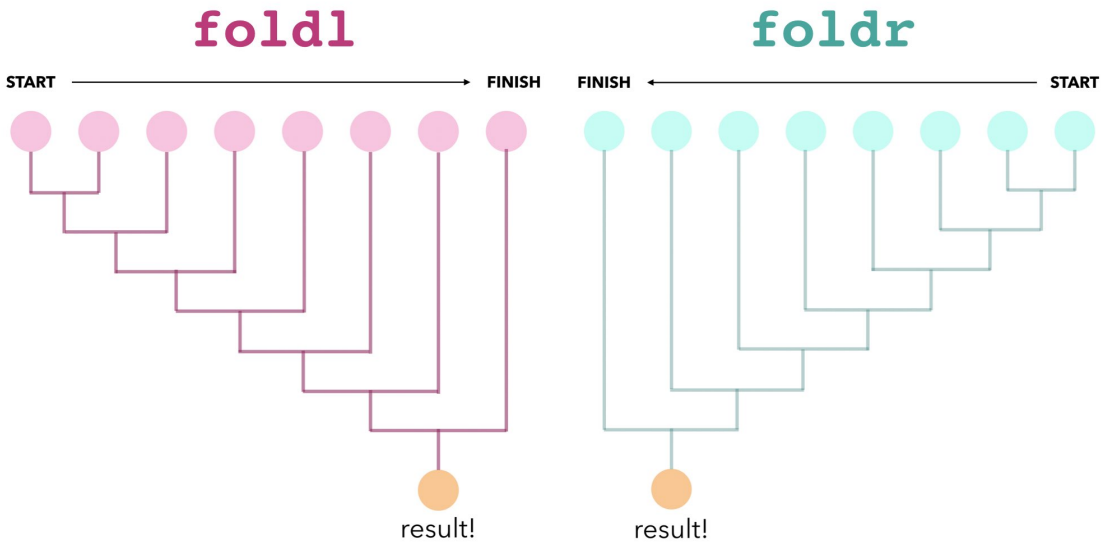
```
>>> assert Fold.loop(
...     [Some(1), Some(2), Some(3)],
...     Some(10),
...     sum_two,
... ) == Some(16)
```

Looks like `foldl` in some other languages with some more specifics. See: https://philipschwarz.dev/fpilluminated/?page_id=348#bwg3/137



Is also quite similar to `reduce`.

Public interface for `_loop` method. Cannot be modified directly.

Parameters

- **iterable** (`Iterable`[*KindN*[~_ApplicativeKind, ~_FirstType, ~_SecondType, ~_ThirdType]]) –
- **acc** (*KindN*[~_ApplicativeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]) –
- **function** (`Callable`[[~_FirstType], `Callable`[[~_UpdatedType], ~_UpdatedType]]) –

Return type *KindN*[~_ApplicativeKind, ~_UpdatedType, ~_SecondType, ~_ThirdType]

classmethod collect(*iterable*, *acc*)

Transforms an iterable of containers into a single container.

Quick example for regular containers:

```
>>> from returns.io import IO
>>> from returns.iterables import Fold

>>> items = [IO(1), IO(2)]
>>> assert Fold.collect(items, IO(())) == IO((1, 2))
```

If container can have failed values, then this strategy fails on any existing failed like type.

It is enough to have even a single failed value in iterable for this type to convert the whole operation result to be a failure. Let's see how it works:

```
>>> from returns.result import Success, Failure
>>> from returns.iterables import Fold

>>> empty = []
>>> all_success = [Success(1), Success(2), Success(3)]
>>> has_failure = [Success(1), Failure('a'), Success(3)]
>>> all_failures = [Failure('a'), Failure('b')]

>>> acc = Success(())  # empty tuple

>>> assert Fold.collect(empty, acc) == Success(())
>>> assert Fold.collect(all_success, acc) == Success((1, 2, 3))
>>> assert Fold.collect(has_failure, acc) == Failure('a')
>>> assert Fold.collect(all_failures, acc) == Failure('a')
```

If that's now what you need, check out *collect_all()* to force collect all non-failed values.

Public interface for `_collect` method. Cannot be modified directly.

Parameters

- **iterable** (`Iterable`[*KindN*[~_ApplicativeKind, ~_FirstType, ~_SecondType, ~_ThirdType]]) –
- **acc** (*KindN*[~_ApplicativeKind, `Tuple`[~_FirstType, ...], ~_SecondType, ~_ThirdType]) –

Return type *KindN*[~_ApplicativeKind, `Tuple`[~_FirstType, ...], ~_SecondType, ~_ThirdType]

classmethod collect_all(*iterable*, *acc*)

Transforms an iterable of containers into a single container.

This method only works with `FailableN` subtypes, not just any `ApplicativeN` like *collect()*.

Strategy to extract all successful values even if there are failed values.

If there's at least one successful value and any amount of failed values, we will still return all collected successful values.

We can return failed value for this strategy only in a single case: when default element is a failed value.

Let's see how it works:

```
>>> from returns.result import Success, Failure
>>> from returns.iterables import Fold

>>> empty = []
>>> all_success = [Success(1), Success(2), Success(3)]
>>> has_failure = [Success(1), Failure('a'), Success(3)]
>>> all_failures = [Failure('a'), Failure('b')]

>>> acc = Success(())  # empty tuple

>>> assert Fold.collect_all(empty, acc) == Success(())
>>> assert Fold.collect_all(all_success, acc) == Success((1, 2, 3))
>>> assert Fold.collect_all(has_failure, acc) == Success((1, 3))
>>> assert Fold.collect_all(all_failures, acc) == Success(())
>>> assert Fold.collect_all(empty, Failure('c')) == Failure('c')
```

If that's now what you need, check out *collect()* to collect only successful values and fail on any failed ones.

Public interface for `_collect_all` method. Cannot be modified directly.

Parameters

- **iterable** (`Iterable[KindN[~_FailableKind, ~_FirstType, ~_SecondType, ~_ThirdType]]`) –
- **acc** (*KindN*[~_FailableKind, `Tuple`[~_FirstType, ...], ~_SecondType, ~_ThirdType]) –

Return type *KindN*[~_FailableKind, `Tuple`[~_FirstType, ...], ~_SecondType, ~_ThirdType]

class Fold

Bases: *returns.iterables.AbstractFold*

Concrete implementation of `AbstractFold` of end users.

Use it by default.

Types

class Immutable

Bases: `object`

Helper type for objects that should be immutable.

When applied, each instance becomes immutable. Nothing can be added or deleted from it.

```
>>> from returns.primitives.types import Immutable
>>> class MyModel(Immutable):
...     ...

>>> model = MyModel()
>>> model.prop = 1
Traceback (most recent call last):
  ...
returns.primitives.exceptions.ImmutableStateError
```

See *returns.primitives.container.BaseContainer* for examples.

Exceptions

exception UnwrapFailedError(*container*)

Bases: `Exception`

Raised when a container can not be unwrapped into a meaningful value.

Parameters **container** (`ForwardRef`) –

halted_container

exception ImmutableStateError

Bases: `AttributeError`

Raised when a container is forced to be mutated.

It is a sublclass of `AttributeError` for two reasons:

1. It seems kinda reasonable to expect `AttributeError` on attribute modification

2. It is used inside `typing.py` this way, we do have several typing features that requires that behaviour

See: https://github.com/dry-python/returns/issues/394

9.19 Development tooling

9.19.1 Tracing Failures

Sometimes we want to trace where the `Failure` has occurred in our system, `returns` provide a way to trace those failures. By default tracing is disabled.

The trace is accessible by *trace* property that is available for `Result`, `IOResult` containers. It's basically a list containing all `inspect.FrameInfo` objects from the call stack when the `Failure` was originally created.

To enable it you can use *collect_traces*. See examples below:

You can use it as a context manager:

```
>>> from inspect import FrameInfo

>>> from returns.result import Failure, Result
>>> from returns.primitives.tracing import collect_traces

>>> def get_failure(argument: str) -> Result[str, str]:
...     return Failure(argument)

>>> non_traced_failure = get_failure('Normal Failure')
>>> with collect_traces():
...     traced_failure = get_failure('Traced Failure')

>>> assert non_traced_failure.trace is None
>>> assert isinstance(traced_failure.trace, list)
>>> assert all(isinstance(trace_line, FrameInfo) for trace_line in traced_failure.trace)

>>> for trace_line in traced_failure.trace:
...     print(f"{trace_line.filename}:{trace_line.lineno} in `{trace_line.function}`")
...
/returns/returns/result.py:529 in `Failure`
/example_folder/example.py:5 in `get_failure`
/example_folder/example.py:1 in `<module>`
```

Or as a decorator:

```
>>> from inspect import FrameInfo

>>> from returns.io import IOFailure, IOResult
>>> from returns.result import Failure, Result
>>> from returns.primitives.tracing import collect_traces

>>> @collect_traces
... def traced_function(value: str) -> IOResult[str, str]:
...     return IOFailure(value)

>>> non_traced_failure = Failure('Normal Failure')
```

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```
>>> traced_failure = traced_function('Traced Failure')

>>> assert non_traced_failure.trace is None
>>> assert isinstance(traced_failure.trace, list)
>>> assert all(isinstance(trace_line, FrameInfo) for trace_line in traced_failure.trace)

>>> for trace_line in traced_failure.trace:
...     print(f"{trace_line.filename}:{trace_line.lineno} in `{trace_line.function}`")
...
/returns/returns/result.py:525 in `Failure`
/returns/returns/io.py:852 in `IOFailure`
/example_folder/example.py:7: in `traced_function`
/usr/lib/python3.8/contextlib.py:75 in `inner`
/example_folder/example.py:1 in `<module>`
```

Warning: Activating trace can make your program noticeably slower if it has many points where `Failure` is often created.

Warning: `collect_traces` is not thread safe, beware to use it with threading!

Warning: Traces are meant to be used during development only.

9.19.2 API Reference

collect_traces() → AbstractContextManager[None]
collect_traces(*function: returns.primitives.tracing._FunctionType*) → returns.primitives.tracing._FunctionType
Context Manager/Decorator to active traces collect to the Failures.

```
>>> from inspect import FrameInfo

>>> from returns.io import IOResult
>>> from returns.result import Result
>>> from returns.primitives.tracing import collect_traces

>>> with collect_traces():
...     traced_failure = Result.from_failure('Traced Failure')
>>> non_traced_failure = IOResult.from_failure('Non Traced Failure')

>>> assert non_traced_failure.trace is None
>>> assert isinstance(traced_failure.trace, list)
>>> assert all(isinstance(trace_line, FrameInfo) for trace_line in traced_failure.
↪trace)

>>> for trace_line in traced_failure.trace:
...     print(f'{trace_line.filename}:{trace_line.lineno} in `{trace_line.function}`
↪')
```

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```
...
/returns/returns/result.py:525 in `Failure`
/returns/returns/result.py:322 in `from_failure`
/example_folder/example.py:1 in `<module>`
```

Parameters **function** (Optional[~_FunctionType]) –

Return type Union[~_FunctionType, AbstractContextManager[None]]

9.20 mypy plugin

We provide a custom `mypy` plugin to fix existing issues, provide new awesome features, and improve type-safety of things developers commonly use.

9.20.1 Installation

You will need to install `mypy` separately. It is not bundled with `returns`.

To install any `mypy` plugin add it to the `plugins` section of the config file.

```
[mypy]
plugins =
  returns.contrib.mypy.returns_plugin
```

We recommend to always add our plugin as the first one in chain.

9.20.2 Configuration

You can have a look at the suggested `mypy` configuration in our own repository.

You can also use nitpick tool to enforce the same `mypy` configuration for all your projects.

We recommend to use our own setup. Add this to your `pyproject.toml`:

```
[tool.nitpick]
style = "https://raw.githubusercontent.com/wemake-services/wemake-python-styleguide/
↪master/styles/mypy.toml"
```

And use `flake8` to lint that configuration defined in the setup matches yours. This will allow to keep them in sync with the upstream.

9.20.3 Supported features

- `kind` feature adds Higher Kinded Types (HKT) support
- `curry` feature allows to write typed curried functions
- `partial` feature allows to write typed partial application
- `flow` feature allows to write better typed functional pipelines with `flow` function
- `pipe` feature allows to write better typed functional pipelines with `pipe` function
- `decorators` allows to infer types of functions that are decorated with `@safe`, `@maybe`, `@impure`, etc

9.20.4 Further reading

- Mypy official docs
- Mypy plugins docs

9.20.5 API Reference

Plugin definition

TYPED_DECORATORS: typing_extensions.Final = frozenset({'returns.functions.not_', 'returns.future.asyncify', 'returns.future.future', 'returns.future.future_safe', 'returns.io.impure', 'returns.io.impure_safe', 'returns.maybe.maybe', 'returns.result.safe'})
Set of full names of our decorators.

TYPED_PARTIAL_FUNCTION: typing_extensions.Final = 'returns.curry.partial'
Used for typed `partial` function.

TYPED_CURRY_FUNCTION: typing_extensions.Final = 'returns.curry.curry'
Used for typed `curry` decorator.

TYPED_FLOW_FUNCTION: typing_extensions.Final = 'returns._internal.pipeline.flow.flow'
Used for typed `flow` call.

TYPED_PIPE_FUNCTION: typing_extensions.Final = 'returns._internal.pipeline.pipe.pipe'
Used for typed `pipe` call.

TYPED_KINDN: typing_extensions.Final = 'returns.primitives.hkt.KindN'
Used for HKT emulation.

Custom mypy plugin to solve the temporary problem with python typing.

Important: we don't do anything ugly here. We only solve problems of the current typing implementation.

`mypy` API docs are here: https://mypy.readthedocs.io/en/latest/extending_mypy.html

We use `pytest-mypy-plugins` to test that it works correctly, see: https://github.com/mkurnikov/pytest-mypy-plugins

plugin(*version*)
Plugin's public API and entrypoint.

Parameters **version** (`str`) –

Return type `Type[Plugin]`

Kind

attribute_access(*ctx*)
Ensures that attribute access to `KindN` is correct.

In other words:

```
from typing import TypeVar
from returns.primitives.hkt import KindN
from returns.interfaces.mappable import MappableN

_MappableType = TypeVar('_MappableType', bound=MappableN)

kind: KindN[_MappableType, int, int, int]
reveal_type(kind.map)  # will work correctly!
```

Parameters **ctx** (`AttributeContext`) –

Return type `Type`

dekind(*ctx*)
Infers real type behind `Kind` form.

Basically, it turns `Kind[IO, int]` into `IO[int]`. The only limitation is that it works with only `Instance` type in the first type argument position.

So, `dekind(KindN[T, int])` will fail.

Parameters **ctx** (`FunctionContext`) –

Return type `Type`

kinded_signature(*ctx*)
Returns the internal function wrapped as `Kinded[def]`.

Works for `Kinded` class when `__call__` magic method is used. See *returns.primitives.hkt.Kinded* for more information.

Parameters **ctx** (`MethodSigContext`) –

Return type `CallableType`

kinded_call(*ctx*)
Reveals the correct return type of `Kinded.__call__` method.

Turns `-> KindN[I, t1, t2, t3]` into `-> I[t1, t2, t3]`.

Also strips unused type arguments for `KindN`, so: - `KindN[IO, int, <nothing>, <nothing>]` will be `IO[int]` - `KindN[Result, int, str, <nothing>]` will be `Result[int, str]`

It also processes nested `KindN` with recursive strategy.

See *returns.primitives.hkt.Kinded* for more information.

Parameters **ctx** (`MethodContext`) –

Return type `Type`

kinded_get_descriptor(*ctx*)
Used to analyze `@kinded` method calls.

We do this due to `__get__` descriptor magic.

Parameters **ctx** (`MethodContext`) –

Return type Type

Curry

analyze(*ctx*)

Returns proper type for curried functions.

Parameters **ctx** (FunctionContext) –

Return type Type

Partial

analyze(*ctx*)

This hook is used to make typed curring a thing in *returns* project.

This plugin is a temporary solution to the problem. It should be later replaced with the official way of doing things. One day functions will have better API and we plan to submit this plugin into mypy core plugins, so it would not be required.

Internally we just reduce the original function's argument count. And drop some of them from function's signature.

Parameters **ctx** (FunctionContext) –

Return type Type

Flow

analyze(*ctx*)

Helps to analyze flow function calls.

By default, mypy cannot infer and check this function call:

```
>>> from returns.pipeline import flow
>>> assert flow(
...     1,
...     lambda x: x + 1,
...     lambda y: y / 2,
... ) == 1.0
```

But, this plugin can! It knows all the types for all lambda functions in the pipeline. How?

1. We use the first passed parameter as the first argument to the first passed function
2. We use parameter + function to check the call and reveal types of current pipeline step
3. We iterate through all passed function and use previous return type as a new parameter to call current function

Parameters **ctx** (FunctionContext) –

Return type Type

Pipe

Typing `pipe` functions requires several phases.

It is pretty obvious from its usage:

1. When we pass a sequence of functions we have to reduce the final callable type, it is require to match the `callable` protocol. And at this point we also kinda try to check that all pipeline functions do match, but this is impossible to do 100% correctly at this point, because generic functions don't have a type argument to infer the final result
2. When we call the function, we need to check for two things. First, we check that passed argument fits our instance requirement. Second, we check that pipeline functions match. Now we have all arguments to do the real inference.
3. We also need to fix generic in method signature. It might be broken, because we add new generic arguments and return type. So, it is safe to reattach generic back to the function.

Here's when it works:

```
>>> from returns.pipeline import pipe

>>> def first(arg: int) -> bool:
...     return arg > 0
>>> def second(arg: bool) -> str:
...     return 'bigger' if arg else 'not bigger'

>>> pipeline = pipe(first, second)  # `analyzed` is called
>>> assert pipeline(1) == 'bigger'  # `signature and `infer` are called
>>> assert pipeline(0) == 'not bigger'  # `signature and `infer` again
```

analyze(*ctx*)
This hook helps when we create the pipeline from sequence of funcs.

Parameters **ctx** (`FunctionContext`) –

Return type `Type`

infer(*ctx*)
This hook helps when we finally call the created pipeline.

Parameters **ctx** (`MethodContext`) –

Return type `Type`

signature(*ctx*)
Helps to fix generics in method signature.

Parameters **ctx** (`MethodSigContext`) –

Return type `CallableType`

Decorators

analyze(*sym*)

Changes a type of a decorator.

This problem appears when we try to change the return type of the function. However, currently it is impossible due to this bug: https://github.com/python/mypy/issues/3157

It uses the passed function to copy its type. We only copy arguments and return type is defined by type annotations.

Parameters **sym** (Optional[SymbolTableNode]) –

Return type Callable[[FunctionContext], Type]

9.21 pytest plugin

We use special `pytest` plugin to improve the testing side of this project.

For example: it is a popular request to ensure that your container does have its error pass handled. Because otherwise, developers might forget to do it properly. It is impossible to fix with types, but is really simple to check with tests.

9.21.1 Installation

You will need to install `pytest` separately.

9.21.2 Usage

There's no need to install anything special. `pytest` will automatically find and use this plugin.

To use it in your tests, request `returns` fixture like so:

```
def test_my_container(returns):
    ...
```

assert_equal

We have a special helper to compare containers' equality.

It might be an easy task for two `Result` or `Maybe` containers, but it is not very easy for two `ReaderResult` or `FutureResult` instances.

Take a look:

```
>>> from returns.result import Result
>>> from returns.context import Reader

>>> assert Result.from_value(1) == Result.from_value(1)
>>> Reader.from_value(1) == Reader.from_value(1)
False
```

So, we can use *assert_equal()* or `returns.assert_equal` method from our `pytest` fixture:

```
>>> from returns.result import Success
>>> from returns.context import Reader
>>> from returns.contrib.pytest import ReturnsAsserts

>>> def test_container_equality(returns: ReturnsAsserts):
...     returns.assert_equal(Success(1), Success(1))
...     returns.assert_equal(Reader.from_value(1), Reader.from_value(1))

>>> # We only run these tests manually, because it is a doc example:
>>> returns_fixture = getfixture('returns')
>>> test_container_equality(returns_fixture)
```

is_error_handled

The first helper we define is `is_error_handled` function. It tests that containers do handle error track.

```
>>> from returns.result import Failure, Success
>>> from returns.contrib.pytest import ReturnsAsserts

>>> def test_error_handled(returns: ReturnsAsserts):
...     assert not returns.is_error_handled(Failure(1))
...     assert returns.is_error_handled(
...         Failure(1).lash(lambda _: Success('default value')),
...     )

>>> # We only run these tests manually, because it is a doc example:
>>> returns_fixture = getfixture('returns')
>>> test_error_handled(returns_fixture)
```

We recommend to unit test big chunks of code this way. This is helpful for big pipelines where you need at least one error handling at the very end.

This is how it works internally:

- Methods like `fix` and `lash` mark errors inside the container as handled
- Methods like `map` and `alt` just copies the error handling state from the old container to a new one, so there's no need to re-handle the error after these methods
- Methods like `bind` create new containers with unhandled errors

---

Note: We use monkeypathing of containers inside tests to make this check possible. They are still purely functional inside. It does not affect production code.

---

assert_trace

Sometimes we have to know if a container is created correctly in a specific point of our flow.

`assert_trace` helps us to check exactly this by identifying when a container is created and looking for the desired function.

```
>>> from returns.result import Result, Success, Failure
>>> from returns.contrib.pytest import ReturnsAsserts

>>> def desired_function(arg: str) -> Result[int, str]:
...     if arg.isnumeric():
...         return Success(int(arg))
...     return Failure('"{0}" is not a number'.format(arg))

>>> def test_if_failure_is_created_at_convert_function(
...     returns: ReturnsAsserts,
... ):
...     with returns.assert_trace(Failure, desired_function):
...         Success('not a number').bind(desired_function)

>>> def test_if_success_is_created_at_convert_function(
...     returns: ReturnsAsserts,
... ):
...     with returns.assert_trace(Success, desired_function):
...         Success('42').bind(desired_function)

>>> # We only run these tests manually, because it is a doc example:
>>> returns_fixture = getfixture('returns')
>>> test_if_failure_is_created_at_convert_function(returns_fixture)
>>> test_if_success_is_created_at_convert_function(returns_fixture)
```

markers

We also ship a bunch of pre-defined markers with `returns`:

- `returns_lawful` is used to mark all tests generated by our *hypothesis plugin*

9.21.3 Further reading

- pytest docs

9.21.4 API Reference

class ReturnsAsserts

Bases: `object`

Class with helpers assertions to check containers.

assert_equal(*first*, *second*, ***, *deps=None*, *backend='asyncio'*)

Can compare two containers even with extra calling and awaiting.

Parameters **backend** (`str`) –

Return type None

is_error_handled(*container*)
Ensures that container has its error handled in the end.

Return type bool

assert_trace(*trace_type*, *function_to_search*)
Ensures that a given function was called during execution.

Use it to determine where the failure happened.

Parameters

- **trace_type** (*~_ReturnsResultType*) –
- **function_to_search** (*~_FunctionType*) –

Return type Iterator[None]

returns(*_patch_containers*)
Returns our own class with helpers assertions to check containers.

Return type *ReturnsAsserts*

pytest_configure(*config*)
Hook to be executed on import.

We use it define custom markers.

Return type None

assert_equal(*first*, *second*, ***, *deps=None*, *backend='asyncio'*)
Custom `assert` function to compare two any containers.

The important note here is that this `assert` should probably used in tests. Not real application code.

It will call all `Reader` based containers and `await` all `Future` based ones.

It also works recursively. For example, `ReaderFutureResult` will be called and then awaited.

You can specify different dependencies to call your containers. And different backends to `await` then using `anyio`.

By the way, `anyio` should be installed separately.

Parameters **backend** (str) –

Return type None

9.22 hypothesis plugin

We provide several extra features for Hypothesis users. And encourage to use it together with `returns`.

9.22.1 Installation

You will need to install `hypothesis` separately. It is not bundled with `returns`.

We also require `anyio` package for this plugin to work with async laws.

9.22.2 hypothesis entrypoint

We support a `hypothesis` entrypoint that is executed on `hypothesis` import.

There we are regestering all our containers as strategies. So, you don't have to. Example:

```
from returns.result import Result
from hypothesis import strategies as st

assert st.from_type(Result).example()
```

This is a convenience thing only.

9.22.3 strategy_from_container

We provide a utility function to create `hypothesis` strategy from any container.

You can use it to easily register your own containers.

```
from hypothesis import strategies as st
from returns.contrib.hypothesis.containers import strategy_from_container

st.register_type_strategy(
    YourContainerClass,
    strategy_from_container(YourContainerClass),
)
```

You can also pass `use_init` keyword argument if you wish to use `__init__` method to instantiate your containers. Turned off by default. Example:

```
st.register_type_strategy(
    YourContainerClass,
    strategy_from_container(YourContainerClass, use_init=True),
)
```

Or you can write your own `hypothesis` strategy. It is also fine.

9.22.4 check_all_laws

We also provide a very powerful mechanism of checking defined container laws. It works in a combitation with "Laws as Values" feature we provide in the core.

```
from returns.contrib.hypothesis.laws import check_all_laws
from your.module import YourCustomContainer

check_all_laws(YourCustomContainer)
```

This one line of code will generate ~100 tests for all defined law in both `YourCustomContainer` and all its super types, including our internal ones.

We also provide a way to configure the checking process with `settings_kwargs`:

```
check_all_laws(YourCustomContainer, settings_kwargs={'max_examples': 500})
```

This will increase the number of generated test to 500. We support all kwargs from `@settings`, see @settings docs.

You can also change how `hypothesis` creates instances of your container. By default, we use `.from_value`, `.from_optional`, and `.from_failure` if we are able to find them.

But, you can also pass types without these methods, but with `__init__` defined:

```
from typing import Callable, TypeVar
from typing_extensions import final
from returns.interfaces.mappable import Mappable1
from returns.primitives.container import BaseContainer
from returns.primitives.hkt import SupportsKind1

_ValueType = TypeVar('_ValueType')
_NewValueType = TypeVar('_NewValueType')

@final
class Number(
    BaseContainer,
    SupportsKind1['Number', _ValueType],
    Mappable1[_ValueType],
):
    def __init__(self, inner_value: _ValueType) -> None:
        super().__init__(inner_value)

    def map(
        self,
        function: Callable[[_ValueType], _NewValueType],
    ) -> 'Number[_NewValueType]':
        return Number(function(self._inner_value))

# We want to allow ``__init__`` method to be used:
check_all_laws(Number, use_init=True)
```

As you see, we don't support any `from` methods here. But, `__init__` would be used to generate values thanks to `use_init=True`.

By default, we don't allow to use `__init__`, because there are different complex types like `Future`, `ReaderFutureResult`, etc that have complex `__init__` signatures. And we don't want to mess with them.

Warning:: Checking laws is not compatible with `pytest-xdist`, because we use a lot of global mutable state there. Please, use `returns_lawful` marker to exclude them from `pytest-xdist` execution plan.

9.22.5 Further reading

- Projects Extending hypothesis

9.22.6 API Reference

Types we have already registered for you

Used to register all our types as hypothesis strategies.

See: https://hypothesis.readthedocs.io/en/latest/strategies.html

But, beware that we only register concrete types here, interfaces won't be registered!

REGISTERED_TYPES: Sequence[Type[*returns.primitives.laws.Lawful*]] = (<class 'returns.result.Result'>, <class 'returns.maybe.Maybe'>, <class 'returns.io.IO'>, <class 'returns.io.IOResult'>, <class 'returns.future.Future'>, <class 'returns.future.FutureResult'>, <class 'returns.context.requires_context.RequiresContext'>, <class 'returns.context.requires_context_result.RequiresContextResult'>, <class 'returns.context.requires_context_ioresult.RequiresContextIOResult'>, <class 'returns.context.requires_context_future_result.RequiresContextFutureResult'>)

Our types that we register in hypothesis to be working with `st.from_type`

DSL to register custom containers

strategy_from_container(*container_type*, ***, *use_init=False*)

Creates a strategy from a container type.

Basically, containers should not support `__init__` even when they have one. Because, that can be very complex: for example `FutureResult` requires `Awaitable[Result[a, b]]` as an `__init__` value.

But, custom containers pass `use_init` if they are not an instance of `ApplicativeN` and do not have a working `.from_value` method. For example, pure `MappableN` can do that.

We also try to resolve generic arguments. So, `Result[_ValueType, Exception]` will produce any value for success cases and only exceptions for failure cases.

Parameters

- **container_type** (`Type[ForwardRef]`) –
- **use_init** (`bool`) –

Return type `Callable[[type], SearchStrategy]`

DSL to define laws

law_definition

alias of `staticmethod`

class Law(*function*)

Bases: *returns.primitives.types.Immutable*

Base class for all laws. Does not have an attached signature.

Should not be used directly. Use `Law1`, `Law2` or `Law3` instead.

definition
Function used to define this law.

property name: str
Returns a name of the given law. Basically a name of the function.

Return type str

class Law1(*function*)
Bases: *returns.primitives.laws.Law*, Generic[returns.primitives.laws._TypeArgType1, returns.primitives.laws._ReturnType]

Law definition for functions with a single argument.

Parameters **function** (Callable[[~_TypeArgType1], ~_ReturnType]) –

definition
Function used to define this law.

class Law2(*function*)
Bases: *returns.primitives.laws.Law*, Generic[returns.primitives.laws._TypeArgType1, returns.primitives.laws._TypeArgType2, returns.primitives.laws._ReturnType]

Law definition for functions with two arguments.

Parameters **function** (Callable[[~_TypeArgType1, ~_TypeArgType2], ~_ReturnType]) –

definition
Function used to define this law.

class Law3(*function*)
Bases: *returns.primitives.laws.Law*, Generic[returns.primitives.laws._TypeArgType1, returns.primitives.laws._TypeArgType2, returns.primitives.laws._TypeArgType3, returns.primitives.laws._ReturnType]

Law definition for functions with three argument.

Parameters **function** (Callable[[~_TypeArgType1, ~_TypeArgType2, ~_TypeArgType3], ~_ReturnType]) –

definition
Function used to define this law.

class Lawful(**args*, ***kwds*)
Bases: Generic[returns.primitives.laws._Caps]

Base class for all lawful classes.

Allows to smartly collect all defined laws from all parent classes.

classmethod laws()
Collects all laws from all parent classes.

Algorithm:

1. First, we collect all unique parents in __mro__
2. Then we get the laws definition from each of them
3. Then we structure them in a type: its_laws way

Return type Dict[Type[*Lawful*], Sequence[*Law*]]

class LawSpecDef
Bases: object

Base class for all collection of laws aka LawSpecs.

Plugin internals

check_all_laws(*container_type*, *, *settings_kwargs=None*, *use_init=False*)
Function to check all defined mathematical laws in a specified container.

Should be used like so:

```
from returns.contrib.hypothesis.laws import check_all_laws
from returns.io import IO

check_all_laws(IO)
```

You can also pass different hypothesis settings inside:

```
check_all_laws(IO, {'max_examples': 100})
```

Note: Cannot be used inside doctests because of the magic we use inside.

See also:

- https://sobolevn.me/2021/02/make-tests-a-part-of-your-app
- https://mmhaskell.com/blog/2017/3/13/obey-the-type-laws

Parameters

- **container_type** (Type[*Lawful*]) –
- **settings_kwargs** (Optional[Dict[str, Any]]) –
- **use_init** (bool) –

Return type None

container_strategies(*container_type*, *, *settings*)
Registers all types inside a container to resolve to a correct strategy.

For example, let's say we have Result type. It is a subtype of ContainerN, MappableN, BindableN, etc. When we check this type, we need MappableN to resolve to Result.

Can be used independently from other functions.

Parameters

- **container_type** (Type[*Lawful*]) –
- **settings** (_Settings) –

Return type Iterator[None]

maybe_register_container(*container_type*, *, *use_init*)
Temporary registers a container if it is not registered yet.

Parameters

- **container_type** (Type[*Lawful*]) –
- **use_init** (bool) –

Return type Iterator[None]

pure_functions()
Context manager to resolve all Callable as pure functions.

It is not a default in hypothesis.

Return type Iterator[None]

type_vars()
Our custom TypeVar handling.

There are several noticeable differences:

1. We add mutable types to the tests: like list and dict
2. We ensure that values inside strategies are self-equal, for example, nan does not work for us

Return type Iterator[None]

9.23 Version history

We follow Semantic Versions since the 1.0.0 release. Versions before 1.0.0 are 0Ver-based: incremental in minor, bugfixes only are patches. See 0Ver.

9.23.1 0.17.0

Features

- Enables Pattern Matching support for Result containers
- Enables Pattern Matching support for Maybe container
- Enables Pattern Matching support for IOResult container
- Improves hypothesis plugin, now we detect when type cannot be constructed and give a clear error message

9.23.2 0.16.0

Features

- Makes _Nothing a singleton
- Refactor flow function to be faster

Bugfixes

- Fixes that `assert_trace` was not catching containers from `@safe`-wrapped functions

Misc

- Fixes typos in documentation

9.23.3 0.15.0 aka The initial HKT release

Features

- Adds Higher Kinded Types partial support
- **Breaking**: drops `python3.6` support
- **Breaking**: makes our `mypy` plugin not optional, but required!
- **Breaking**: changes all `RequiresContext`-based type arguments order, previously we used to specify `_EnvType` as the first type argument, now it is the last one. This is done to respect new HKT rules
- **Breaking**: renames `.rescue` to `.lash`
- **Breaking**: removes all old interfaces from `primitives/interfaces.py`, use new typeclasses instead
- **Breaking**: `Maybe` is fully reworked to be lawful
- **Breaking**: removes `value_or` pointfree method, because it is impossible to express with HKT
- **Breaking**: removes `.value_or`, `.unwrap`, and `.failure` methods from `FutureResult` and `RequiresContext`-based types, because we do require these methods to raise an exception on failure, but these methods were lazy and did not raise the required exception
- **Breaking**: changes how `is_successful` is typed: now we allow any `Unwrappable` interface instances there, including custom ones
- **Breaking**: changes `UnwrapFailedError` constructor, now it does accept an `Unwrappable` instance instead of a `BaseContainer`
- **Breaking**: removes `.fix` method from all containers, also removes `fix` pointfree function
- **Breaking**: Removes `coalesce` function, because it is impossible to properly type it
- **Breaking**: Removes all `Context*` based types with `.ask()` method, use new `.ask()` methods on the `Reader`-based containers
- **Breaking**: Now `Future` and `FutureResult` can be awaited multiple times
- **Breaking**: Removes `.unify()` method from several containers, use `unify()` pointfree function instead
- **Breaking**: Removes `.from_iterable` method from all containers, instead adds better `iterables` support, we now have `returns.iterables` module with `Fold` helper
- **Breaking**: Renames property `empty` to `no_args` of all `RequiresContext`-based classes
- Adds new public interfaces: see `returns.interfaces`
- Adds `methods` package with several helpful things inside
- Adds `FutureSuccess` and `FutureFailure` unit functions to be similar to `Result` and `IOResult`
- Adds `.swap` method to `Result`, `IOResult`, `FutureResult`, and other result based containers

- Adds `.modify_env` method to all `RequiresContext*` types
- Adds `.rescue` to `Maybe`
- Adds `.equals` methods to types that can be compared directly: `Result`, `Maybe`, `IO`, `IOResult`
- Adds missing `from_requires_context_future_result` to `RequiresContext`
- Adds `.from_optional` and `.bind_optional` to `Maybe` container
- Adds `__slots__` to `UnwrapFailedError` with `halted_container`
- Changes `flatten` to work with `KindN` and any possible container
- Adds a helper to test traces to our `pytest` plugin
- Adds `cond` function to `pointfree` and `methods` packages
- Adds `compose_result` HKT method and pointfree function
- Adds `unify` HKT pointfree function
- Adds `bimap` pointfree function
- Adds `unwrap_or_failure` function to `methods` package
- Adds `collect_trace` helper function for better development experience
- Adds `hypothesis` integration and pre-defined "monad laws as values"
- Adds `assert_equal` method to our `pytest` plugin

Bugfixes

- **Breaking**: fixes serious typing issue and changes how `flow` works
- **Breaking**: fixes serious typing issue and changes how `pipe` works, now it has a hard limit of 20 parameters
- Fixes that `RequiresContextFutureResult` was not supported by `pytest` plugin
- Fixes incorrect `partial` behaviour in an edge case, #618
- Fixes that `.apply` method of `IOResult` was working incorrectly, it was returning `IOFailure(2)` as a result of `IOFailure(1).apply(IOFailure(2))`
- Fixes bug that `safe(tap(...))` was revealing invalid types sometimes

Misc

- Adds a lot of new typetests
- Checks that now all math laws are checked for all types
- Changes docs structure, adds new `Interfaces`, `HKT`, and `Methods` pages
- Changed `__str__` method in `BaseContainer` class to `__repr__` method
- Adds `Quickstart` guide

9.23.4 0.14.0

Features

- **Breaking**: renames mypy plugin from `decorator_plugin` to `returns_plugin` because of a complete rewrite and lots of new features
- **Breaking**: changes `@safe`, `@impure`, `impure_safe`, `@maybe` semantics: they do not work with `async` functions anymore; now you are forced to use `Future` and its helpers to work with `async` functions
- **Breaking**: renames `Maybe.new` to `Maybe.from_value`. Because all our other containers support this protocol. Only `Maybe` was different, sorry for that!
- **Breaking**: renames `.from_success()` to `.from_value()`, there's no need in two separate methods
- **Breaking**: renames `.from_successful_io()` to `.from_io()`, there's no need in two separate methods
- **Breaking**: renames `.from_successful_context()` to `.from_context()`, there's no need in two separate methods
- **Breaking**: since we now support `.apply()` method, there's no more need in `*_squash` converters, they are removed
- **Breaking**: renamed `Instanceable` to `Applicative`
- **Breaking**: changes `.from_io` and `.from_failed_io` of `IOResult` to return `Any` instead of `NoReturn` unfilled type
- **Breaking**: removes `.lift` and `.lift_*` methods from all containers, use `map_`, `bind_result`, `bind_io`, and other pointfree helpers instead
- **Breaking**: removes `@pipeline` function. It was a mistake: it does not work with mixed container types, it does not type failures properly, it does not work with `IO` and `Future`, it enforces to write imperative code in a functional codebase. Use `flow` instead
- Adds typed `partial` and `curry` mypy plugins!
- Adds typed `flow` plugin, now it can accept any number of arguments, it now also has **excellent** type inference
- Adds typed `pipe` plugin, now it can accept any number of arguments, it now also has good type inference
- Adds `managed` pipeline function that is useful for working with stateful computations
- Adds typed `map_`, `fix`, and `alt` pointfree functions
- Adds typed `bind_result`, `bind_io`, `bind_ioresult`, `bind_context`, `bind_context_result`, `bind_future`, `bind_async`, and `bind_awaitable` pointfree functions
- Adds typed `bind_async_future` and `bind_async_future_result` pointfree functions
- Adds typed `unify` pointfree function
- Adds typed `apply` pointfree function
- Adds typed `value_or` pointfree function
- Adds `pytest` plugin with the ability to tests error handling
- Adds `Future` container to easily work with `async` functions
- Adds `FutureResult` container to easily work with `async` function that might fail
- Adds `RequiresContextFutureResult` container
- Adds `ReaderFutureResult` alias for `RequiresContextFutureResult`
- Adds `RequiresContextFutureResultE` and `ReaderFutureResultE` aliases

- Adds `Future`, `FutureResult` and `RequiresContextFutureResult` support for all existing pointfree functions
- Adds `bind_io` method to `IOResult`
- Adds `bind_io` method to `RequiresContextIOResult`
- Adds `or_else` method to `Maybe`
- Adds `.from_io` and `.from_failed_io` to `RequiresContextIOResult`
- Syncs naming in `from_*` methods, now all parameters are named `inner_value`
- Adds `not_` composition helper
- Adds `flatten` support for `Future`, `FutureResult` and `RequiresContextFutureResult`
- Adds `__copy__` and `__deepcopy__` magic methods to `Immutable` class
- Speeds up `is_successful` function
- Makes all `Context` context helpers abstract, so you cannot create new instances of this class, also adds `__slots__` to these classes
- Improves `RequiresContext*` types with `NoDeps` where it is logically true

Bugfixes

- Fixes that `@safe` decorator was generating incorrect signatures for functions with `Any`
- Fixes that `.rescue()` of `RequiresContextResult` was returning `Any`
- Fixes that `.rescue()` of `RequiresContextIOResult` was returning `Any`
- Fixes that `RequiresContextResult` and `RequiresContextIOResult` were not `final`
- Fixes that `ImmutableStateError` was not a subclass of `AttributeError`
- Fixes that `IOResult` was not showing `str` representation of wrapped `inner_value`

Misc

- Replaces `pytest-asyncio` with `anyio` plugin, now we test compatibility with any IO stack: `asyncio`, `trio`, `curio`
- Updates lots of dependencies
- Adds lots of new tests
- Updates lots of docs
- Removes "IO marker" name from docs in favor for "IO container", it is not special at all. Why would we call it differently?

9.23.5 0.13.0

Features

- **Breaking**: renames `join` to `flatten`, sorry!
- **Breaking**: renames `box` to `bind` and moves it to `returns.pointfree`
- **Breaking**: removes `Maybe.rescue` and `Maybe.fix` methods
- **Breaking**: renames `io_squash` to `squash_io` and moves it to `returns.converters`
- **Breaking**: moves all interfaces from `returns.primitives.container` to `returns.primitives.interfaces`
- Adds `rescue` pointfree function
- Adds `ResultE` alias for `Result[..., Exception]`
- Adds `RequiresContext` container and `Context` helper class
- Adds `RequiresContext` support for `bind` pointfree function
- Adds `RequiresContext` support for `flatten` function
- Adds `RequiresContextResult` container
- Adds `RequiresContextResultE` alias
- Adds `ReaderResult` and `ReaderResultE` aliases for `RequiresContextResult[..., ..., Exception]`
- Adds `RequiresContextResult` support for `bind` and `rescue`
- Adds `RequiresContextResult` support for `flatten`
- Adds `IOResult` helper to work better with `IO[Result[a, b]]`
- Adds `IOResultE` alias for `IOResult[a, Exception]`
- Adds `IOResult` support for `bind`
- Adds `IOResult` support for `flatten`
- Adds `IOResult` support for `@pipeline`
- Adds `IOResult` support for `coalesce`
- Adds `IOResult` support for `is_successful`
- Adds `RequiresContextIOResult` container
- Adds `RequiresContextIOResultE` alias
- Adds `ReaderIOResult` and `ReaderIOResultE` aliases for `RequiresContextIOResult[..., ..., Exception]`
- Adds `RequiresContextIOResult` support for `bind` and `rescue`
- Adds `RequiresContextIOResult` support for `flatten`
- Adds `Result.lift`, `Maybe.lift`, `RequiresContext.lift`, and `RequiresContextResult.lift` functions in addition to `IO.lift`
- Adds `Immutable` primitive type
- Adds `Unitable` protocol and `.from_success()` and `.from_failure()` methods for all `Result` related classes
- Adds `Instanceable` protocol and `.from_value()` method for `IO` and `RequiresContext`

- Adds `flow` function, which is similar to `pipe`
- Adds `swap` converter for `Result` and `IOResult`
- Adds `squash_context` function to squash `RequiresContext` similar to `IO`

Bugfixes

- Now `Success` and `Failure` (both `io` and pure) return `Any` and not `NoReturn`
- Fixes how `flatten` works, also adds more tests and docs about `Failure` case
- Fixes `Unwrappable` type being parametrized with only one `TypeVar`
- Changes `Success` and `Failure` to return `Any` instead of `NoReturn`

Misc

- Updates `poetry` version in `travis`
- Improves `pipe` docs with `lambda` and `Generic` problem
- Improves docs in several places
- Now examples in docs tries to be docstests where possible
- Changes how tests are checked with `mypy` in CI

9.23.6 0.12.0

Features

- **Breaking**: now `@pipeline` requires a container type when created: `@pipeline(Result)` or `@pipeline(Maybe)`
- `Maybe` and `Result` now has `success_type` and `failure_type` aliases
- Adds `Result.unify` utility method for better error type composition
- We now support `dry-python/classes` as a first-class citizen
- Adds `io_squash` to squash several `IO` containers into one container with a tuple inside, currently works with `9` containers max at a time
- Adds `untap` function which does convert return type to `None`

Bugfixes

- Fixes that containers were not usable with `multiprocessing`
- Changes the inheritance order, now `BaseContainer` is the first child
- Fixes that `Nothing` had incorrect docstrings

Misc

- Now `generated` package is protected
- Updates `poetry` to `1.0`

9.23.7 0.11.0

Features

- **Breaking**: now `pipe()` does not require argument to be the first value, instead it is required to use: `pipe(f1, f2, f3, f4)(value)`
- **Breaking**: dropped everything from `returns/__init__.py`, because we now have quite a lot of stuff
- **Breaking**: dropped support of zero argument functions for `Nothing.fix`
- **Breaking**: dropped support of zero argument functions for `Nothing.rescue`
- `Maybe` now has `.failure()` to match the same API as `Result`
- Adds `identity` function
- Adds `tap` function
- Now `pipe` allows to pipe 8 steps
- Adds `coalesce_result` and `coalesce_maybe` converters

Bugfixes

- Fixes that code inside `.fix` and `.rescue` of `Maybe` might be called twice

Misc

- Now all methods have doctests
- Updates docs about `Success` and `_Success`, `Failure` and `_Failure`
- Updates docs about `@pipeline`
- Typechecks async functions and decorators inside `typesafety/` tests

9.23.8 0.10.0

Features

- **Breaking**: `python>=3.7,<=3.7.2` are not supported anymore, because of a bug inside `typing` module
- **Breaking**: Now `bind` does not change the type of an error
- **Breaking**: Now `rescue` does not change the type of a value
- **Breaking**: Renames `map_failure` to `alt`
- Adds `box()` function with the ability to box function for direct container composition like: `a -> Container[b]` to `Container[a] -> Container[b]`
- Adds `IO.lift()` function to lift `a -> a` to `IO[a] -> IO[a]`

- Adds `pipe()` function to `pipeline.py`
- Adds `__hash__()` magic methods to all containers

Bugfixes

- Changes `Any` to `NoReturn` in `Success` and `Failure`
- Now all type parameters in `Result`, `Maybe`, and `IO` are covariant

Misc

- Massive docs rewrite
- Updates `mypy` version
- Updates `wemake-python-styleguide` and introduces `nitpick`
- Updates `pytest-plugin-mypy`, all tests now use `yml`

9.23.9 0.9.0

Features

- Provides a bunch of primitive interfaces to write your own containers
- Adds `.map_failure()` method
- Adds `flatten()` function to join nested containers

Bugfixes

- Fixes type of `Maybe.fix` and `Maybe.rescue` to work with both `lambda: 1` and `lambda _: 1`

Misc

- Improves `README`

9.23.10 0.8.0

Features

- Reintroduces the `Maybe` container, typed!
- Introduces converters from one type to another
- Adds `mypy` plugin to type decorators
- Complete rewrite of `Result` types
- Partial API change, now `Success` and `Failure` are not types, but functions
- New internal types introduced: `FixableContainer` and `ValueUnwrapContainer`

Bugfixes

- Fixes issue when you could return `IO` container from `Result.bind`
- Fixes `@pipeline` return type

Misc

- Reapplied all types to `.py` files
- Improved docs about `IO` and `Container` concept
- Adds docs about container composition
- Moves from `Alpha` to `Beta`

9.23.11 0.7.0

Features

- Adds `IO` container
- Adds `unsafe` module with unsafe functions
- Changes how functions are located inside the project

Bugfixes

- Fixes container type in `@pipeline`
- Now `is_successful` is public
- Now `raise_exception` is public

Misc

- Changes how `str()` function works for container types
- Total rename to "container" in the source code

9.23.12 Version 0.6.0

Features

- `safe` and `pipeline` now supports `asyncio`
- `is_successful` now returns `Literal` types if possible

9.23.13 Version 0.5.0

Features

- Adds `compose` helper function
- Adds public API to `import returns`
- Adds `raise_exception` helper function
- Adds full traceback to `.unwrap()`

Misc

- Updates multiple dev-dependencies, including `mypy`
- Now search in the docs is working again
- Relicenses this project to `BSD`
- Fixes copyright notice in the docs

9.23.14 Version 0.4.0 aka Goodbye, containers!

Features

- Moves all types to `.pyi` files
- Renames all classes according to new naming pattern
- **HUGE** improvement of types
- Renames `fmap` to `map`
- Renames `do_notation` to `pipeline`, moves it to `functions.py`
- Renames `ebind` to `rescue`
- Renames `efmap` to `fix`
- Renames `container` to `Container`
- Removes `Maybe` container, since typing does not have `NonNullable` type

9.23.15 Version 0.3.1

Bugfixes

- Adds `py.typed` file to be `PEP561` compatible

9.23.16 Version 0.3.0, Renamed to `returns`

The project is renamed to `returns` and moved to `dry-python` org.

Features

- Adds `.pyi` files for all modules, to enable `mypy` support for 3rd party users

9.23.17 Version 0.2.0

Features

- Adds `Maybe` container
- Adds immutability and `__slots__` to all containers
- Adds methods to work with failures
- Adds `safe` decorator to convert exceptions to `Result` container
- Adds `is_successful()` function to detect if your result is a success
- Adds `failure()` method to unwrap values from failed containers

Bugfixes

- Changes the type of `.bind` method for `Success` container
- Changes how equality works, so now `Failure(1) != Success(1)`
- Changes how new instances created on unused methods

Misc

- Improves docs

9.23.18 Version 0.1.1

Bugfixes

- Changes how `PyPI` renders package's page

Misc

- Improves `README` with new badges and installation steps

9.23.19 Version 0.1.0

Initial release. Featuring only `Result` and `do_notation`.

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PYTHON MODULE INDEX

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