Abstract Base Classes

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Summary

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PEP 3119

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e.g. collections.abc.Sequence

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Python is not Java, C++, C#

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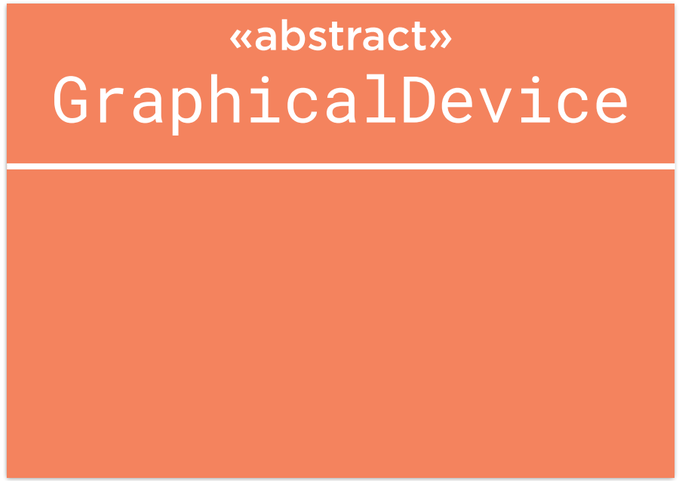

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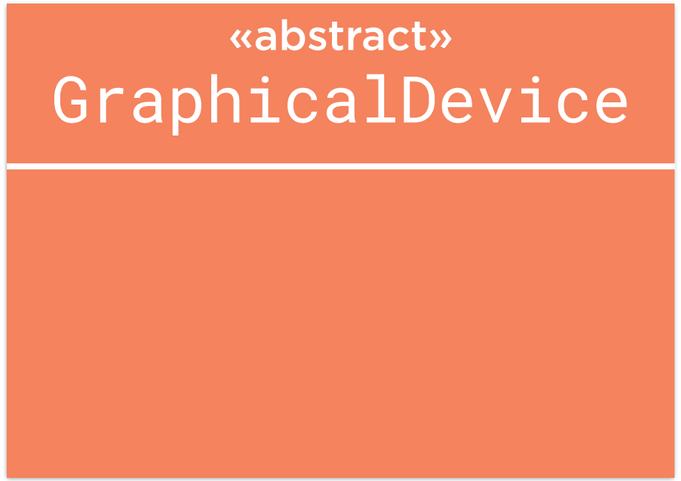

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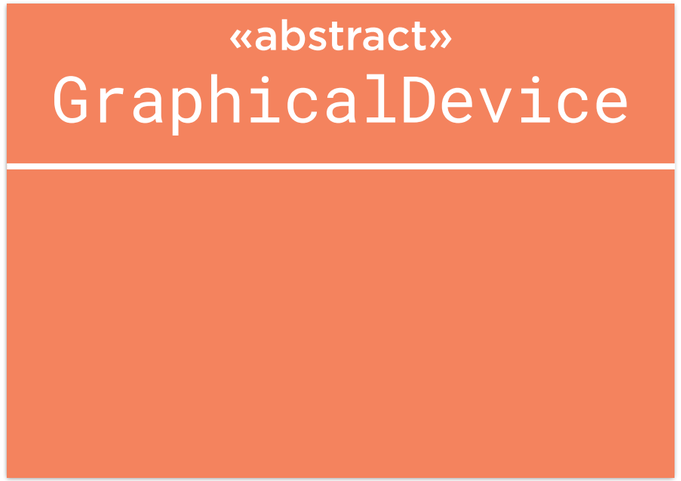

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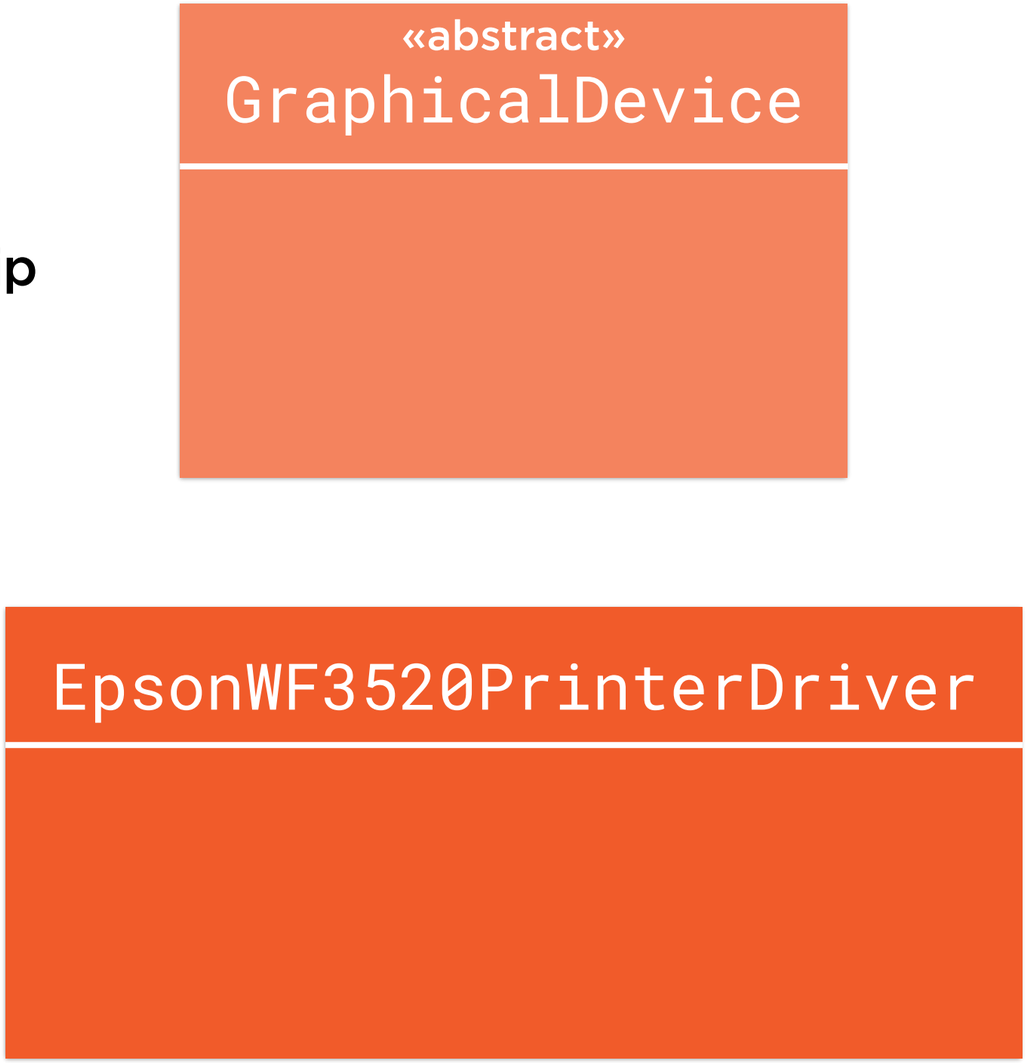

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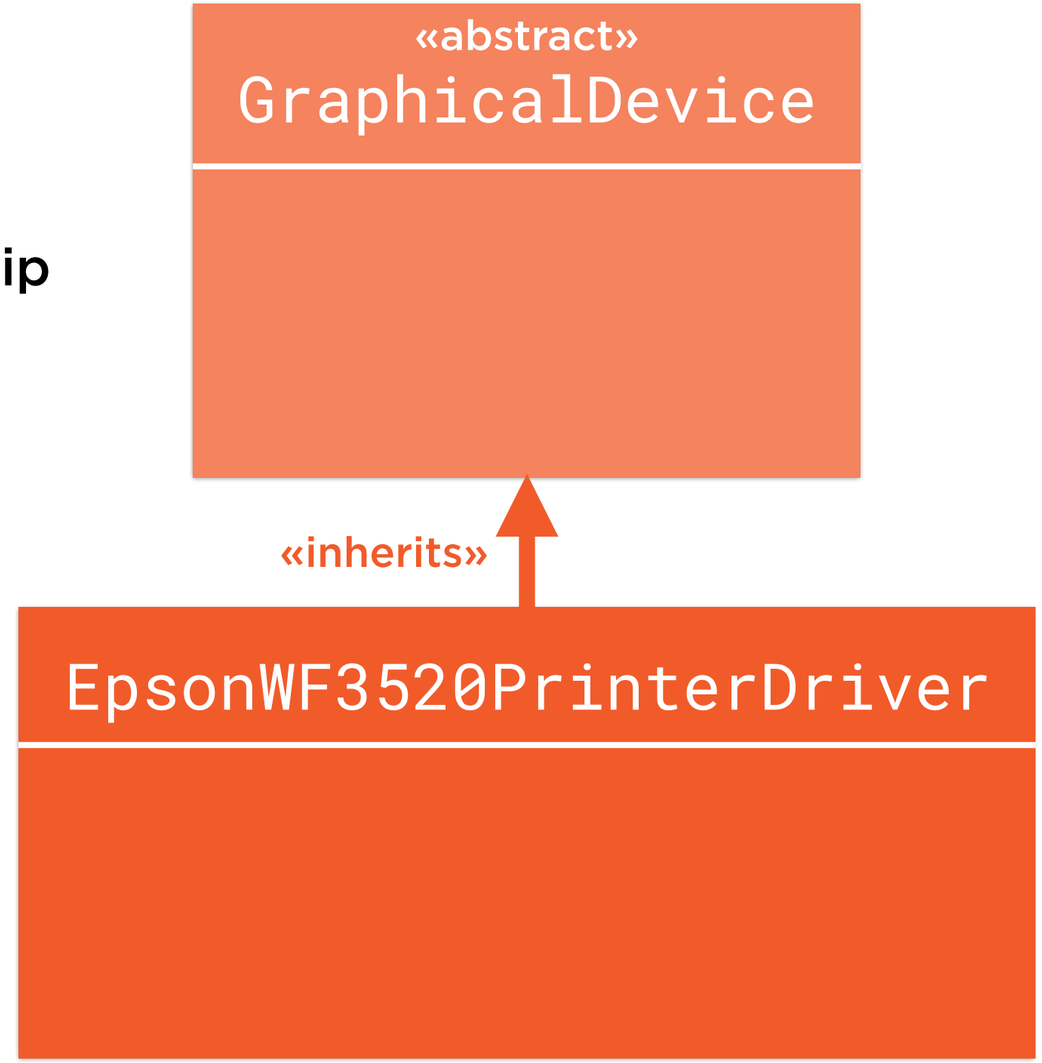

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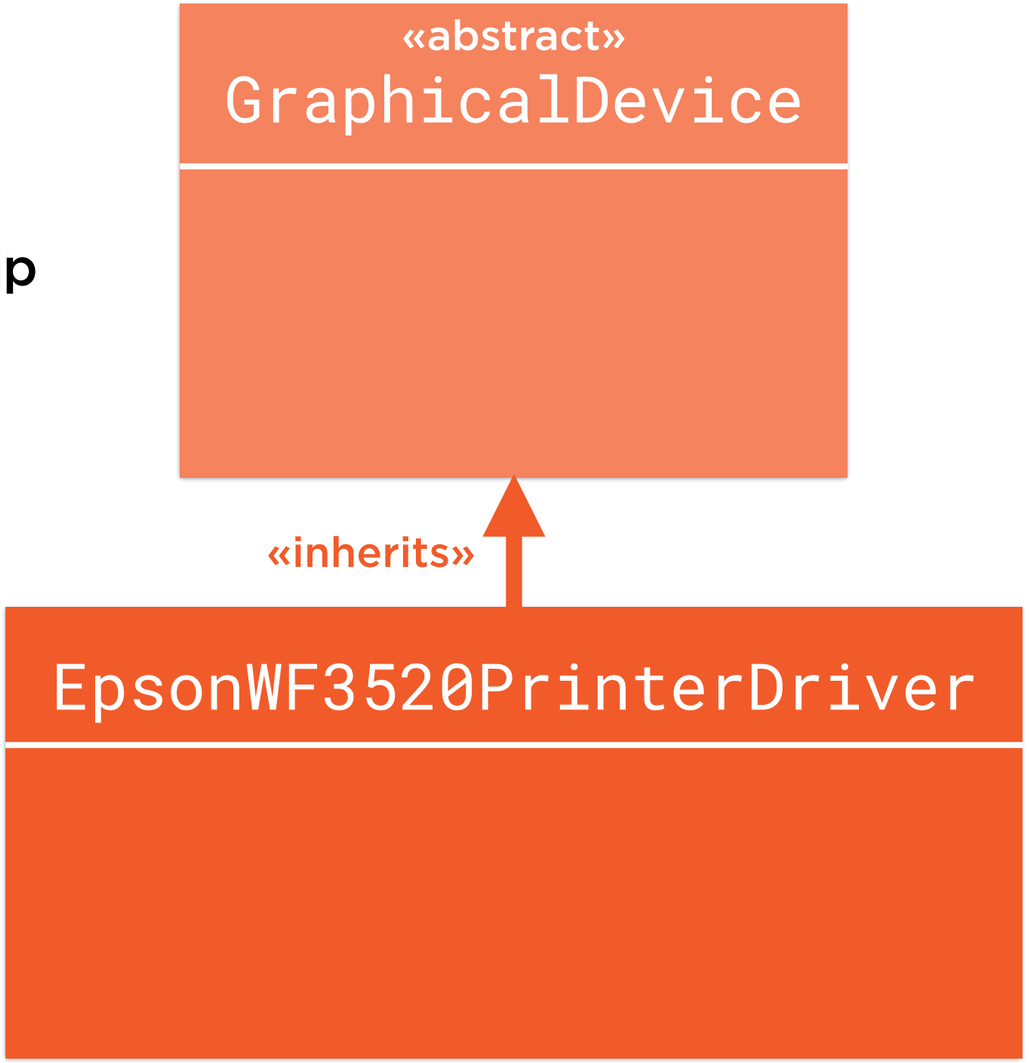

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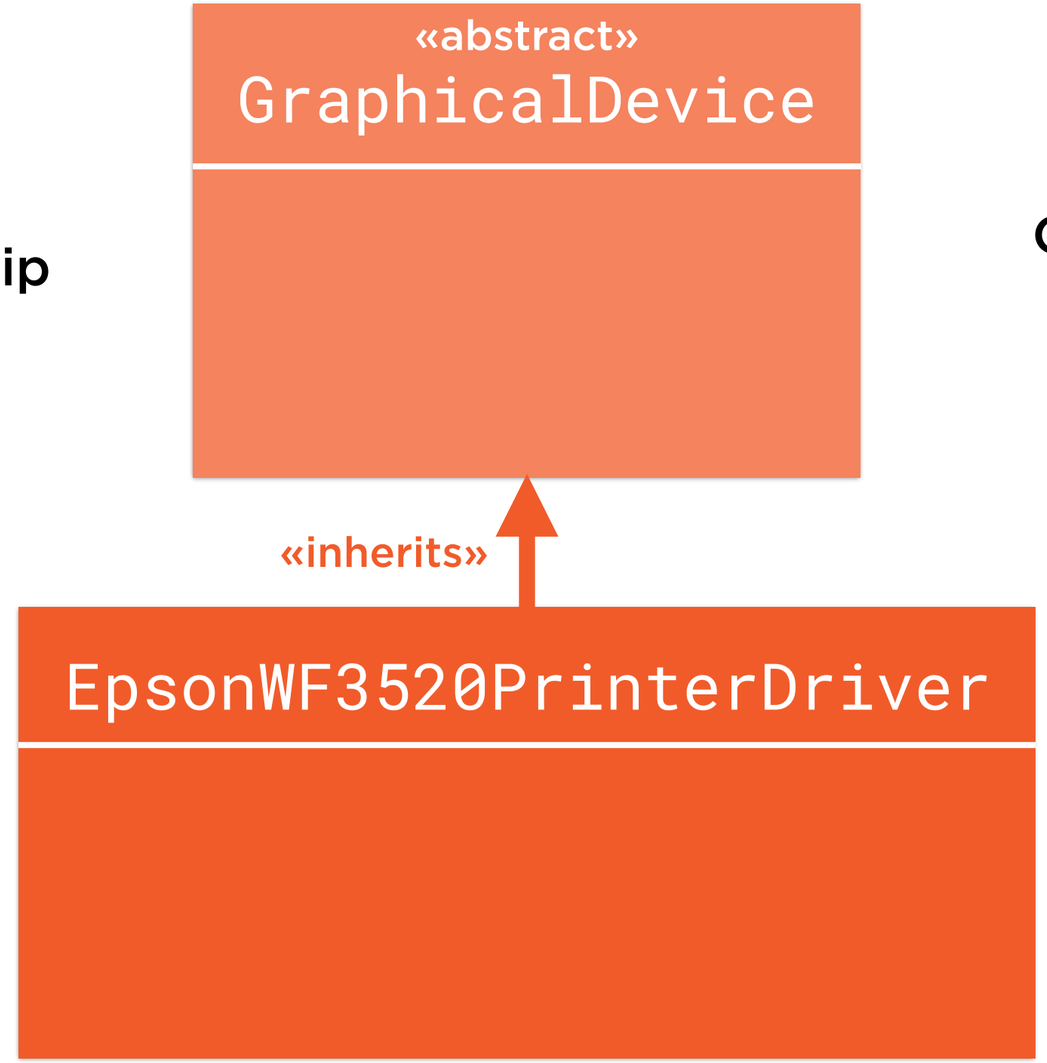
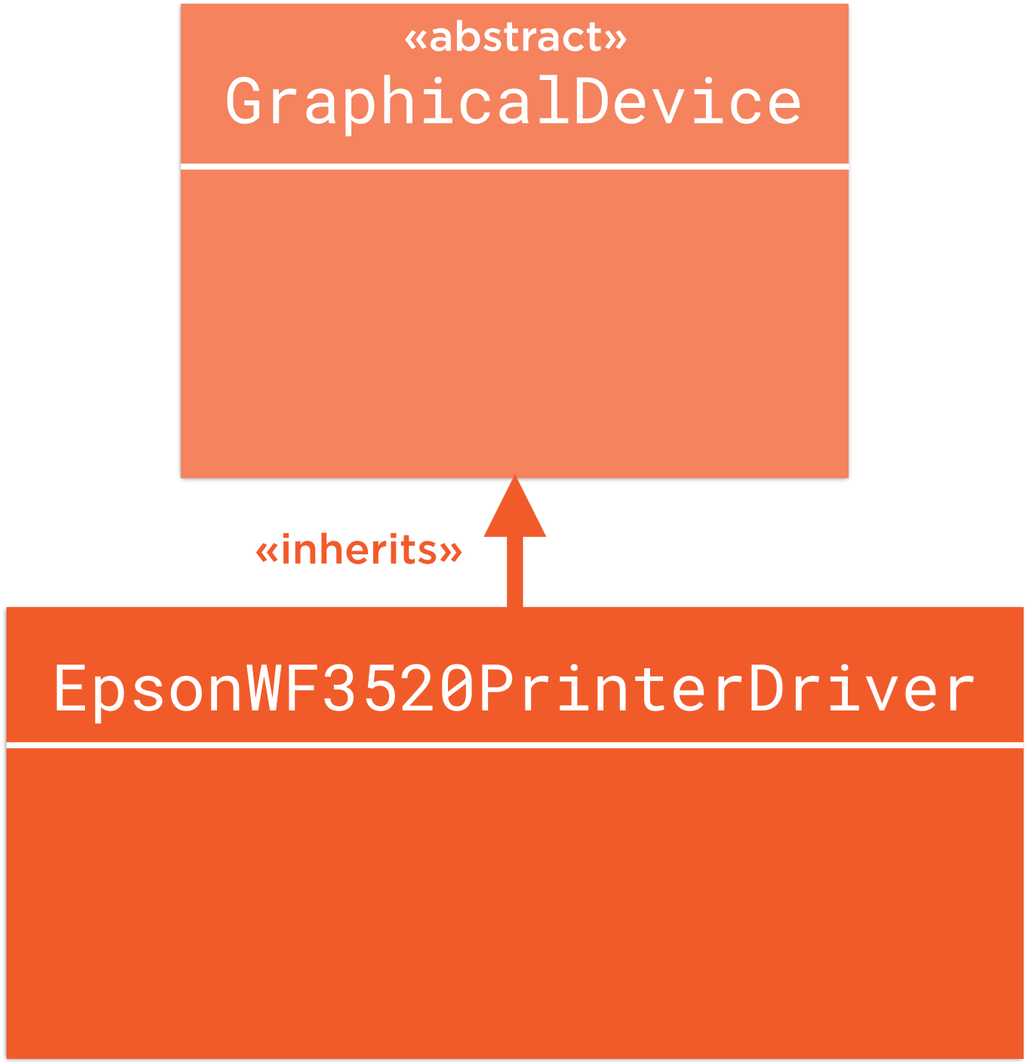


Abstract

Cannot be meaningfully instantiated

Why Are Abstract Base Classes Useful?



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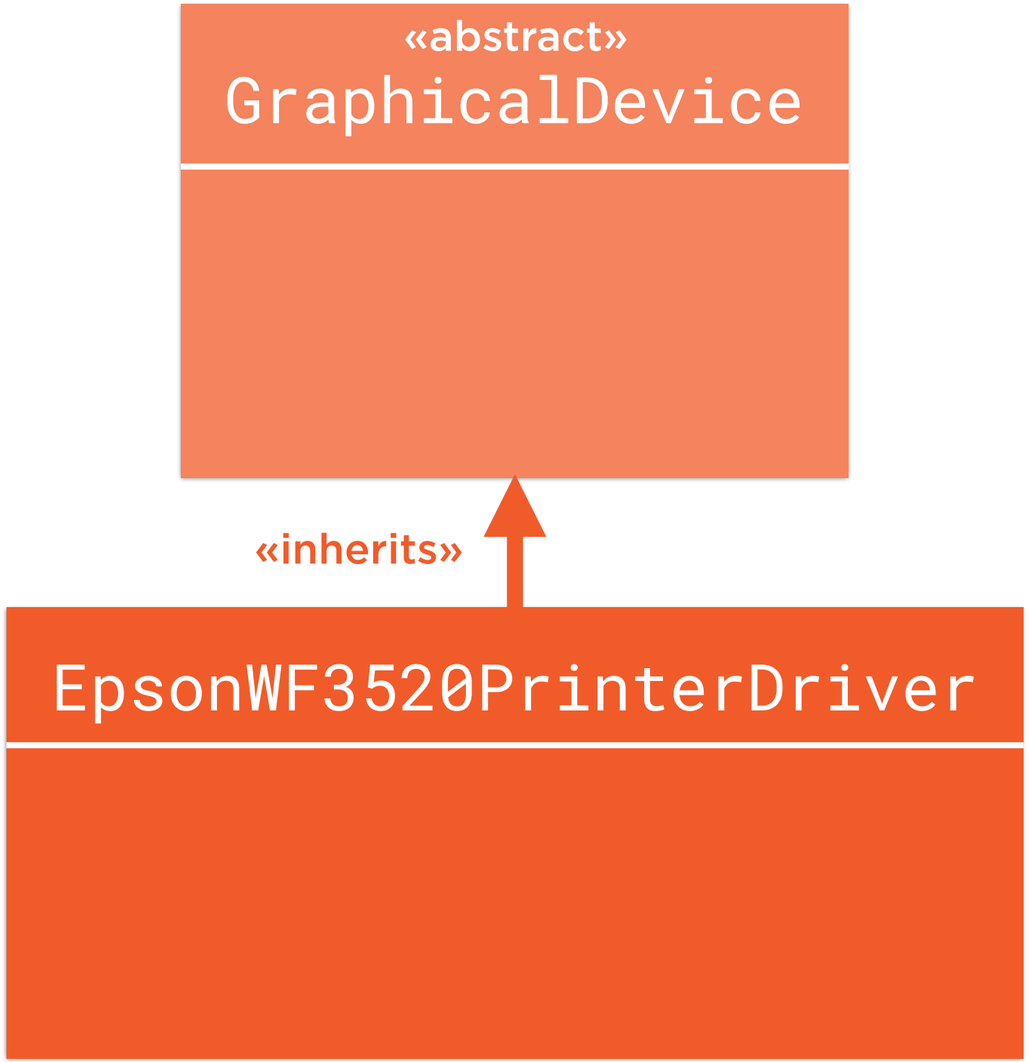

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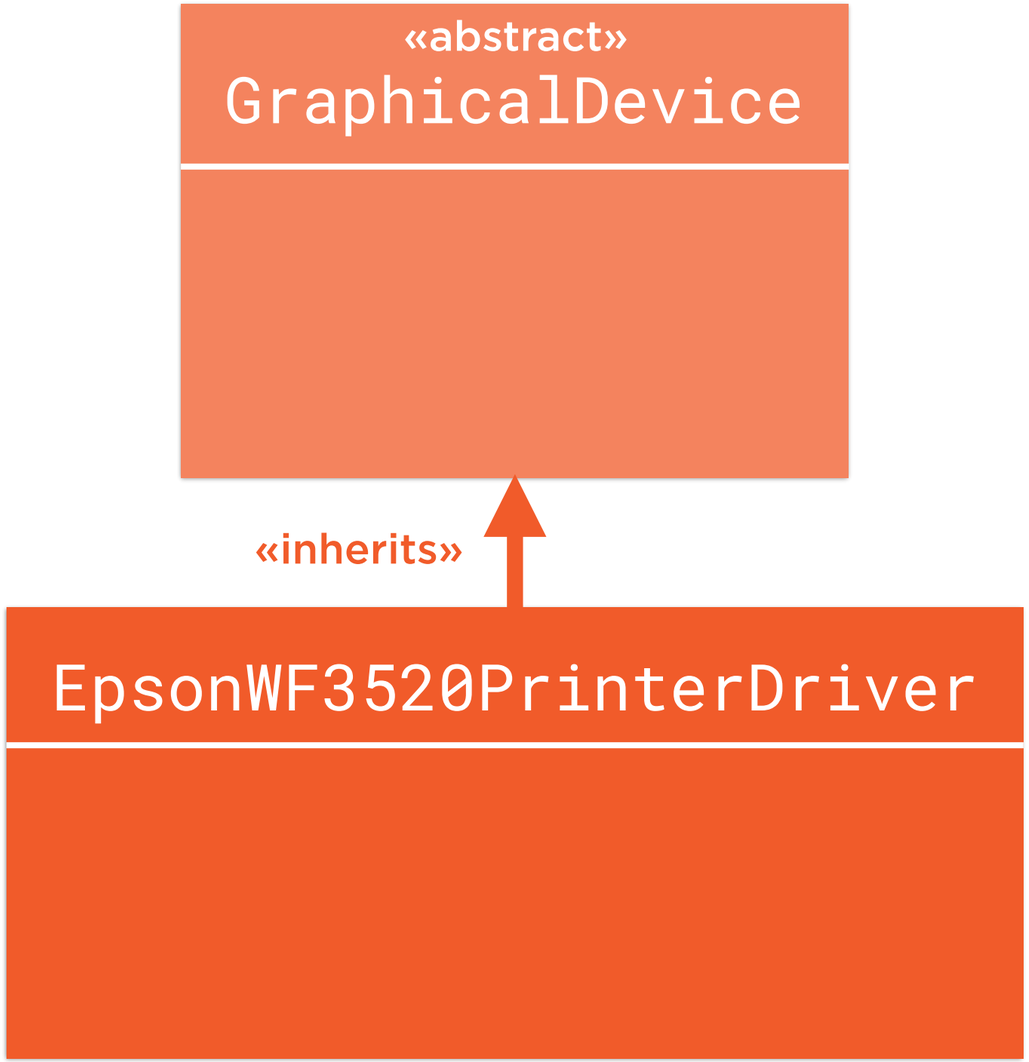

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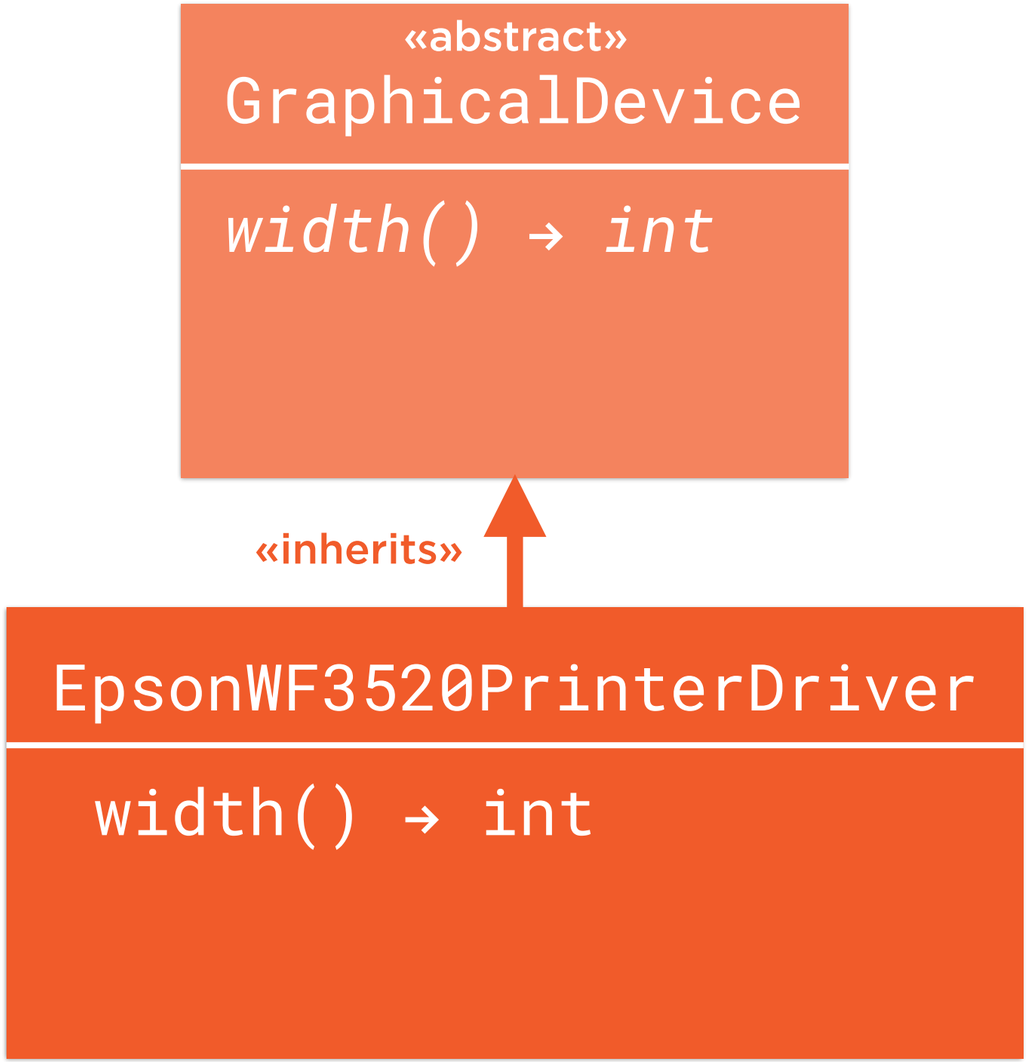

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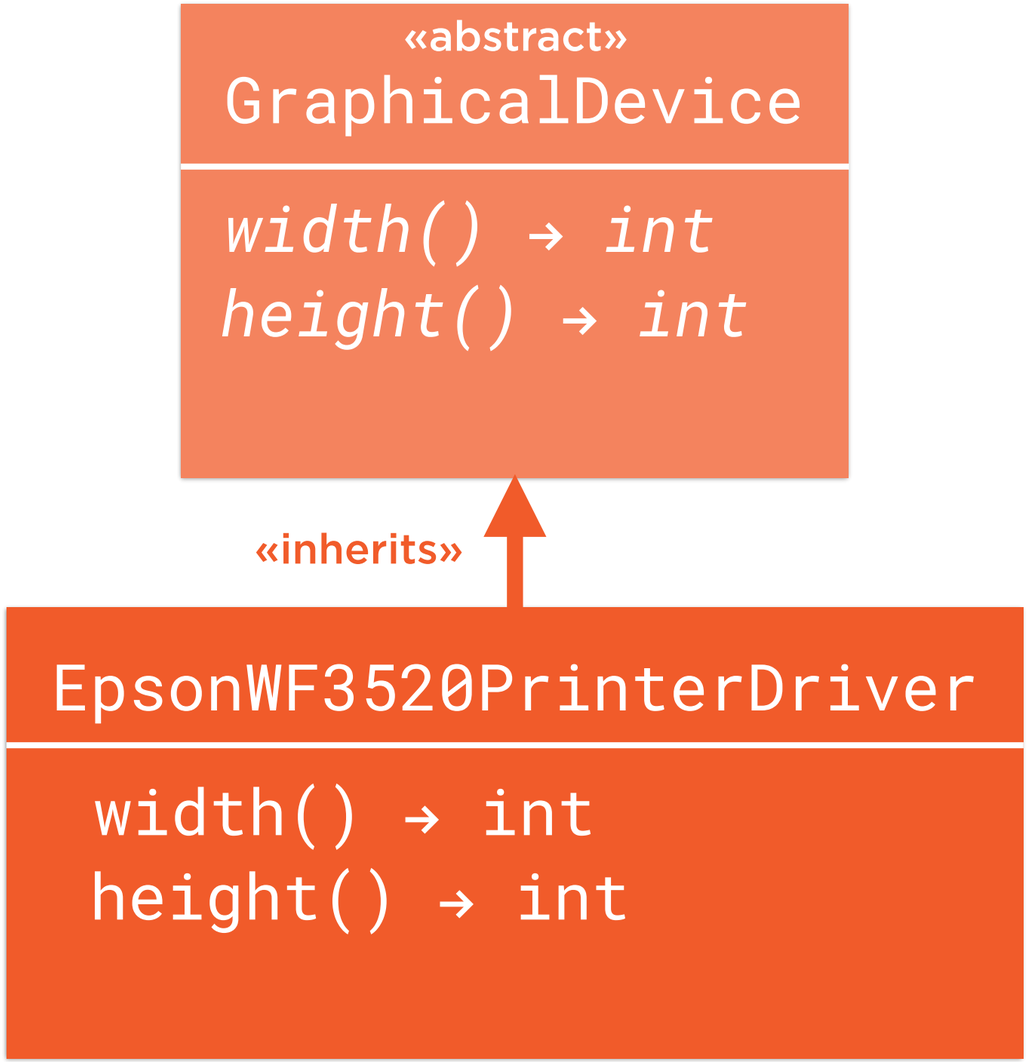

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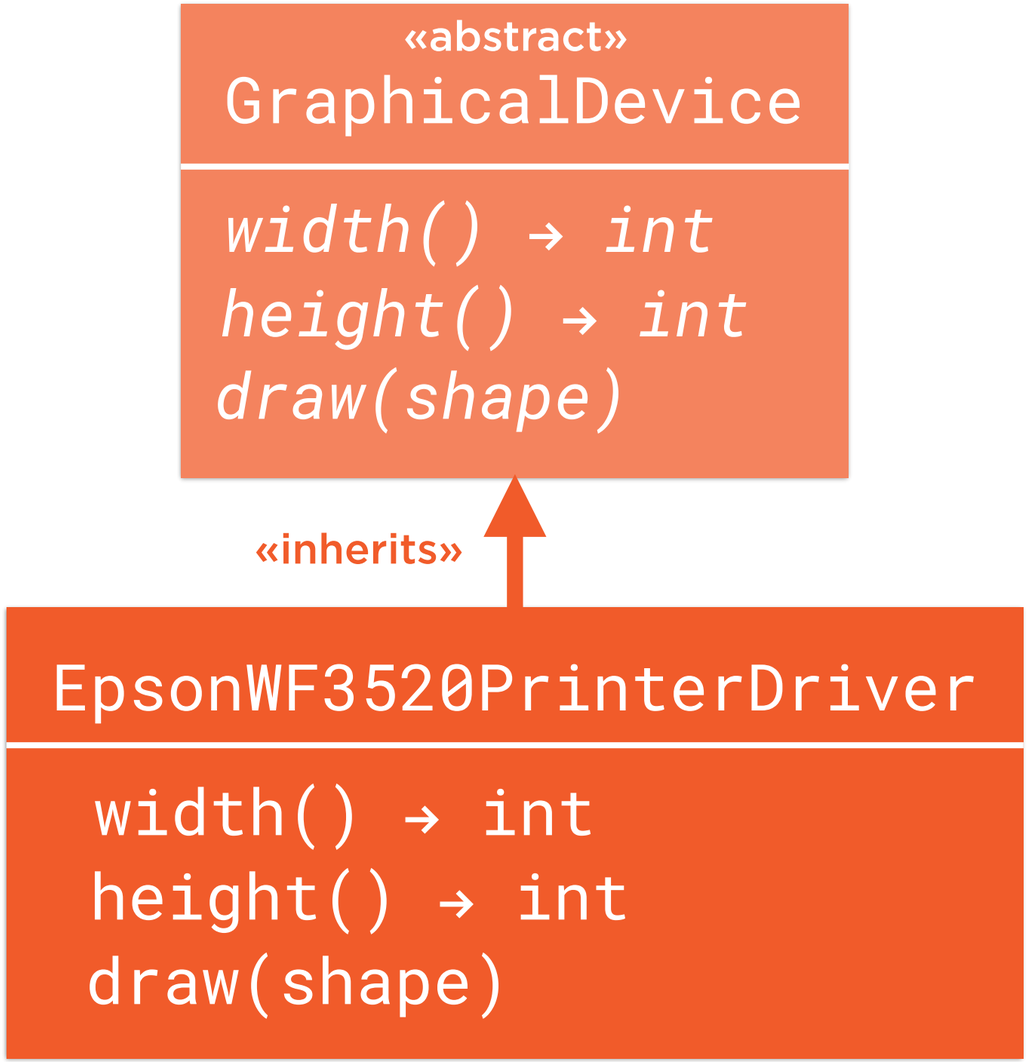

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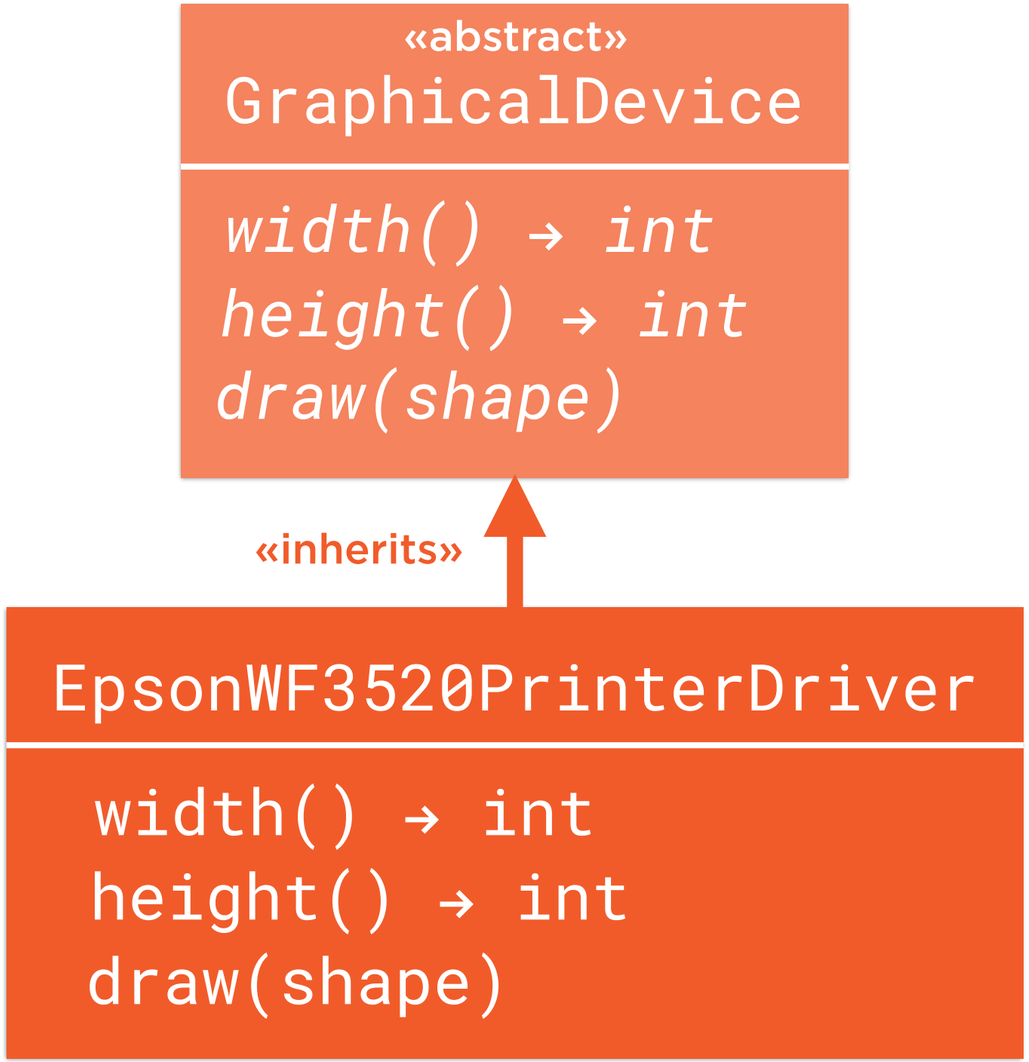

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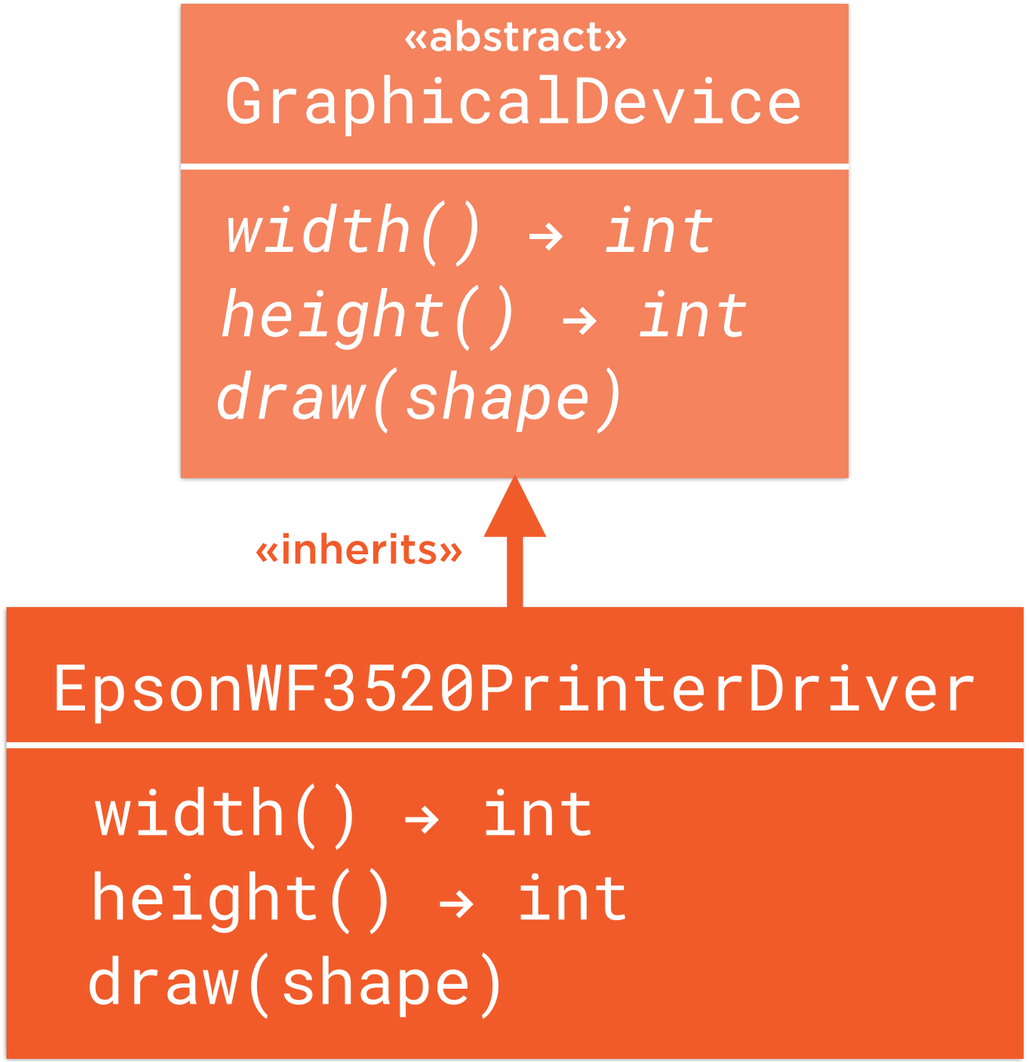

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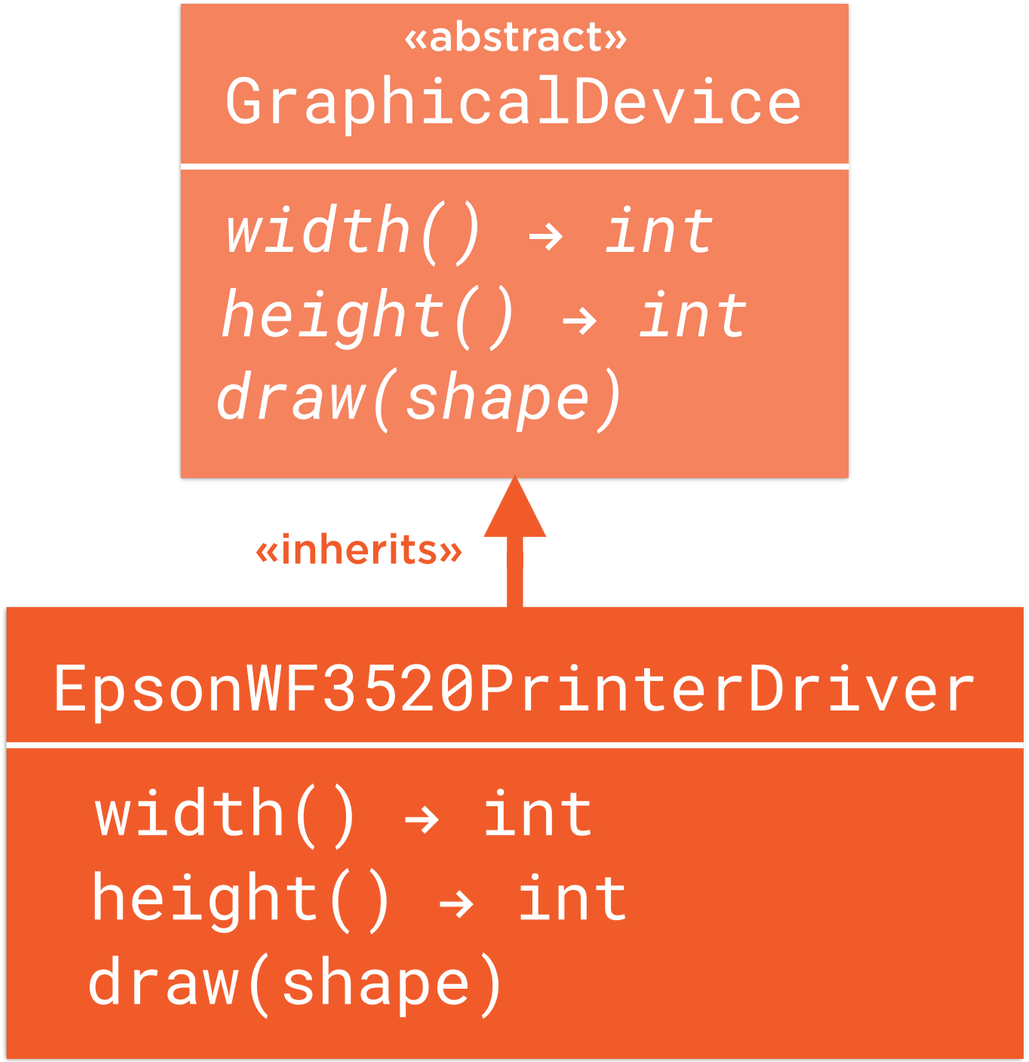

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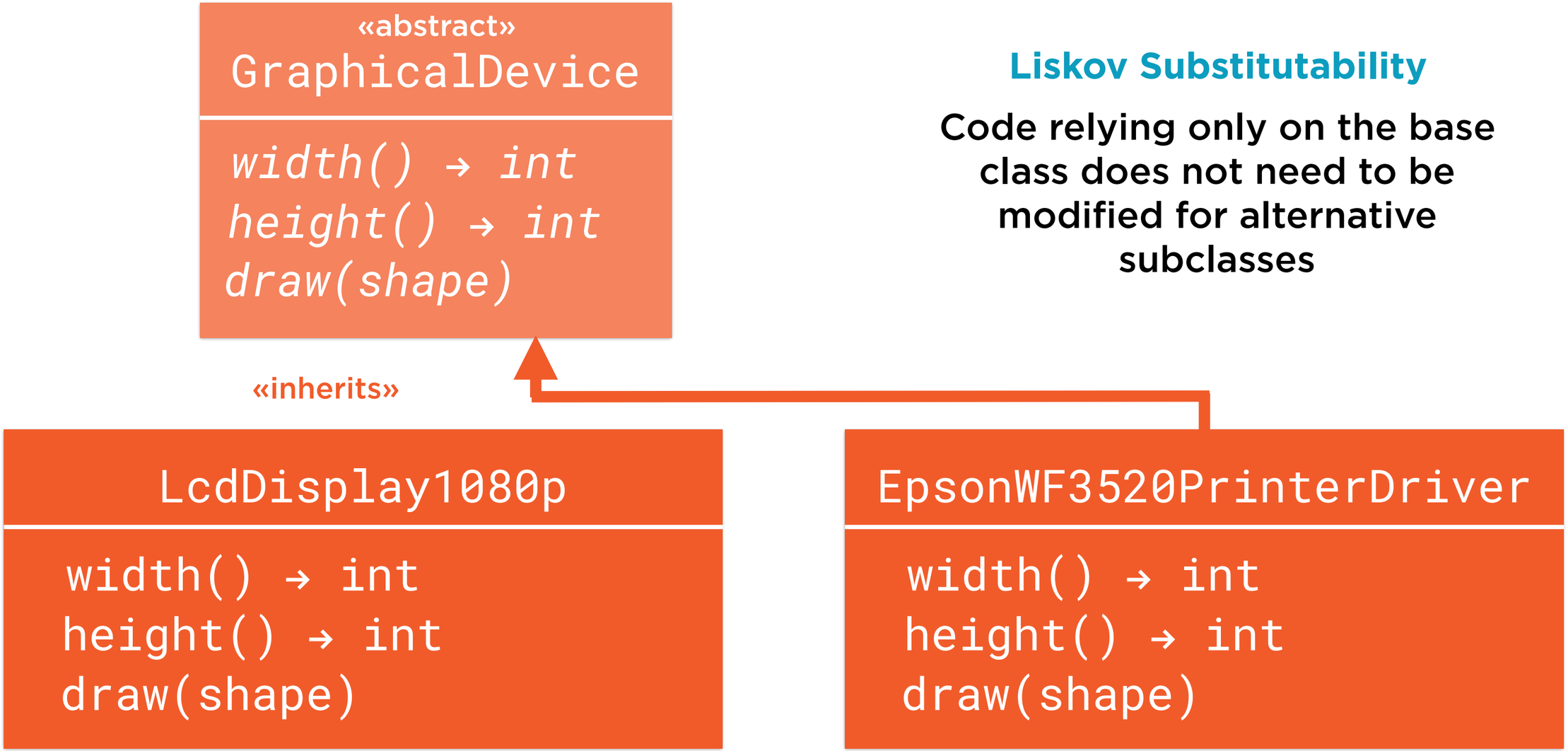

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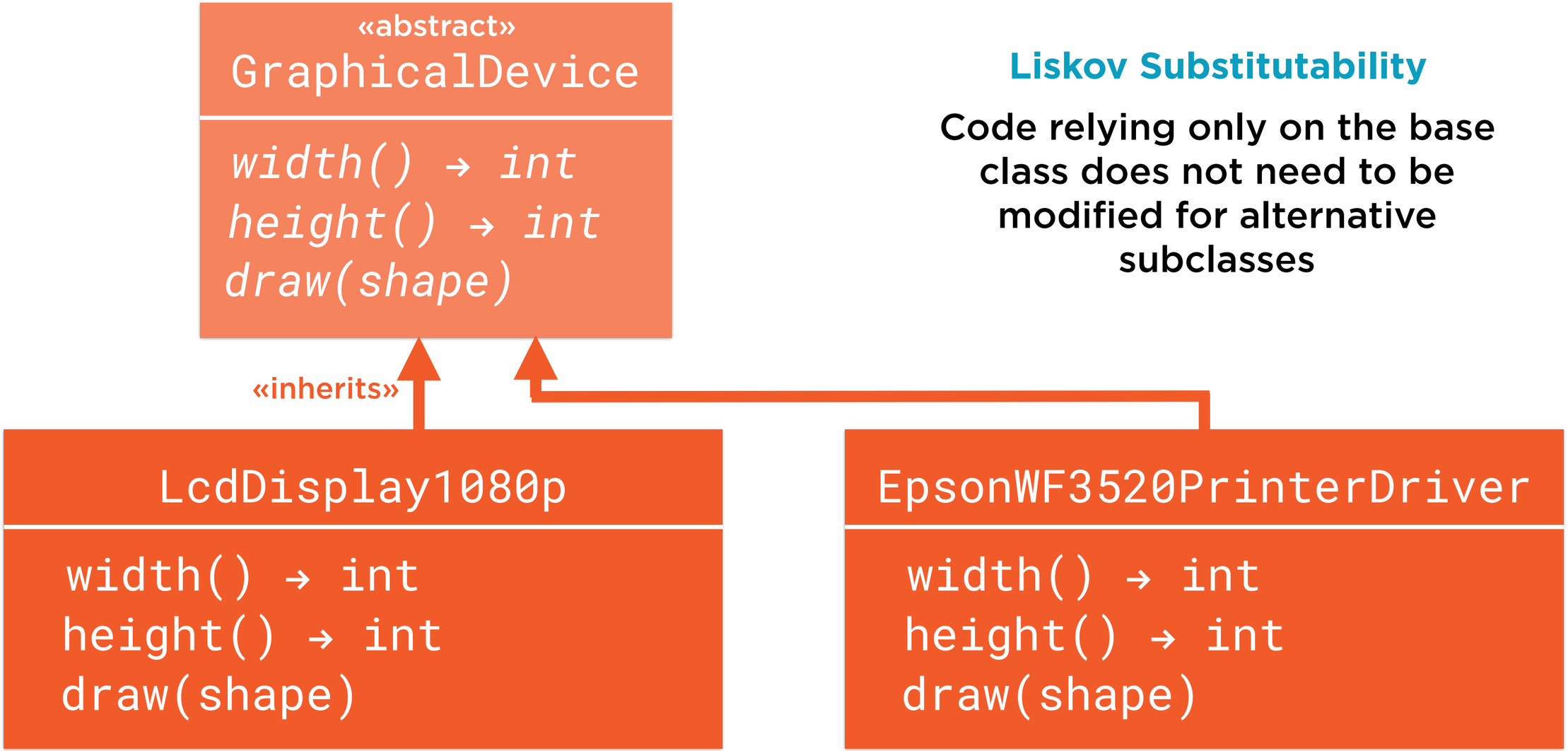

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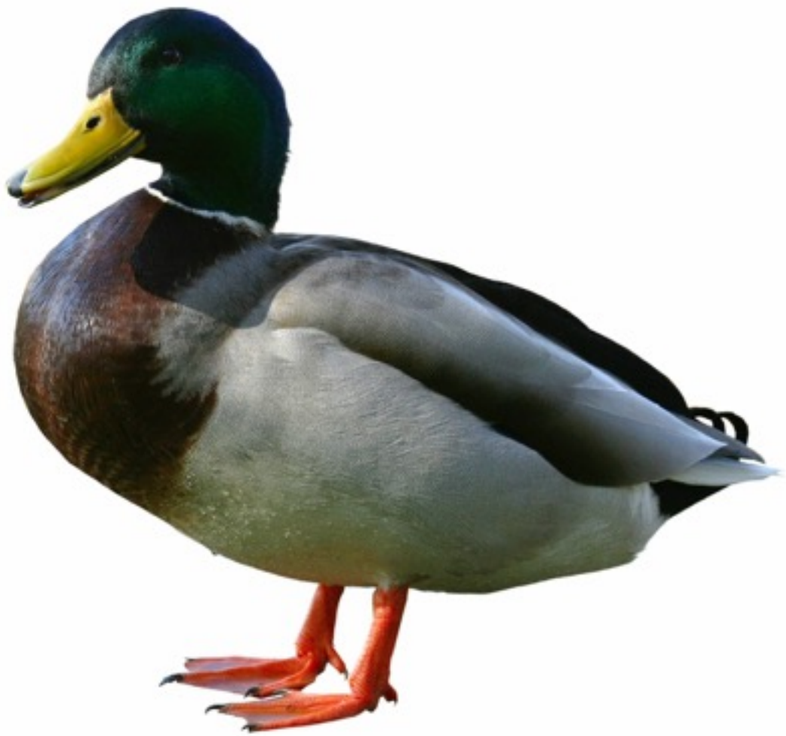
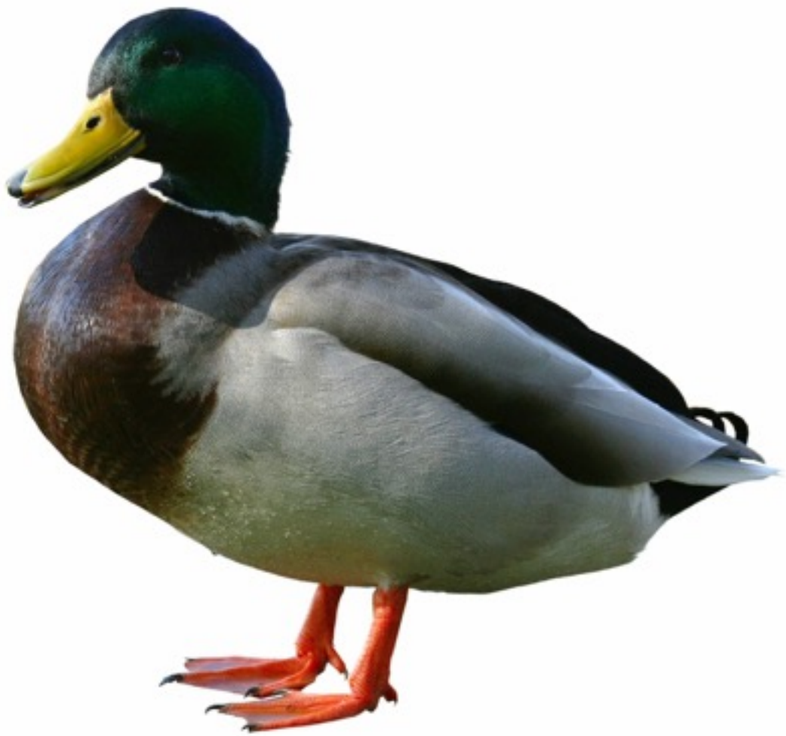


What About Duck Typing?

"When I see a bird that walks like a duck and swims like a duck and quacks like a duck, I call that bird a duck."

James Whitcomb Riley
American poet and author



A conforming MutableSequence must implement all 16 methods.

«abstract»

MutableSequence

```
__contains__(item) → bool
__delitem__(index)
__iadd__(iterable)
__iter__() → iterator
__getitem__() → object
__len__() → int
__reversed__() → iterator
__setitem__() → object
append(item)
count(item) → int
extend(iterable)
index(item) → int
insert(index, item)
pop() → object
remove(item)
reverse()
```

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Abstract Base Classes in Python

Motivations for Abstract Base Classes

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Specification

ABCs are effective for specifying interface protocols

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Detection

ABCs can be used to detect conforming objects

Python Is Not Java, C#, C++, *etc*.

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«builtin»

`list`

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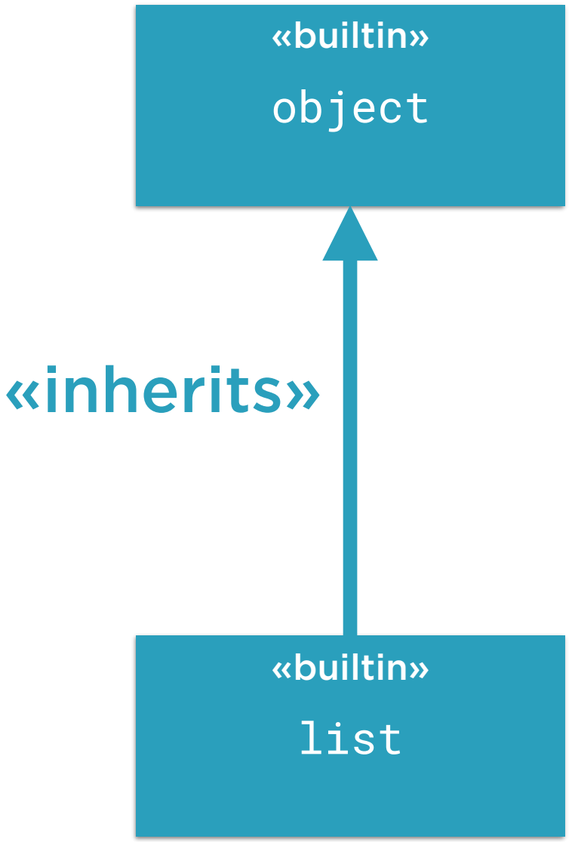

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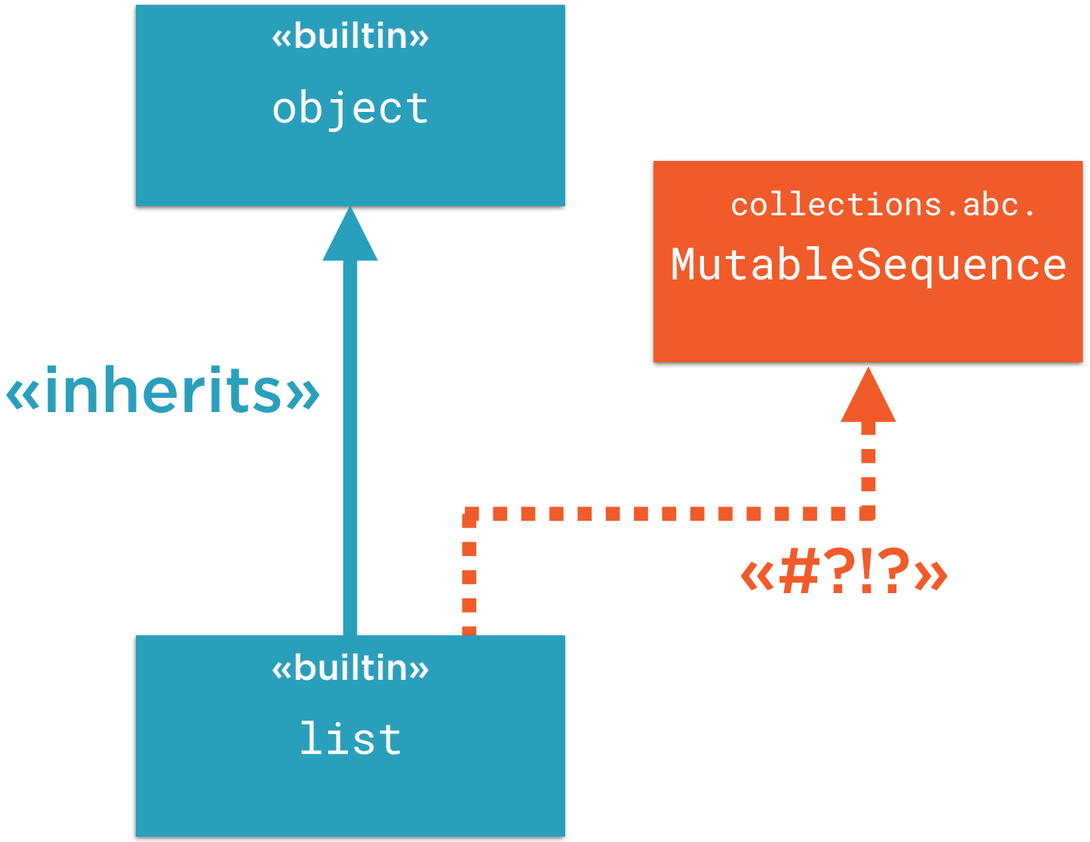

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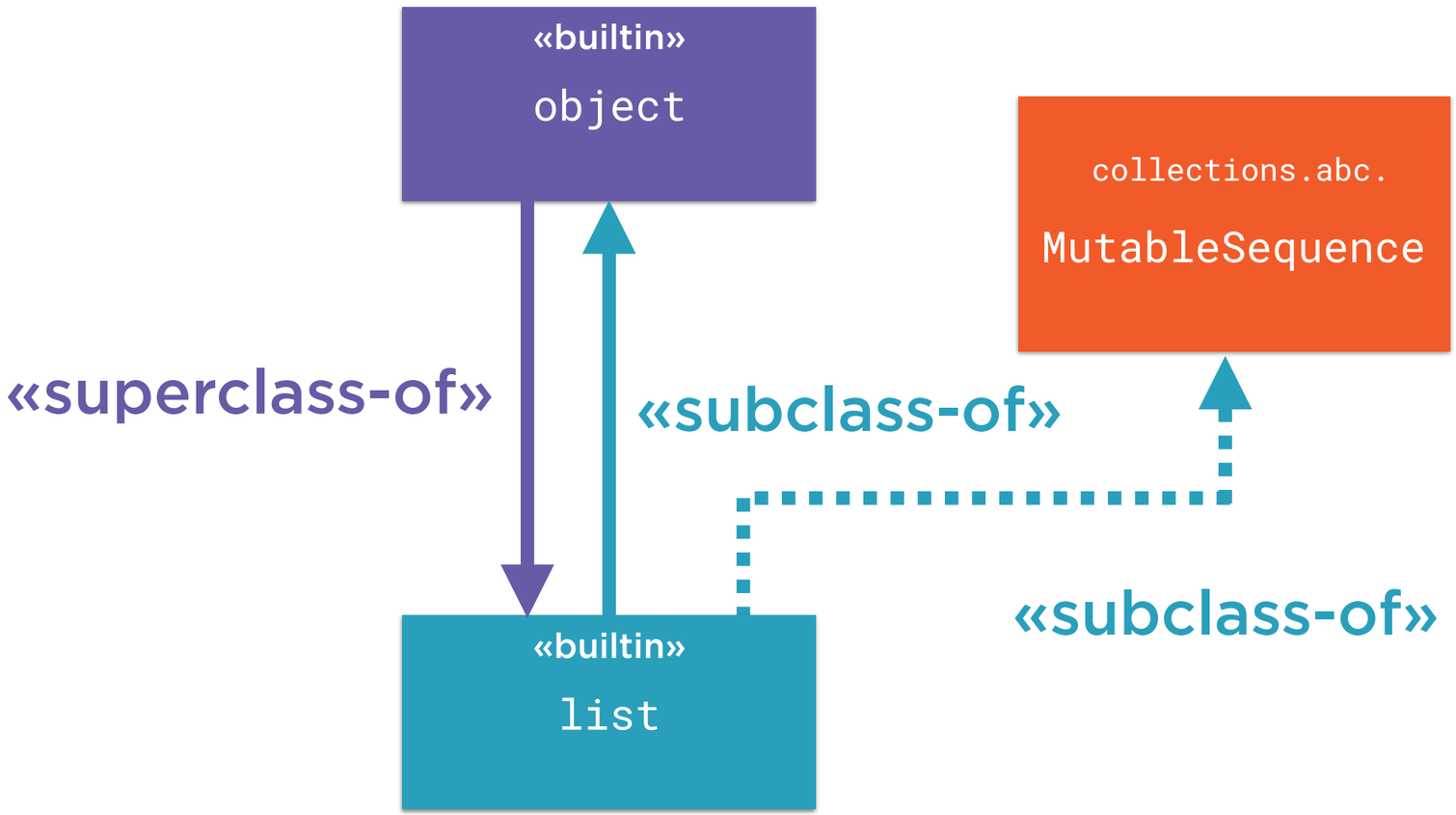
…but the base class provides rudimentary implementations of many in terms of just **5**.

issubclass(list, MutableSequence)



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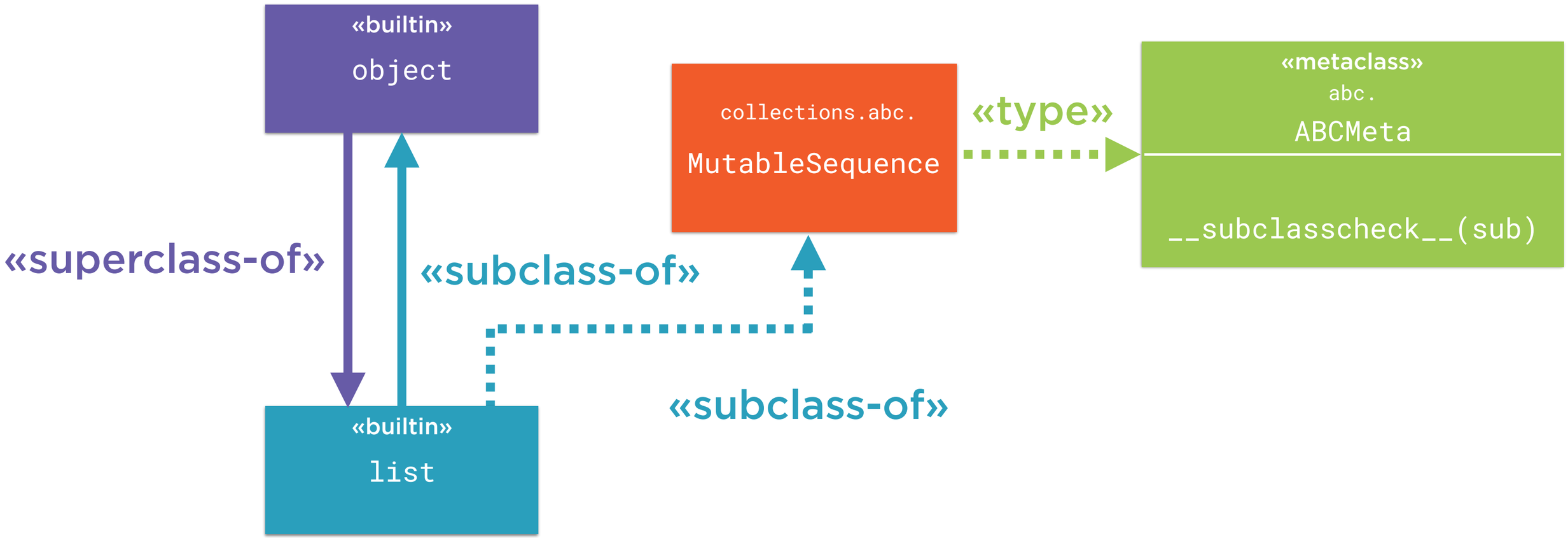

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if hasattr(type(MutableSequence), '__subclasscheck__'):
    return type(MutableSequence).__subclasscheck__(list)
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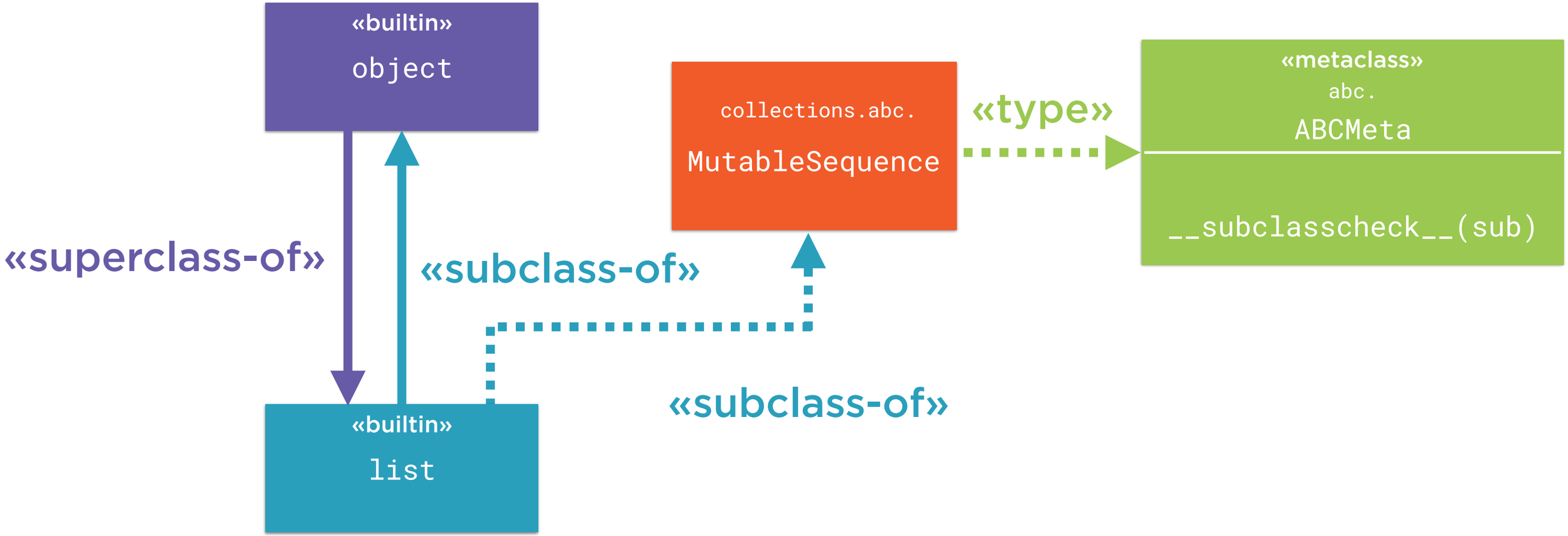

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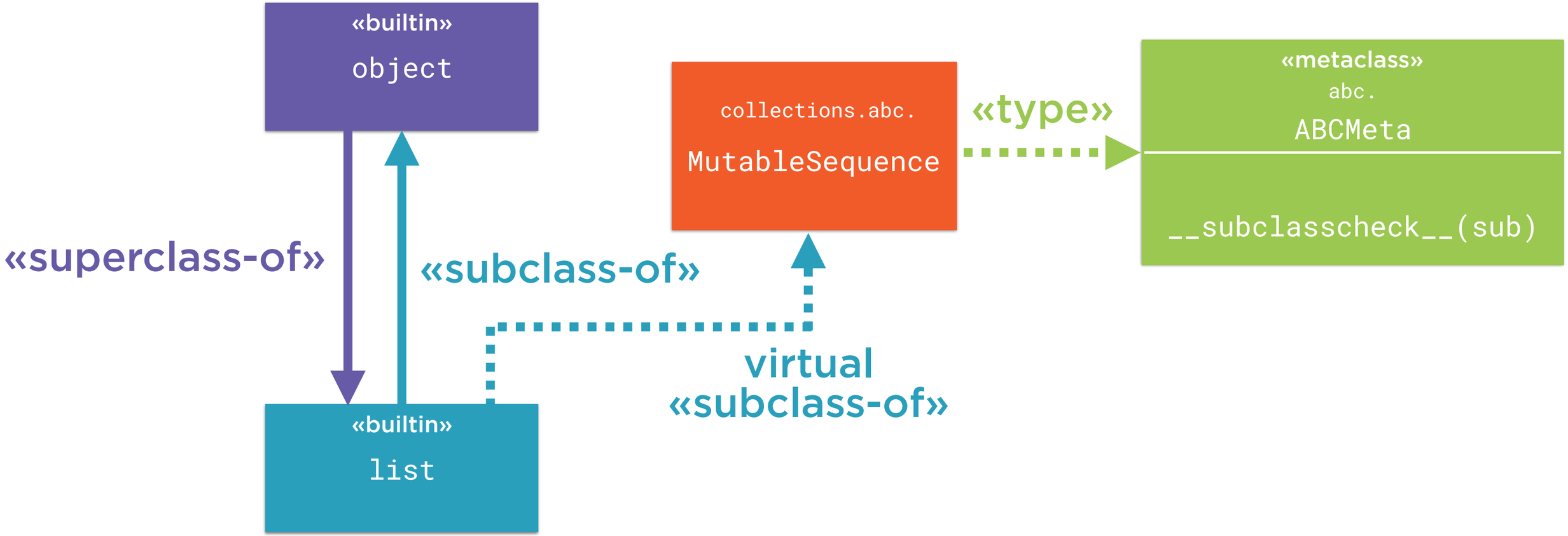

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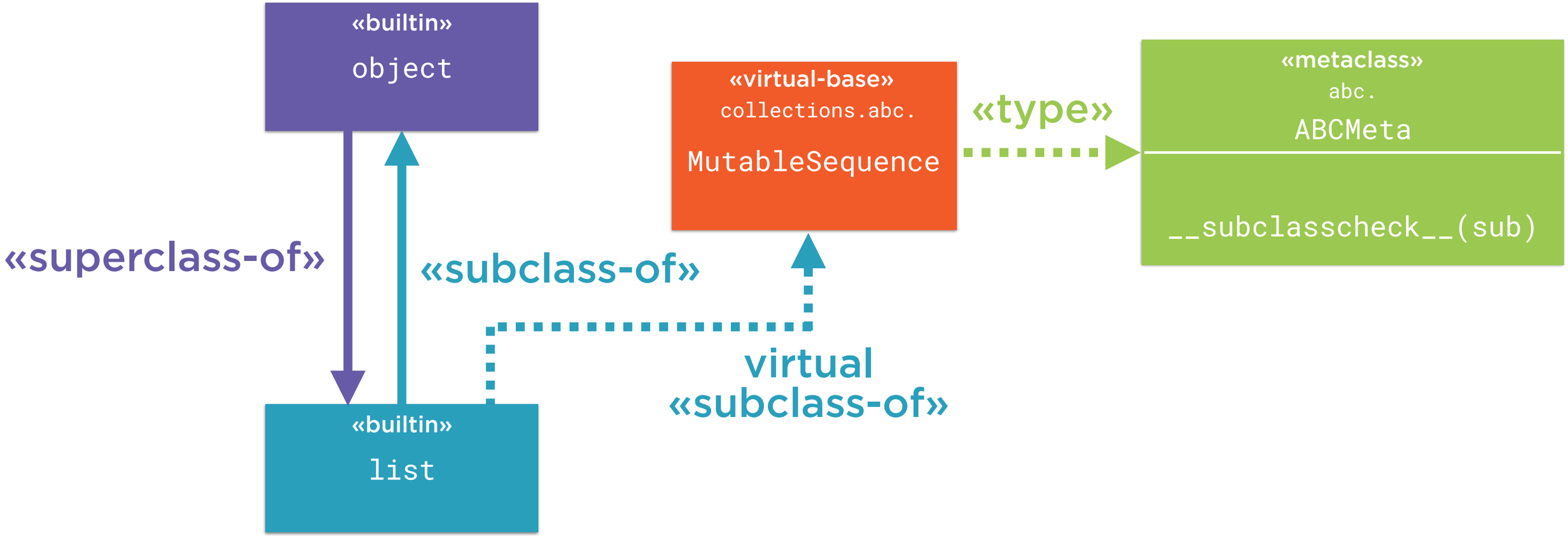

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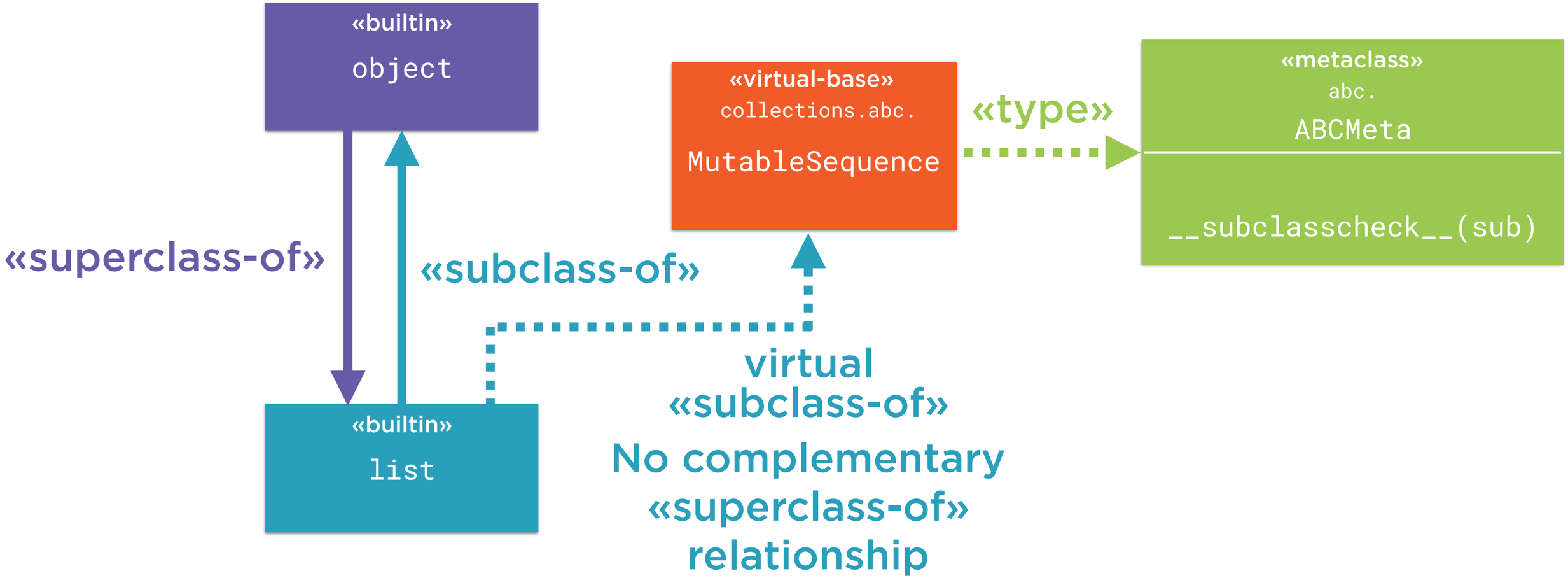

Abstract Base Classes in Practice

Non-transitive Subclass Relationships

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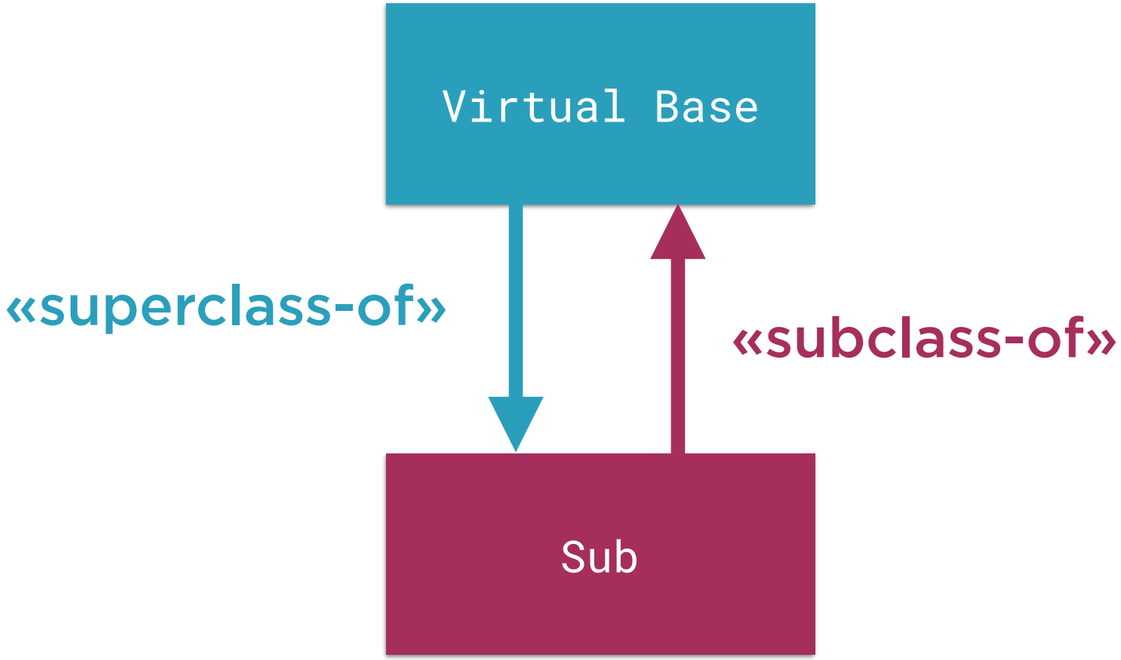

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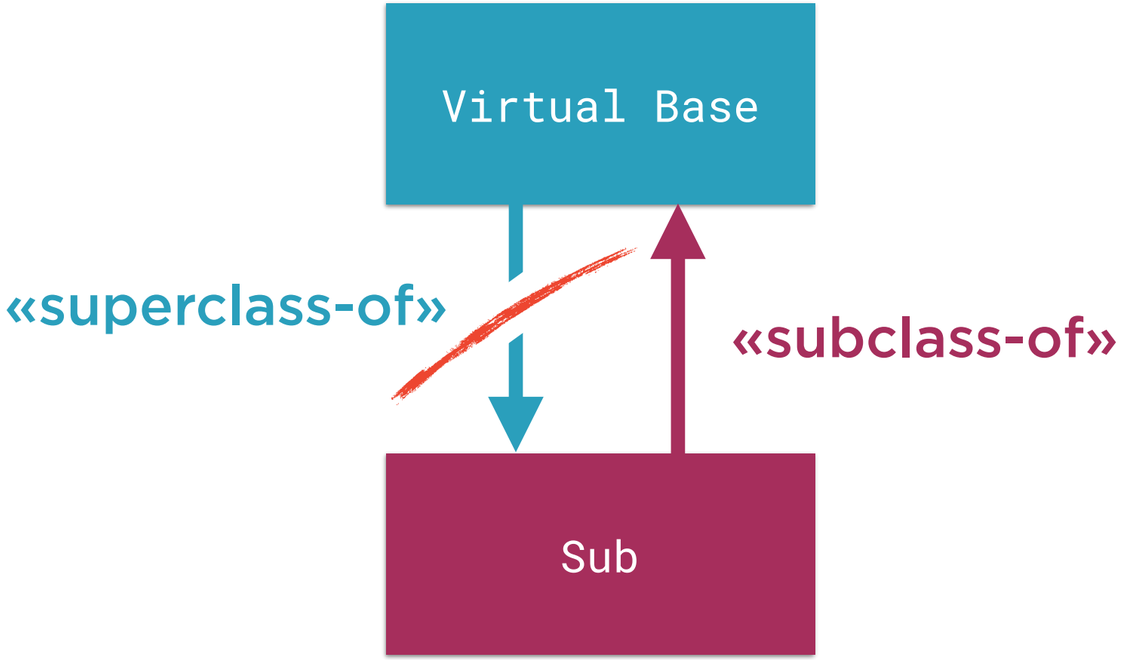

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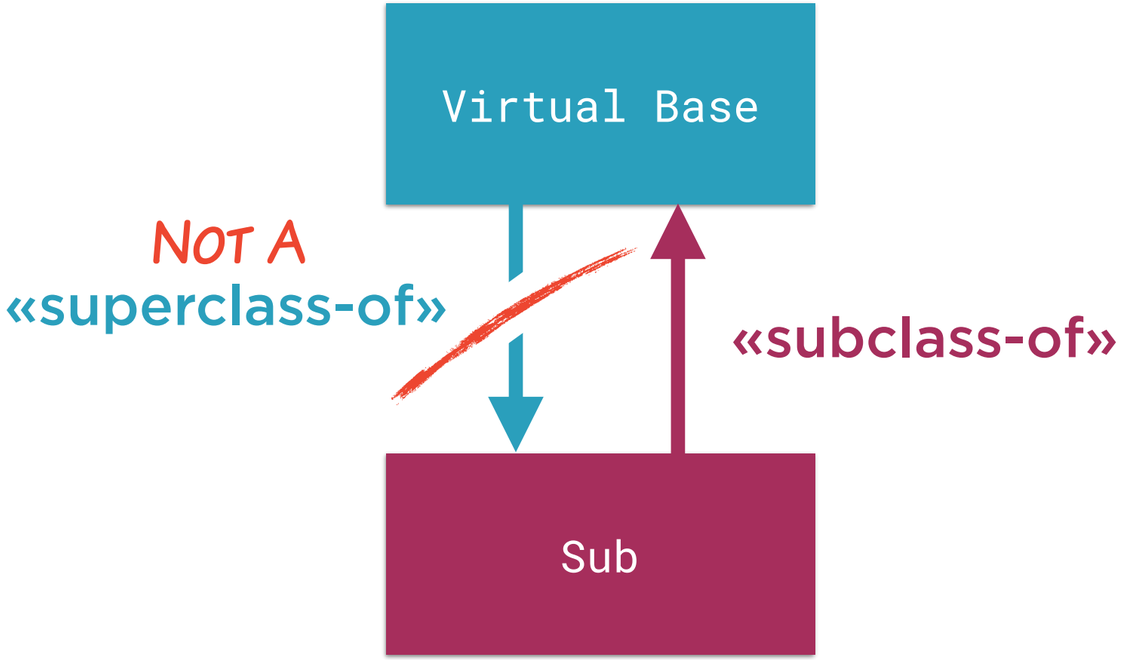

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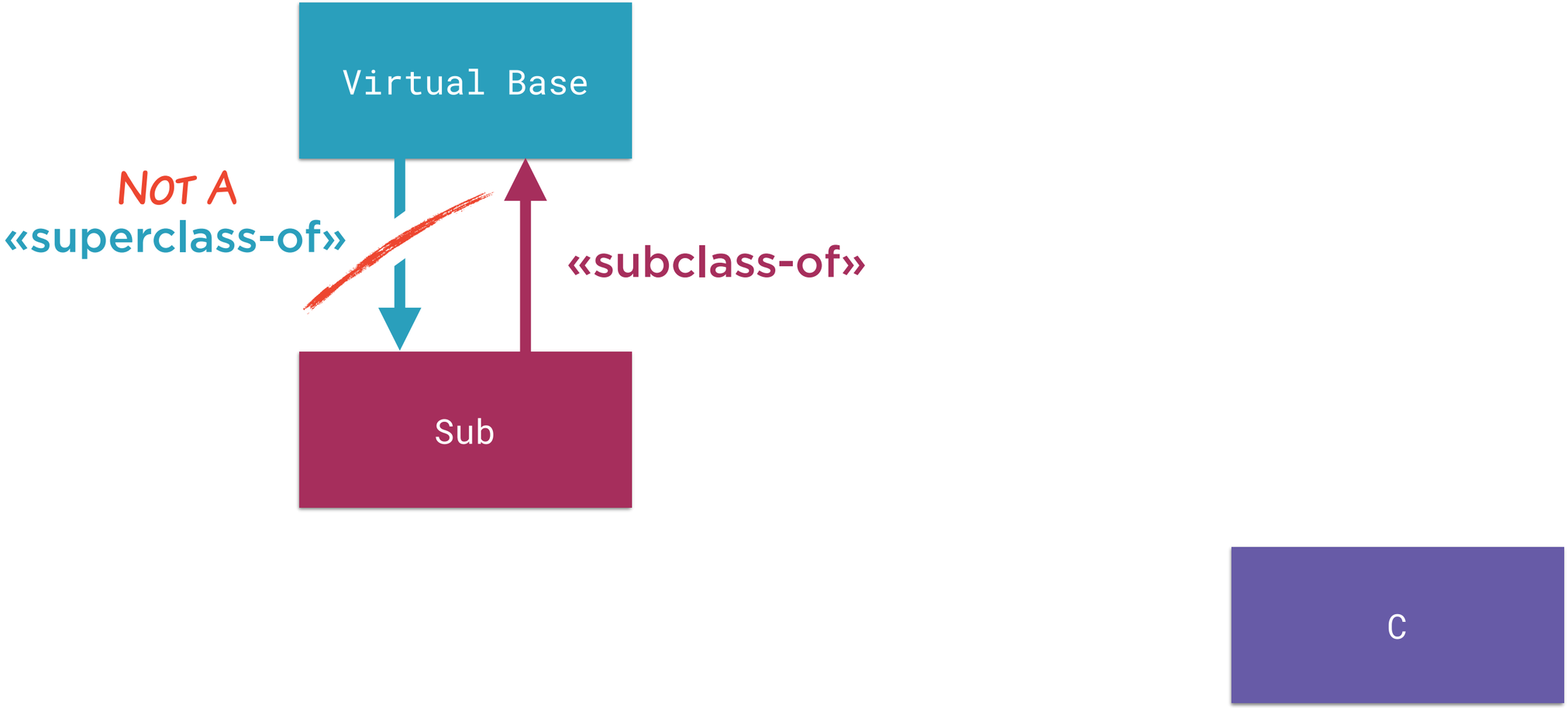

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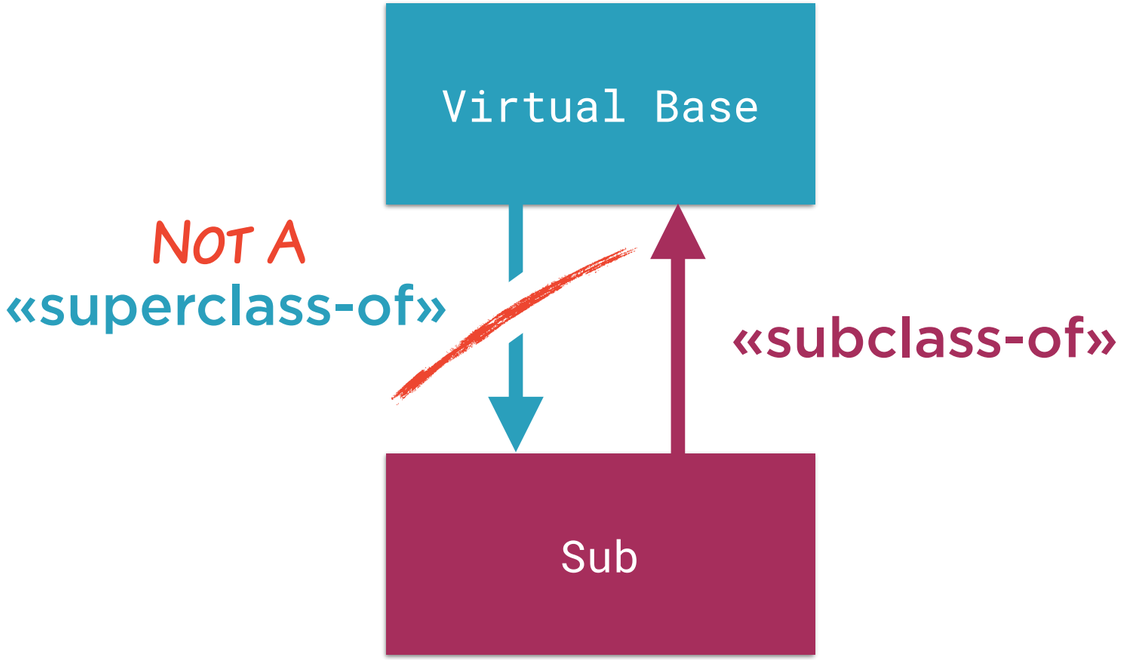

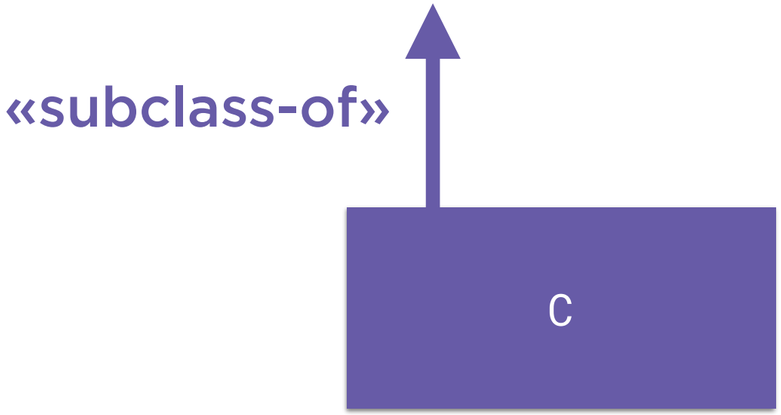

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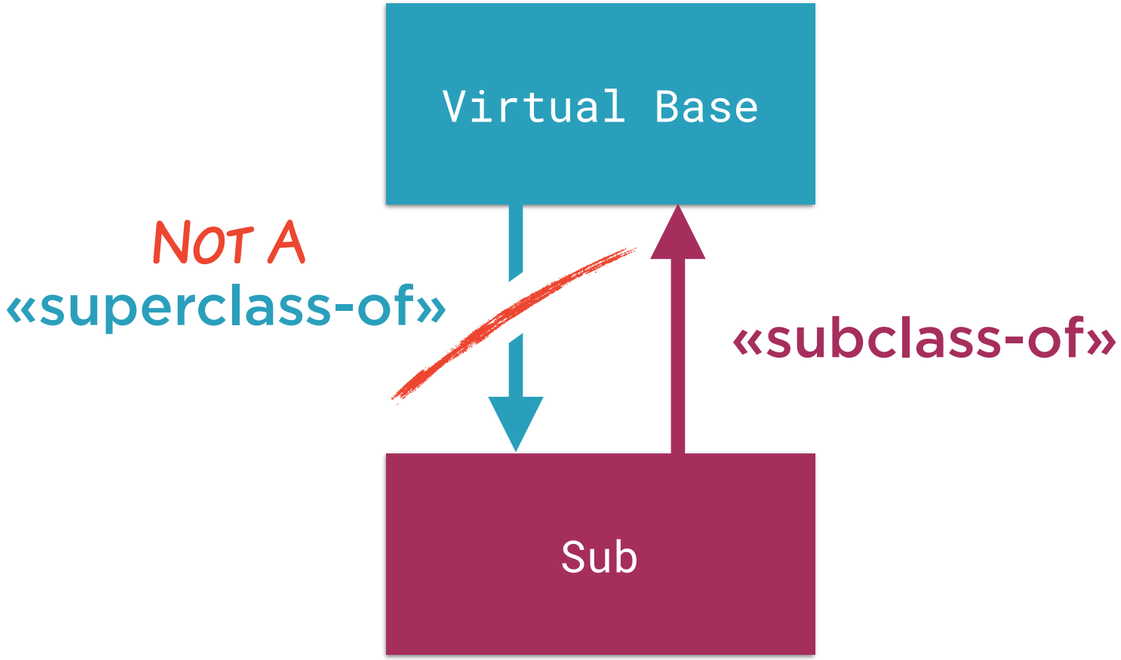

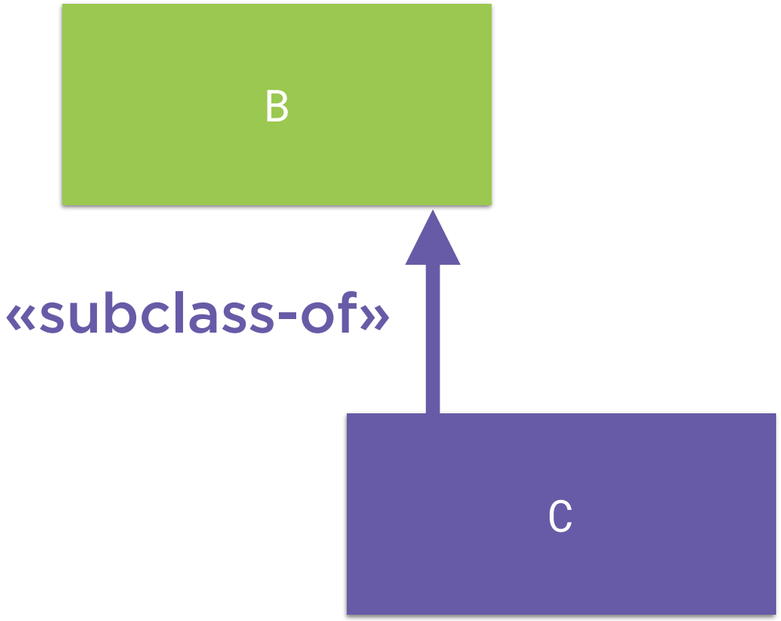

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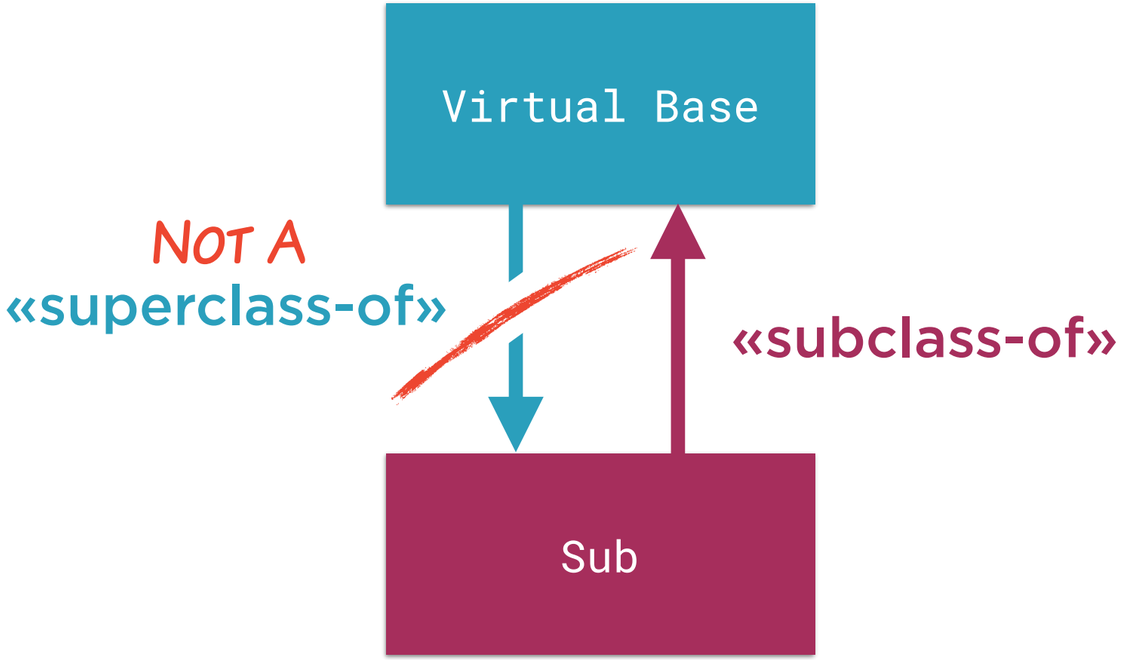

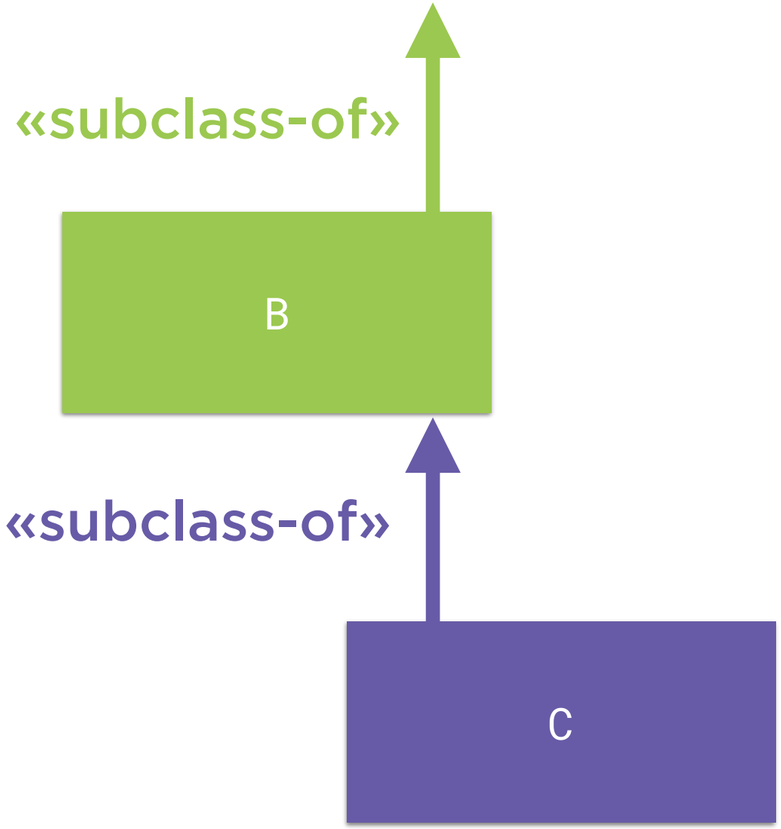

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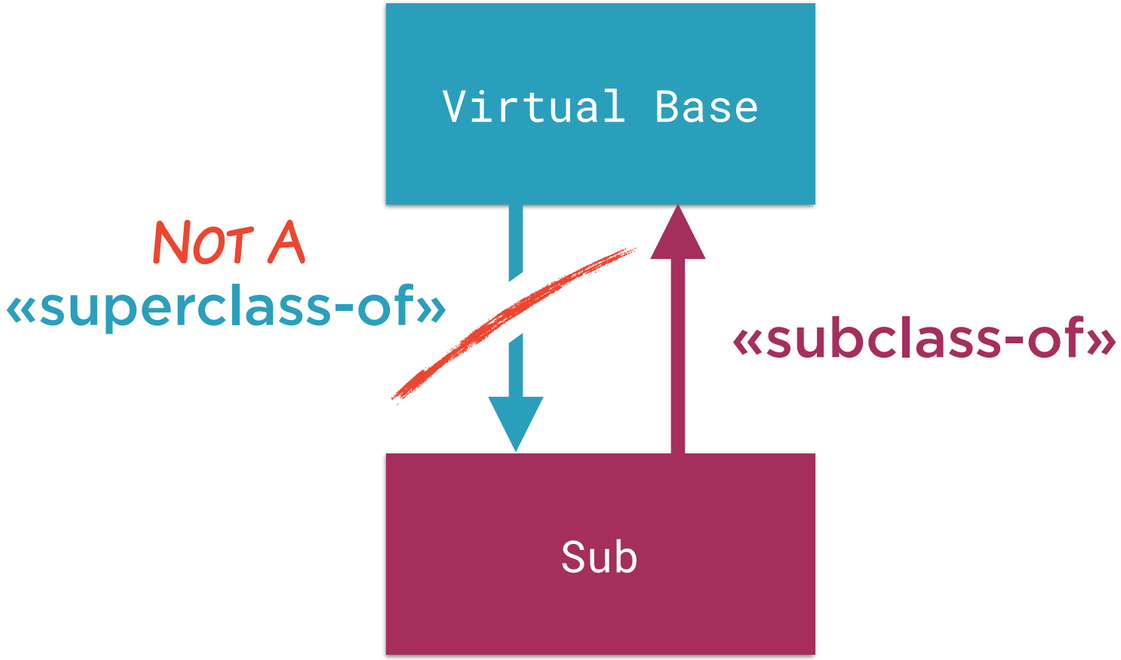

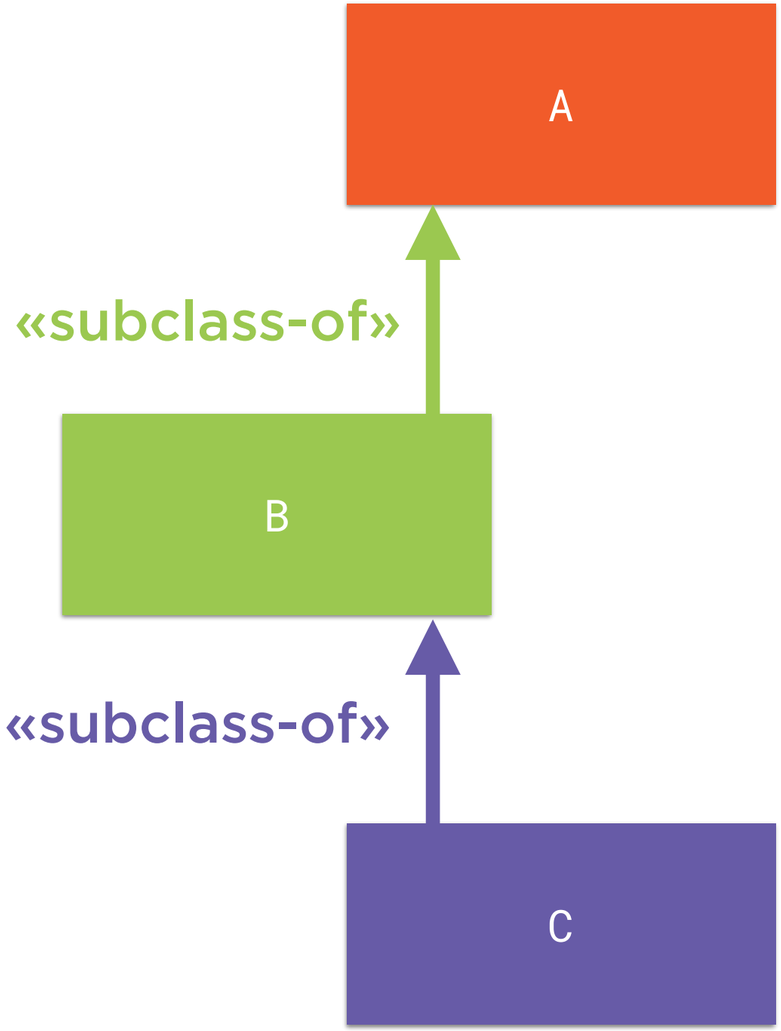

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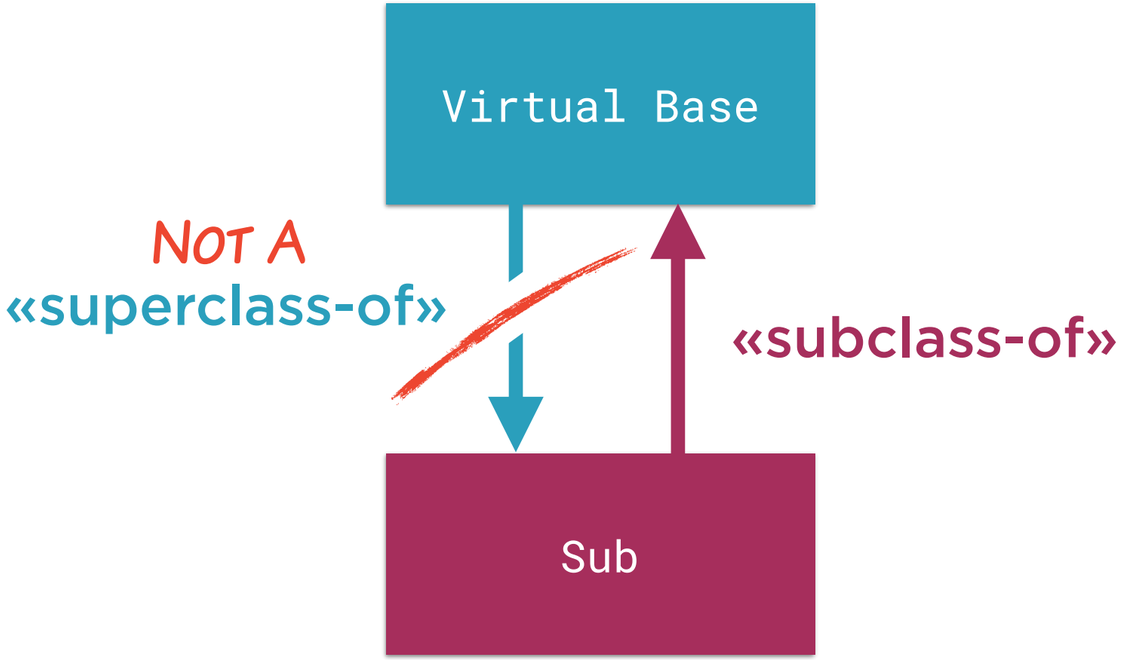

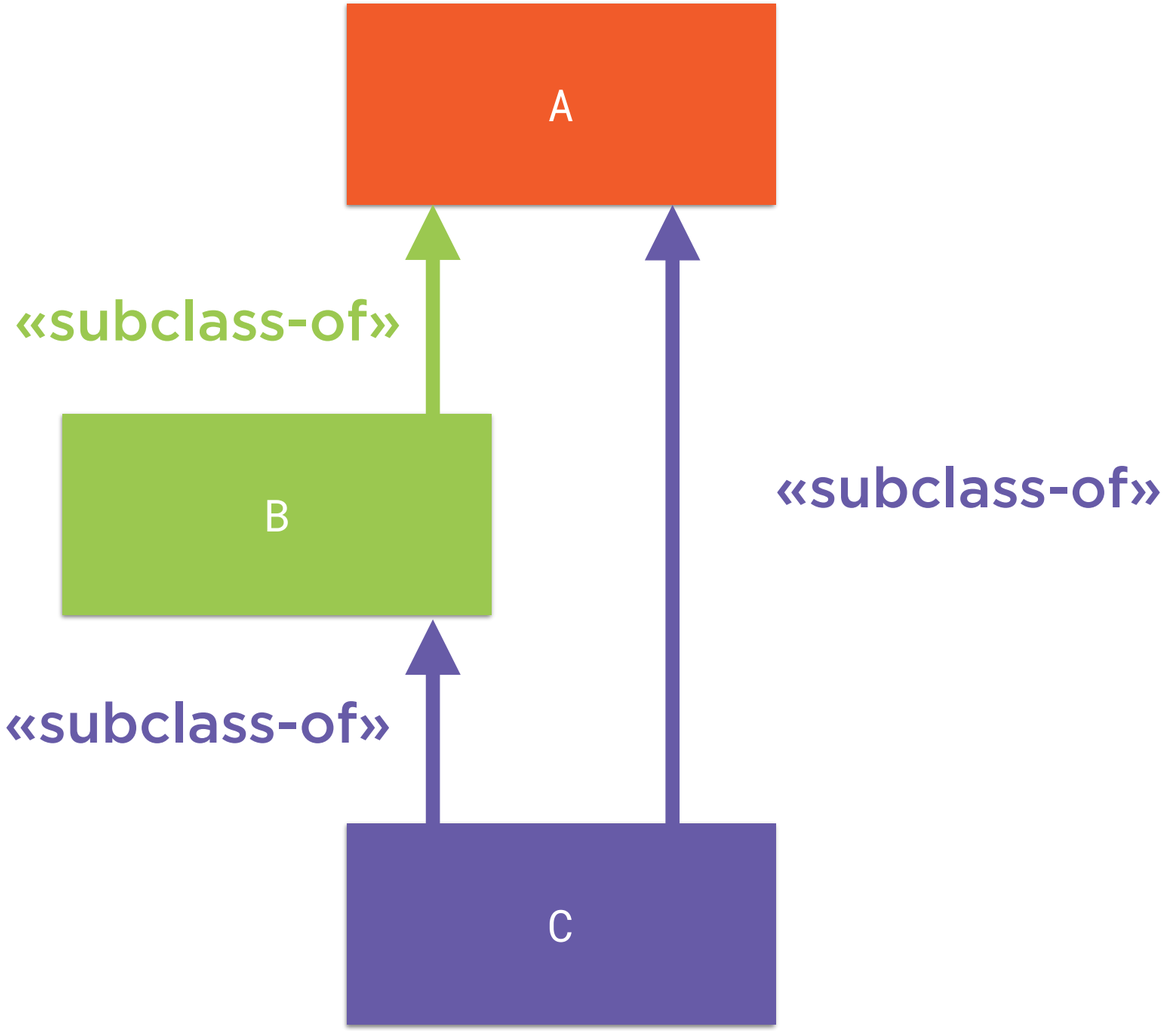

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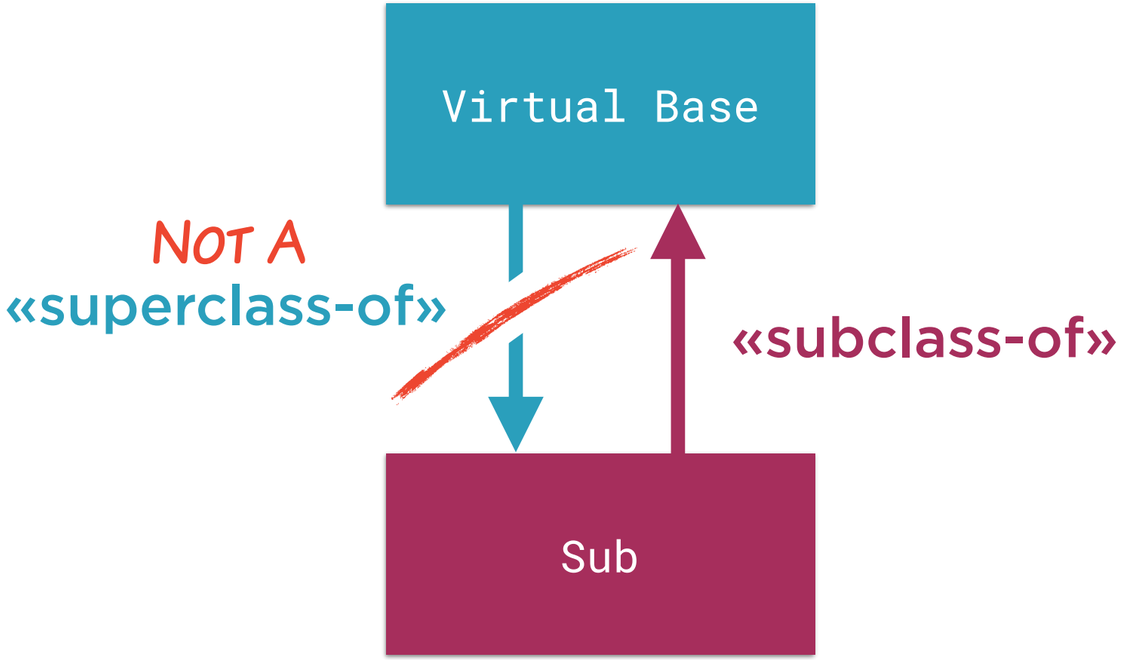

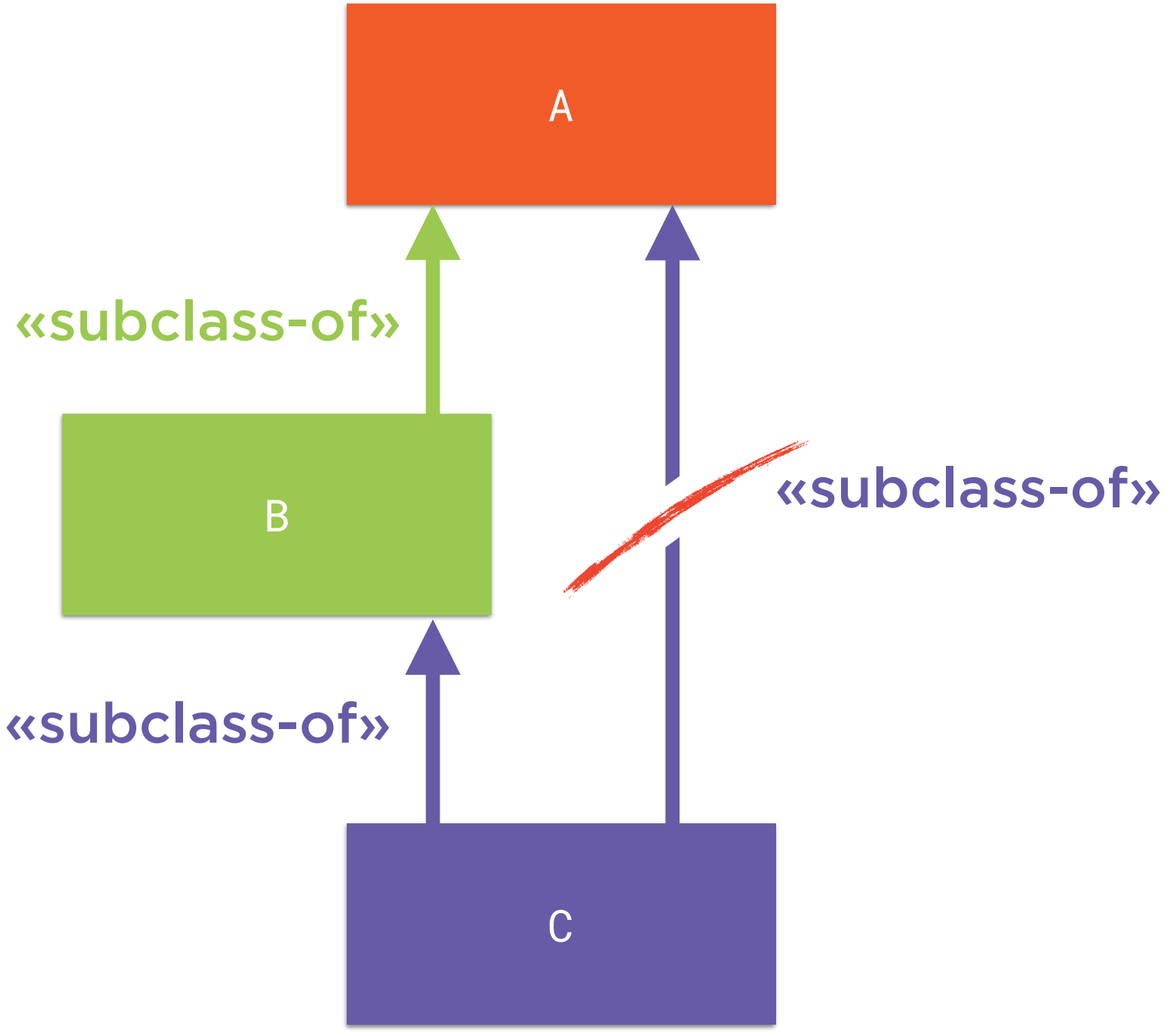

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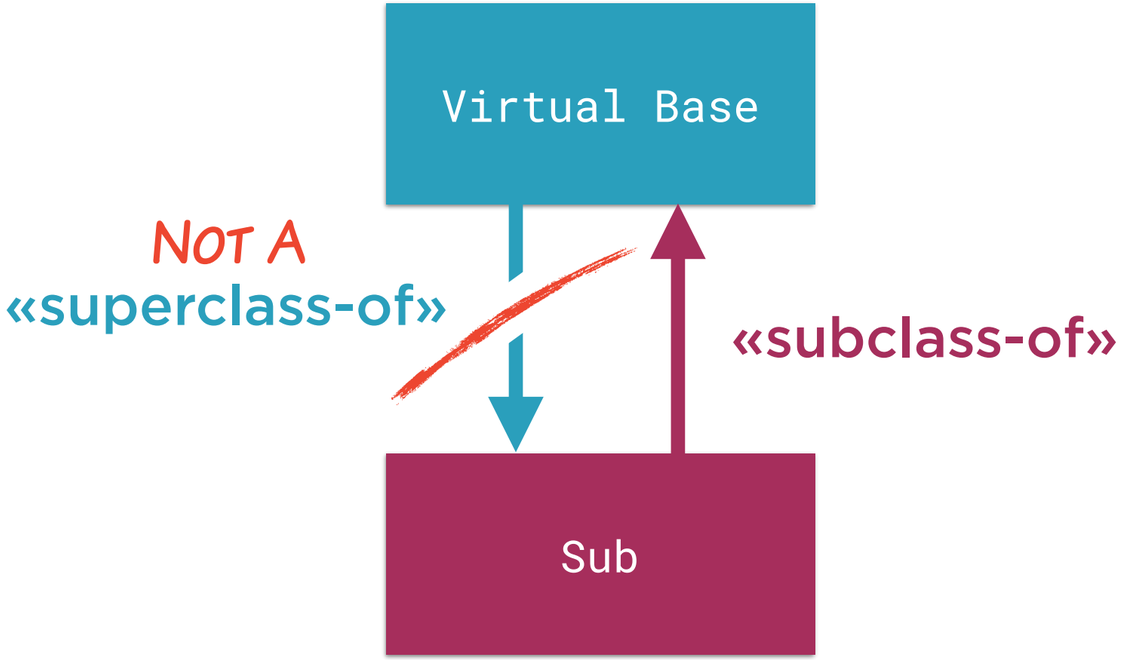
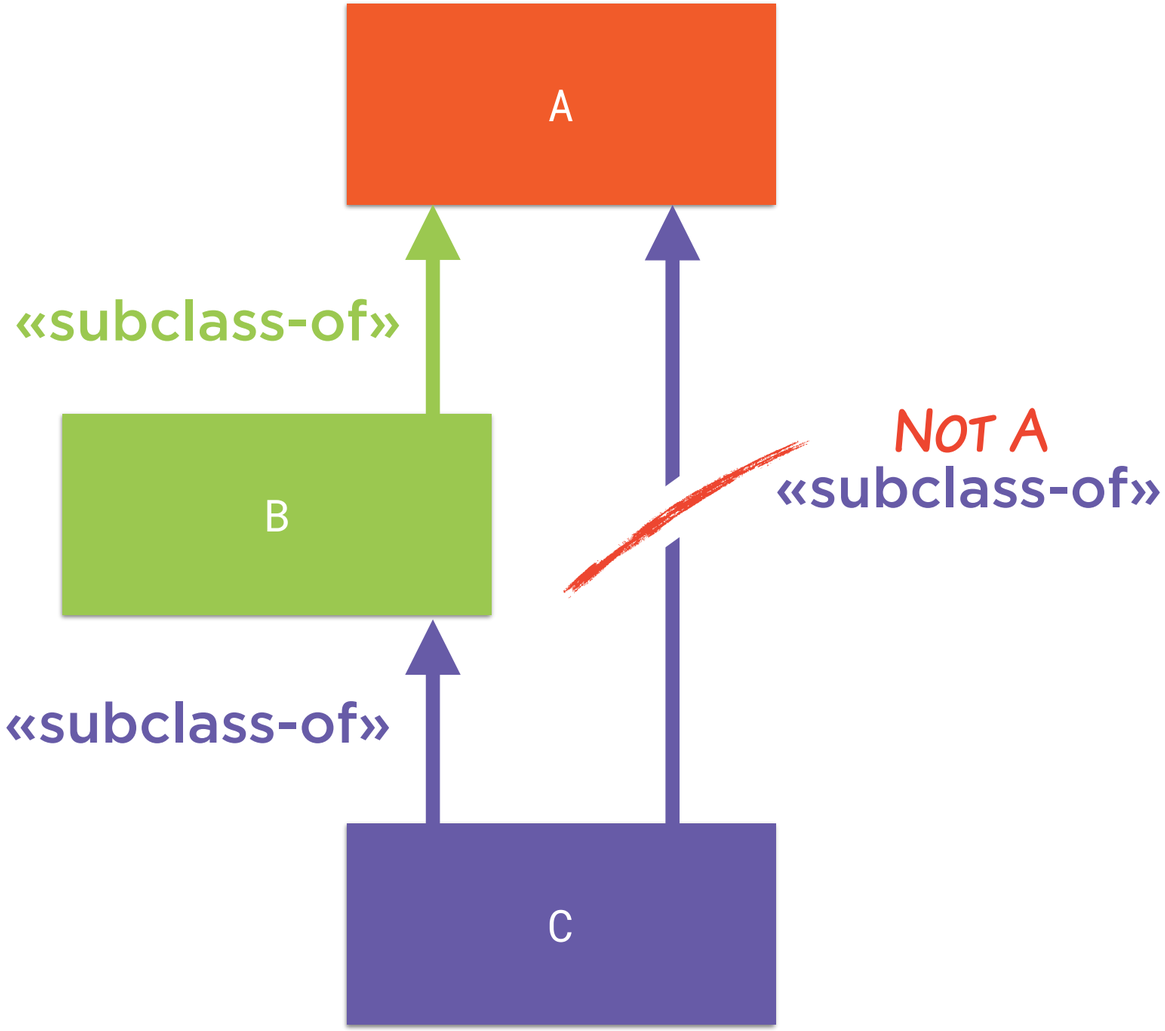
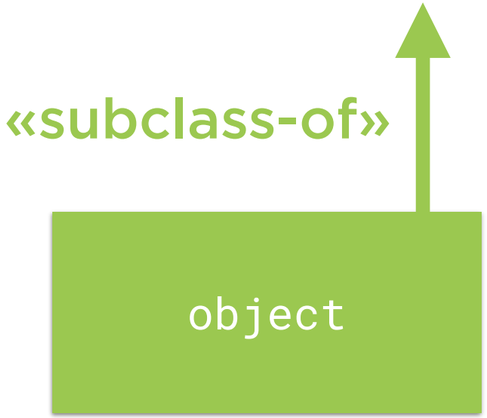




object


«subclass-of»
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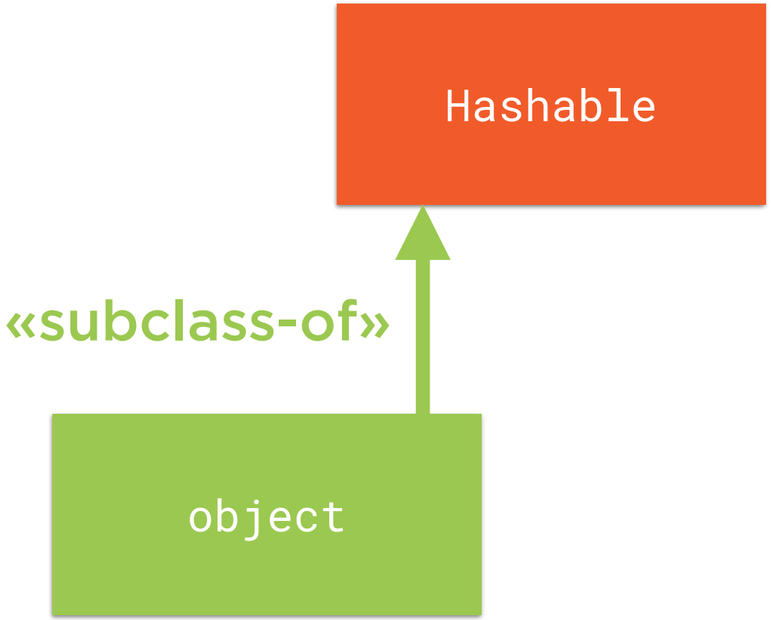
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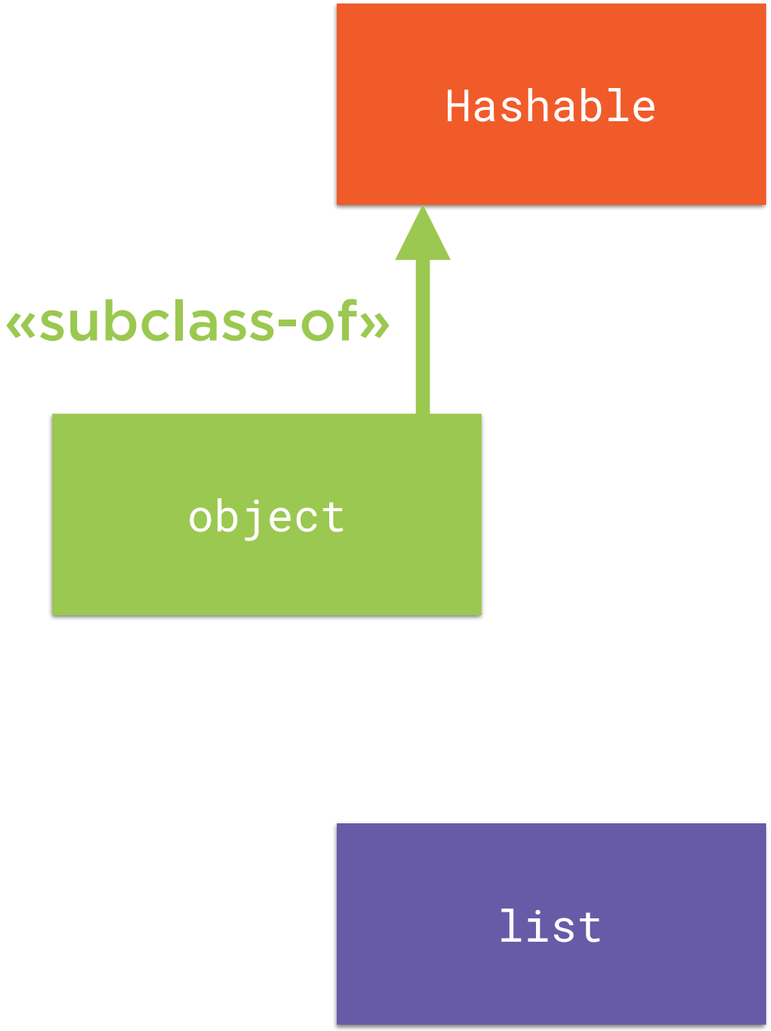
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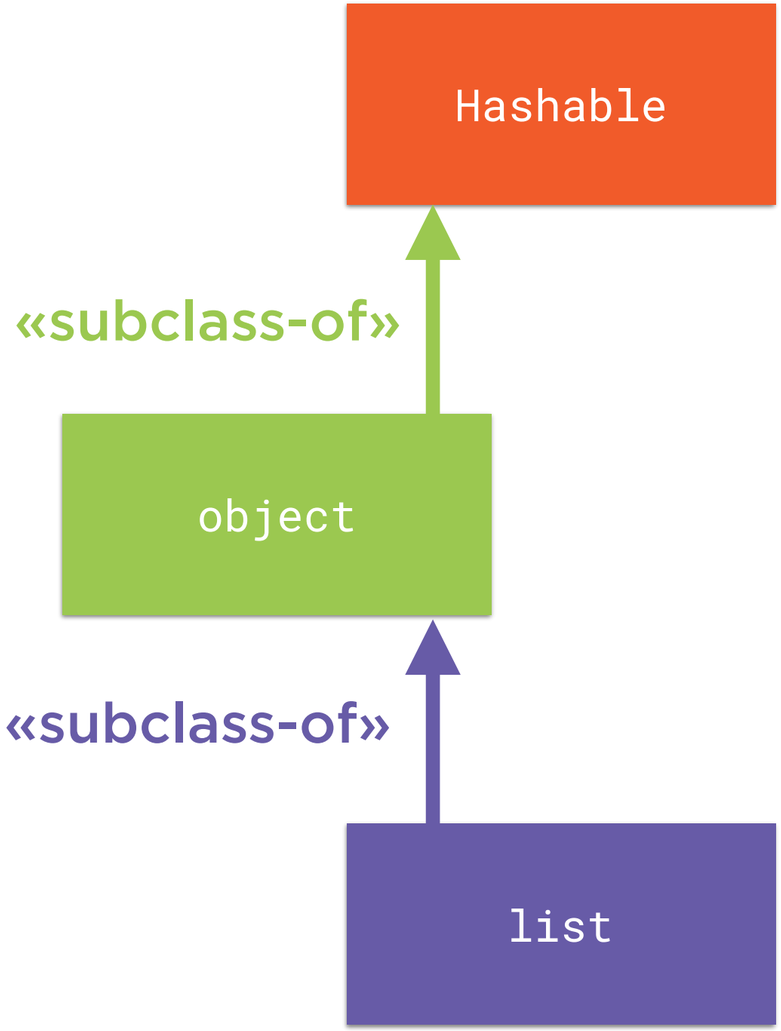
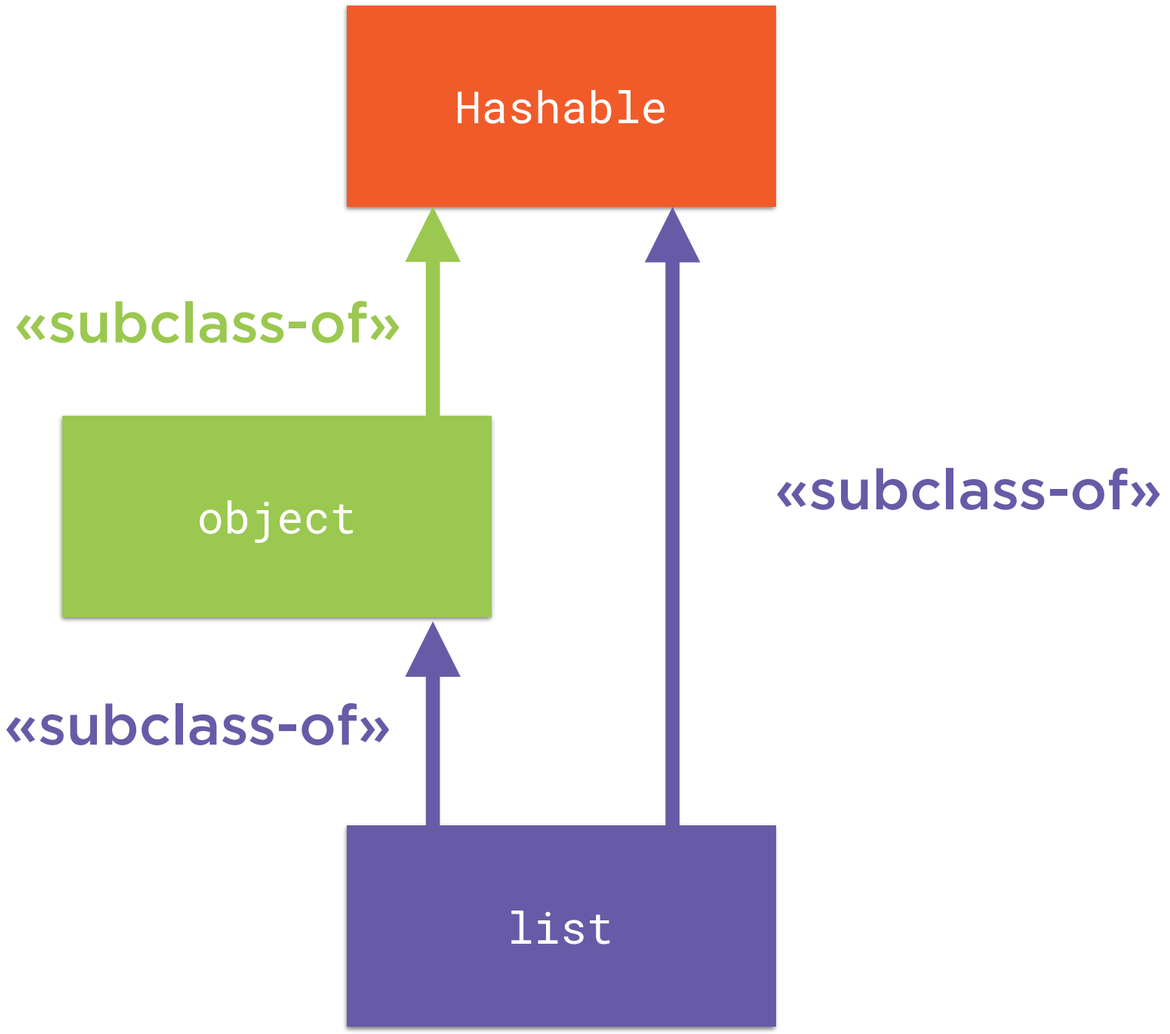
object
list


Hashable
«subclass-of»
object
«subclass-of»
list


Hashable
«subclass-of»
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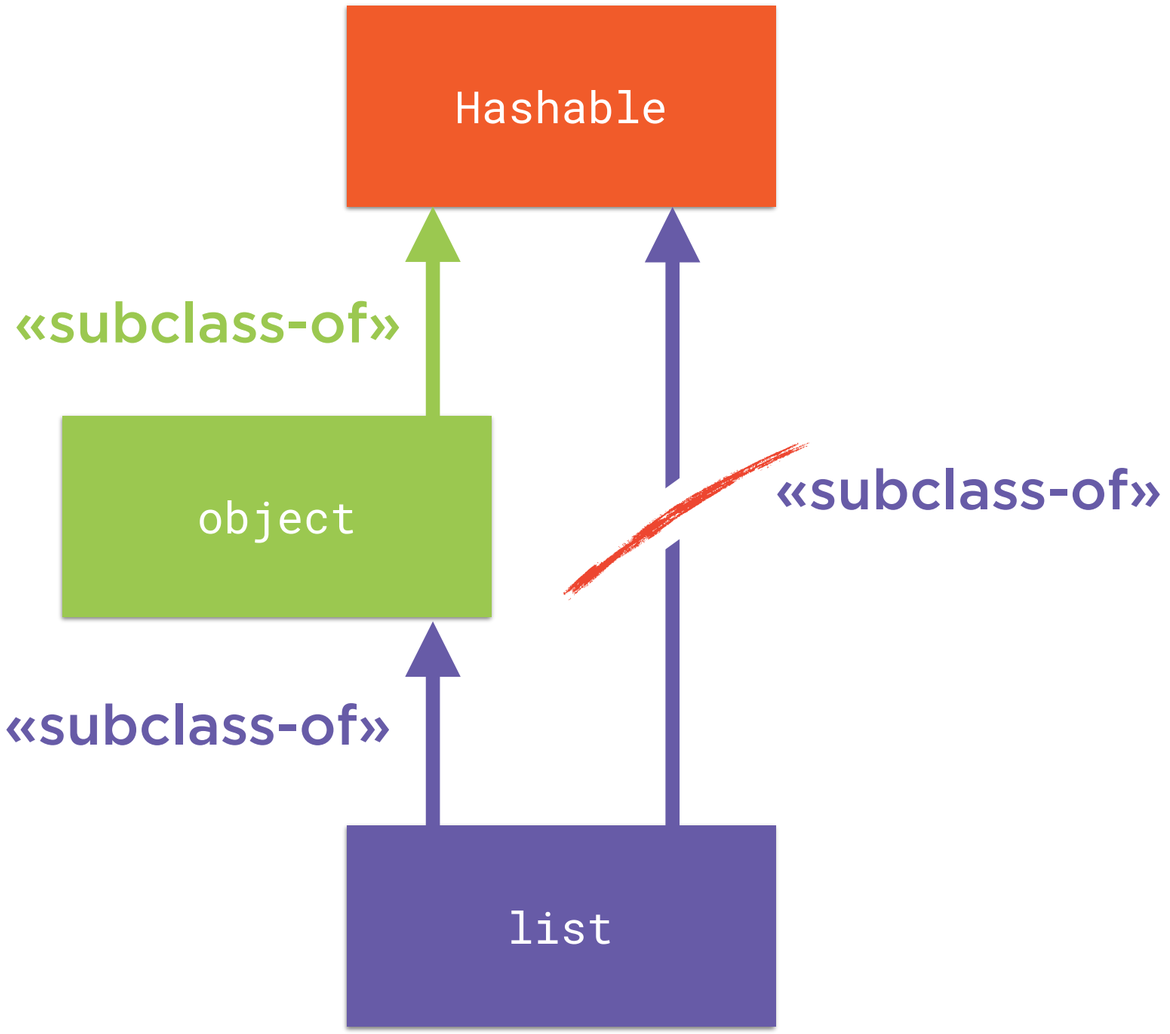
Hashable
«subclass-of»
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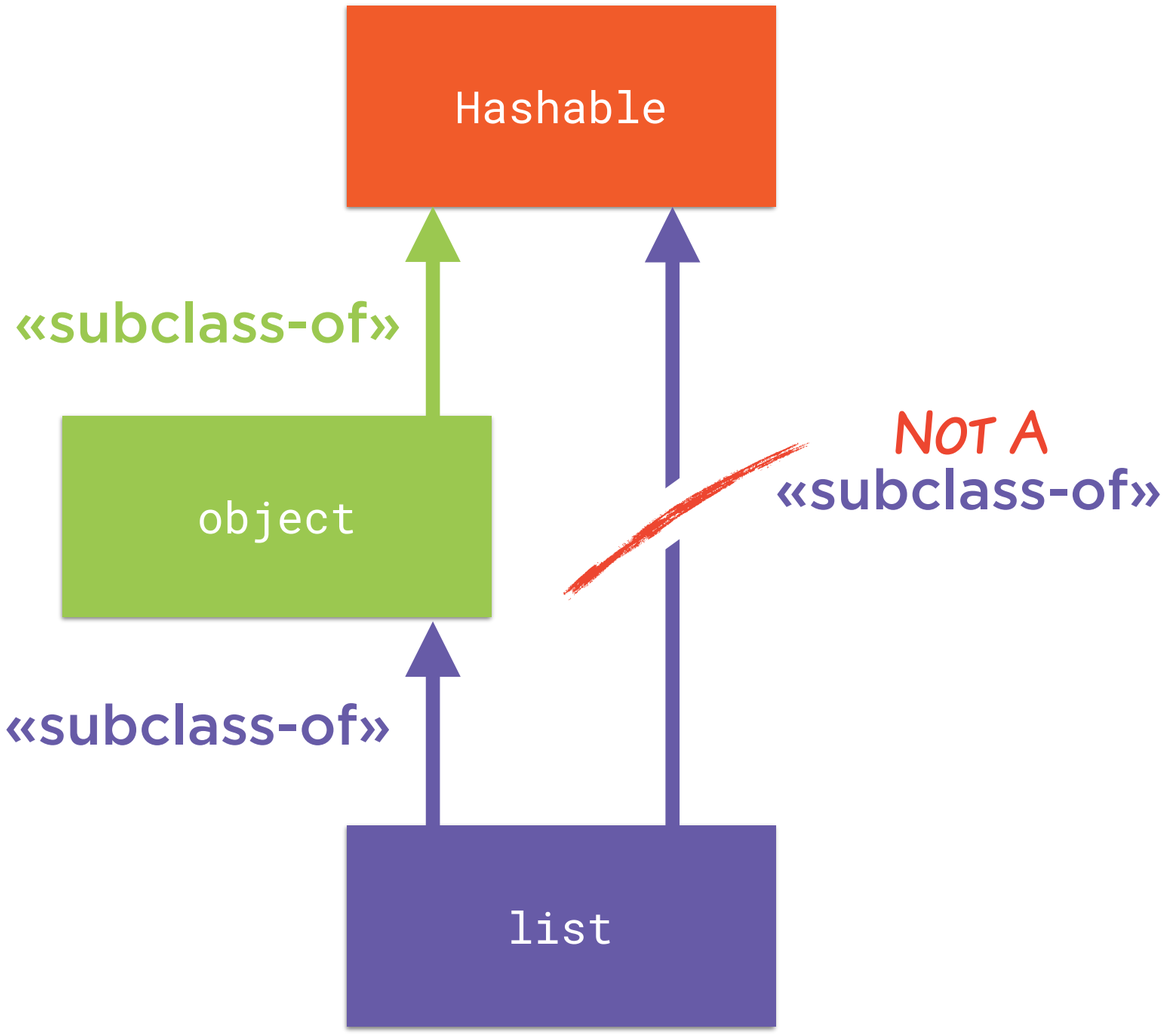
Hashable
«subclass-of»
object
NOT A
«subclass-of»
«subclass-of»
list

Method Resolution With Virtual Base Classes

Library Support for Abstract Base Classes

Standard Library Support for ABCs

Custom Metaclass

`__subclasscheck__()`

`__instancecheck__()`

Tricky to get right

Onerous to implement a metaclass

Standard Library

`abc` **module**

- `ABCMeta` **metaclass**
- `ABC` **base class**
- `@abstractmethod` **decorator**

ABCMeta

ABCMeta

Reliable implementations of

ABCMeta

Reliable implementations of

`__subclasscheck__()`

ABCMeta

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`__instancecheck__()`

in terms of

ABCMeta

Reliable implementations of

`__subclasscheck__()`

`__instancecheck__()`

in terms of

`__subclasshook__()`

ABCMeta

Reliable implementations of

`__subclasscheck__()`

`__instancecheck__()`

in terms of

`__subclasshook__()`

ABCMeta

```
ABCMeta.__instancecheck__(sub)
```

and

```
ABCMeta.__subclasscheck__(sub)
```

delegate to

```
Base.__subclasshook__(sub)
```

ABCMeta

```
Base.__subclasshook__(sub)
```

ABCMeta

```
Base.__subclasshook__(sub)
```

True

ABCMeta

```
Base.__subclasshook__(sub)
```

True

False

ABCMeta

```
Base.__subclasshook__(sub)
```

True

False

NotImplemented

ABCMeta

```
Base.__subclasshook__(sub)
```

True

False

NotImplemented : to lookup via MRO

ABCMeta

```
Base.__subclasshook__(sub)
```

True : when sub is a subclass of Base

False : when sub is not a subclass of Base

NotImplemented : to lookup via MRO

Virtual Subclass Registration

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Register a class as a *virtual* subclass

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Base metaclass must be `ABCMeta`

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Call `register(sub)` **metamethod**

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Call `register(sub)` metamethod

Call to `register()` returns its argument

Virtual Subclass Registration

Register a class as a *virtual* subclass

Base metaclass must be `ABCMeta`

Call `register(sub)` metamethod

Call to `register()` returns its argument

Can use `@register` as a class-decorator

Combining Subclass Detection and Registration

Combining Subclass Detection and Registration

Combining Subclass Detection and Registration

You can use both subclass `register()` **and** `__subclasshook__()`

Combining Subclass Detection and Registration

You can use both subclass `register()` and `__subclasshook__()`

`__subclasshook__()` must return `NotImplemented` to trigger lookup of registered subclasses.

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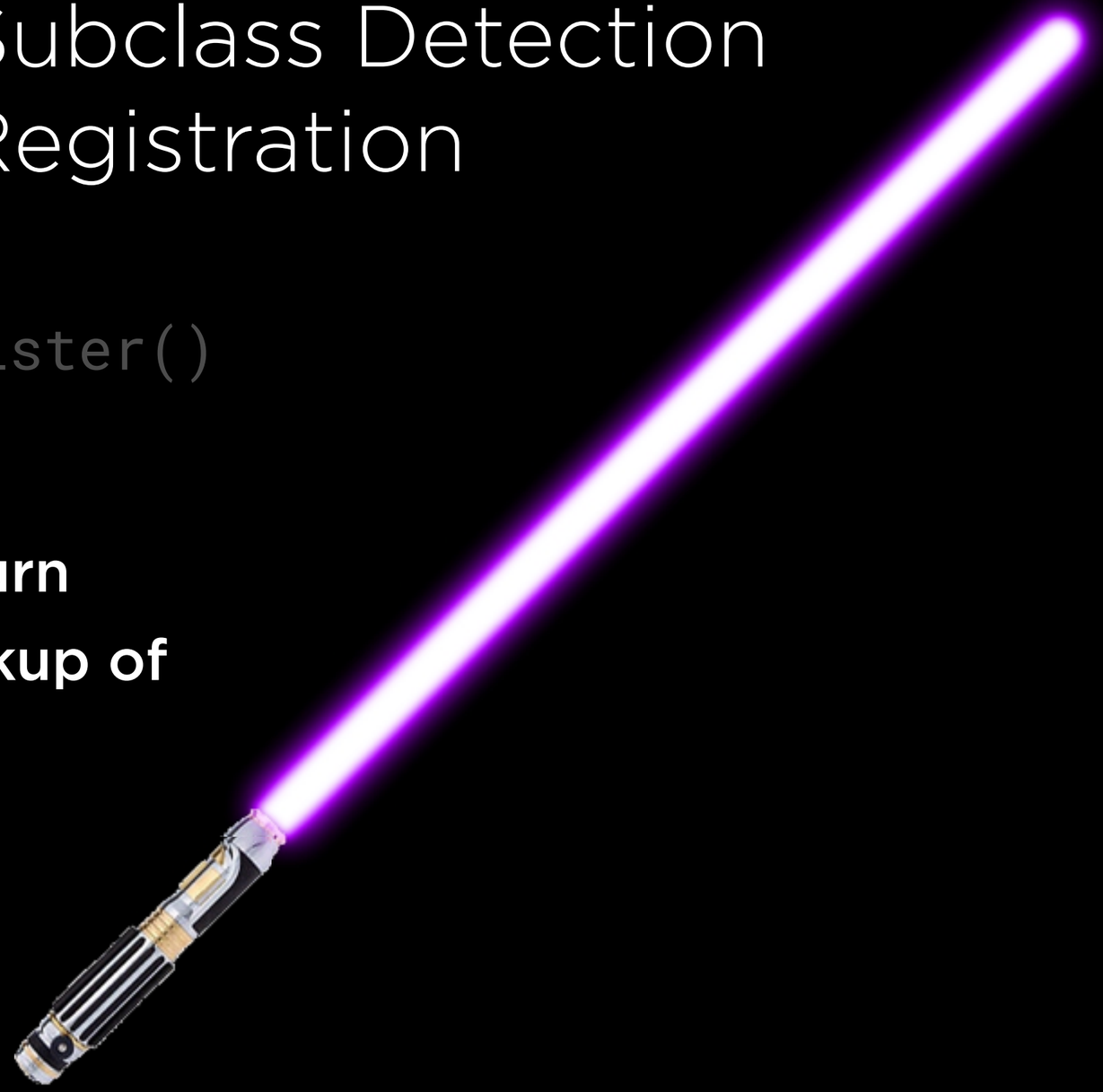

The ABC Convenience Base Class

The ABC Base Class – In Its Entirety!

```
class ABC(metaclass=ABCMeta):
    """Helper class that provides a standard way to create an ABC using
    inheritance.
    """
    pass
```

Declaring Abstract Methods

Abstract Methods

Abstract Methods

Declared in Abstract Base Classes

Marked with the `@abstractmethod` decorator

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Useful Definition Not Required

Python syntax requires a placeholder definition

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Declared in Abstract Base Classes

Marked with the `@abstractmethod` decorator

Useful Definition Not Required

Python syntax requires a placeholder definition

Must Be Overridden in Concrete Classes

Abstract methods prevent instantiation of ABCs

Abstract Methods

```
from abc import (ABC, abstractmethod)

class AbstractBaseClass(ABC):  # metaclass is ABCMeta

    @abstractmethod
    def an_abstract_method(self):
        raise NotImplementedError  # Method body syntactically required.
```

Metaclass must be `ABCMeta` for abstractness to be enforced

Combining Method Decorators

Combining Method Decorators

`@abstractmethod`
must be innermost

`@property`
getters and setters can be independently abstract

```
class AbstractBaseClass(ABC):

    @staticmethod
    @abstractmethod
    def an_abstact_static_method():
        raise NotImplementedError

    @classmethod
    @abstractmethod
    def an_abstract_class_method(cls):
        raise NotImplementedError

    @property
    @abstractmethod
    def an_abstract_property(self):
        raise NotImplementedError

    @an_abstract_property.setter
    @abstractmethod
    def an_abstract_property(self, value):
        raise NotImplementedError
```

Abstract Descriptors

Abstract Descriptors

`__get__()`, `__set__()` and `__delete__()` can be independently abstract

`__isabstractmethod__` attribute (*e.g.* property) must evaluate to `True` if any are abstract

```
class MyDataDescriptor(ABC):

    @abstractmethod
    def __get__(self, instance, owner):
        # ...
        pass

    @abstractmethod
    def __set__(self, instance, value):
        # ...
        pass

    @abstractmethod
    def __delete__(self, instance):
        # ...
        pass

    @property
    def __isabstractmethod__(self):
        return True  # or False if not abstract
```

Improving `@invariant` with ABCs

Summary

Summary

Summary

Abstract Base Classes (ABCs)

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`issubclass()` **delegates to metamethod** `__subclasscheck__()`

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Summary

Abstract Base Classes (ABCs)

`issubclass()` **delegates to metamethod** `__subclasscheck__()`

`isinstance()` **delegates to metamethod** `__instancecheck__()`

`abc` **module provides** `ABCMeta` **and** `ABC`

`ABCMeta` **eases customisation with** `__subclasshook__()` **regular method**

Summary

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Abstract Base Classes (ABCs)

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`ABCMeta` **allows registration of any class – even built-in classes – as a virtual base class**

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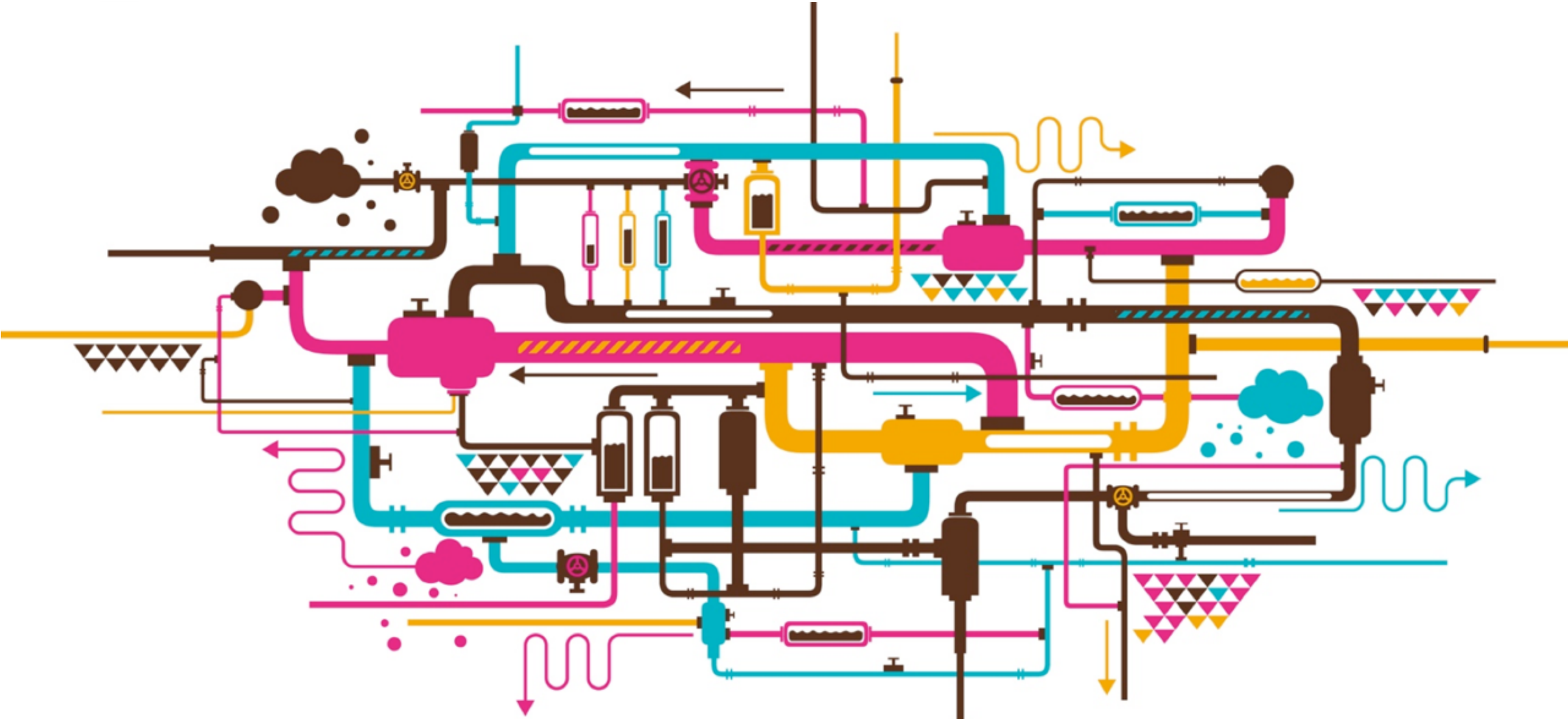
Abstract Base Classes (ABCs)

`ABCMeta` allows registration of any class – even built-in classes – as a virtual base class

`@abstractmethod` makes classes abstract and ensures overriding of methods

`@abstractmethod` **must be innermost when combined with** `@staticmethod`, `@classmethod` **or** `@property`

python™



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Fun!