

Descriptors



Robert Smallshire

COFOUNDER - SIXTY NORTH

@robsmallshire rob@sixty-north.com

Summary

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**Descriptors are the mechanism
behind properties**

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Properties without decorators

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Custom descriptors

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Data descriptors

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Data descriptors

Non-data descriptors

Reviewing Properties



Properties Are Descriptors

The @property Decorator

The @property Decorator

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class Example:
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The @property Decorator

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class Example:  
  
    def p(self):  
        return self._p
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The @property Decorator

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getter
method

The @property Decorator

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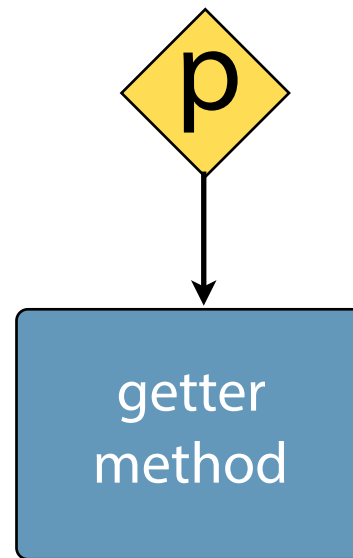


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The @property Decorator

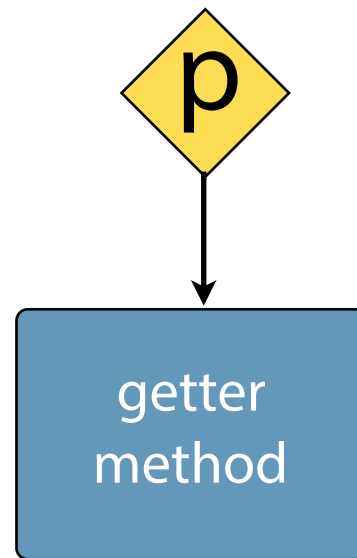
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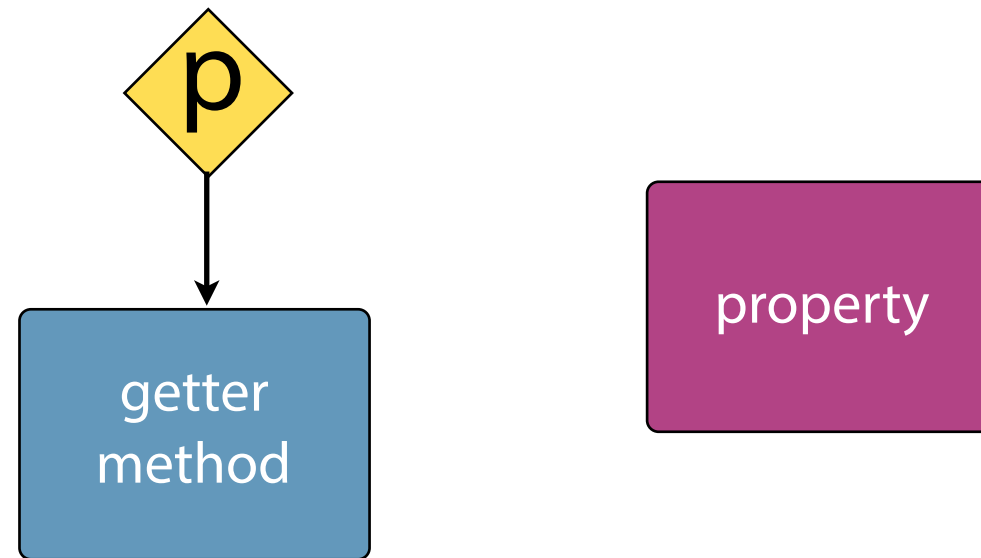
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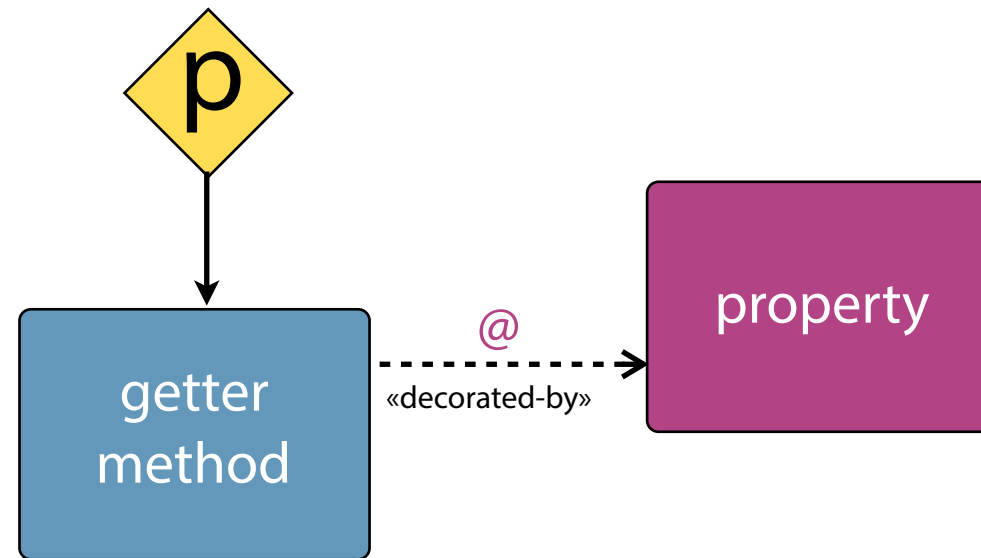
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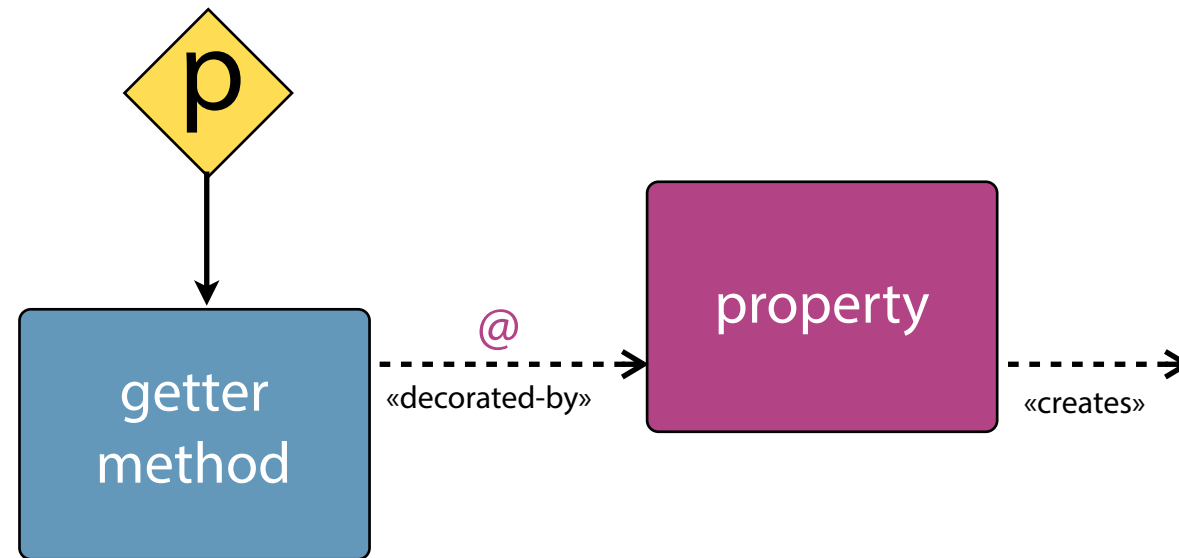
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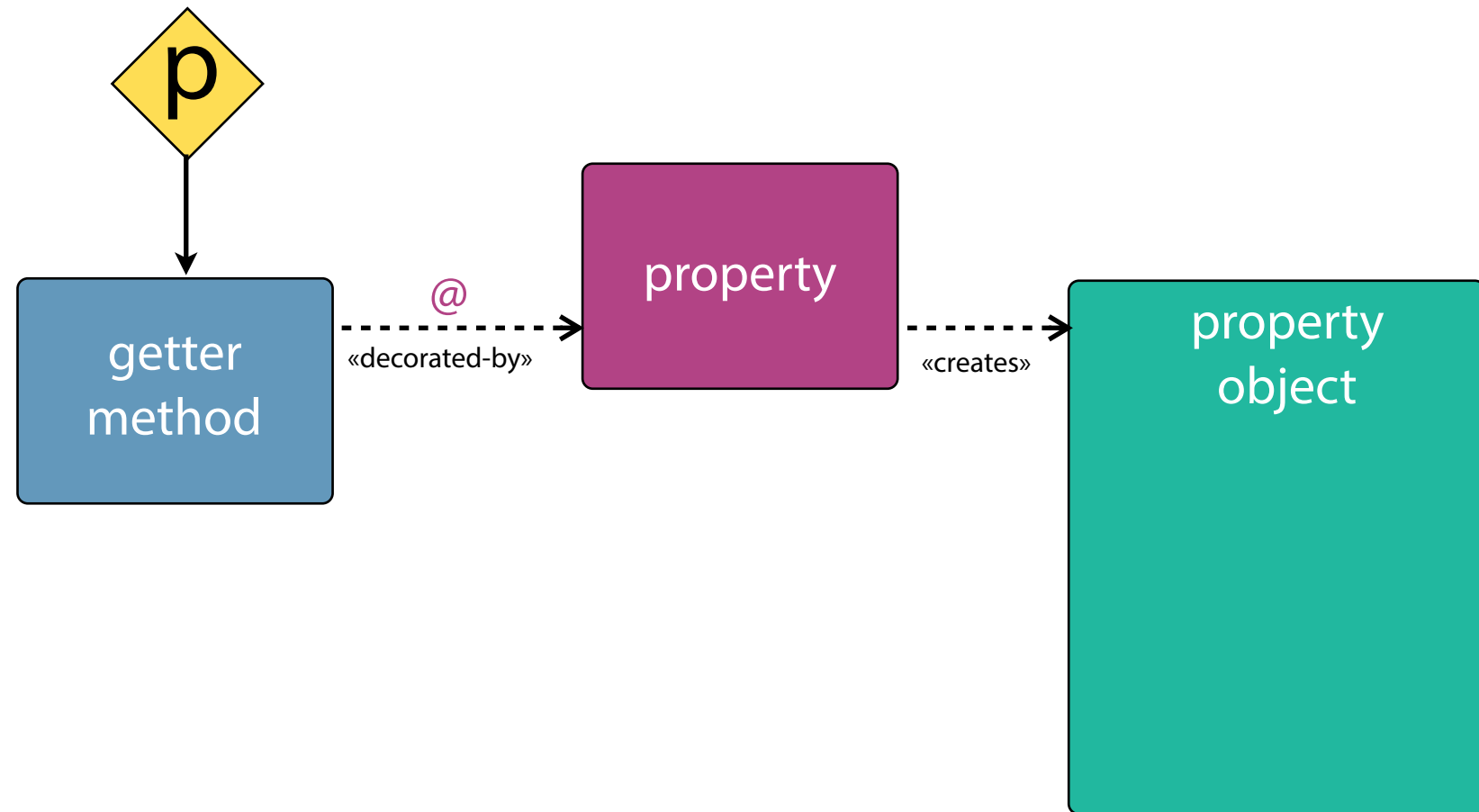
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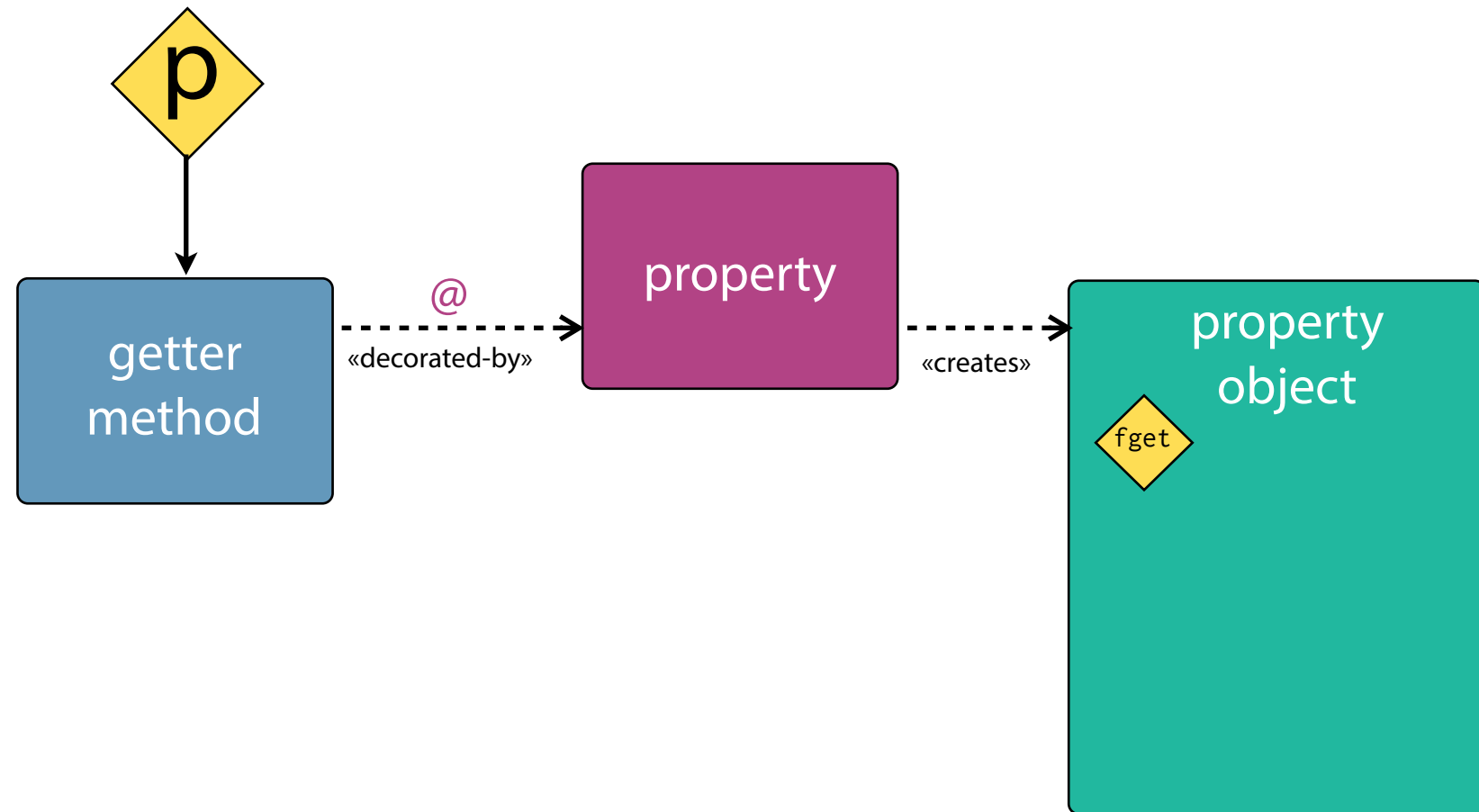
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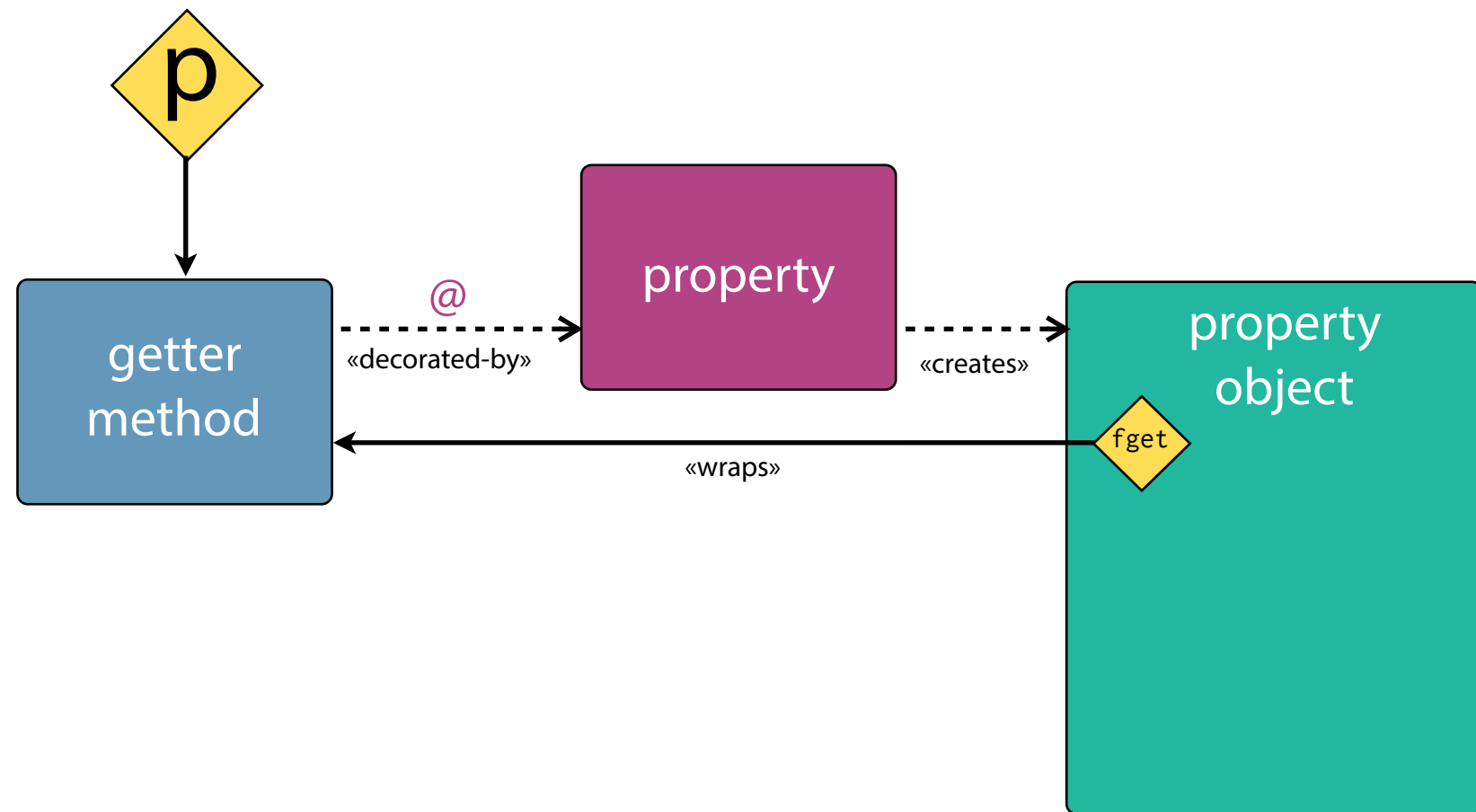
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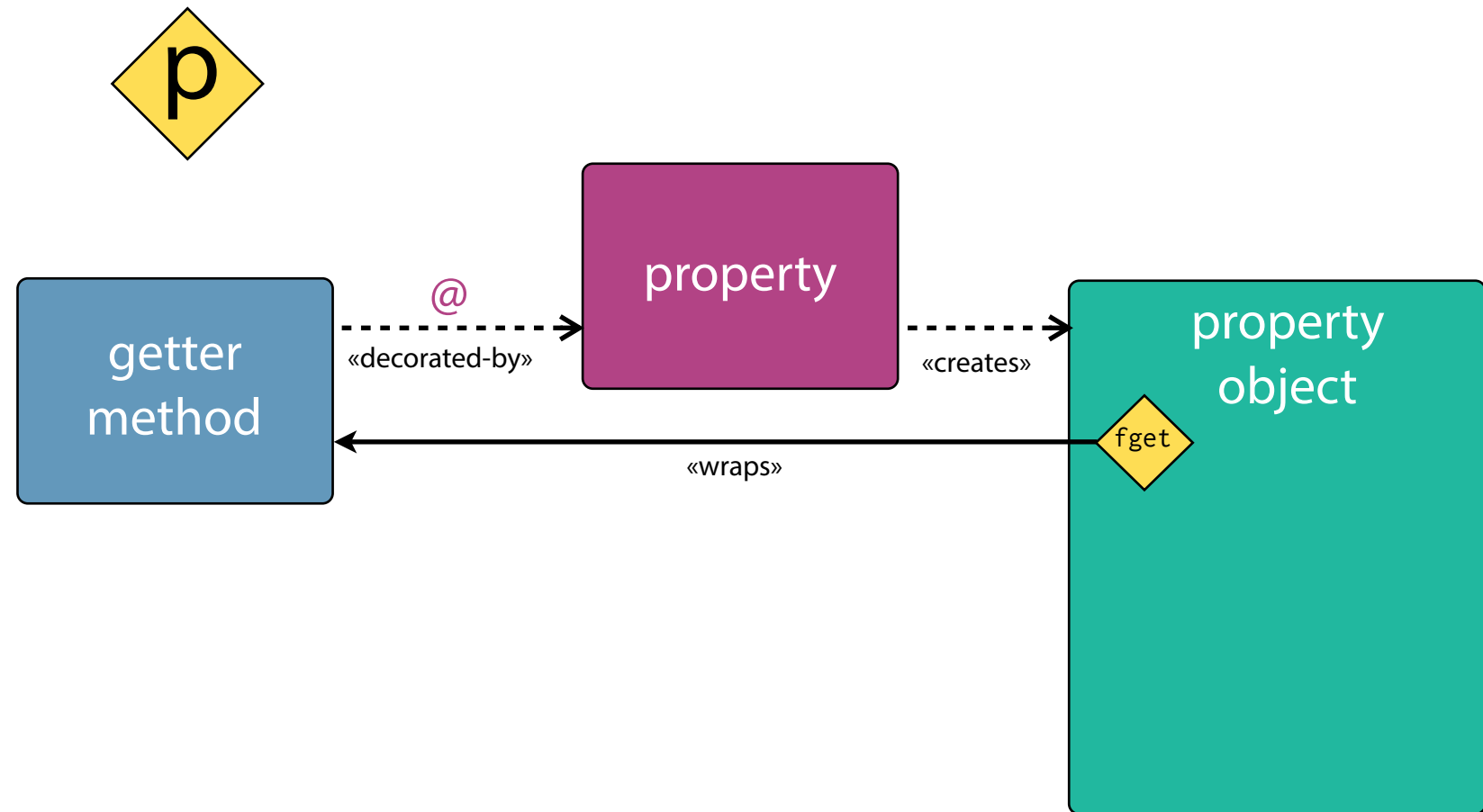
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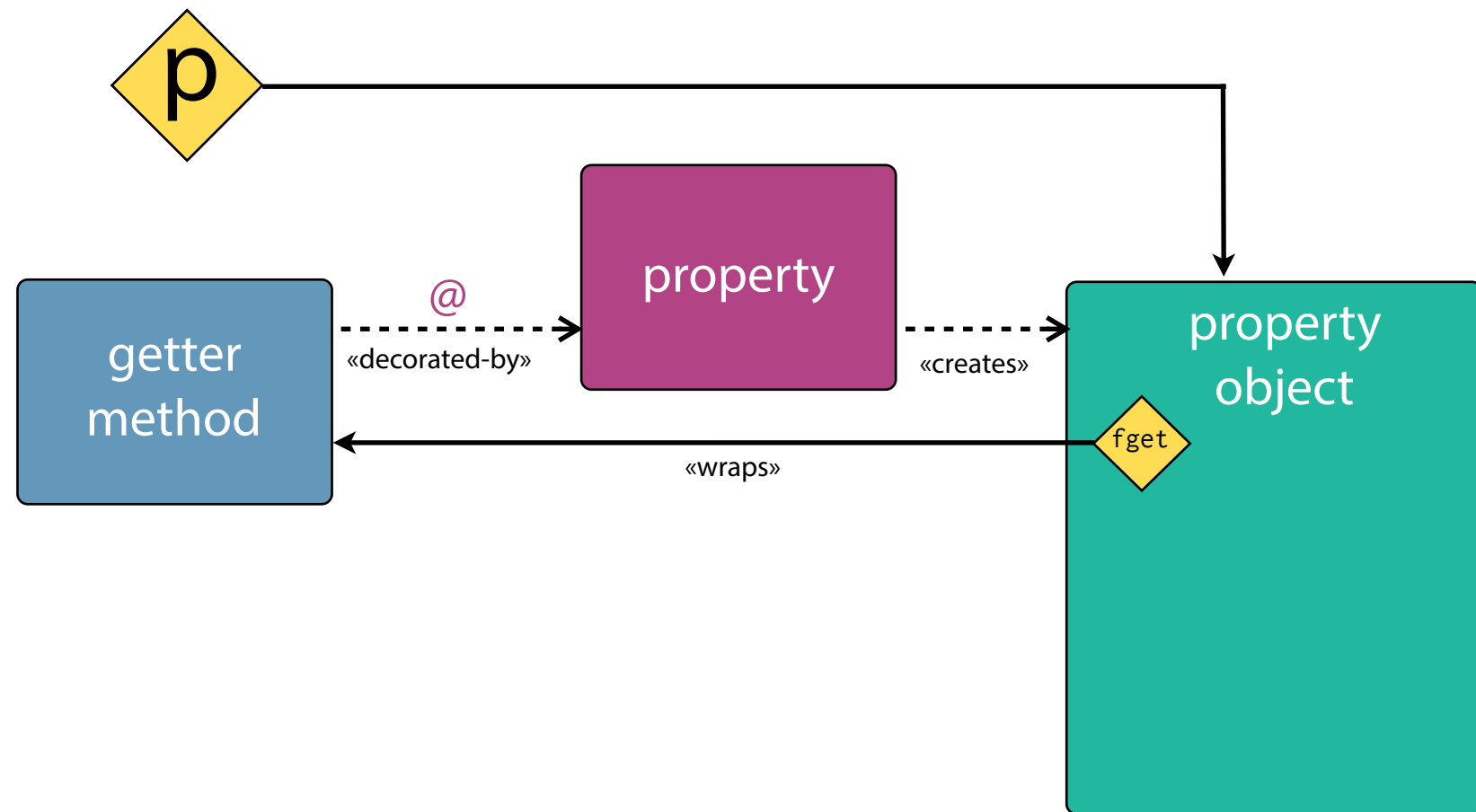
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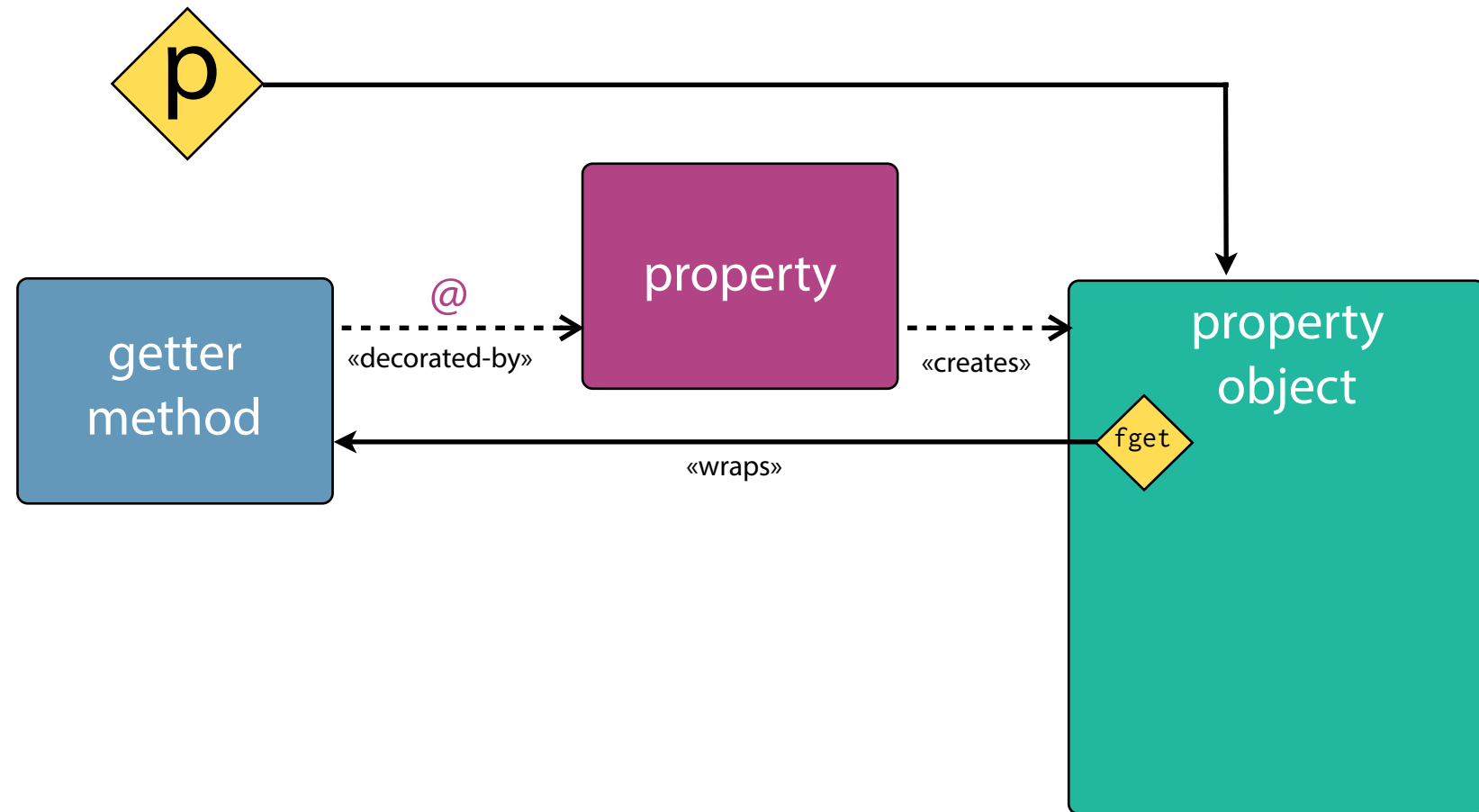
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    def p(self, value):  
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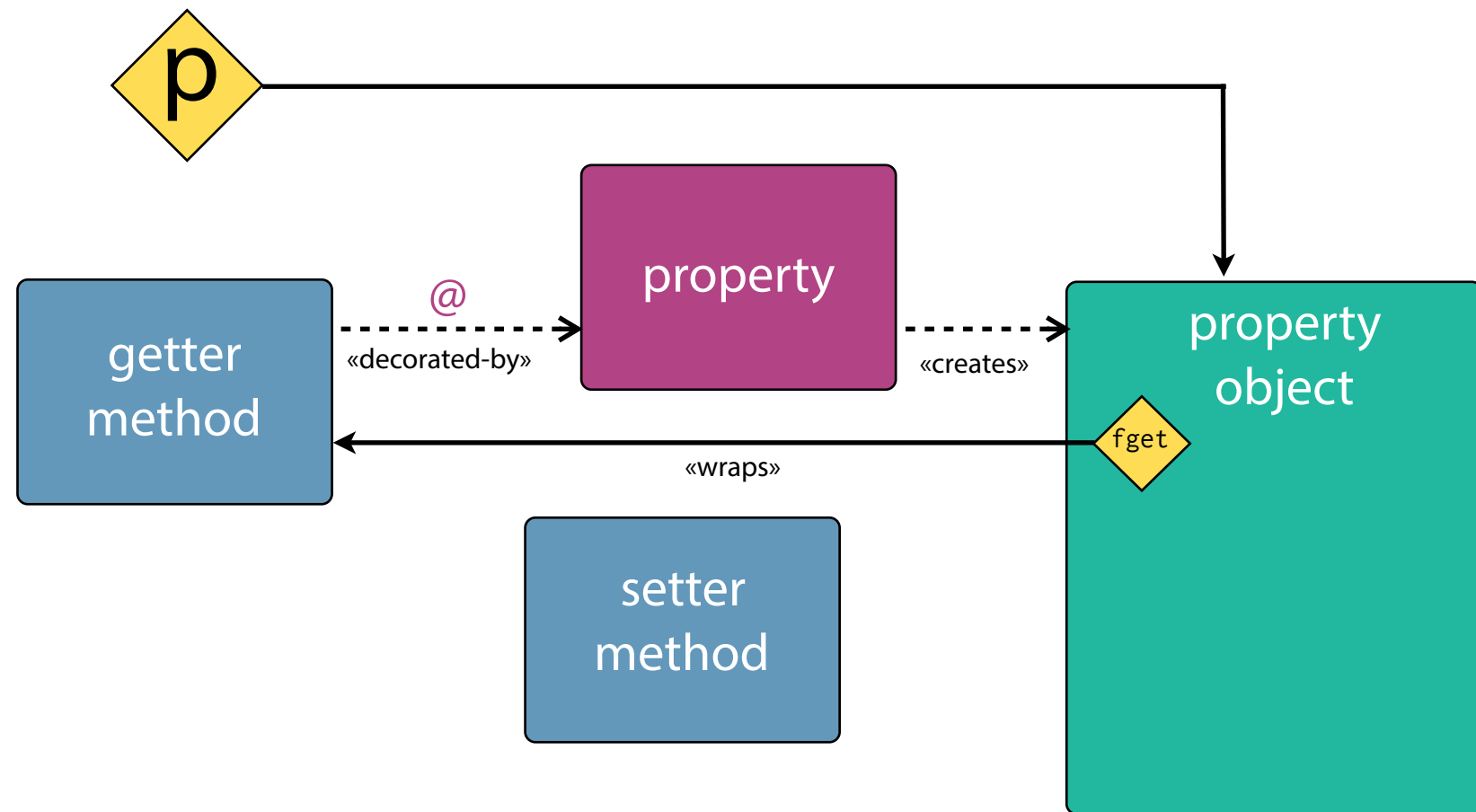
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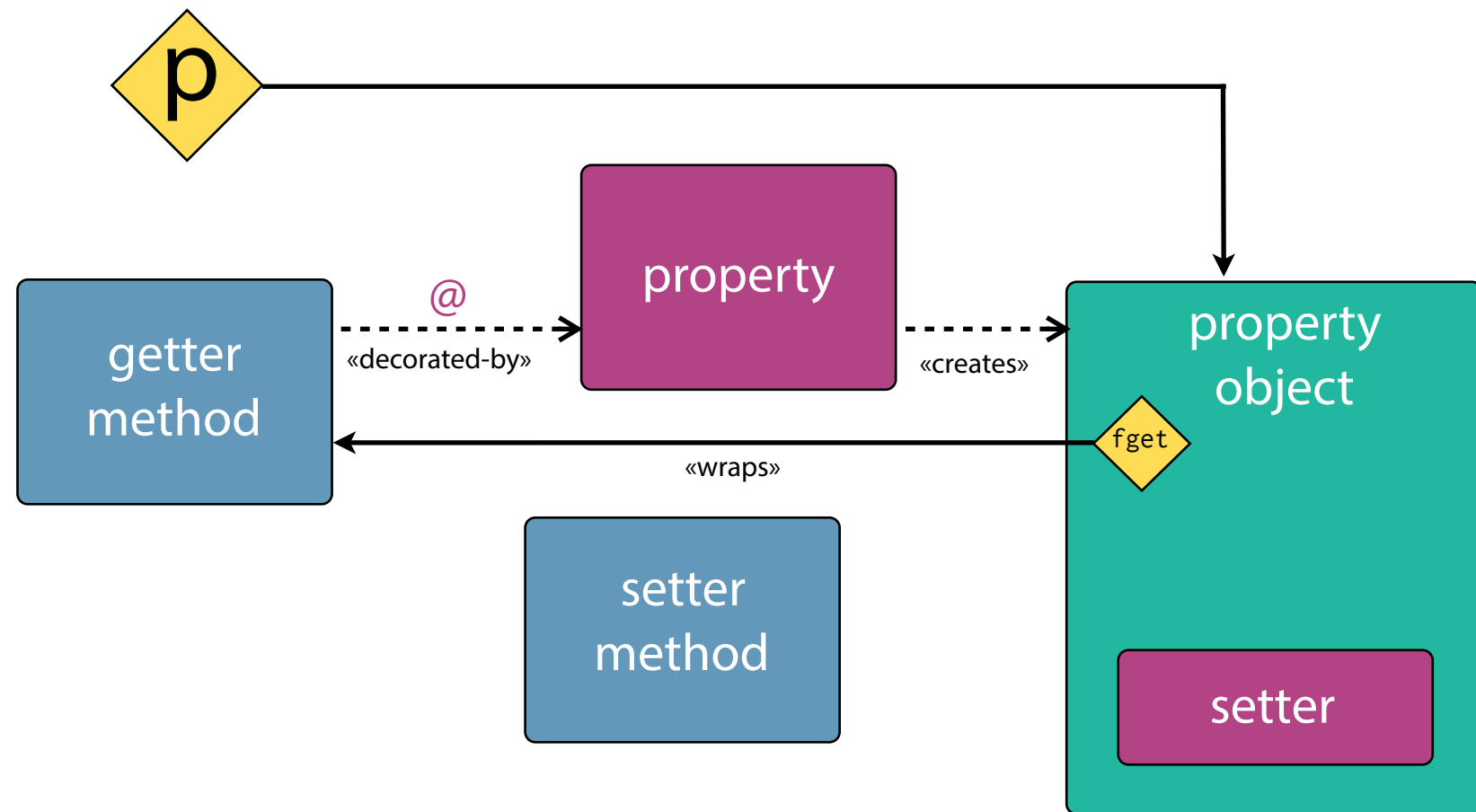
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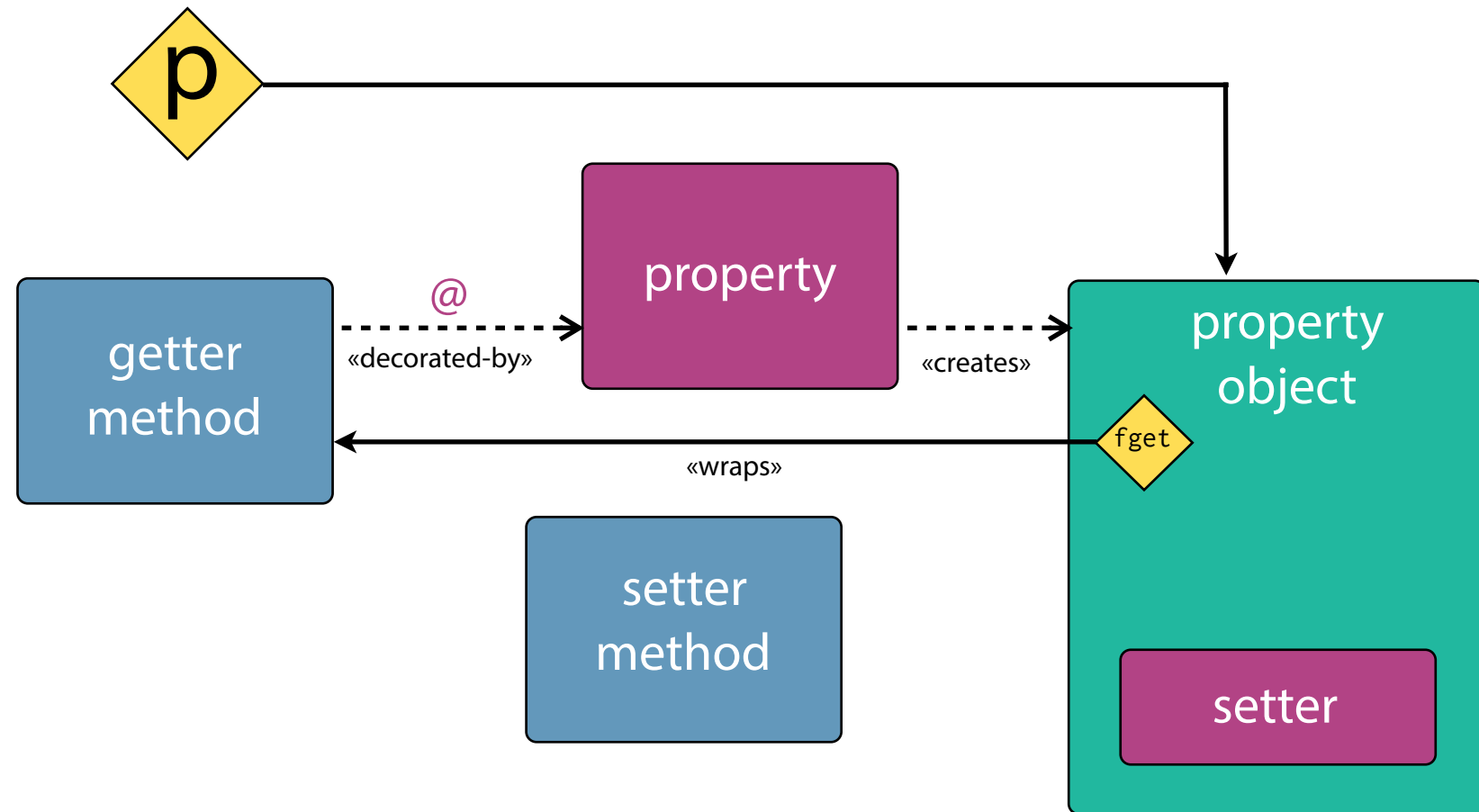
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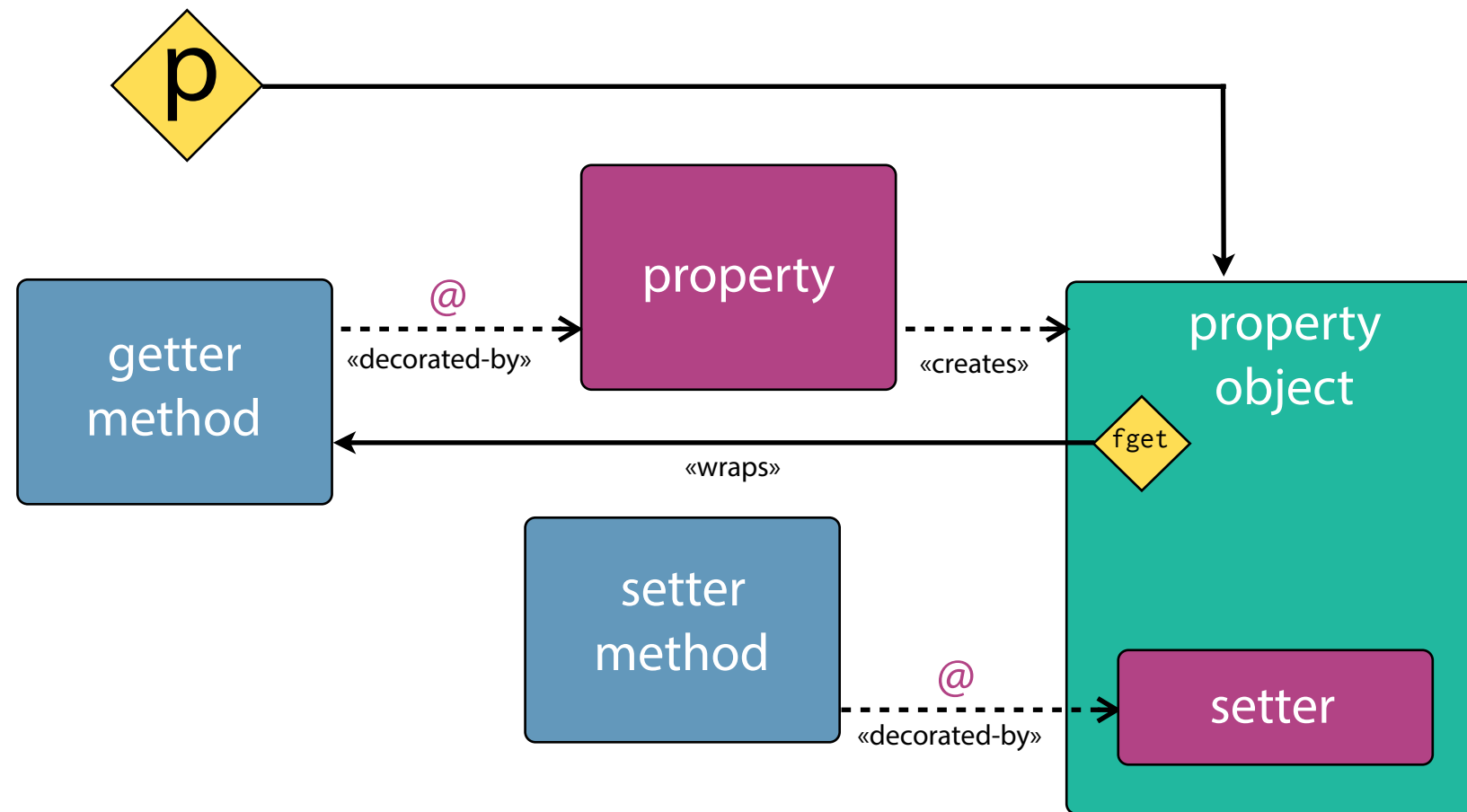
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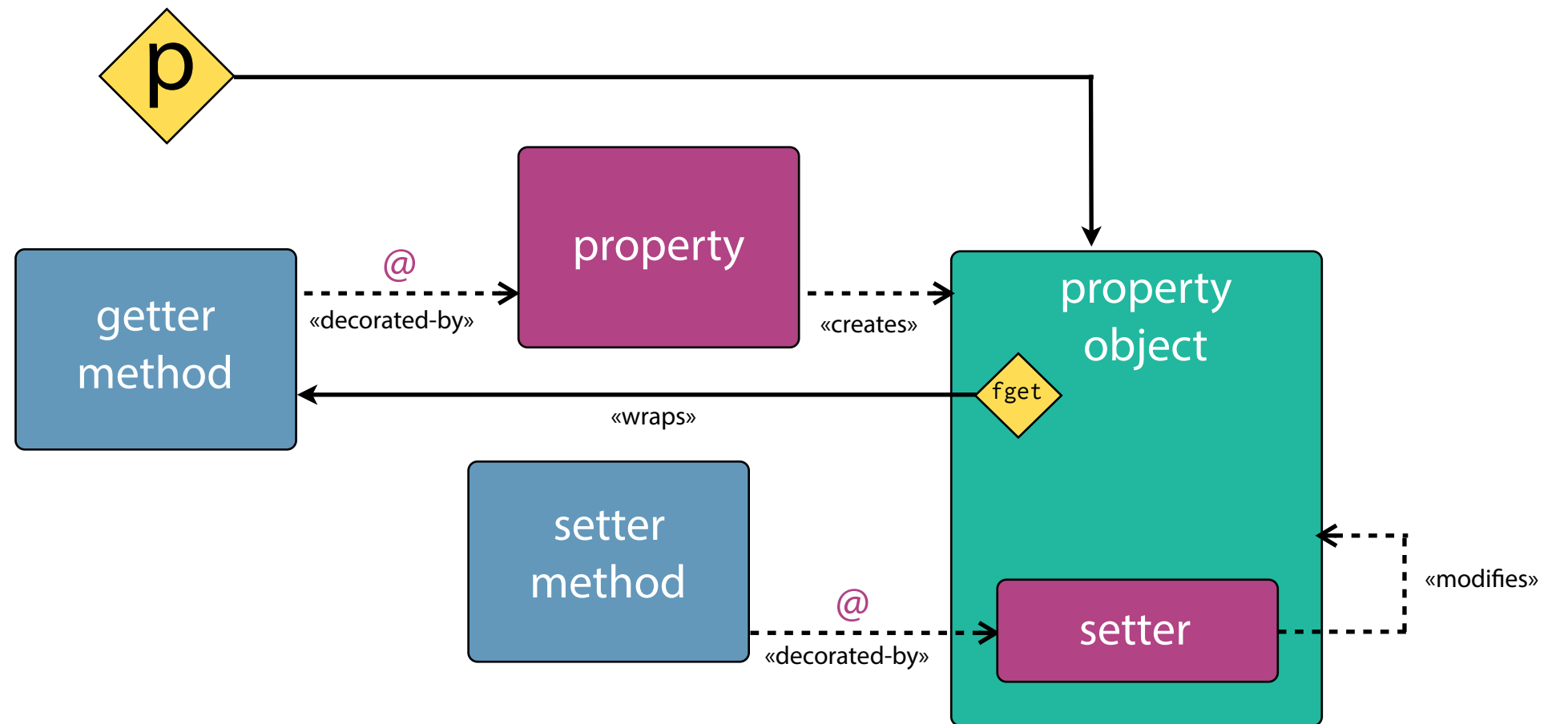
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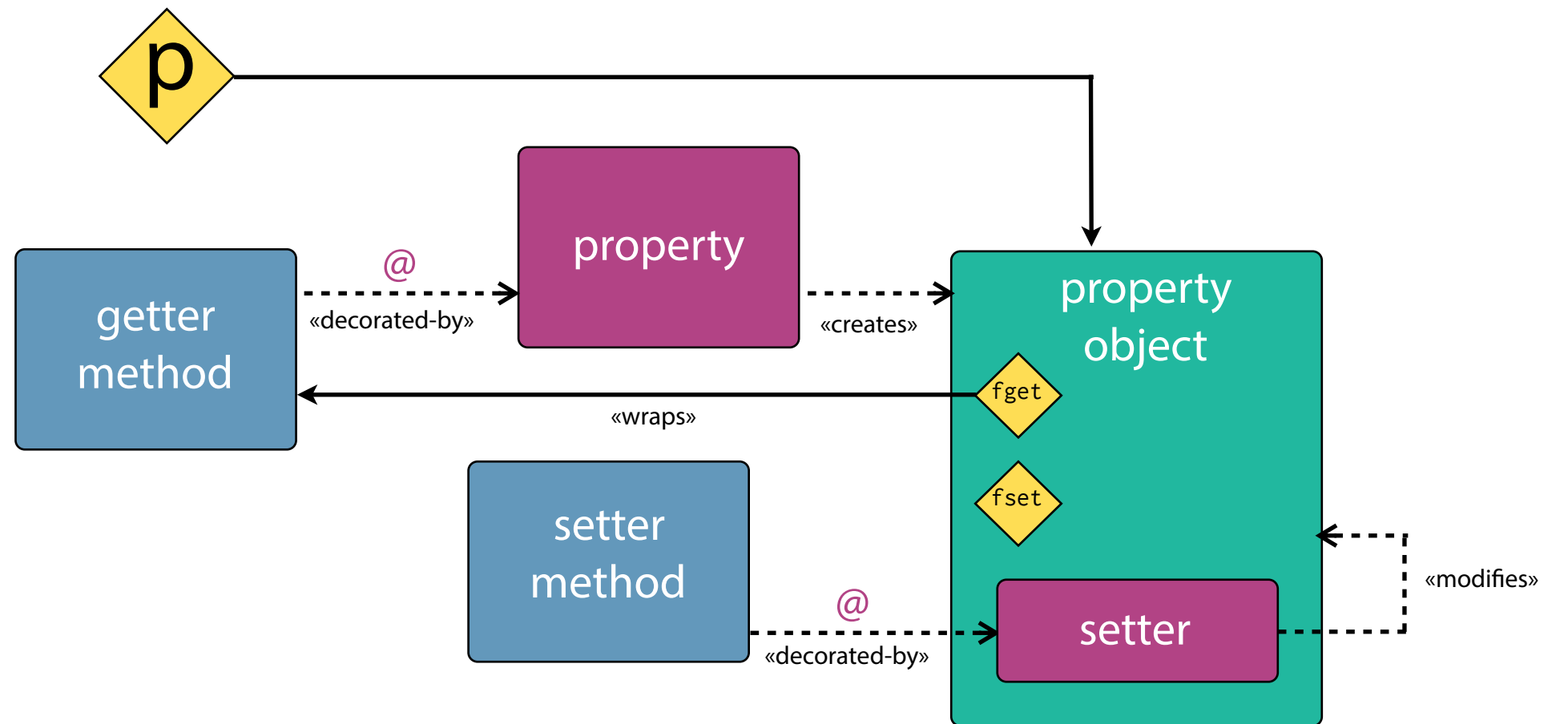
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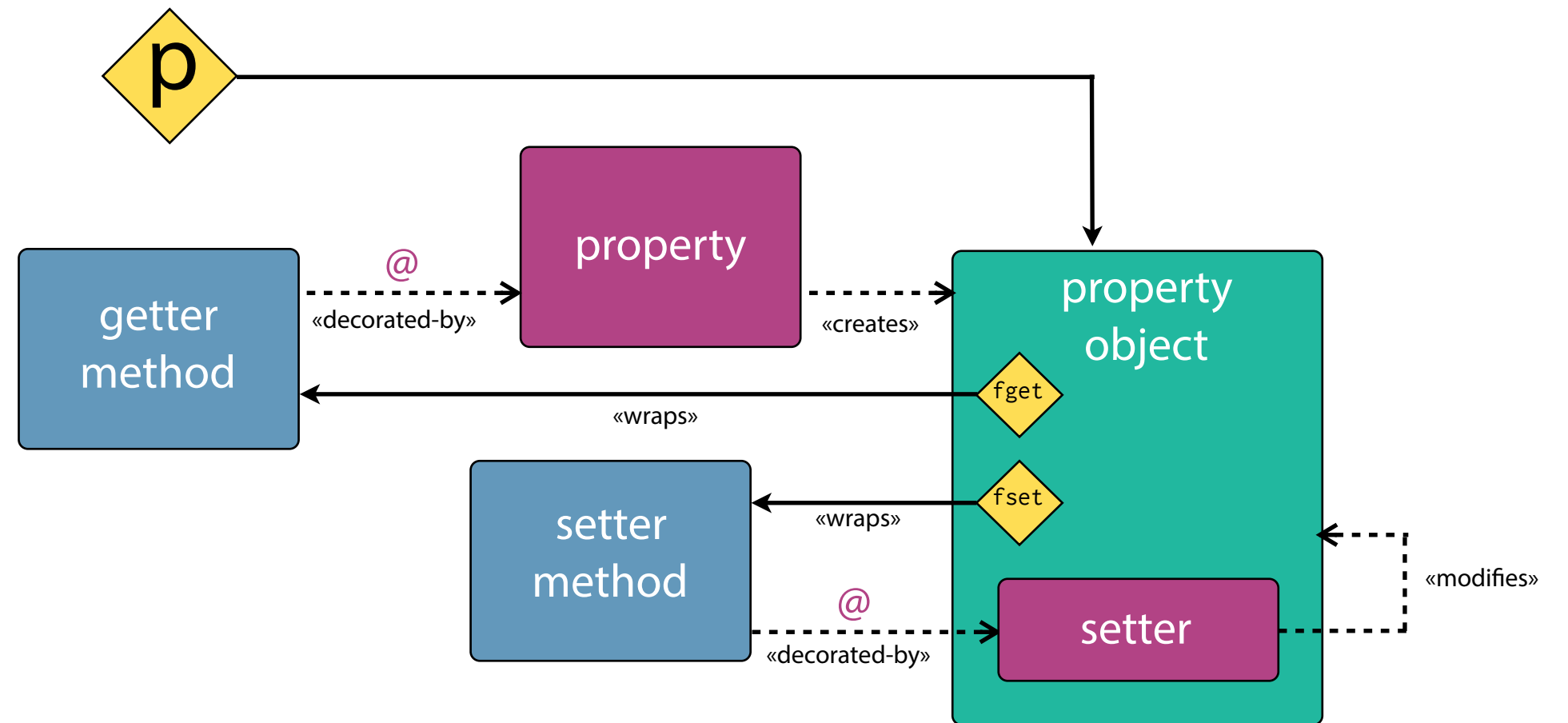
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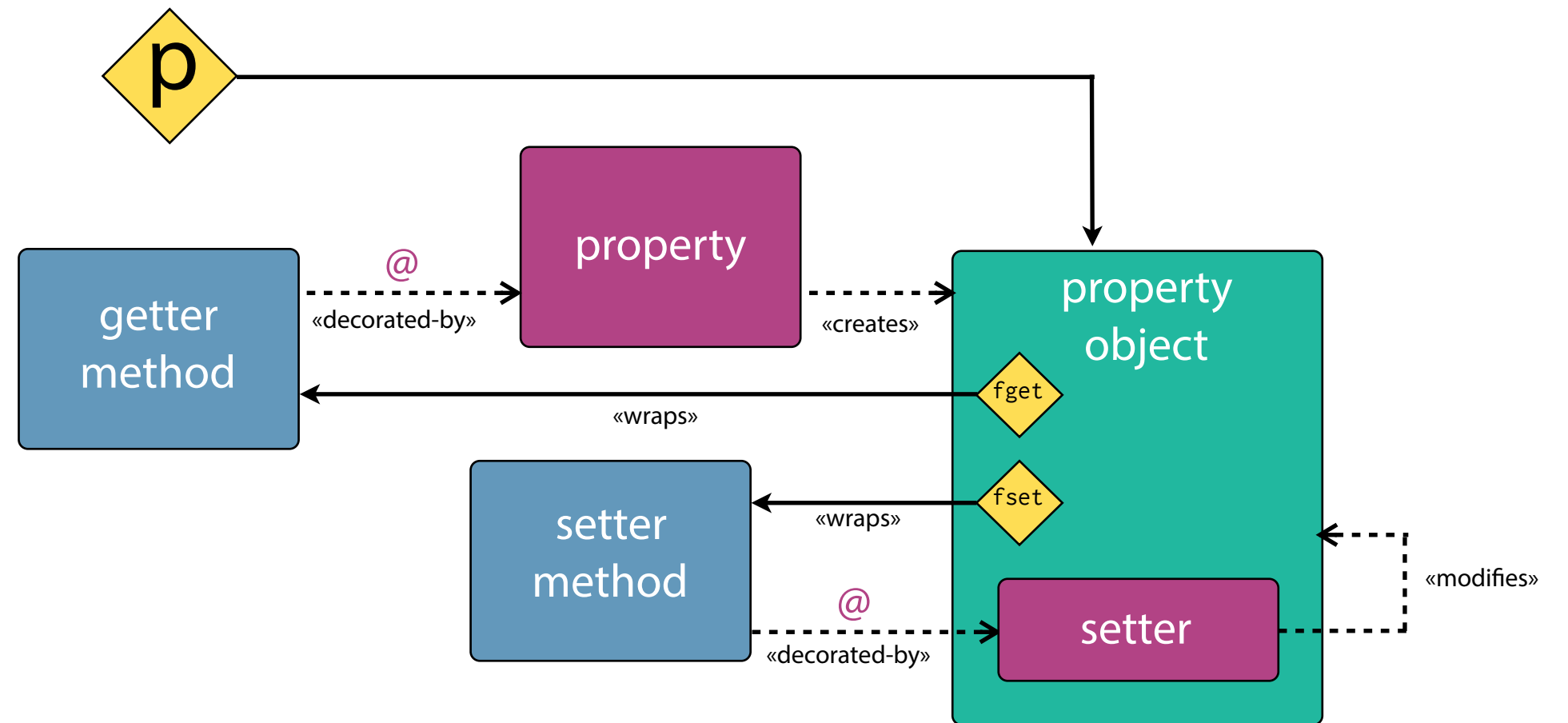
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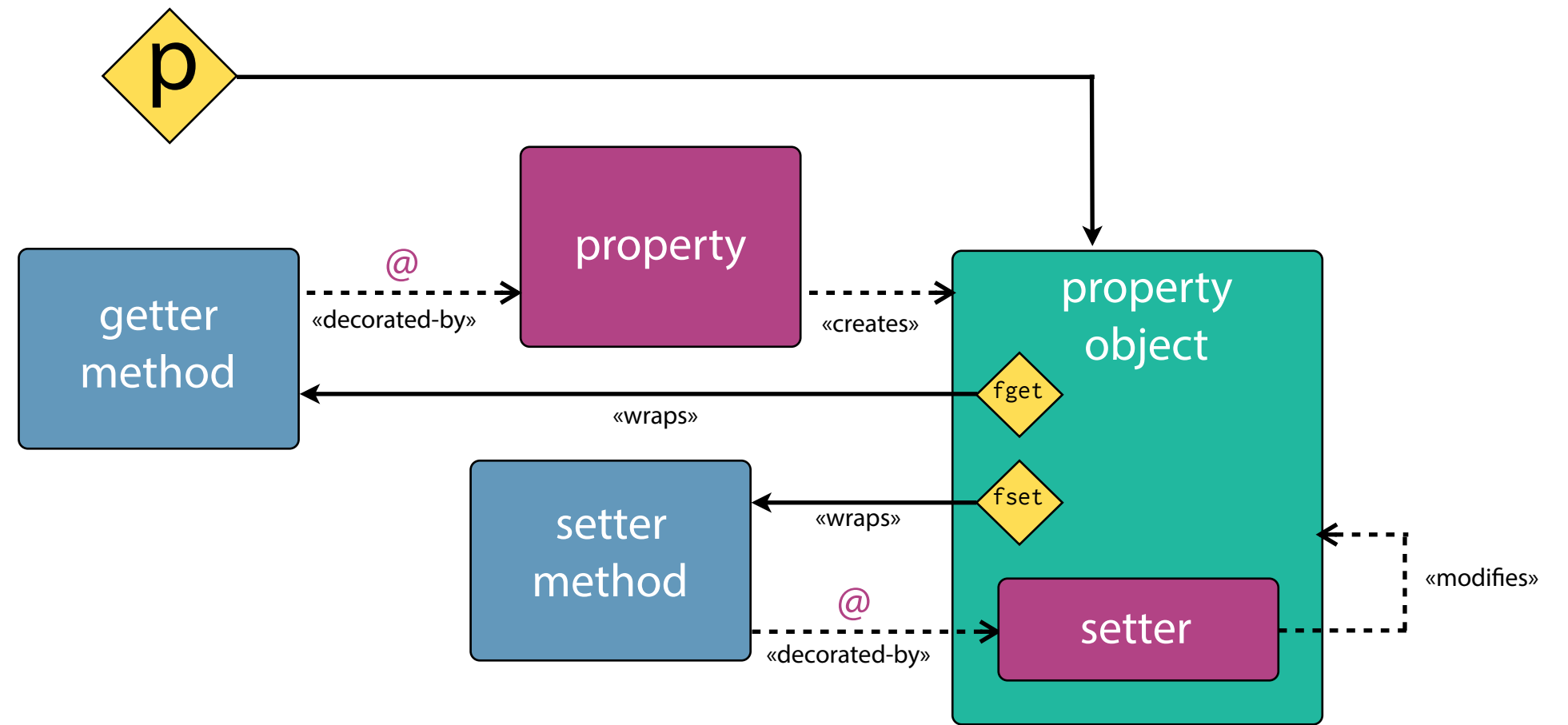
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The property object is a descriptor

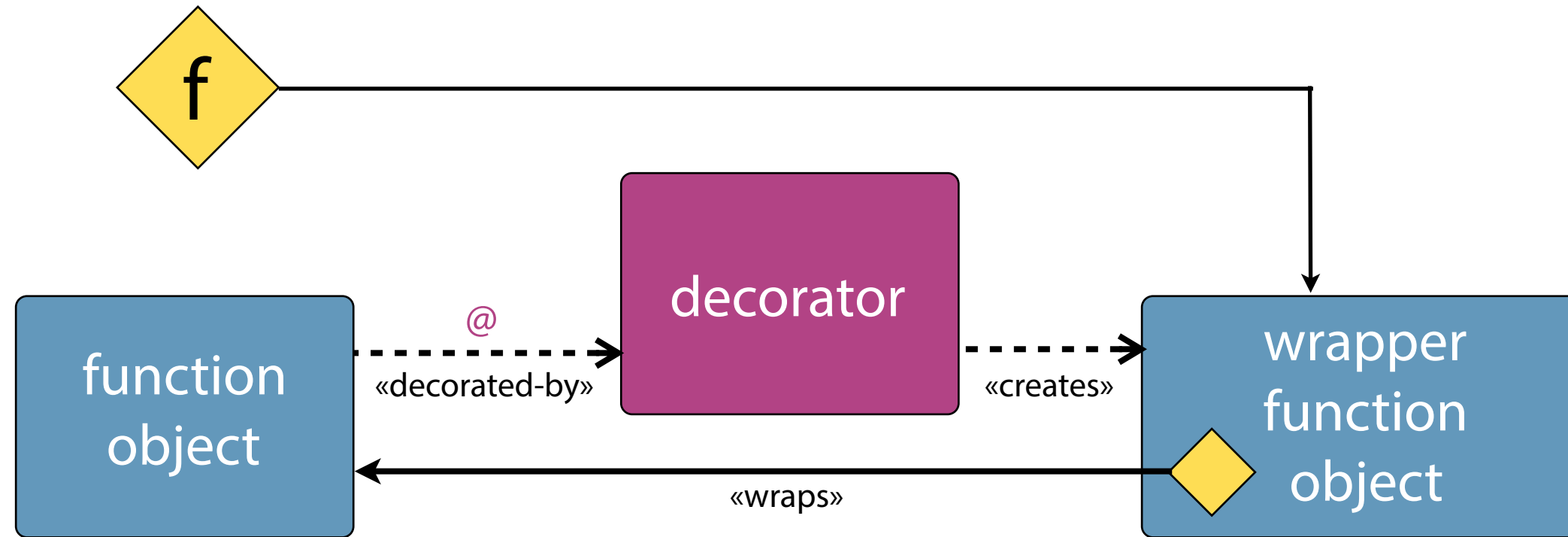
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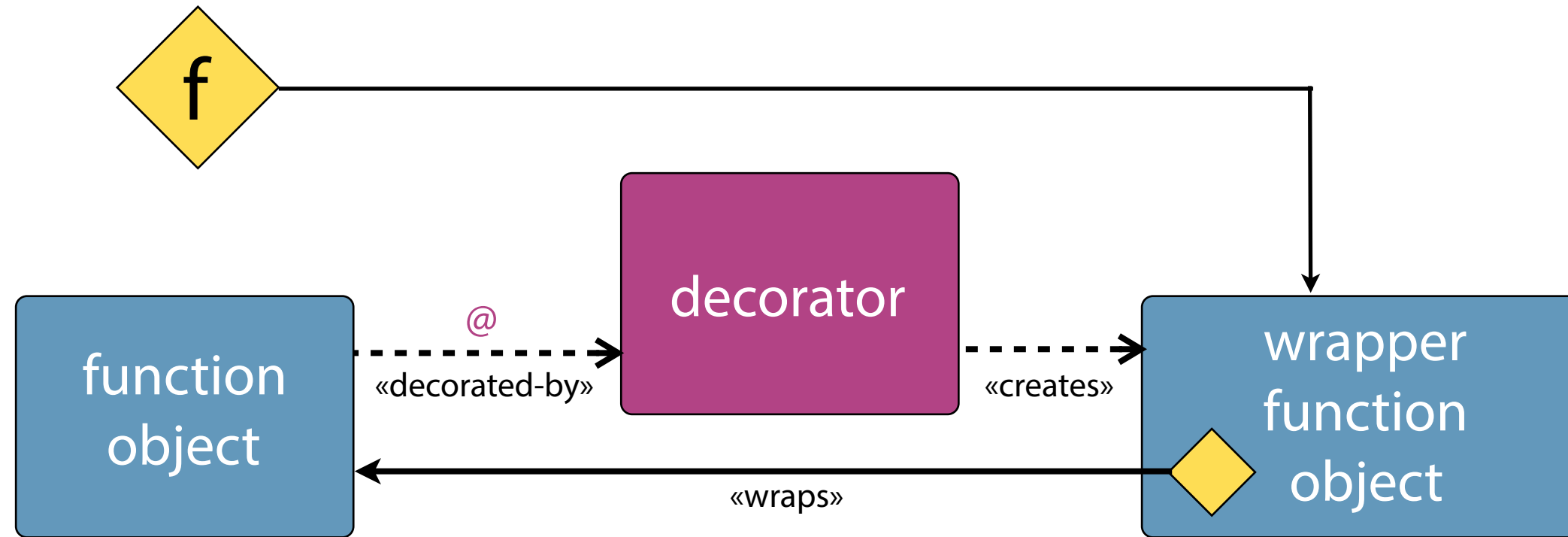
The property object is a descriptor

Decorators Are Just Functions



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@decorator
def f():
    do_something()
```

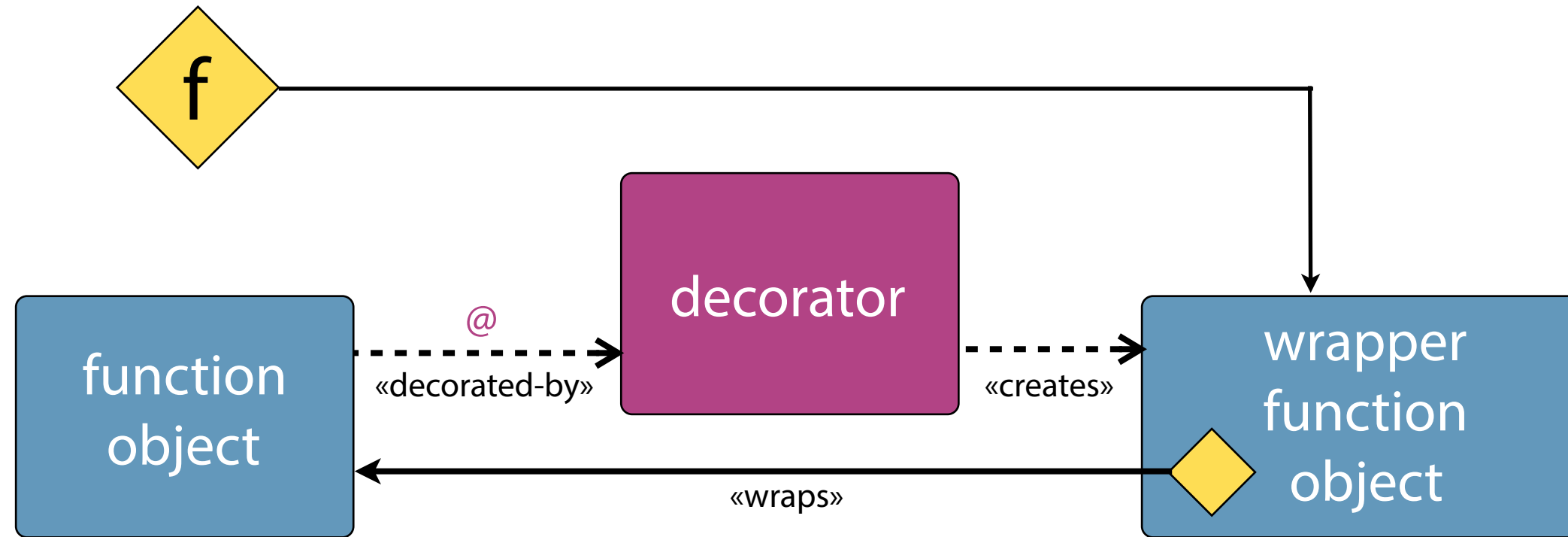
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Decorators Are Just Functions



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@decorator
def f():
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```
def f():
    do_something()

f = decorator(f)
```

Conceptual Descriptor Operations

Descriptor Operations Can Do Almost Anything!

Conceptual Descriptor Operations



Get

Descriptor Operations Can Do Almost Anything!

Conceptual Descriptor Operations



Get

The diagram consists of two adjacent light gray rectangular boxes. The left box contains the word 'Get' in orange text, and the right box contains the word 'Set' in blue text. These boxes are positioned below the title and above the concluding statement.

Set

Descriptor Operations Can Do Almost Anything!

Conceptual Descriptor Operations

Get

Set

Delete

Descriptor Operations Can Do Almost Anything!

Implementing a Descriptor

Implementing a Descriptor

```
from weakref import WeakKeyDictionary

class Positive:

    def __init__(self):
        self._instance_data = WeakKeyDictionary()

    def __get__(self, instance, owner):
        return self._instance_data[instance]

    def __set__(self, instance, value):
        if value <= 0:
            raise ValueError("Value {} is not positive".format(value))
        self._instance_data[instance] = value

    def __delete__(self, instance):
        raise AttributeError("Cannot delete attribute")
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Descriptor
Protocol

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>>> pluto = Planet(name='Pluto', radius_metres=1184e3,  
... mass_kilograms=1.305e22, orbital_period_seconds=7816012992,  
... surface_temperature_kelvin=55)
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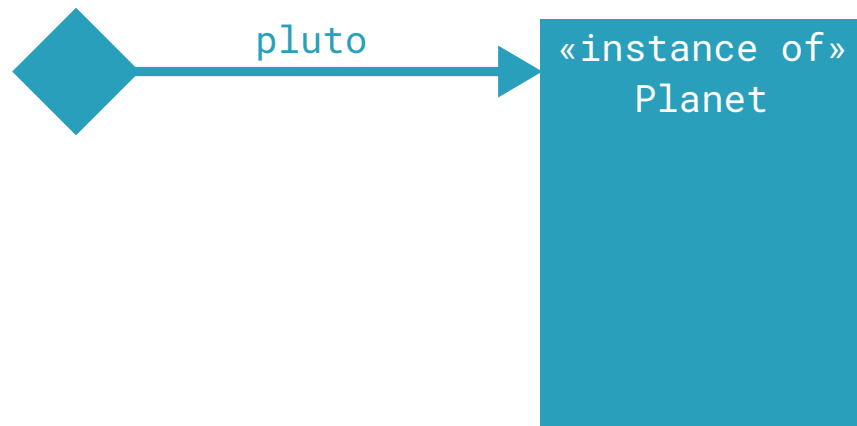
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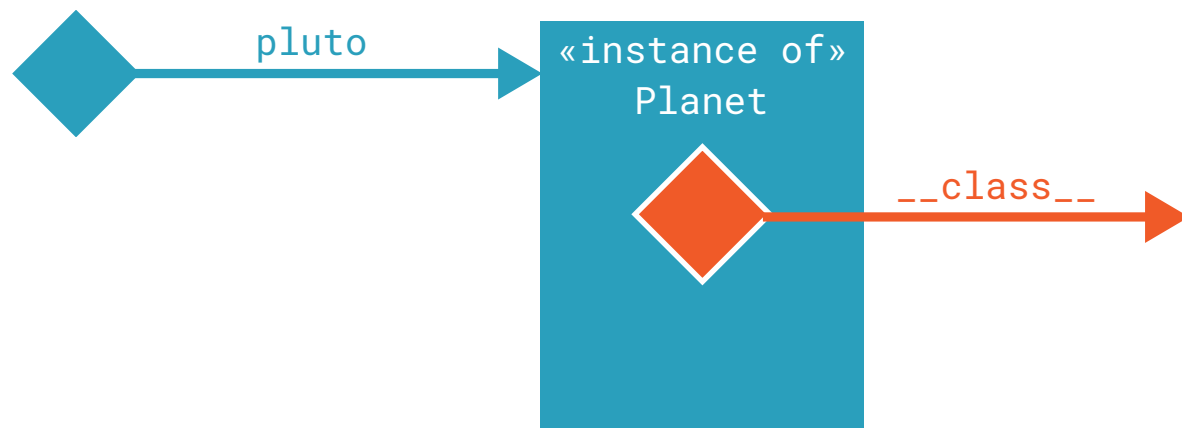
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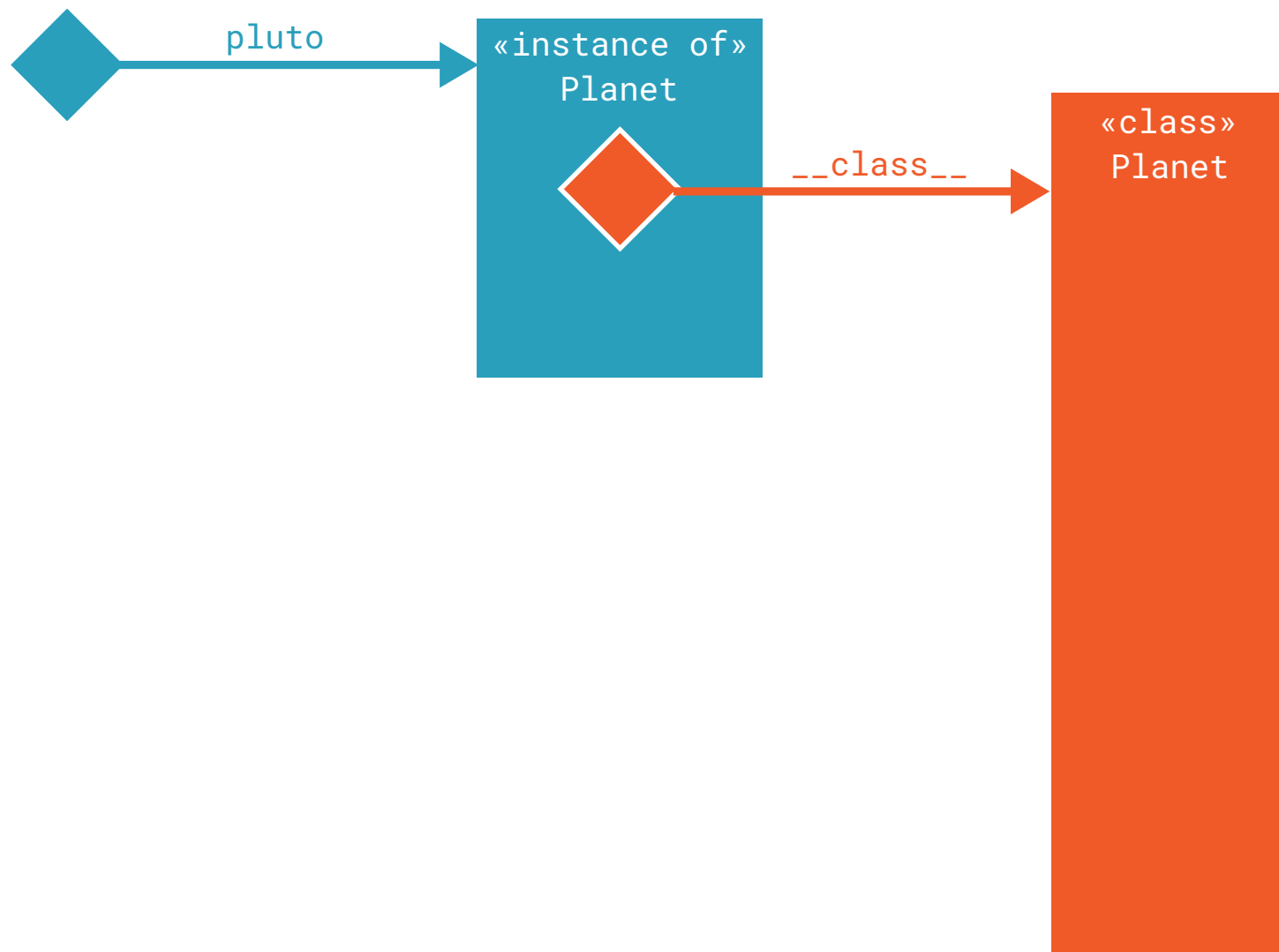
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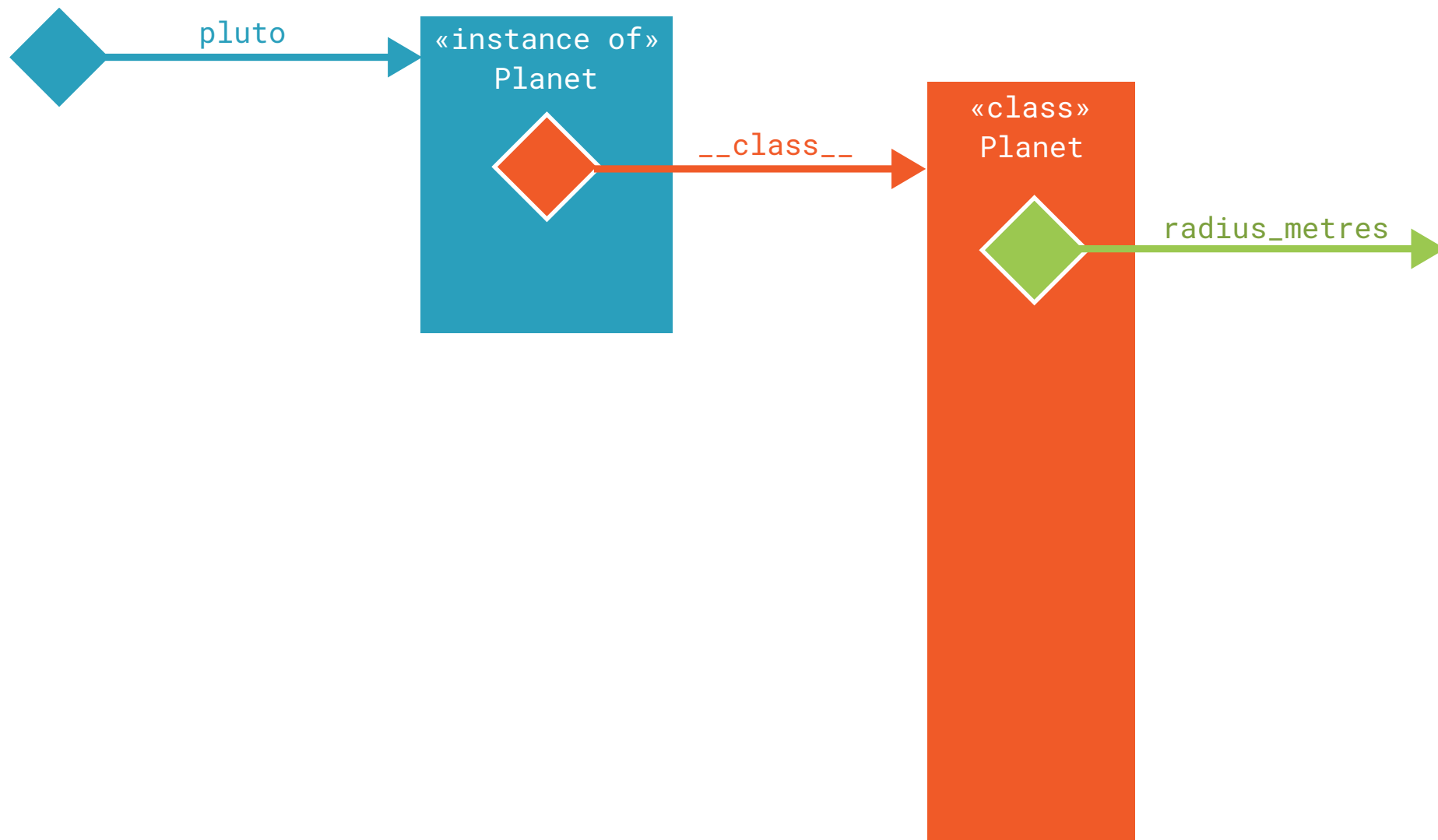
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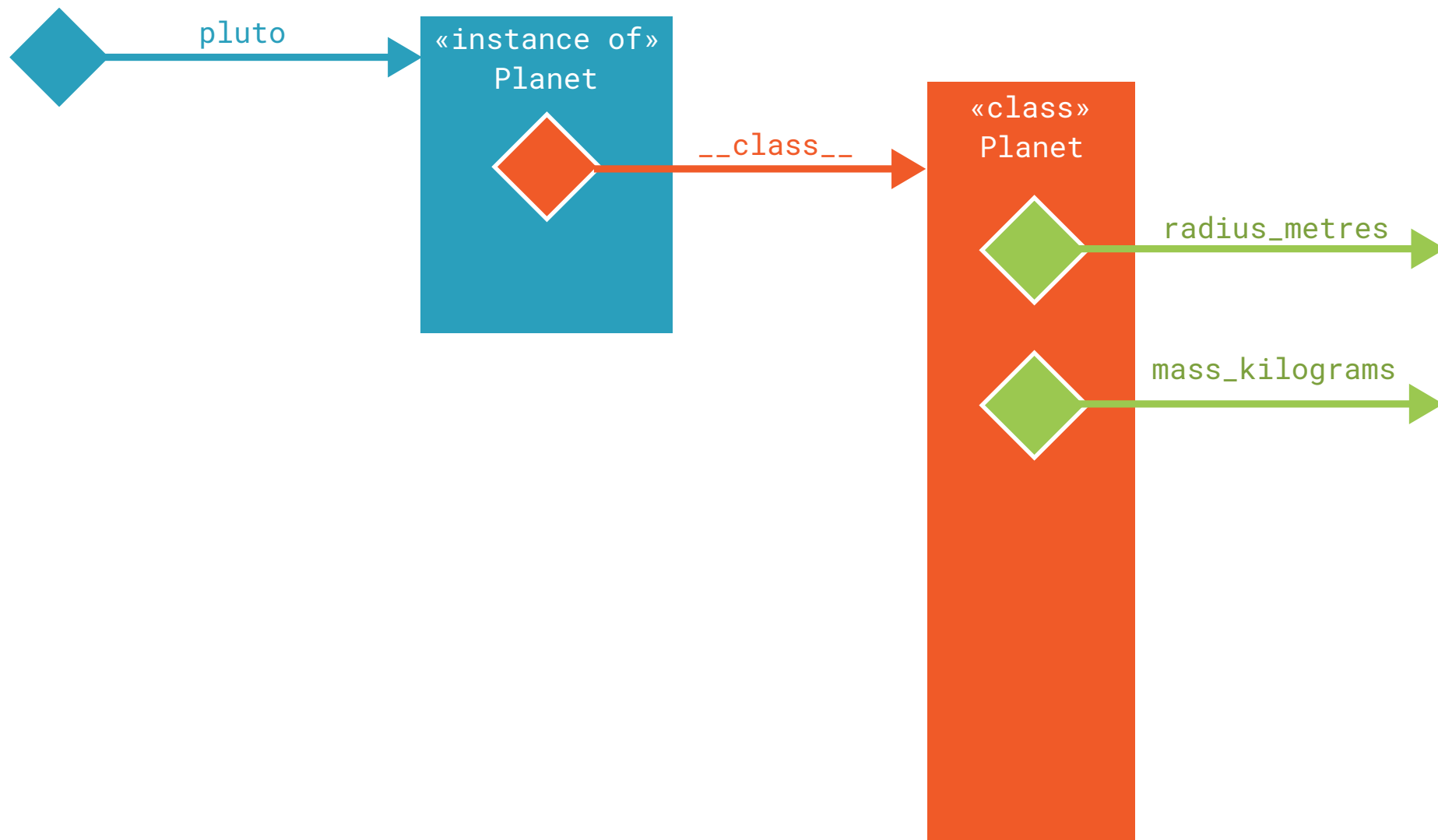
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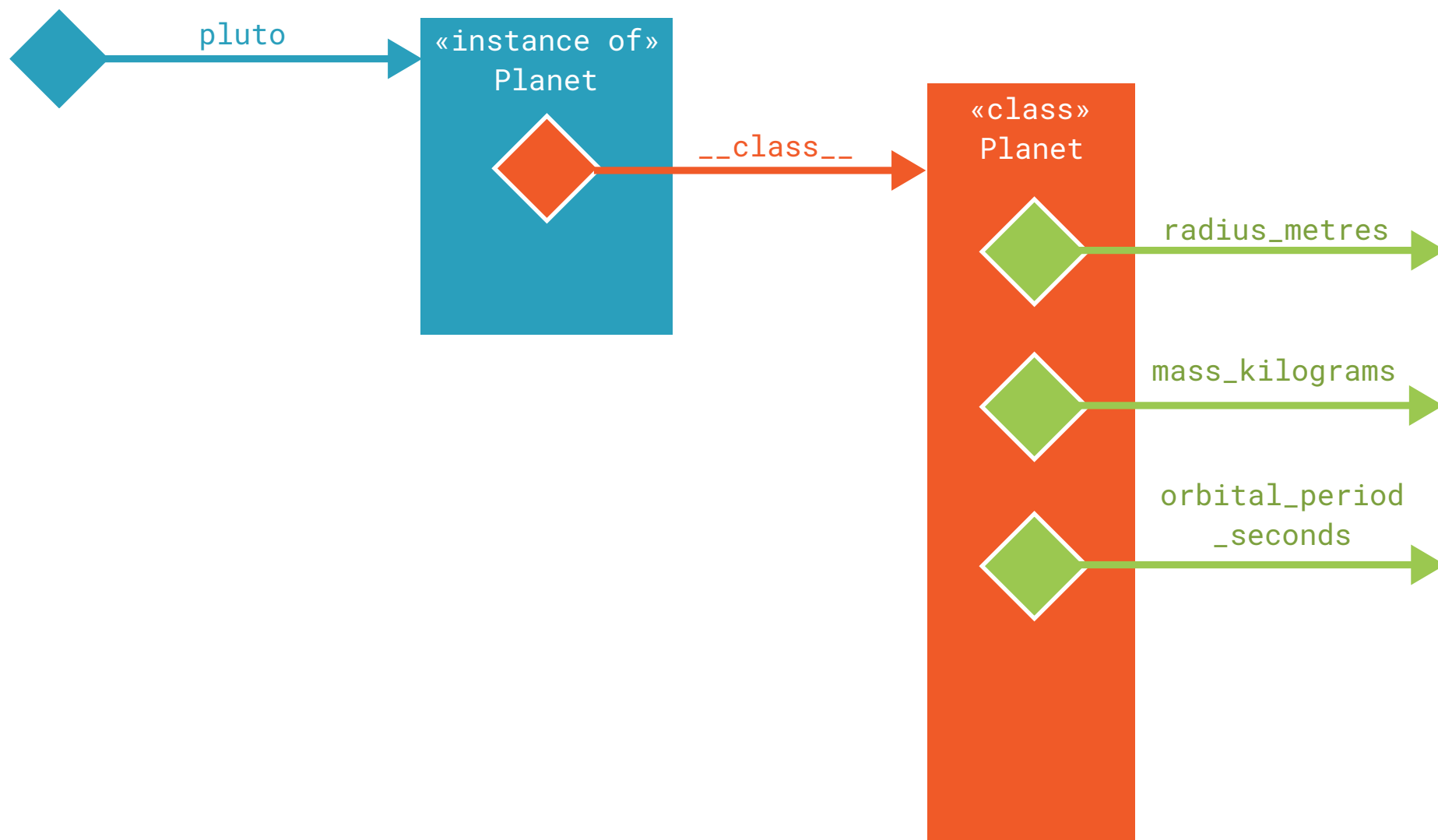
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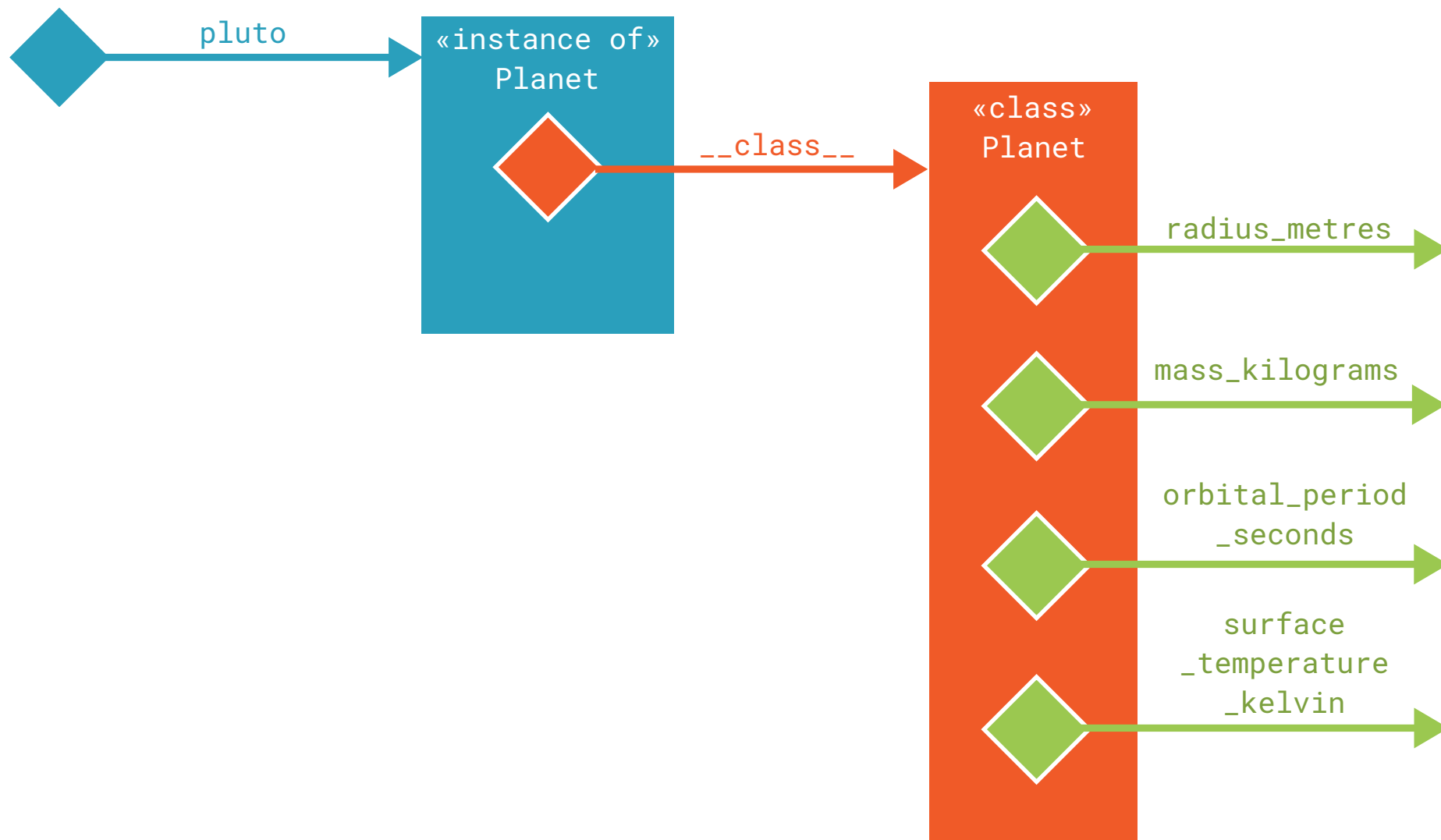
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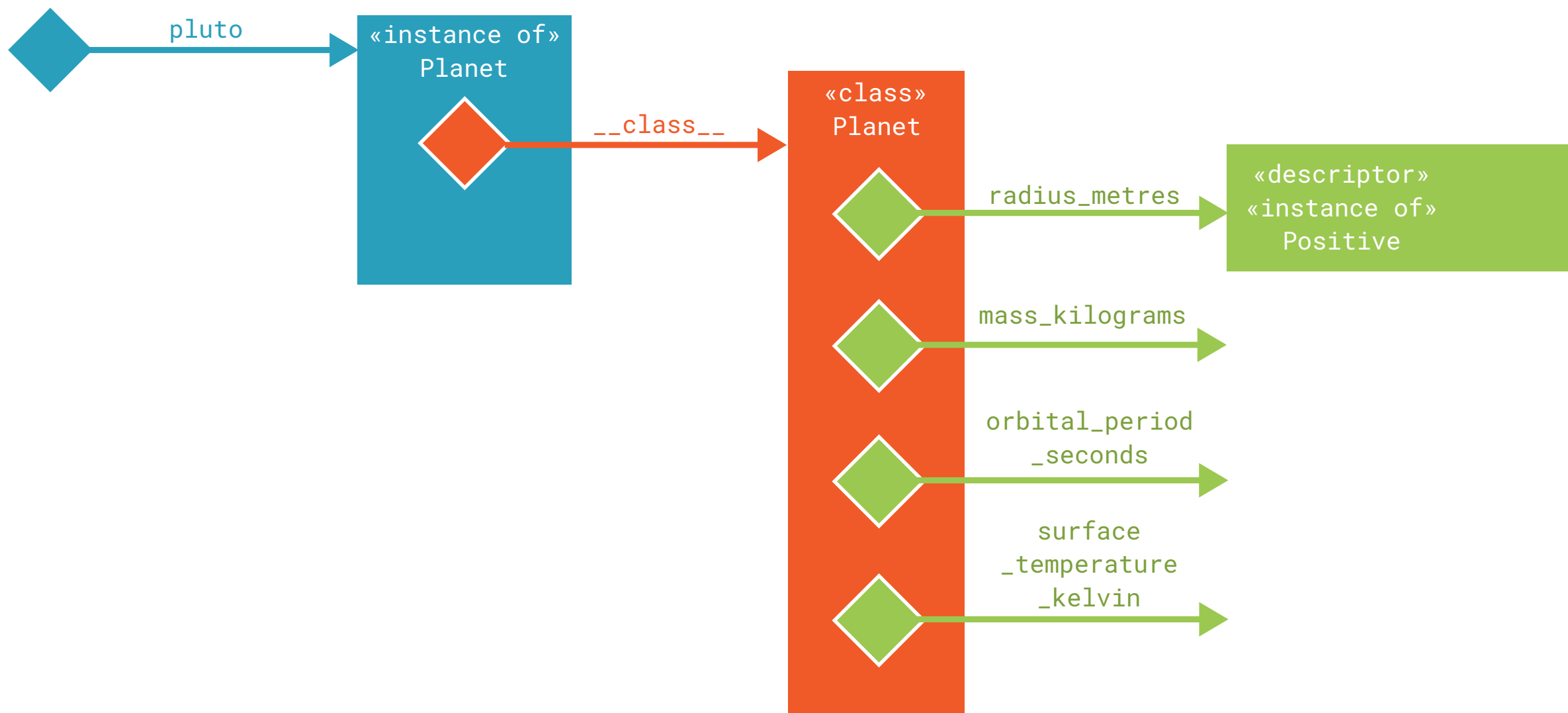
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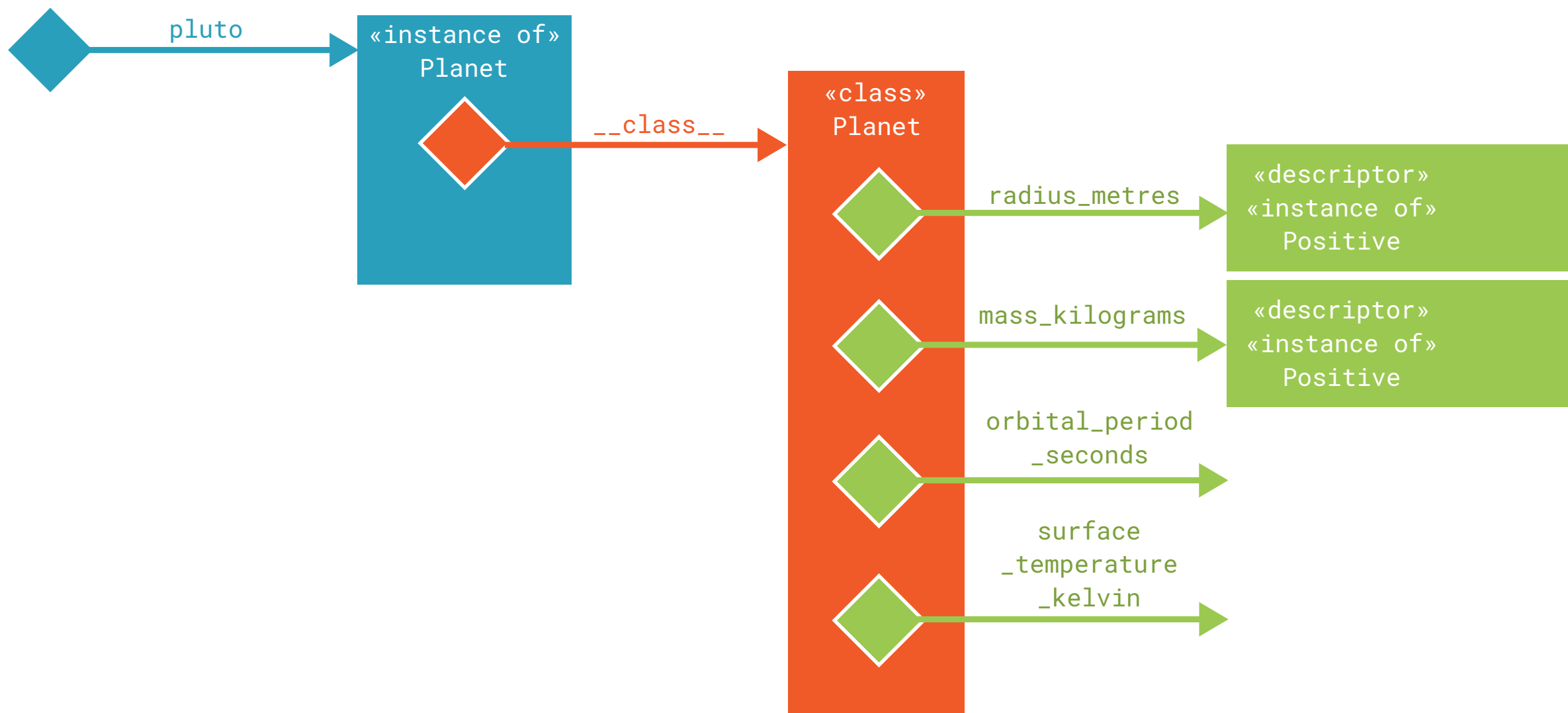
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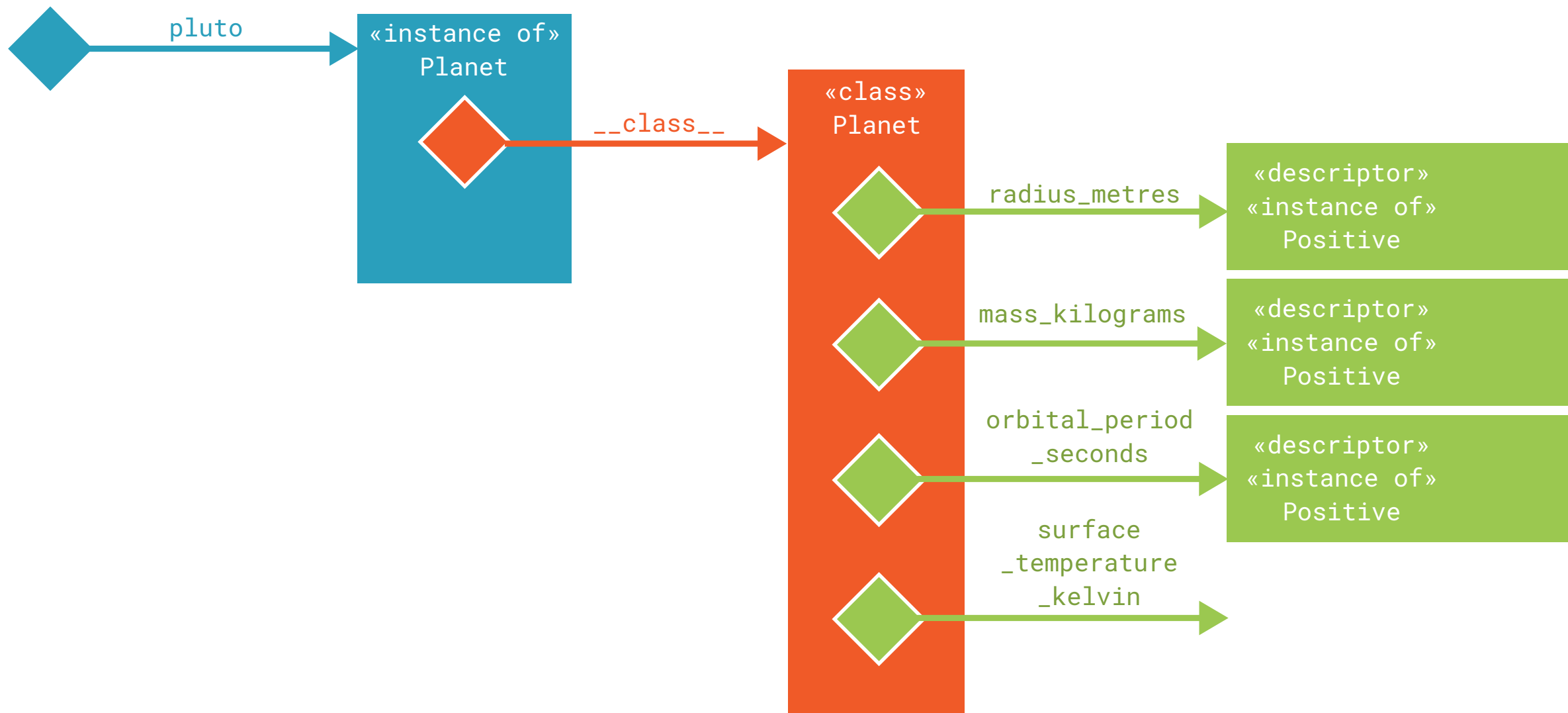
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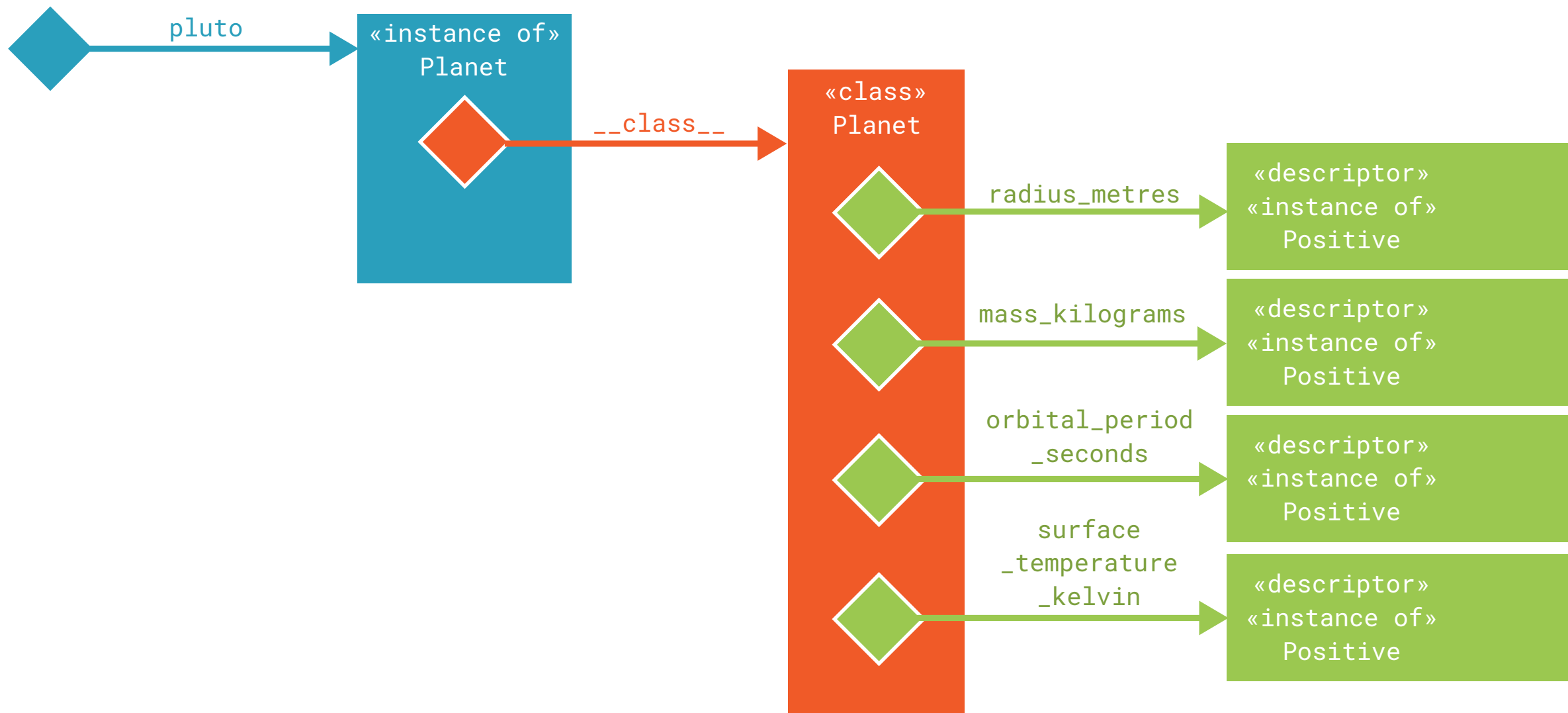
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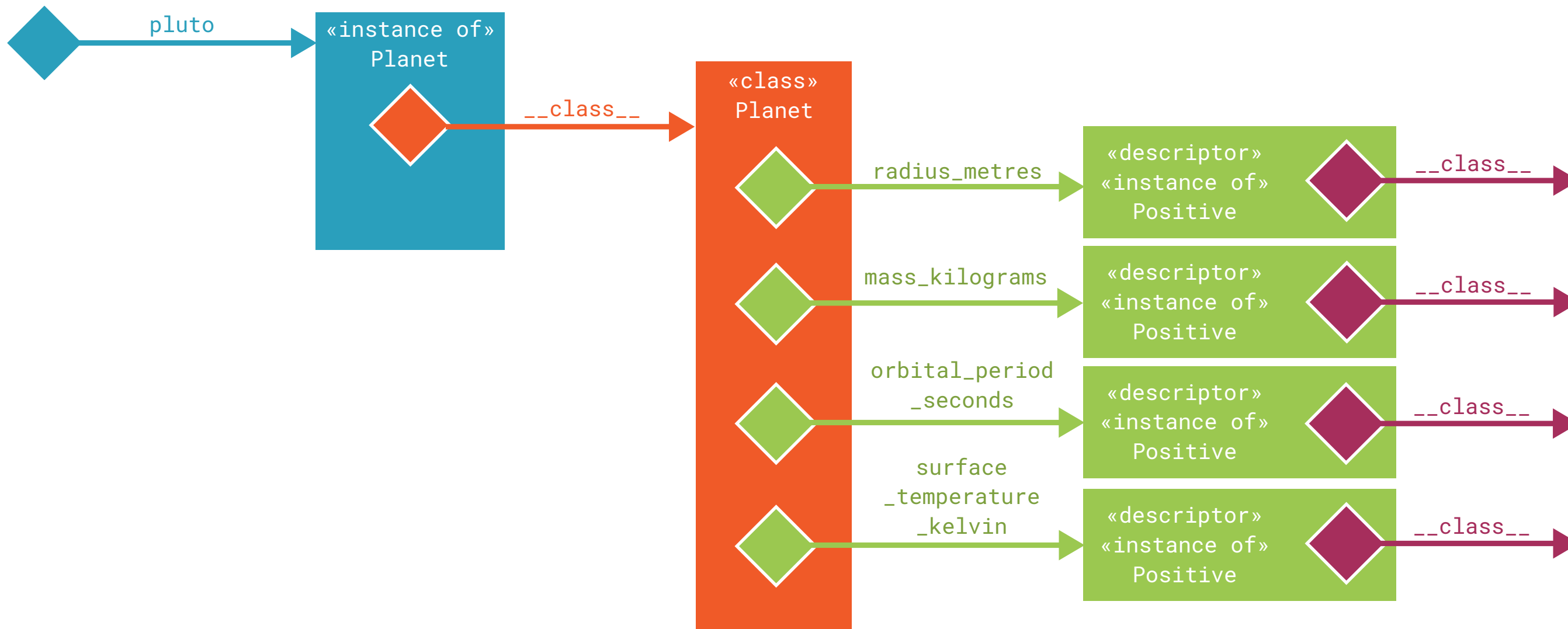
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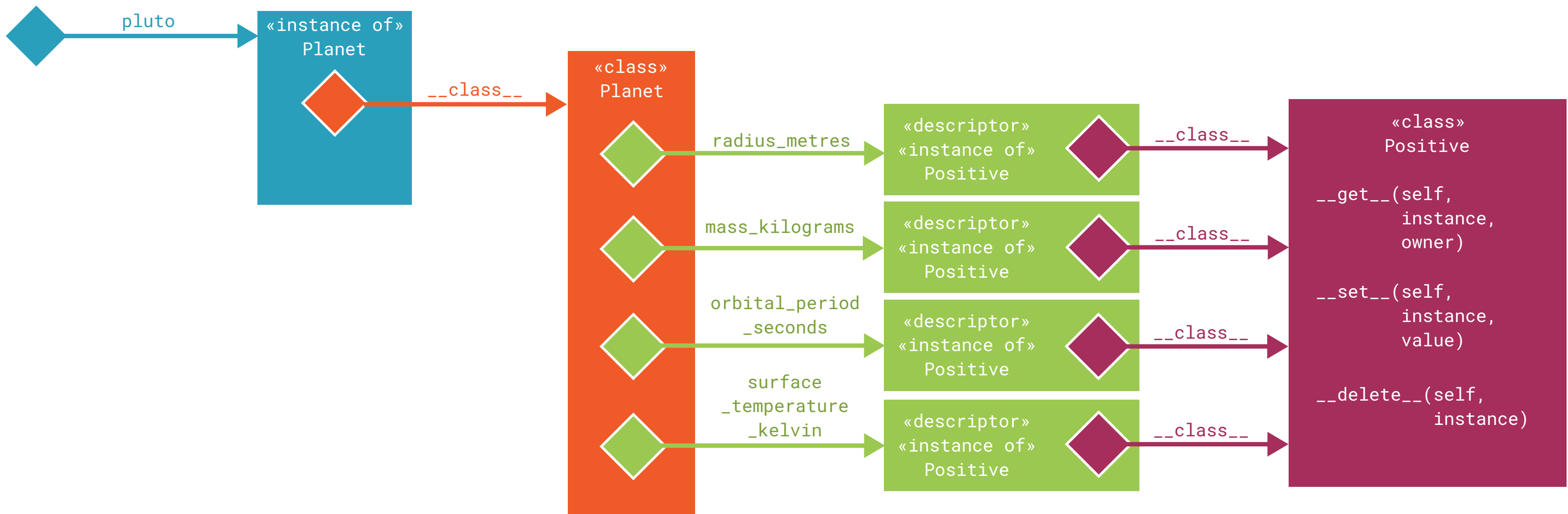
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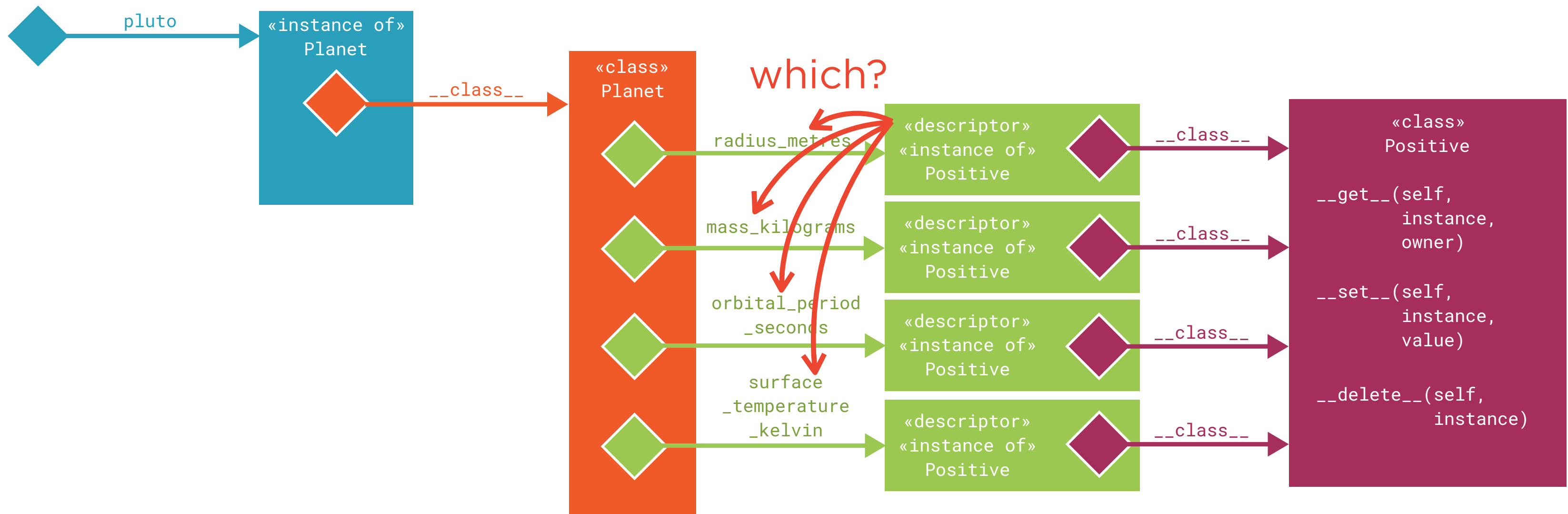
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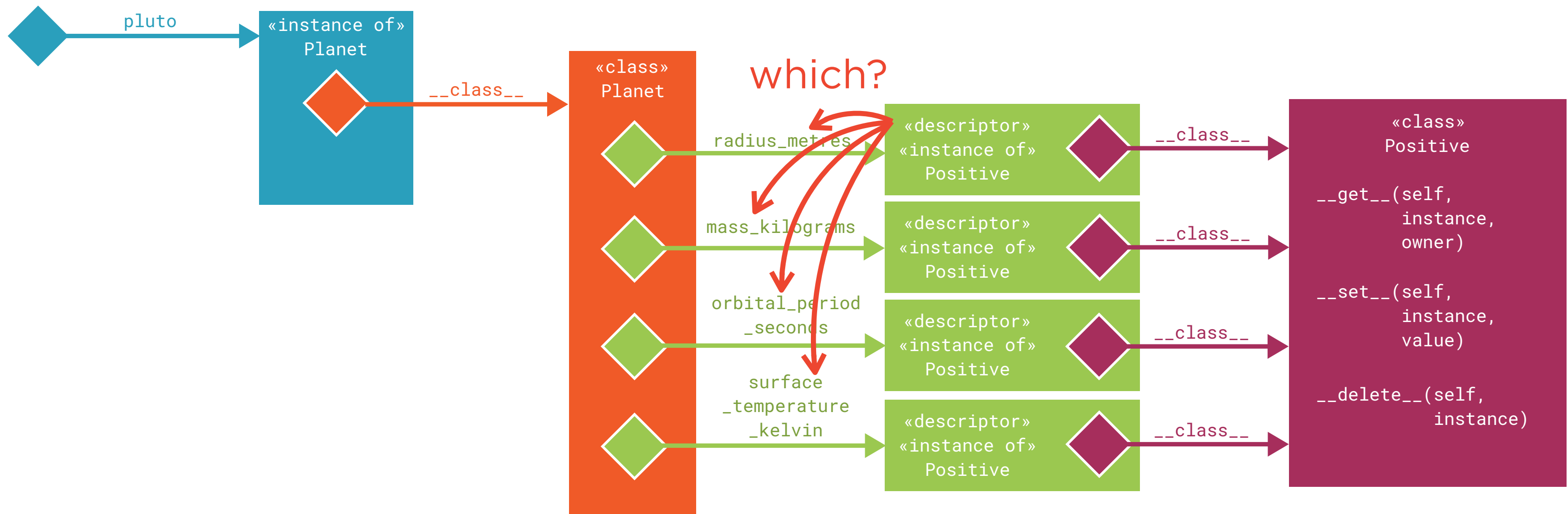
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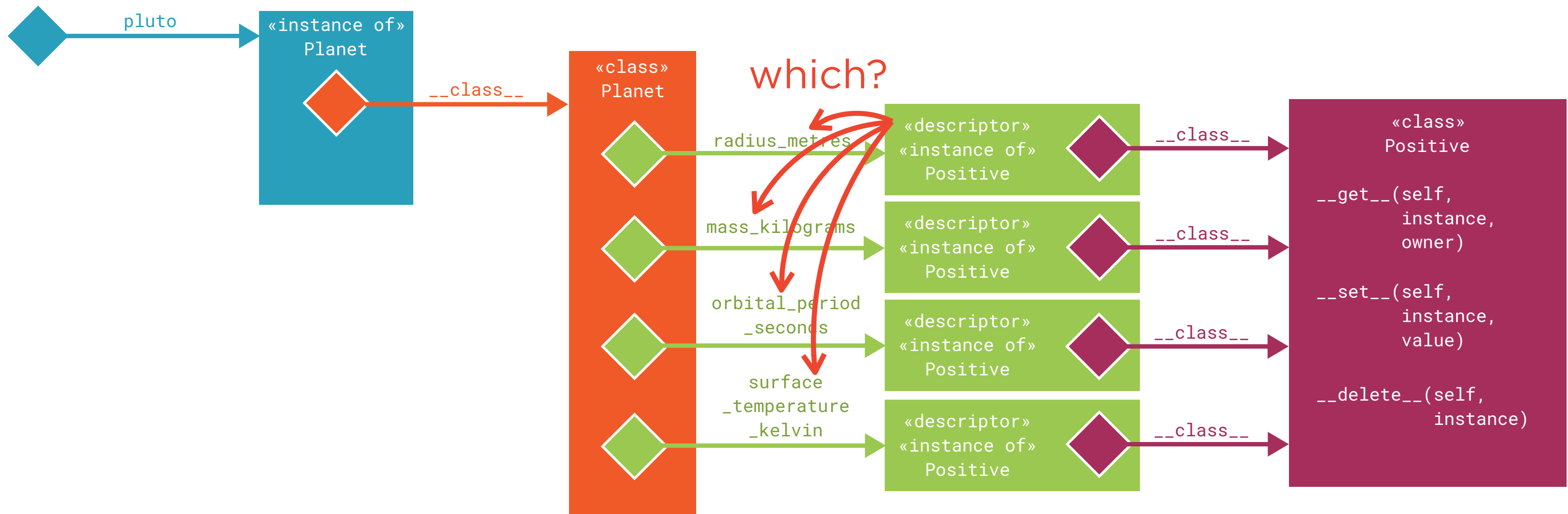
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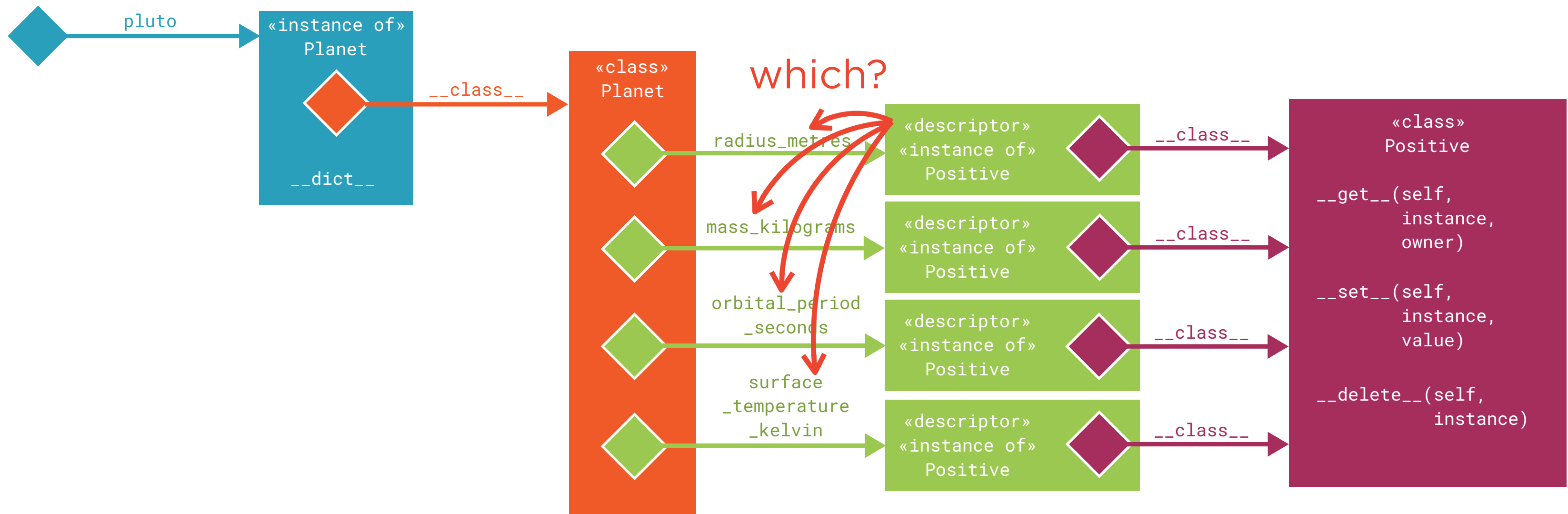


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No way of correlating
descriptor instances
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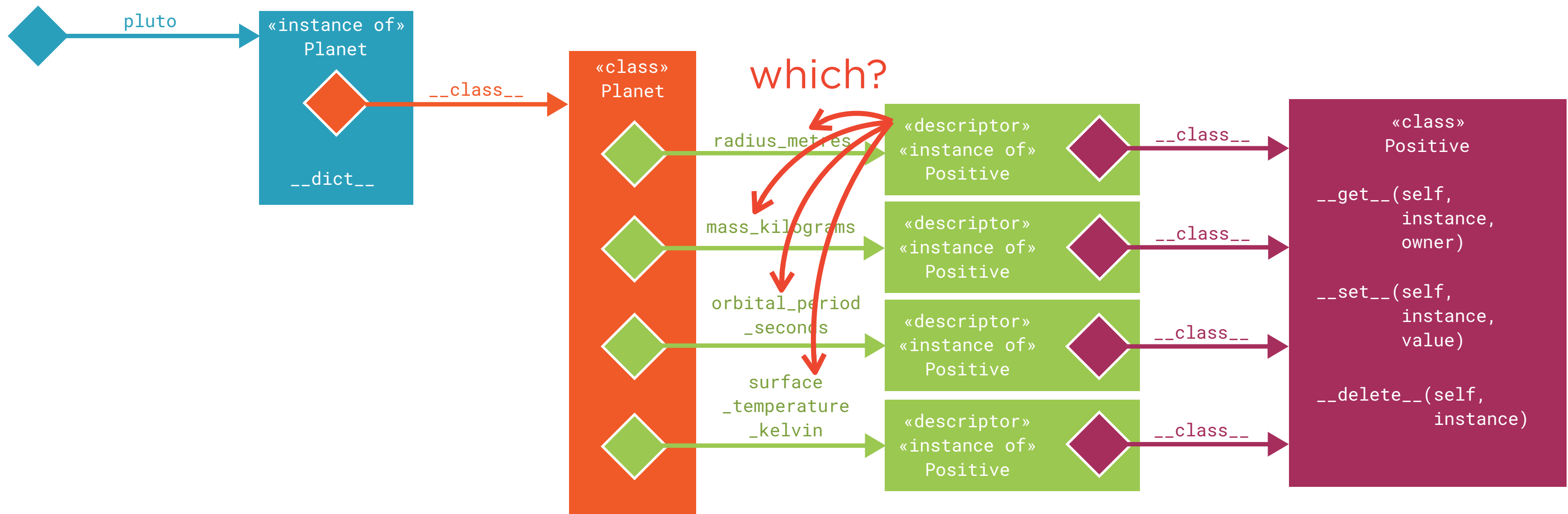


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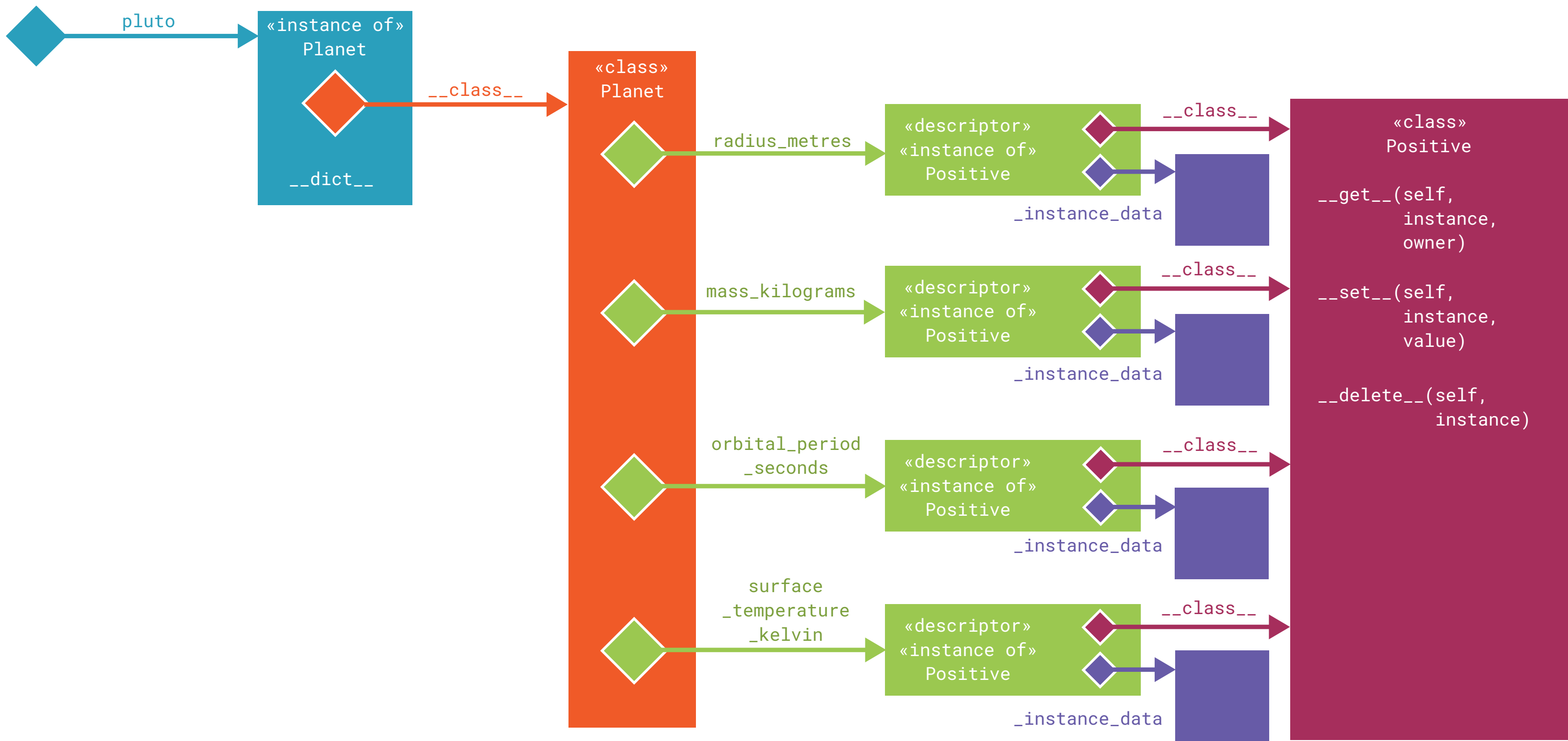


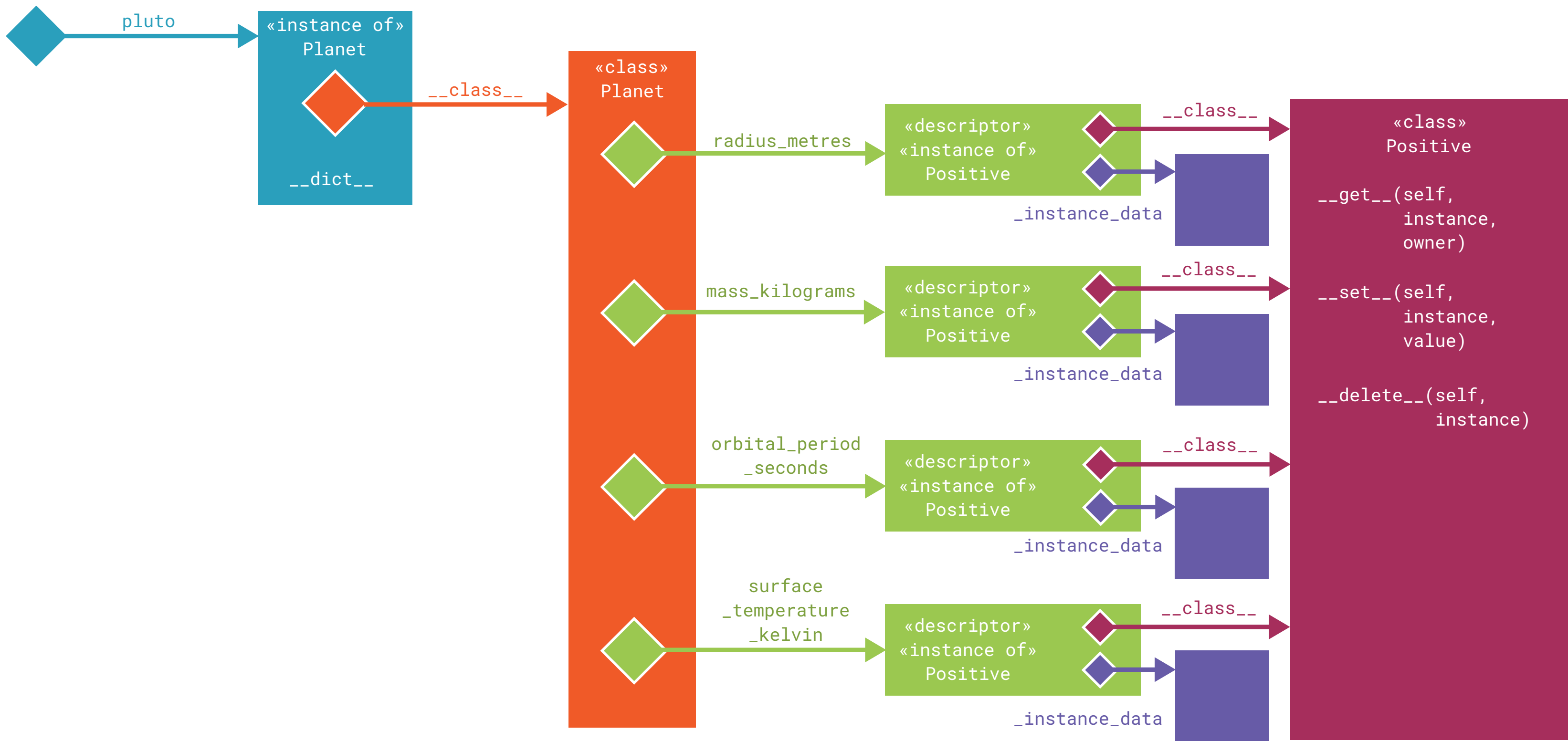
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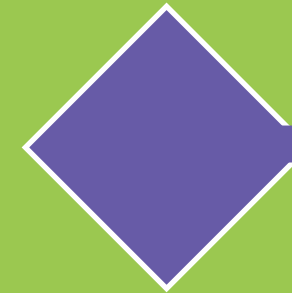
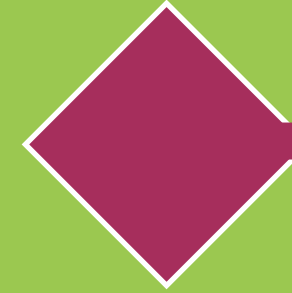




`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`

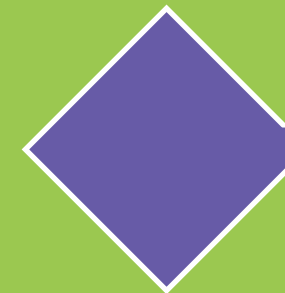
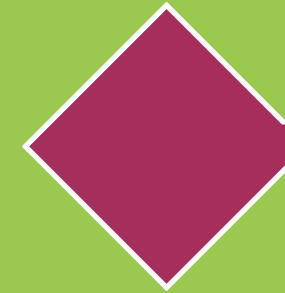


`_instance_data`

`_instance_data`



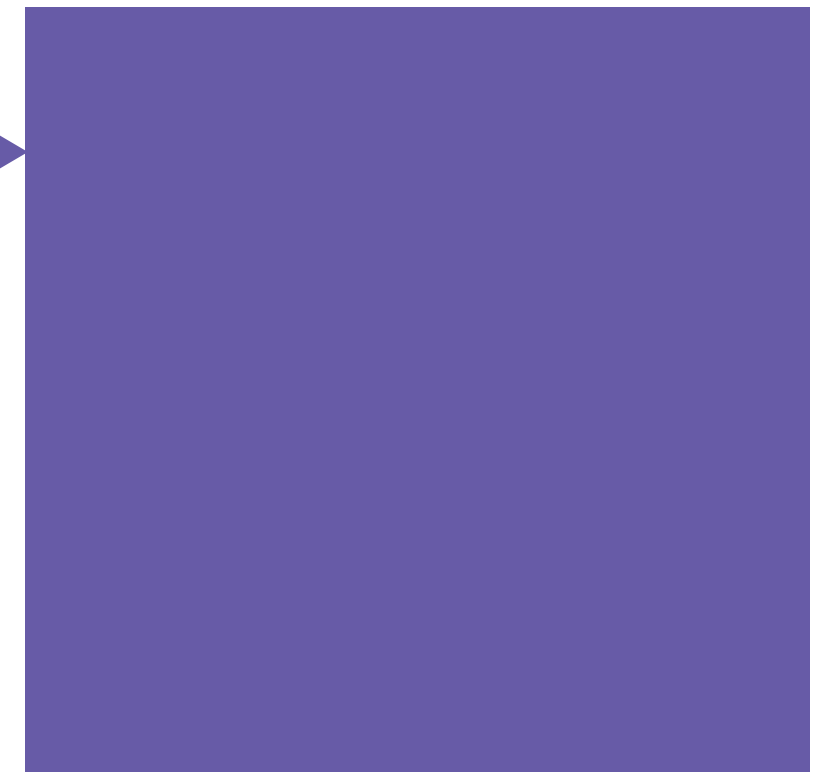
«descriptor»
«instance of»
Positive



`__class__`

WeakKeyDictionary

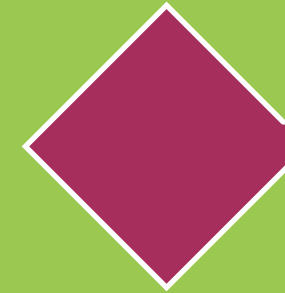
`_instance_data`



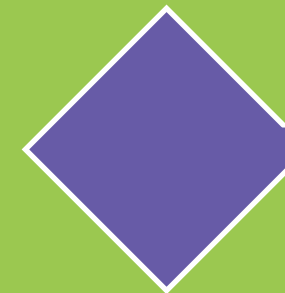
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



WeakKeyDictionary

`pluto: 1.31e22`

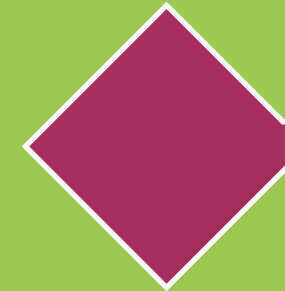
`_instance_data`



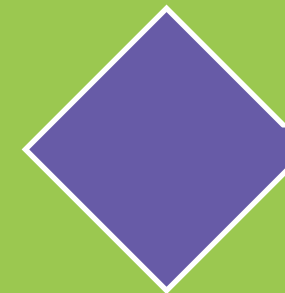
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



WeakKeyDictionary

```
pluto: 1.31e22  
mars: 6.39e23
```

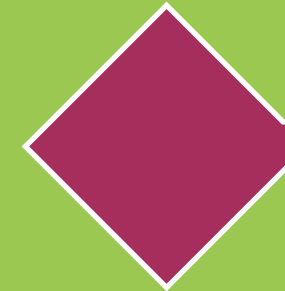
`_instance_data`



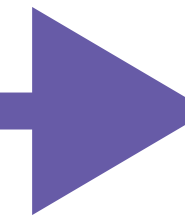
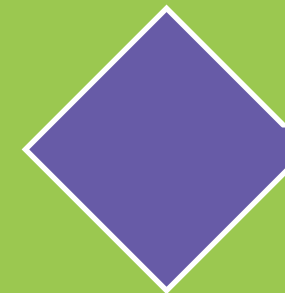
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



WeakKeyDictionary

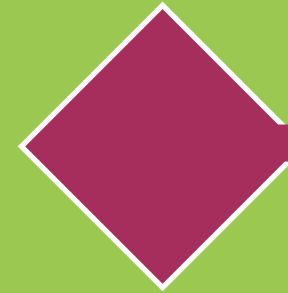
```
pluto: 1.31e22  
mars: 6.39e23  
earth: 5.97e24
```

`_instance_data`

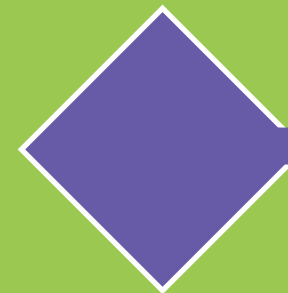
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



`_instance_data`

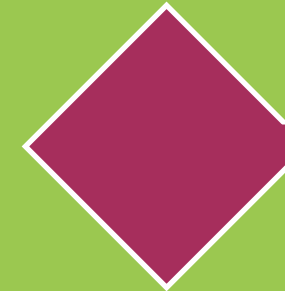
WeakKeyDictionary

```
pluto: 1.31e22  
mars: 6.39e23  
earth: 5.97e24  
venus: 4.87e24
```

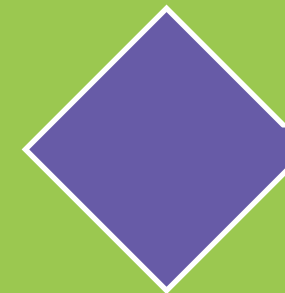
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



WeakKeyDictionary

```
pluto: 1.31e22  
mars: 6.39e23  
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venus: 4.87e24
```

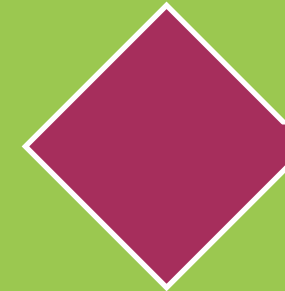
`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

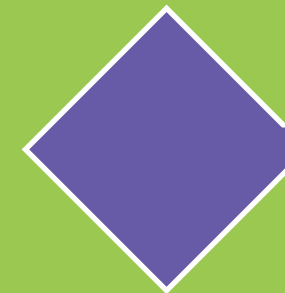
`_instance_data`



«descriptor»
«instance of»
Positive



`__class__`



WeakKeyDictionary

```
pluto: 1.31e22  
mars: 6.39e23  
earth: 5.97e24  
venus: 4.87e24
```

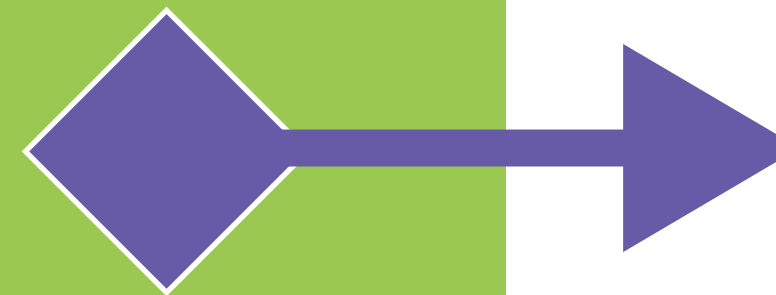
`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

`_instance_data`



`__class__`



«descriptor»
«instance of»
Positive

WeakKeyDictionary

```
pluto: 1.31e22  
mars: 6.39e23  
earth: 5.97e24  
venus: 4.87e24
```

`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

`_instance_data`

```
earth: 5.97e24
```

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

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pluto: 1.31e22  
mars: 6.39e23  
earth: 5.97e24  
venus: 4.87e24
```

`_instance_data`

All mass_in_kilograms
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WeakKeyDictionary

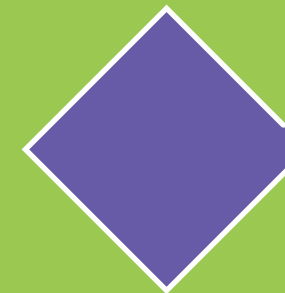
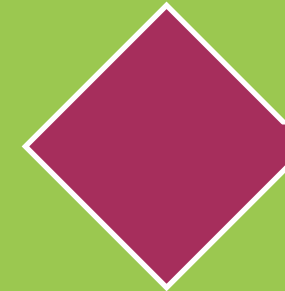
`_instance_data`

All radius_in_metres
values stored in a single
WeakKeyDictionary

`earth: 5.97e24`

«descriptor»
«instance of»
Positive

`__class__`



WeakKeyDictionary

`pluto: 1.31e22`

`mars: 6.39e23`

`earth: 5.97e24`

`venus: 4.87e24`

`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

`_instance_data`

All radius_in_metres
values stored in a single
WeakKeyDictionary

`earth: 6.37e6`
`venus: 6.05e6`

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

`pluto: 1.31e22`
`mars: 6.39e23`
`earth: 5.97e24`
`venus: 4.87e24`

`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

`_instance_data`

All radius_in_metres
values stored in a single
WeakKeyDictionary

`earth: 6.37e6`
`venus: 6.05e6`

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

`pluto: 1.31e22`
`mars: 6.39e23`
`earth: 5.97e24`
`venus: 4.87e24`

`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

keys are weak-references
to Planet **instances** – not
names

`_instance_data`

All radius_in_metres
values stored in a single
WeakKeyDictionary

`earth: 6.37e6`
`venus: 6.05e6`

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

`pluto: 1.31e22`
`mars: 6.39e23`
`earth: 5.97e24`
`venus: 4.87e24`

`_instance_data`

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WeakKeyDictionary

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`_instance_data`

All radius_in_metres
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WeakKeyDictionary

`venus: 6.05e6`

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

`pluto: 1.31e22`

`mars: 6.39e23`

`venus: 4.87e24`

`_instance_data`

All mass_in_kilograms
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`_instance_data`

All radius_in_metres
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`venus: 6.05e6`

«descriptor»
«instance of»
Positive

`__class__`

WeakKeyDictionary

`pluto: 1.31e22`

`mars: 6.39e23`

`venus: 4.87e24`

`_instance_data`

All mass_in_kilograms
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WeakKeyDictionary

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names

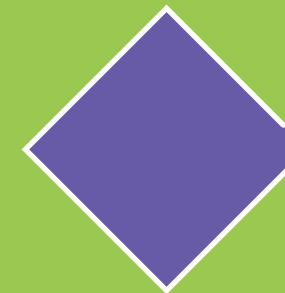
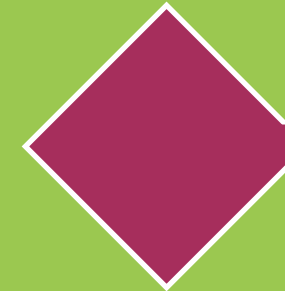
`_instance_data`

All radius_in_metres
values stored in a single
WeakKeyDictionary

`venus: 4.87e24`

«descriptor»
«instance of»
Positive

`__class__`



`_instance_data`

All mass_in_kilograms
values stored in a single
WeakKeyDictionary

WeakKeyDictionary

`pluto: 1.31e22`

`mars: 6.39e23`

`venus: 4.87e24`

keys are weak-references
to Planet **instances** – not
names

Calling Descriptors on Classes

Data- Versus Non-Data Descriptors

Descriptor Categories

Descriptor Categories

Non-Data Descriptor

`__get__()`

Non-data descriptors define **neither**
`__set__()` **nor** `__delete__()`

Descriptor Categories

Non-Data Descriptor

`__get__()`

Non-data descriptors define **neither**
`__set__()` **nor** `__delete__()`

Data Descriptor

`__get__()`

`__set__()`

and / or

`__delete__()`

Attribute Lookup

`object.__getattr__`

Attribute Lookup

`object.__getattr__`

`obj.attr`

Attribute Lookup

`object.__getattr__`

`obj.attr`

`type(obj).__dict__['attr'].__get__(obj, type(obj))`

Attribute Lookup Precedence

Attribute Lookup Precedence

If an instance `__dict__` has an entry with the same name as a **data-descriptor** (`__get__`, `__set__`/`__delete__`) the **data-descriptor** takes precedence

Attribute Lookup Precedence

If an instance `__dict__` has an entry with the same name as a **data-descriptor** (`__get__`, `__set__`/`__delete__`) the **data-descriptor** takes precedence

If an instance `__dict__` has an entry with the same name as a **non-data-descriptor** (`__get__`) the entry in `__dict__` takes precedence

Attribute Lookup Precedence

Attribute Lookup Precedence

1 data descriptor in class

Attribute Lookup Precedence

1 data descriptor in class

2 instance attribute in `__dict__`

Attribute Lookup Precedence

1 data descriptor in class

2 instance attribute in `__dict__`

3 non-data descriptor in class

Summary

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Reviewed built-in property decorator

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**Create property descriptors without
decorators**

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Create property descriptors without decorators

Implement the descriptor protocol

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Reviewed built-in property decorator

Create property descriptors without decorators

Implement the descriptor protocol

Store per-instance attributes

Summary

Reviewed built-in property decorator

Create property descriptors without decorators

Implement the descriptor protocol

Store per-instance attributes

Class versus instance descriptor lookup