NPRG065: Programming in Python
Lecture 11

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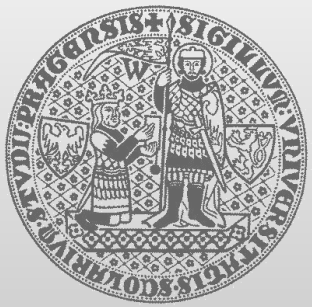

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faculty of mathematics and physics

Descriptors

- Descriptor ~ an object attribute with the methods
  - __get__(self, instance, owner)
  - __set__(self, instance, value)
  - __delete__(self, instance)

  - methods called when the attribute is accessed

- Compared to __getattr__, etc.
  - __getattr__, etc. defined on the class with attribute
  - __get__, etc. defined on the attribute's class

See descriptors.py

Instance attribute lookup

```
class Class:
    ...

instance = Class()
instance.foobar
```

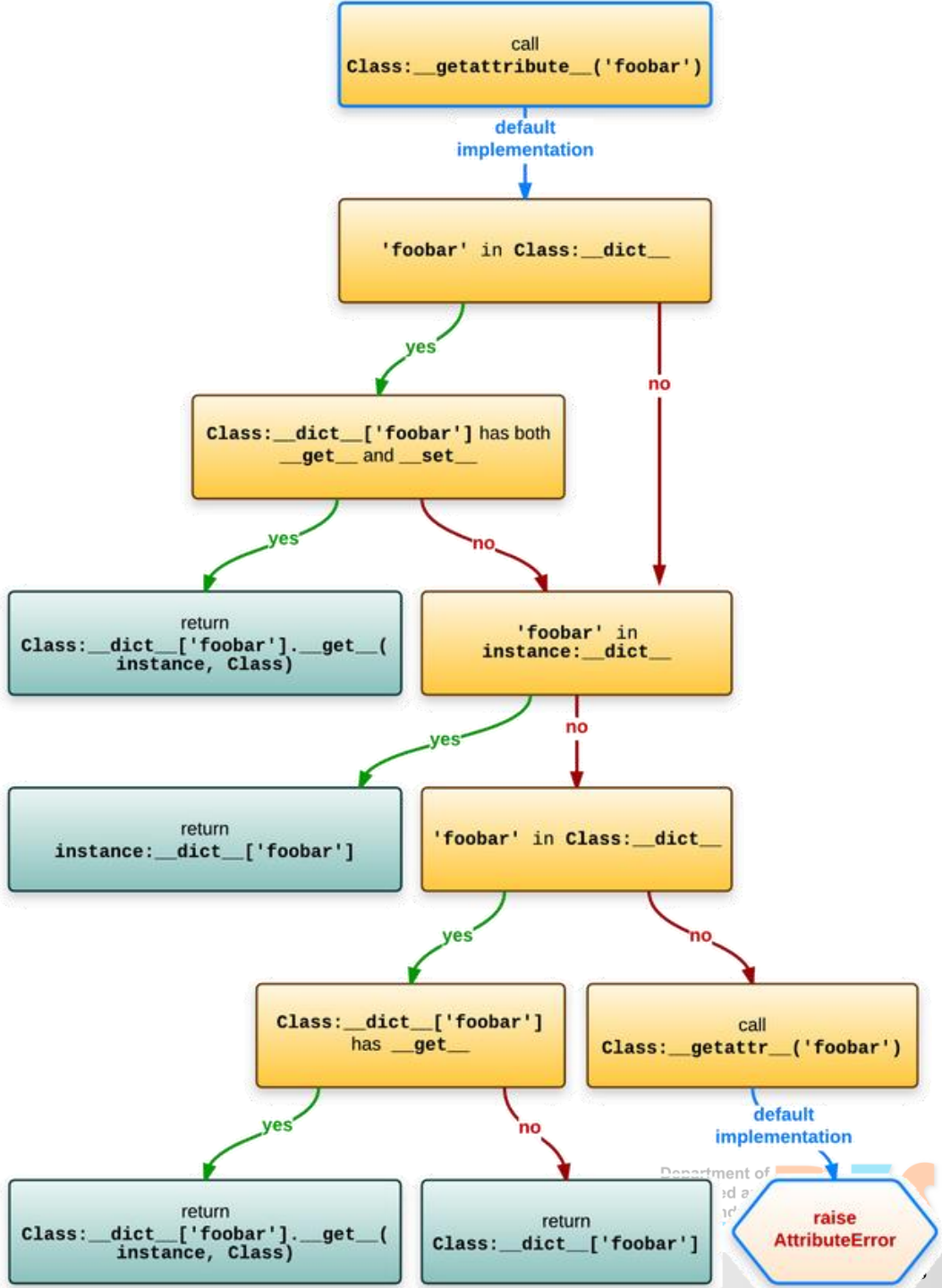

Figure from https://blog.ionelmc.ro/2015/02/09/understanding-python-metaclasses/

__new__(cls[, ...])

- the real “constructor” (create the object)
  - __init__ only initializes the object, it does not create it
- a class method
- creates a new instance of class cls
- remaining arguments are those passed to the object constructor expression
- if __new__() returns an instance of cls, then the new instance’s __init__() will be invoked like __init__(self[, ...]), where self is the new instance and the remaining arguments are the same as were passed to __new__()
- allows subclasses of immutable types (like int, str, or tuple) to customize instance creation

See new_immutable.py

Metaclasses

- Factories for creating classes
- “Common” class definition

```
class Spam:
    eggs = 'my eggs'
```

- Procedural definition via metaclass

```
Spam = type('Spam', (object,), dict(eggs='my eggs'))
```

- These two definitions are completely equivalent
  - In fact, Python transforms the first one into the second one
- **`type`** is a metaclass

See meta_basic.py

Metaclasses

- Even in “common” definition, we can prescribe the metaclass

```
class Spam:
    eggs = 'my eggs'
```

  - is equivalent to

```
class Spam(metaclass=type):
    eggs = 'my eggs'
```

- We can define own metaclasses
  - as subclasses of **`type`**

See meta_basic_own.py

Metaclasses

See
meta_examples.py
for more examples

Class attribute lookup

```
class Class:
    ...

Class.foobar
```

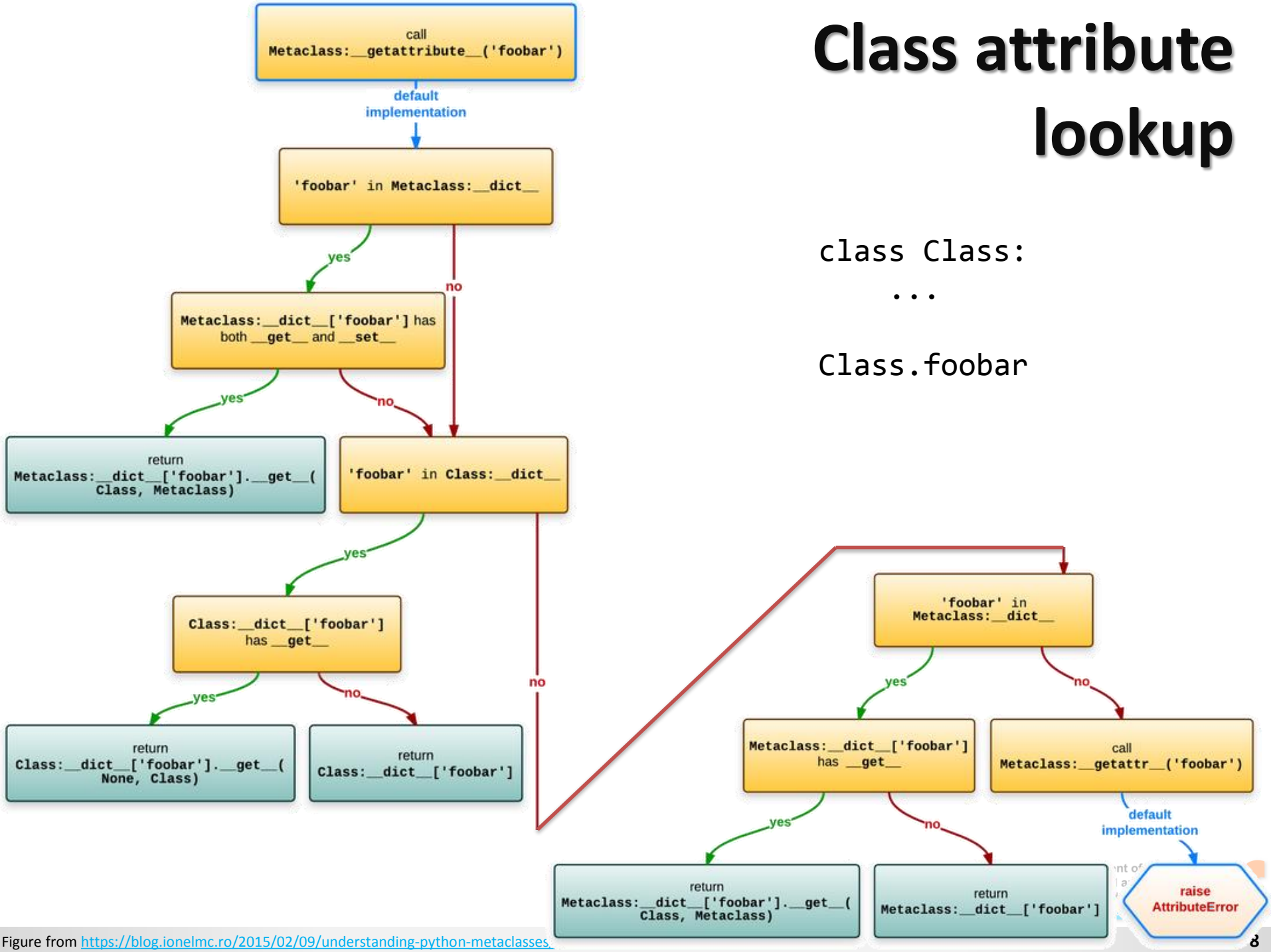

Figure from https://blog.ionelmc.ro/2015/02/09/understanding-python-metaclasses/

Metaclasses

- Metaclasses are used within the implementation of Abstract Base Classes (see lecture 8)

```
import abc

class PluginBase(abc.ABC):
    @abc.abstractmethod
    def process(self, input):
        pass

class ToUpperPlugin(PluginBase):
    def process(self, input):
        return input.upper()
```

- ABC class has ABCMeta metaclass
  - the following definition is equivalent

See meta_abc.py

```
class PluginBase(metaclass=abc.ABCMeta):
    ...
```