

# The Many Faces of Python Descriptors

Utah Python Users Group, May 2015  
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# What Is a Descriptor?



```
__get__(self, obj, cls) <- object.__getattribute__
```

```
__set__(self, obj, value) <- object.__setattr__
```

```
__delete__(self, obj) <- object.__delattr__
```



“data descriptor”

implements both `__get__` and `__set__`

example: `property`

“non-data descriptor”

implements only `__get__`

example: `functions`



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implements both `__get__` and `__set__`

example: `property`

“non-data descriptor”

implements only `__get__`

example: `functions`



“data descriptor”

implements both `__get__` and `__set__`

example: `property`

“non-data descriptor”

implements only `__get__`

example: `functions`



```
def __get__(self, obj, cls):  
    if obj is None:  
        ...  
    ...
```



```
def __get__(self, obj, cls):  
    if obj is None:  
        return self  
    return do_something_cool(obj)
```





```
def __get__(self, obj, cls):  
    if obj is None:  
        return self  
    return do_something_cool(obj)
```



```
def __get__(self, obj, cls):  
    if obj is None:  
        return self  
    return do_something_cool(obj)
```



# Attribute Lookup



`spam.eggs -> getattr(spam, 'eggs')`

“dotted access”

“Attribute references” (language reference)

`object.__getattr__`

`PyObject_GenericGetAttr` (Objects/object.c)



`object.__getattr__`

1. handle “data descriptor” in `type(obj).__dict__`
2. try `obj.__dict__`
3. handle “non-data descriptor”
4. try `type(obj).__gettr__`
5. raise `AttributeError`



`type.__getattr__ (type_getattro)`

1. handle “data descriptor” in `type(cls).__dict__`
2. try `cls.__dict__` (handle descriptor)
3. handle “non-data descriptor”
4. raise `AttributeError`



“special” (“dunder”) method lookup

`_PyType_Lookup` (see `inspect._check_class`):

```
return type(obj).__dict__[name]
```



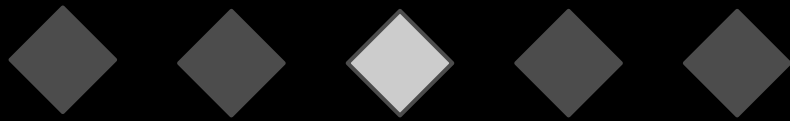
Handling descriptors:

```
return descr.__get__(obj, cls)
```





# Descriptors You Use Every Day

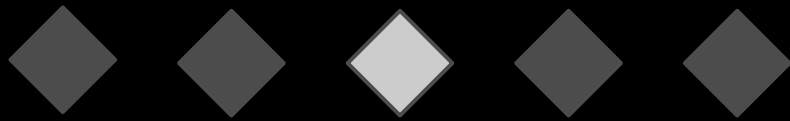


`property(fget, fset, fdel)`

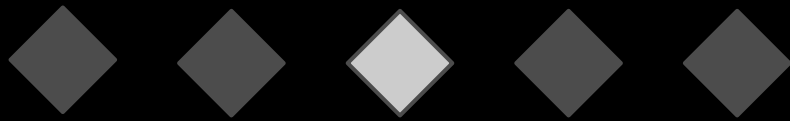
`property.__get__` -> `property.fget`

`property.__set__` -> `property.fset`

`property.__delete__` -> `property.fdel`



```
def __get__(self, obj, cls):  
    if obj is None:  
        return self  
    return self.fget(obj)
```



```
def spam(): ...
```

```
spam.__get__ -> method
```

```
(no __set__ or __delete__)
```

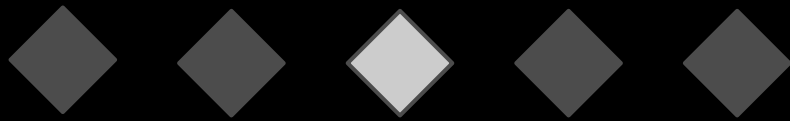


# Python 3

```
def __get__(self, obj, cls):  
    if obj is None:  
        return self  
    return types.MethodType(self, obj)
```

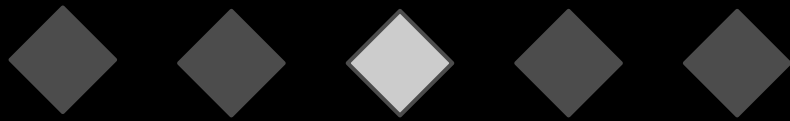


```
>>> class Spam:
...     def eggs(self): pass
...
>>> Spam.eggs
<function Spam.eggs at ...>
>>> Spam().eggs
<bound method Spam.eggs of <Spam object at ...>>
```



# Python 2

```
def __get__(self, obj, cls):  
    if obj is None:  
        return types.UnboundMethodType(self, cls)  
    return types.MethodType(self, obj)
```



```
>>> class Spam:
...     def eggs(self): pass
...
>>> Spam.eggs
<unbound method Spam.eggs>
>>> Spam().eggs
<bound method Spam.eggs of <Spam object at ...>>
```





# Composing New Descriptors



- data vs non-data?
- supports wrapping other descriptors?
- triggered on class vs. on instance?
- cooperative (external state) vs. isolated?
- static (ignore obj, cls)?
- resolve on cls? on obj?



rawattr (staticmethod)

classattr

classonly

nondata

classresolved (classmethod)

classunresolved



# Wrapper Descriptors

	cls	obj	data
rawattr	unresolved	unresolved	no
classattr	class-resolved	class-resolved	no
classonly	class-resolved	AttributeError	no
nondata	resolved	resolved	no
classresolved	class-as-object	class-as-object	no
classunresolved	descriptor	resolved	no



```
class rawattr:
    def __init__(self, w):
        self.w = w
    def __get__(self, obj, cls):
        return self.w
```

```
class Spam:
    @rawattr
    @property
    def eggs(self):
        return None
```

```
assert isinstance(Spam.eggs, property)
spam = Spam()
assert isinstance(spam.eggs, property)
```



```
class classattr:
    def __init__(self, w):
        self.w = w
    def __get__(self, obj, cls):
        if hasattr(self.w, '__get__'):
            return self.w.__get__(None, cls)
        else:
            return self.w
```

```
class Spam:
    @classattr
    @property
    def eggs(self):
        return None

assert isinstance(Spam.eggs, property)
spam = Spam()
assert isinstance(spam.eggs, property)
```



```
class classonly:
```

```
    def __init__(self, w):
```

```
        if isinstance(w, functype):
```

```
            w = classmethod(w)
```

```
        self.w = w
```

```
    def __get__(self, obj, cls):
```

```
        if hasattr(self.w, '__get__'):
```

```
            return self.w.__get__(None, cls)
```

```
        else:
```

```
            raise AttributeError
```

```
class Spam:
```

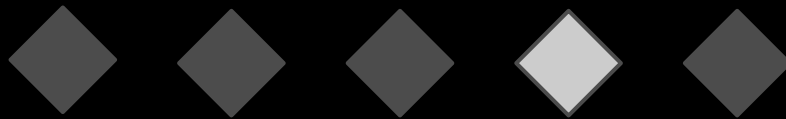
```
    @classonly
```

```
    def eggs(cls):
```

```
        return cls.__name__
```

```
    assert Spam.eggs == 'Spam'
```

```
    Spam().eggs # AttributeError
```



```
class nondata:
```

```
    def __init__(self, w):
```

```
        self.w = w
```

```
    def __get__(self, obj, cls):
```

```
        if hasattr(self.w, '__get__'):
```

```
            return self.w.__get__(obj, cls)
```

```
        else:
```

```
            return self.w
```

```
class Spam:
```

```
    @nondata
```

```
    @property
```

```
    def eggs(self):
```

```
        return 'spamspamspam'
```

```
    assert isinstance(Spam.eggs, property)
```

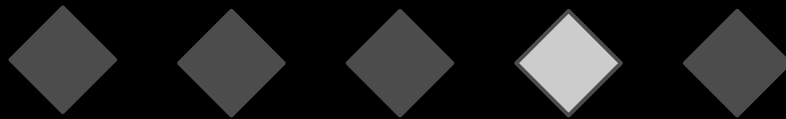
```
    spam = Spam()
```

```
    assert spam.eggs == 'spamspamspam'
```

```
    spam.eggs = 42
```

```
    assert spam.eggs == 42
```





```
class classresolved:
```

```
    def __init__(self, w):
```

```
        self.w = w
```

```
    def __get__(self, obj, cls):
```

```
        if hasattr(self.w, '__get__'):
```

```
            return self.w.__get__(cls, meta)
```

```
        else:
```

```
            return self.w
```

```
class Spam:
```

```
    @classresolved
```

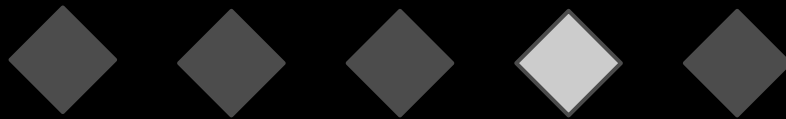
```
    @property
```

```
    def eggs(cls):
```

```
        return cls.__name__
```

```
    assert Spam.eggs == 'Spam'
```

```
    assert Spam().eggs == 'Spam'
```



```
class classunresolved:
```

```
    def __init__(self, w):
```

```
        self.w = w
```

```
    def __get__(self, obj, cls):
```

```
        if obj is None:
```

```
            return self.w
```

```
        else:
```

```
            return self.w.__get__(obj, cls)
```

```
class Spam:
```

```
    @classunresolved
```

```
    @classmethod
```

```
    def eggs(cls):
```

```
        return cls.__name__
```

```
    assert isinstance(Spam.eggs, classmethod)
```

```
    assert Spam().eggs == 'Spam'
```



## Bonus: Descriptor Examples



lazy attributes

reverse name binding

placeholders

# Summary

- Descriptors invoked by object.\_\_getattr\_\_
- \_\_get\_\_ called for class AND object access
- many kinds of descriptor

# Questions

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<http://goo.gl/UGjKPL>

<https://bitbucket.org/ericsnowcurrently/presentations/src/default/utpy-may2015>