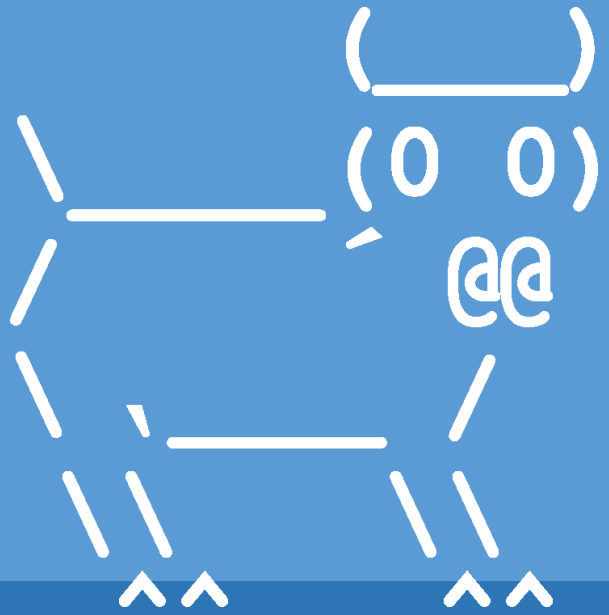
Inheritance



Introduction to Computer Science

Iris Howley

TODAY'S LESSON

Inheritance

(A hierarchy of objects for leveraging parents' implementation)

Inheritance Syntax

Super class

```
class Robot:
    __slots__ = ['name']
    def __init__(self, nm):
        self.name = nm
    def introduce(self):
        return 'I AM ' + self.name.upper()
```

Declares the super class

```
class EvilRobot(Robot):
    morality = 'evil'
```

`EvilRobot` doesn't have an initializer with a parameter!

```
>>> er1 = EvilRobot('Herbert')
>>> er1.name
'Herbert'
```

But it seems to have a name attribute

Inheritance Syntax

Super class

```
class Robot:
    __slots__ = ['name']
    def __init__(self, nm):
        self.name = nm
    def introduce(self):
        return 'I AM ' + self.name.upper()
```

Declares the super class

```
class EvilRobot(Robot):
    morality = 'evil'
```

`EvilRobot` doesn't have an initializer with a parameter!

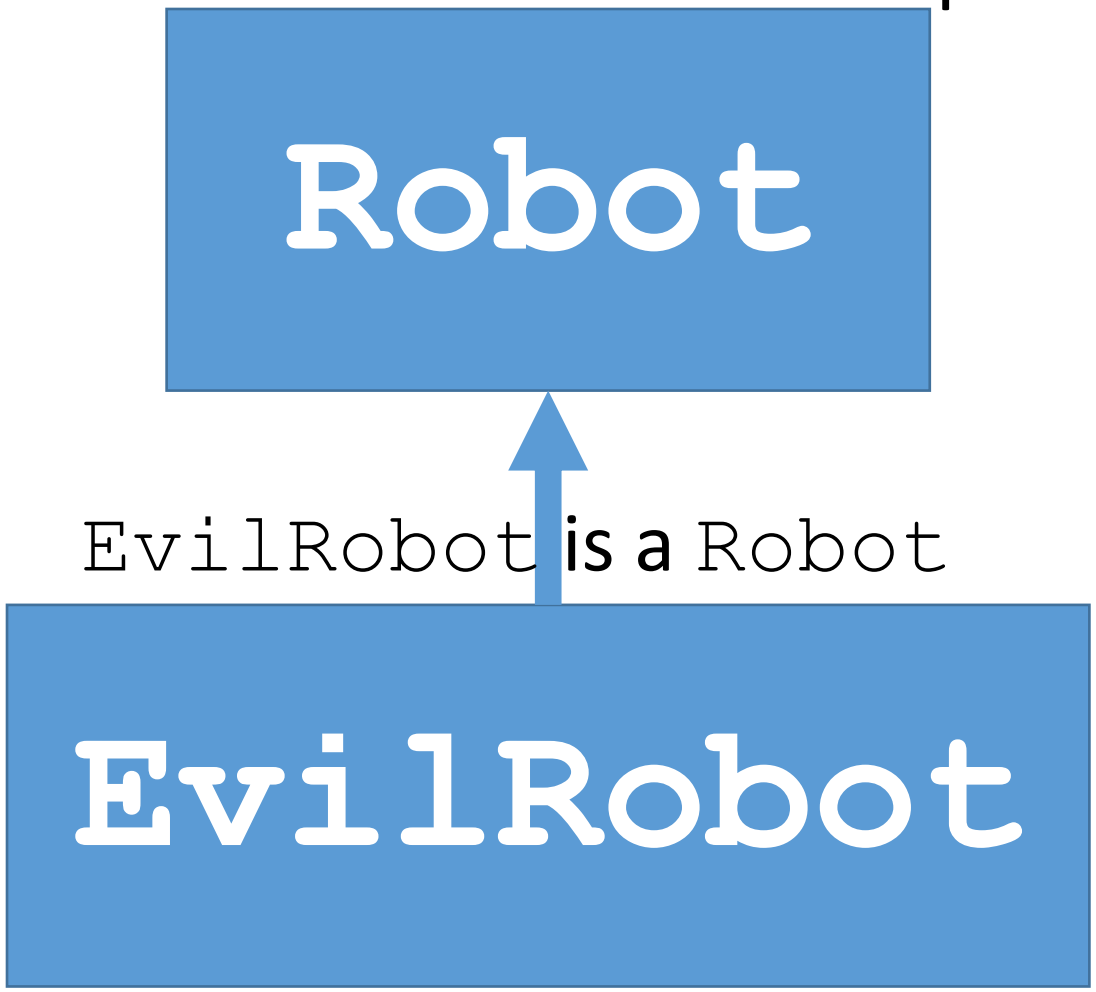
```
>>> er1 = EvilRobot('Herbert')
>>> print(er1.introduce())
I AM HERBERT
```

`EvilRobot` doesn't have an introduce() method

But `Robot` does, and it is calling that!

Class Diagram: Robot

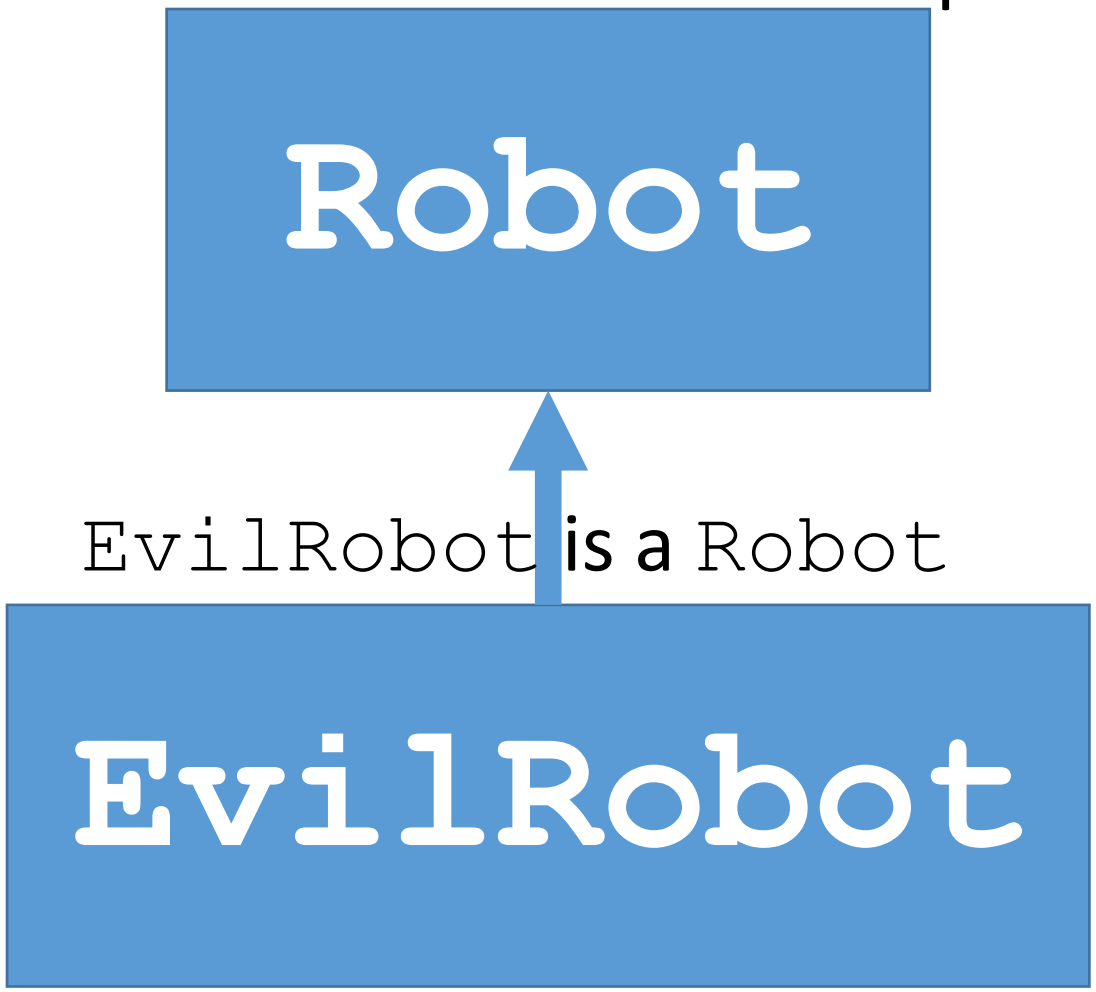
`Robot` is `EvilRobot's` super-class



`EvilRobot` is a sub-class of `Robot`

Class Diagram: Robot

`Robot` is `EvilRobot's` super-class



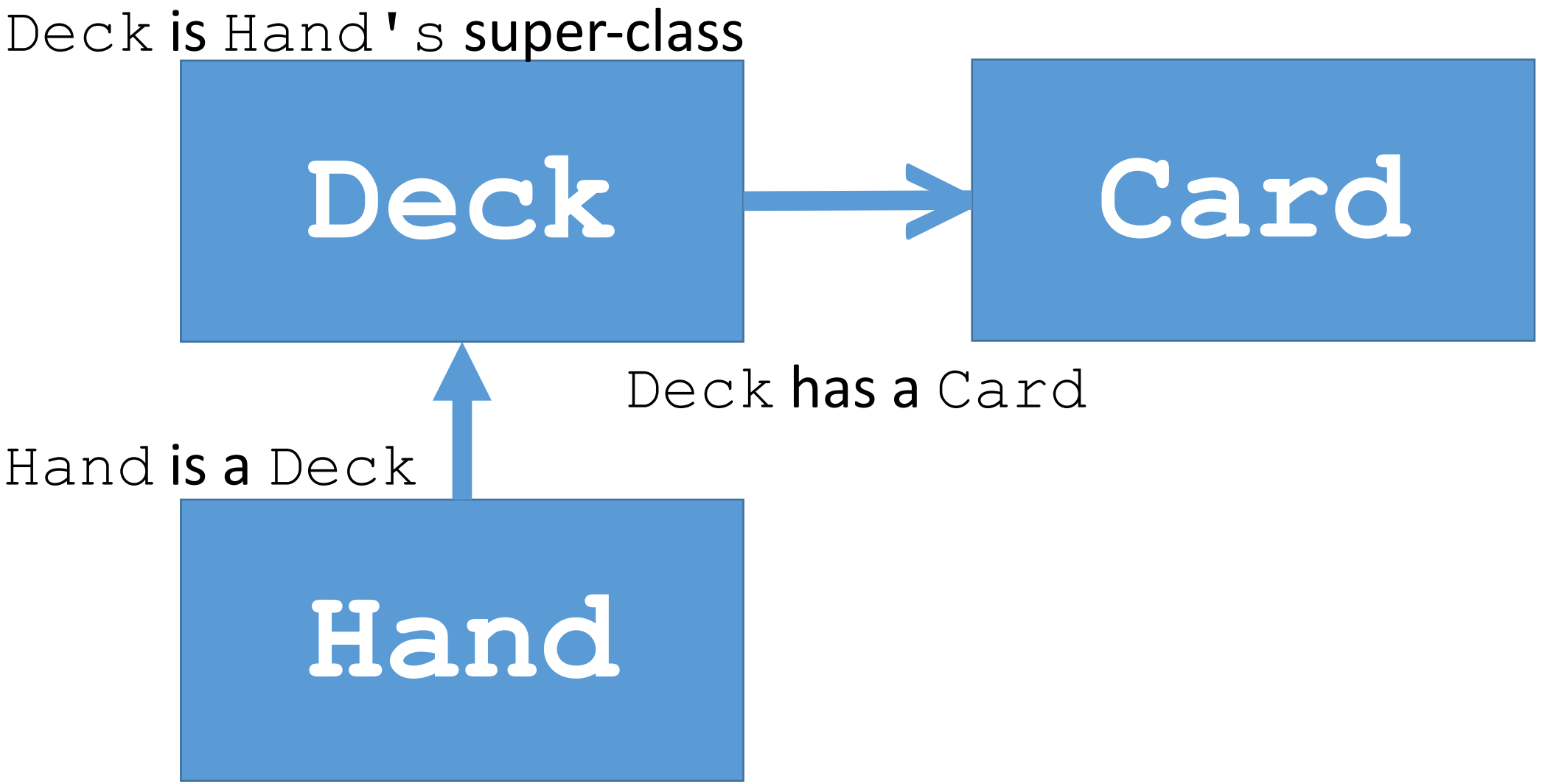
`EvilRobot` is a sub-class of `Robot`

A sub-class inherits methods, attributes from its super-class.

But a super-class does NOT inherit from its sub-classes.

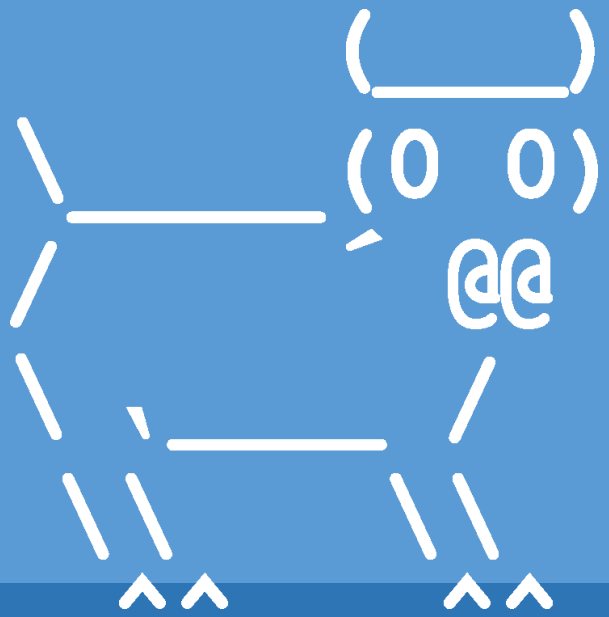
i.e., "A child inherits from the parent."

Class Diagram: Playing Cards



Please contact me!

Super Methods



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TODAY'S LESSON

Super Methods

(Making use of the super class' methods)

```
class Robot:
    __slots__ = ['name'] # instance attribute

    def __init__(self, nm):
        self.name = nm

class EvilRobot(Robot):
    morality = 'evil' # class attribute
    __slots__ = ['mission']

    def __init__(self, misn):
        self.mission = misn
```

What happens when both super & sub-class have `init` method?

```
if __name__ == '__main__':
    er1 = EvilRobot('Name or Mission?!')
    print(er1.name)
AttributeError: 'EvilRobot' object has no attribute 'name'
    print(er1.mission)

    Name or Mission?!
```

The instance's `__init__` method will be called (i.e., `EvilRobot.__init(self, misn)`)

When a sub-class has the same method with same number of parameters as super-class, the sub-class' method will be called.

What if I want both the sub- and super- class methods to be called?

```
class Robot:
    __slots__ = ['name'] # instance attribute

    def __init__(self, nm):
        self.name = nm

class EvilRobot(Robot):
    morality = 'evil'
    __slots__ = ['mission']

    def __init__(self, nm, misn):
        super().__init__(nm)
        self.mission = misn
```

We can call the super class' __init__ method explicitly, if we want to use what's happening in it. (i.e., give all robots a name!)

```
if __name__ == '__main__':
    er1 = EvilRobot('Pearl', 'try to take over the world.')
    print(er1.name, er1.morality, er1.mission)
```

```
Pearl evil try to take over the world
```

Both `__init__` methods will be called, if we explicitly call the super class' `__init_` in the sub-class' `__init__`

We can call the super-class' methods, attributes explicitly using `super()` instead of `self`.

This is true for methods that aren't "special methods," too.

```
class Robot:
    __slots__ = ['name'] # instance attribute

    def __init__(self, nm):
        self.name = nm
    def introduce(self):
        return 'I AM ' + self.name.upper()

class EvilRobot(Robot):
    morality = 'evil' # class attribute
    __slots__ = ['mission']

    def __init__(self, nm, misn):
        Robot.__init__(self, nm)
        self.mission = misn
    def introduce(self):
        return self.mission.upper()
```

What happens when both super & sub-class have the same method (w. same # parameters)?

```
if __name__ == '__main__':
    er1 = EvilRobot('Pearl', 'try to take over the
world.')
    print(er1.name, er1.morality, er1.mission)
```

```
Pearl evil try to take over the world
```

```
    print(er1.introduce())
```

```
TRY TO TAKE OVER THE WORLD
```

The instance's method will be called (i.e., `EvilRobot.introduce()`)

```
class Robot:
    __slots__ = ['name'] # instance attribute

    def __init__(self, nm):
        self.name = nm
    def introduce(self):
        return 'I AM ' + self.name.upper()

class EvilRobot(Robot):
    morality = 'evil' # class attribute
    __slots__ = ['mission']

    def __init__(self, nm, misn):
        Robot.__init__(self, nm)
        self.mission = misn
    def introduce(self):
        return super().introduce() + '\n' + self.mission.upper()
```

…but we can call the super class' methods explicitly!

```
if __name__ == '__main__':
    er1 = EvilRobot('Pearl', 'try to take over the world.')
    print(er1.name, er1.morality, er1.mission)
```

```
Pearl evil try to take over the world
```

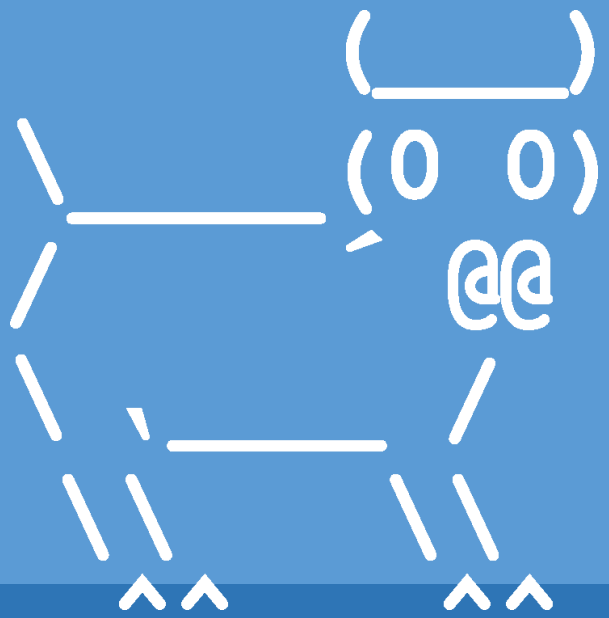
```
print(er1.introduce())
```

```
I AM PEARL
TRY TO TAKE OVER THE WORLD
```

And if we call the super class' method explicitly, it will also be called.

Please contact me!

@property.setter



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TODAY'S LESSON

`Setter methods.`

(Like `@property`, but for modifying properties)

```
class Robot:
    __slots__ = ['_name'] # instance attribute

@property
def name(self):
        return self._name

if __name__ == '__main__'
    robit = Robot()
    robit._name = 'James Franco'
    print(robit.name)
```

@property decorator allows us to access a method like an attribute

```
class Robot:
    __slots__ = ['_name'] # instance attribute


@property
def name(self):
        return self._name


if __name__ == '__main__'
    robit = Robot()
    robit._name = 'James Franco'
    print(robit.name)
```

But to modify that attribute, we still have to access through the underscore attribute name.

UNDERSCORE GUILT!

```
class Robot:
    __slots__ = ['_name'] # instance attribute

@property
def name(self):
        return self._name
@name.setter
def name(self, value):
    self._name = value

if __name__ == '__main__'
    robit = Robot()
    robit.name = 'James Franco'
    print(robit.name)
```

We can use another decorator, `@<PROPERTY>.setter` to allow us to modify a property.

This decorator tells python which method to call when the property appears on the left-hand side of an assignment operator.

YOU CANNOT HAVE A `@property.setter` WITHOUT FIRST DEFINING THE PROPERTY WITH `@property`

WHEN WOULD WE WANT AN `@property` OR `@property.setter` TO DO SOMETHING MORE COMPLEX?

More Complex Property Methods

- Consider a temperature object
  - Has a temperature in Kelvin as an instance attribute
  - But can access the Celsius temperature equivalencies through a celsius property
  - If you change the celsius value of the Temperature object, it really just changes the Kelvin attribute appropriately

POGIL 26. Classes: Properties covers this in considerable depth.

More Complex Property Methods

```
class Temperature:
  __slots__ = ['_kelvin']
  @property
  def celsius(self):
    return self._kelvin - 273.15
  @celsius.setter
  def celsius(self, val):
    self._kelvin = val + 273.15
```

(It would make sense to make a kelvin @property, too…)

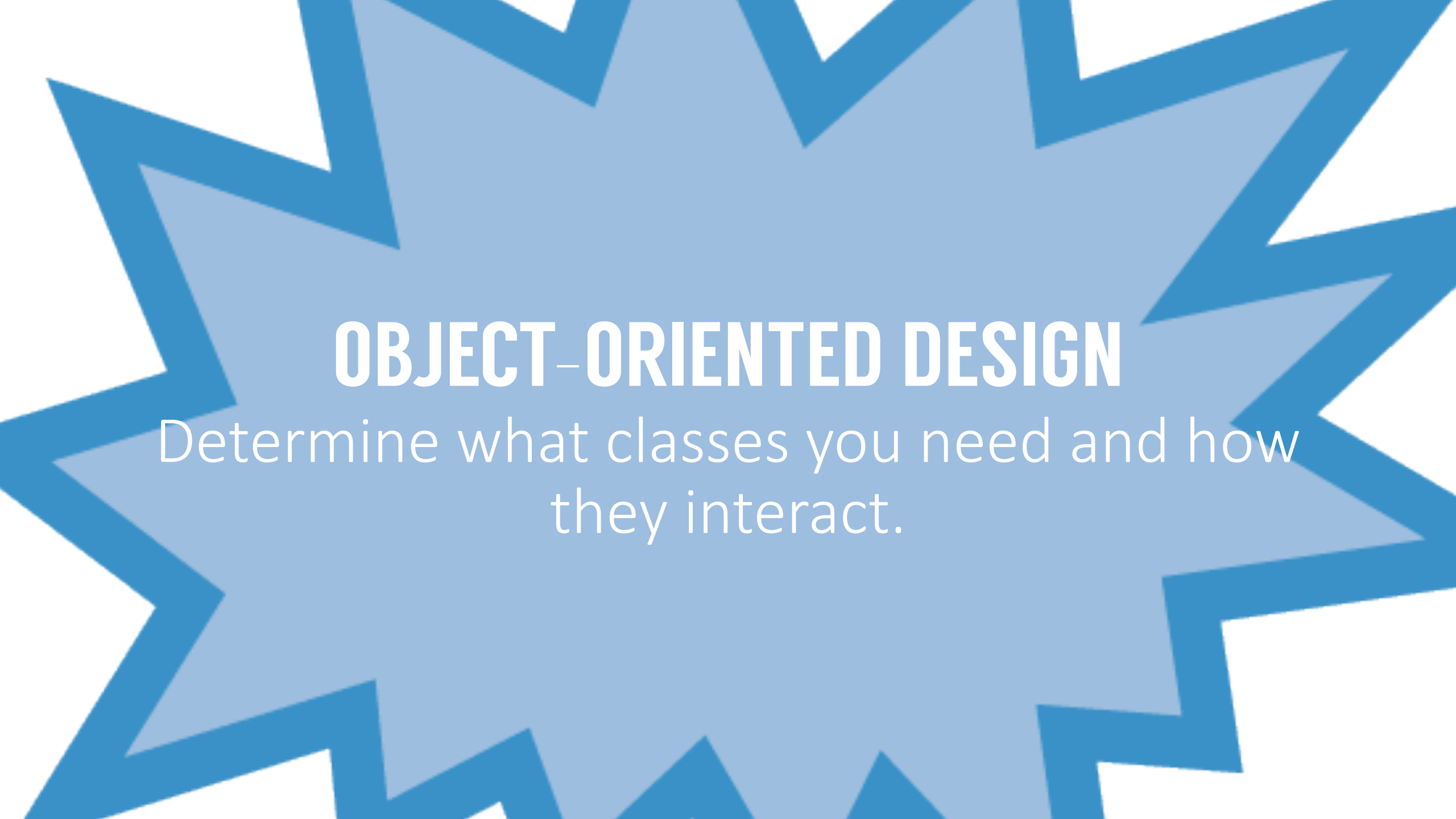
More Complex Property Methods

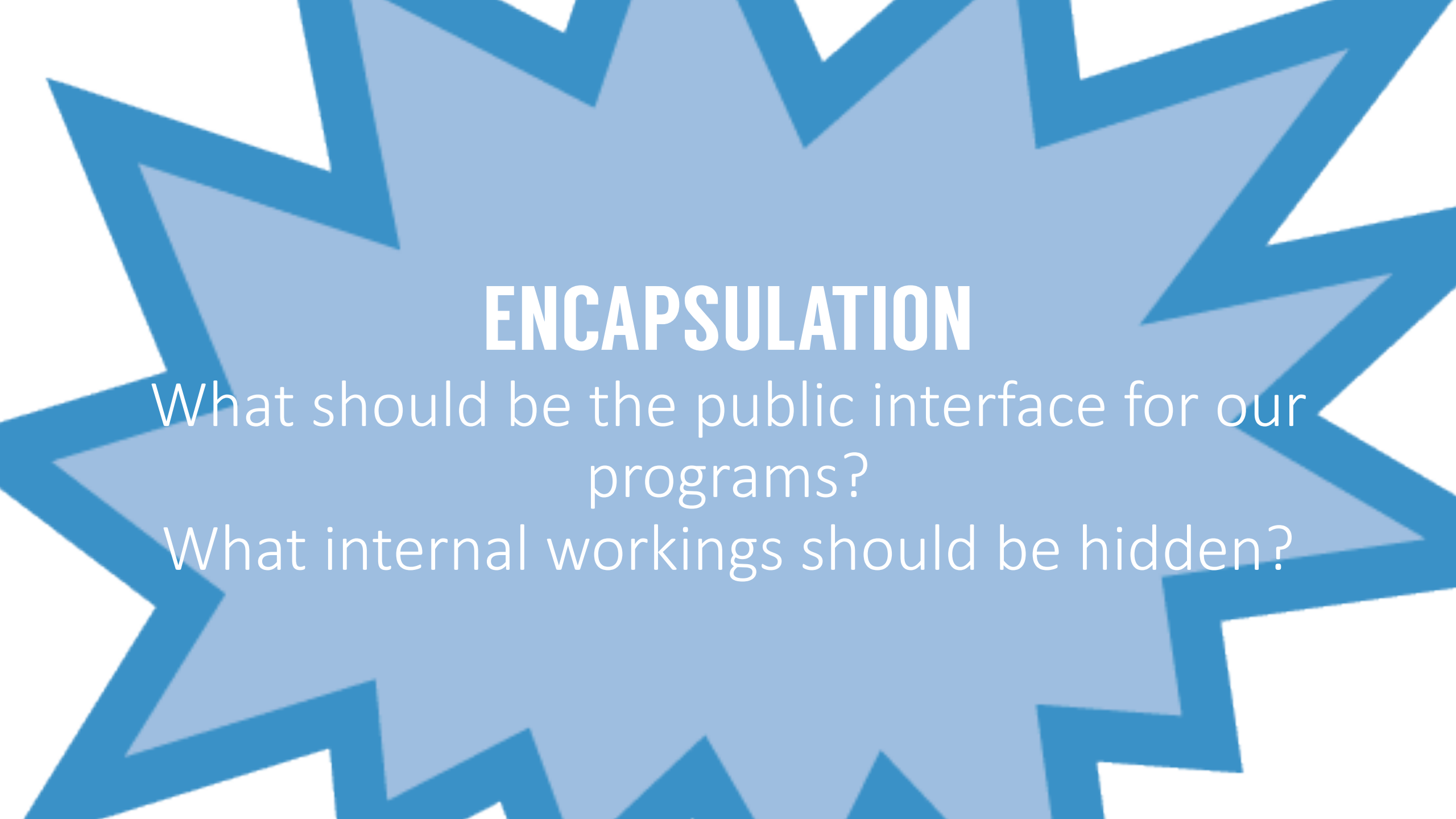
```
>>> t1 = Temperature()
>>> t1.celsius = 0  # uses @celsius.setter
>>> t1._kelvin # accesses the _kelvin attribute directly
273.15
>>> t1.celsius # uses the @property for def celsius
0.0
```

More Complex Property Methods

```
class Temperature:
  __slots__ = ['_kelvin']
  @property
  def celsius(self):
    return self._kelvin - 273.15
  @celsius.setter
  def celsius(self, val):
    self._kelvin = val + 273.15
```

(It would make sense to make a kelvin @property, too…)


OBJECT-ORIENTED DESIGN
Determine what classes you need and how they interact.


ENCAPSULATION
What should be the public interface for our programs?
What internal workings should be hidden?

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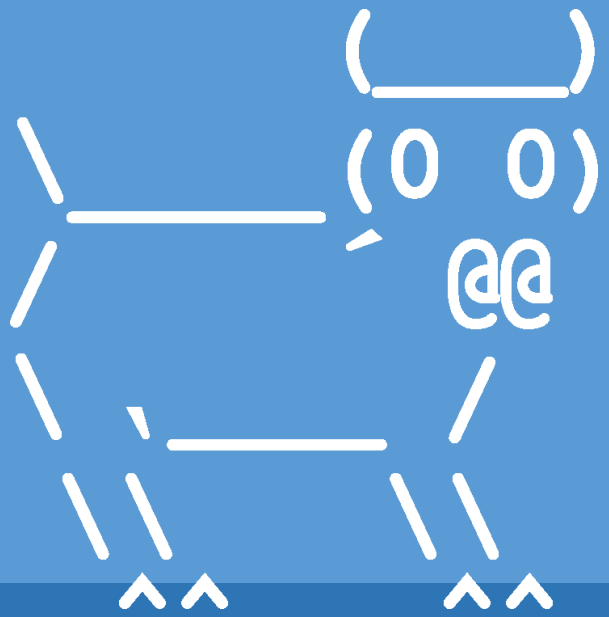
Well-defined Classes



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TODAY'S LESSON

Well-defined classes.

(Leveraging the class-building tools so far)

Well-defined Classes

1. Top-level docstring + every method has a docstring
   - Describe parameters and/or return values
   - In-line comments as needed
2. Meaningful variable/parameter/attribute/method names
3. `__slots__` defined to limit attributes
4. Private helper methods & attributes start with an _underscore to "hide" them
5. Private attributes that need to be accessed are given an `@property` method
6. Private attributes that need to be modified are given an `@property` method and an `@<property>.setter` method.
7. Doctests for methods
8. `__str__(self)` method, useful for debugging

See example Robot.py code on website

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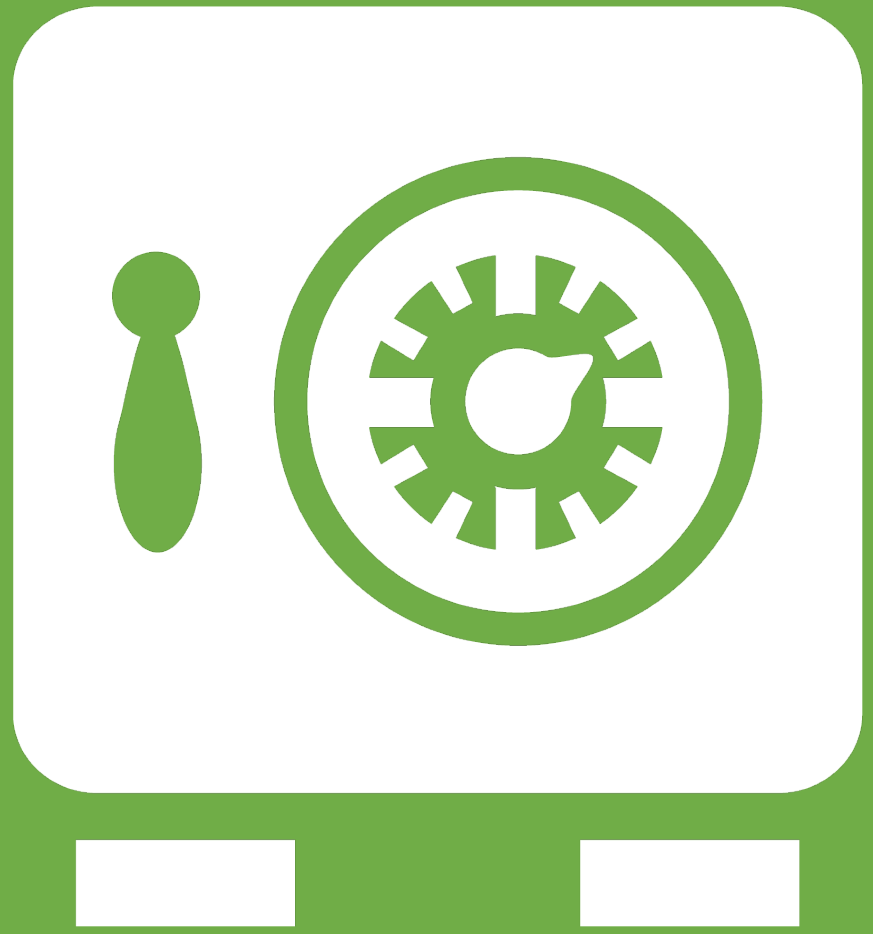

Leftover Slides

Calling Super Methods with `super()`

```
class Robot:
    __slots__ = ['name']
    def __init__(self, nm):
        self.name = nm

class PurposeRobot(Robot):
    __slots__ = ['mission']
    def __init__(self, nm, misn):
        super().__init__(nm)
        self.mission = misn
```

`super().__init__(nm)`

is the same as:

`Robot.__init__(self, nm)`

`super()` lets us call the super-class *implicitly*…

…and we no longer need to pass `self`