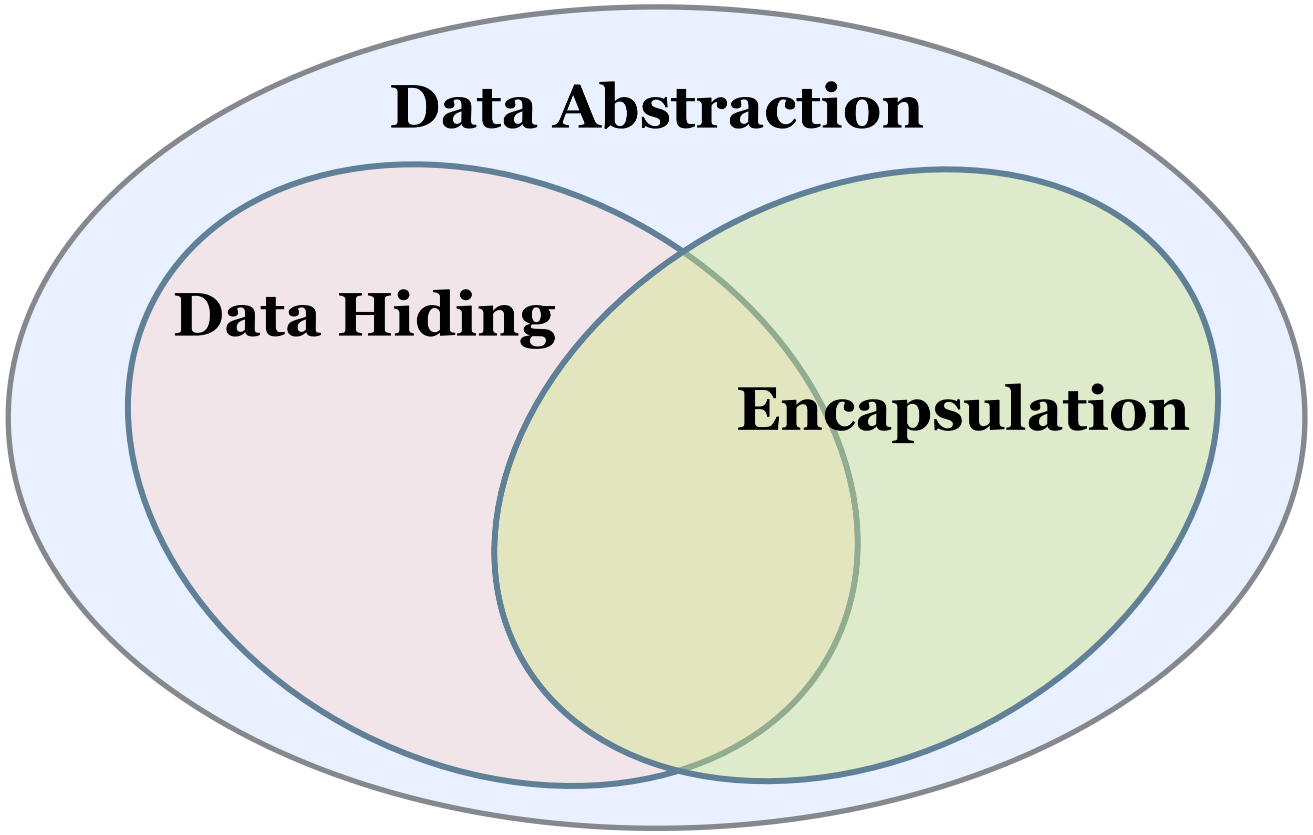
Classes II

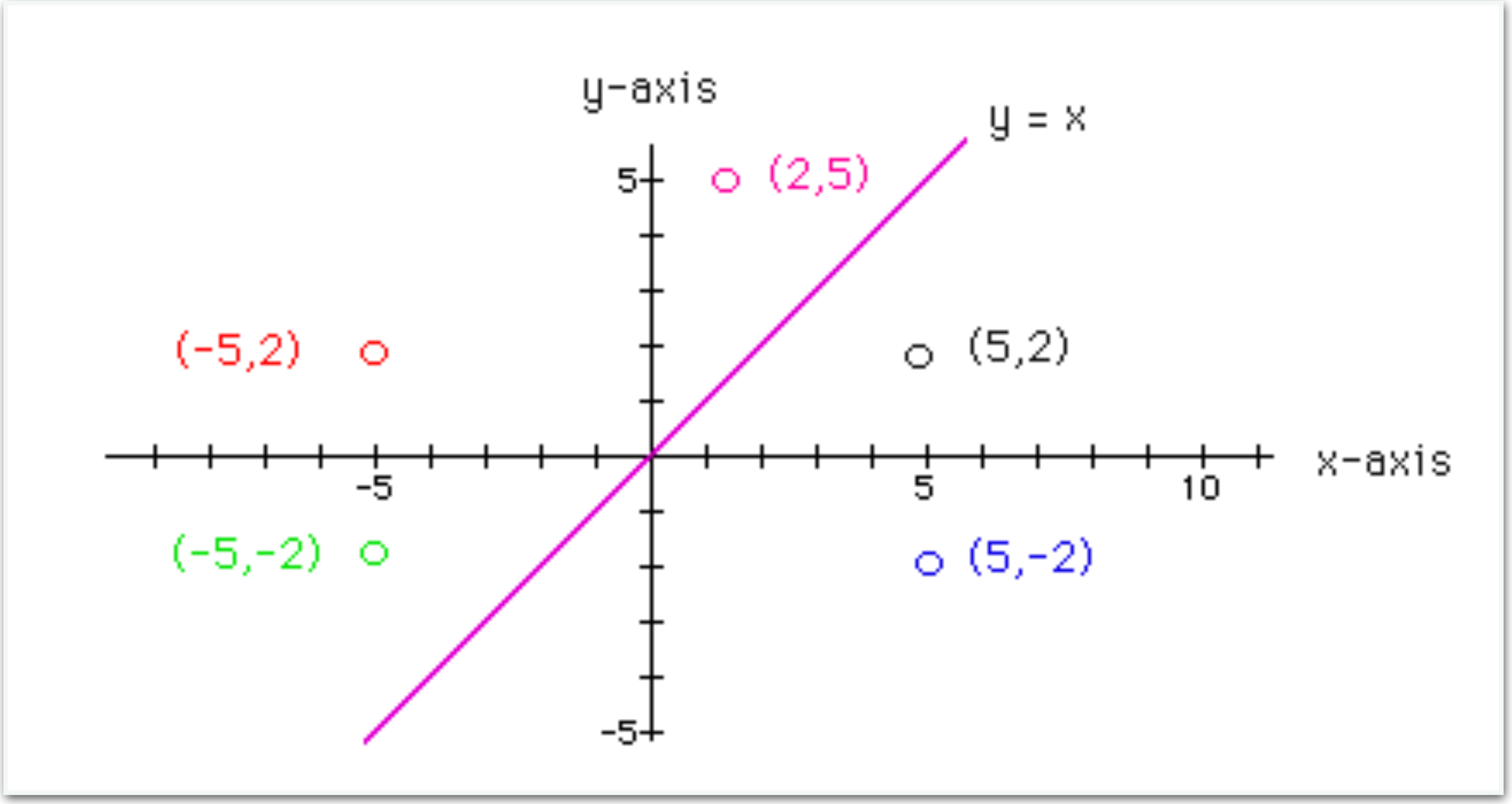
Data Abstraction

- We will learn about how Python supports **data abstraction** (separating the data and details of the implementation from the user) via :
  - **Data hiding:** via attribute naming conventions (private, public)
  - **Encapsulation:** bundling together of data and methods that provide an interface to the data



Lecture Outline

- **Attribute types** (public/private) in Python
- **Print representation** via special method `__str__`
- **Accessor methods** and `@property`
- Putting it all together: `Coordinate` class.

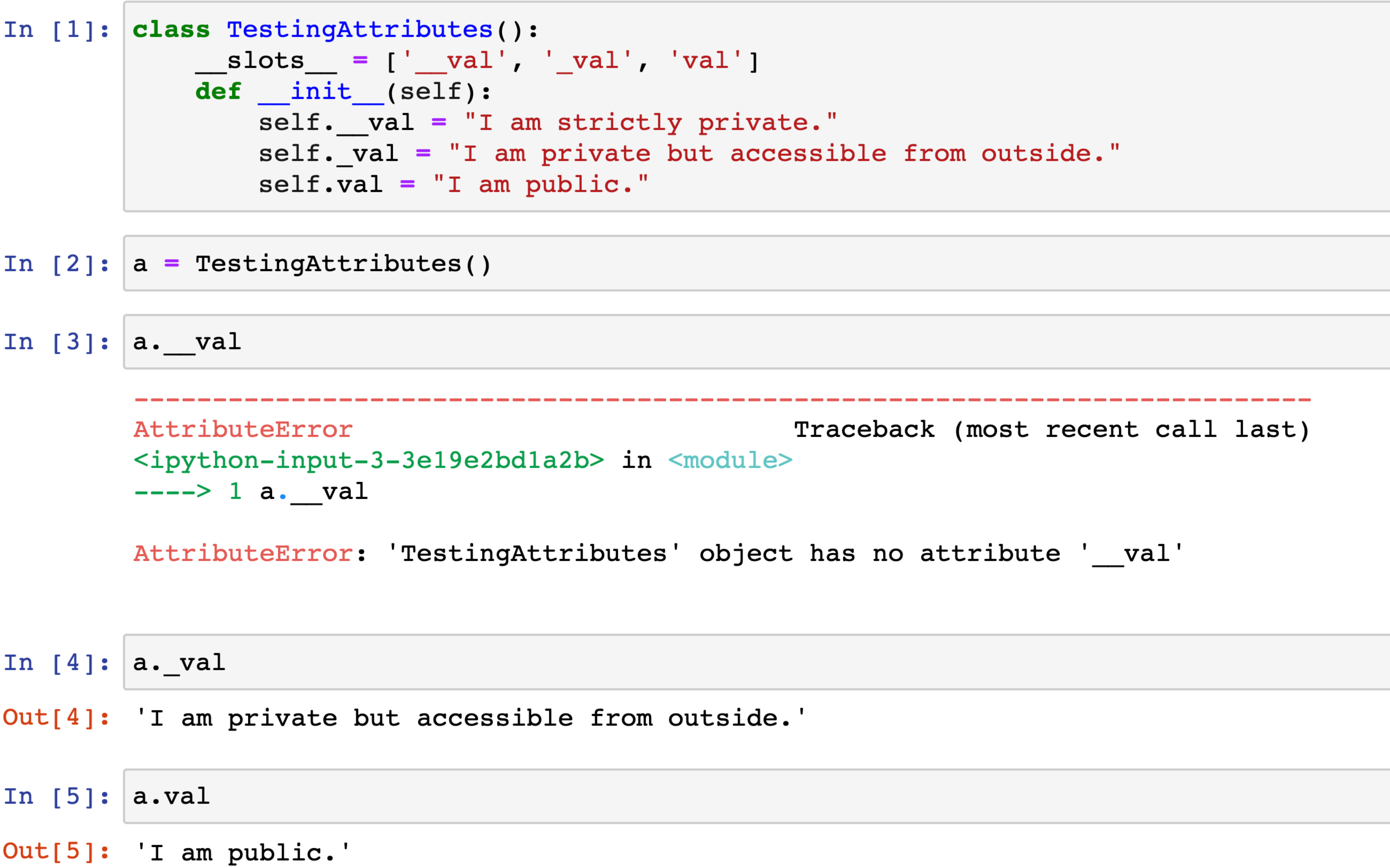


Data Hiding Via Attribute Types

Attribute Naming Convention

- Double leading underscore `(__)` in name (**strictly private**): e.g. `__val`
    - Invisible from outside
    - Strong **you cannot touch this policy**
- Single leading underscore `(_)` in name (**private**): e.g. `_val`
    - Can be accessed from outside, but shouldn't
    - **"Don't touch this unless you are subclass"**
- No leading underscore (**public**): e.g. val
    - **Can be freely used outside class**
- Conventions apply to **procedural attributes** (methods names) as well!

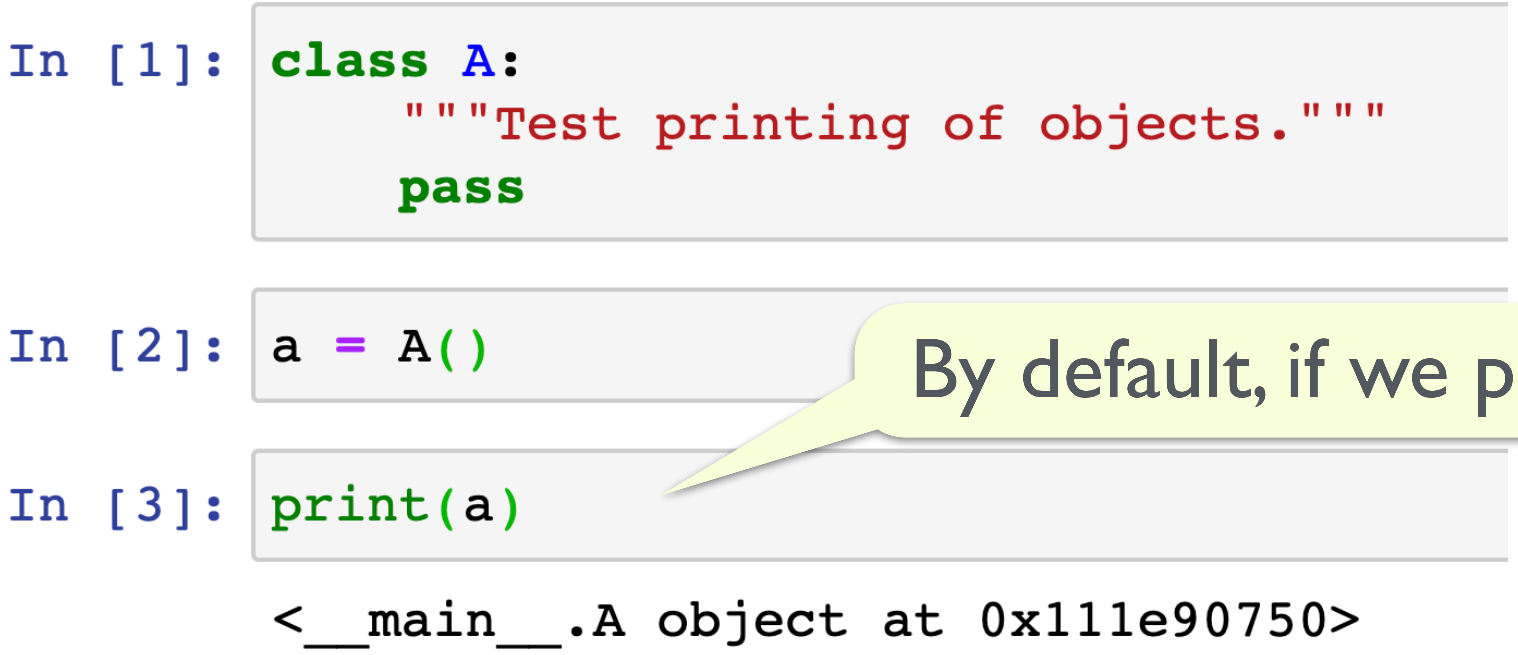
Attribute Naming Convention



```
In [1]: class TestingAttributes():
            __slots__ = ['__val', '_val', 'val']
            def __init__(self):
                self.__val = "I am strictly private."
                self._val = "I am private but accessible from outside."
                self.val = "I am public."

In [2]: a = TestingAttributes()

In [3]: a.__val

        ---------------------------------------------------------------------------
        AttributeError                            Traceback (most recent call last)
        <ipython-input-3-3e19e2bd1a2b> in <module>
        ----> 1 a.__val

        AttributeError: 'TestingAttributes' object has no attribute '__val'


In [4]: a._val

Out[4]: 'I am private but accessible from outside.'

In [5]: a.val

Out[5]: 'I am public.'
```

__str__

Print Representation of an Object



```
In [1]: class A:
            """Test printing of objects."""
            pass

In [2]: a = A()

In [3]: print(a)

        <__main__.A object at 0x111e90750>
```

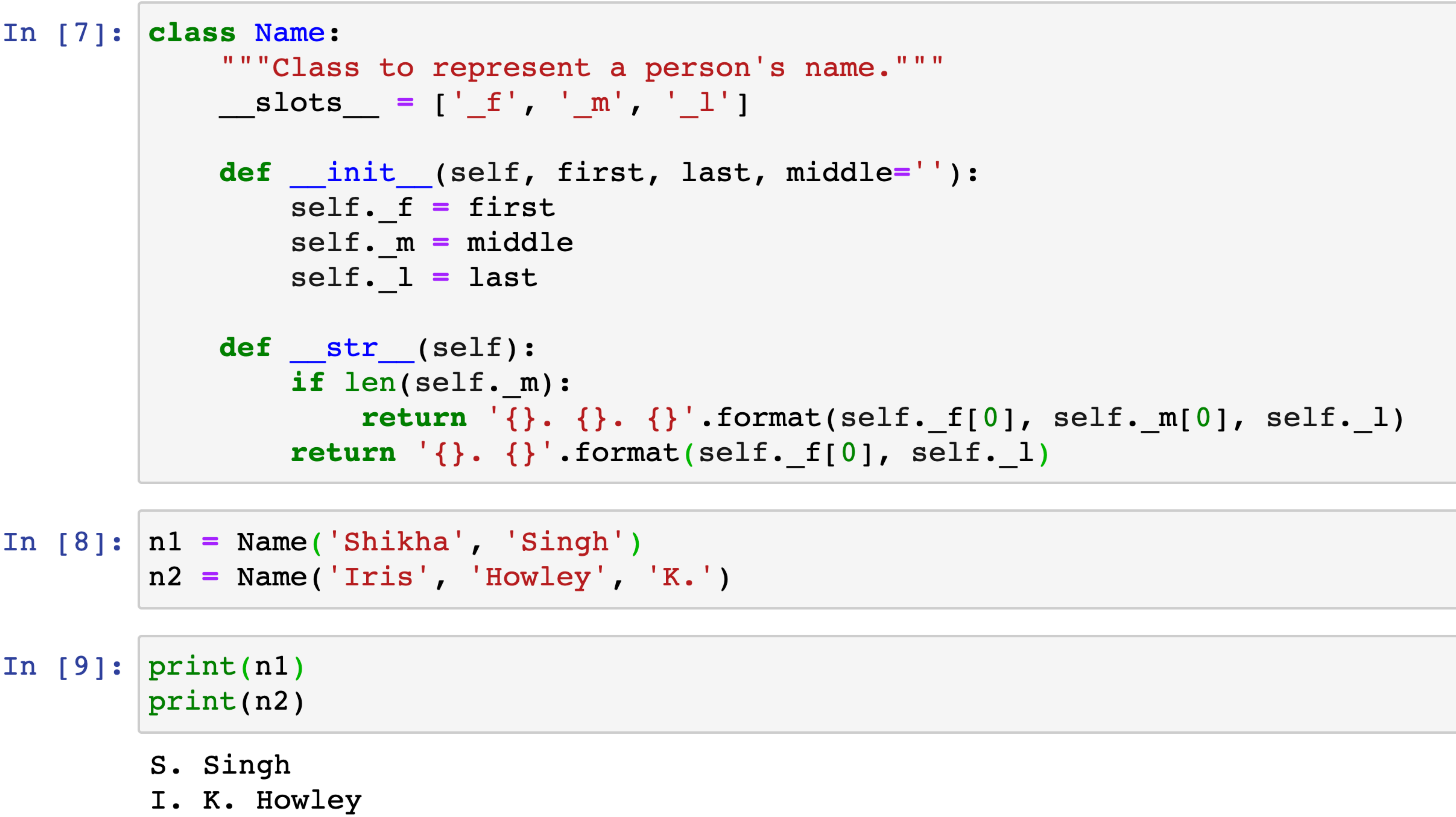
By default, if we print an object, its not “pretty”

- Special method `__str__` is called when we print a class object
- We can customize how the object is printed by writing a `__str__` method for our class
- We can choose how the objects of the class are printed!

Defining the __str__ method

```
class Coordinate(object):
    __slots__ = ['_x', '_y']
    def __init__(self, x, y):
        self._x = x
        self._y = y
    # other methods
    def __str__(self):
        return "<{}, {}>”.format(self._x, self._y)

>>> print(pt)
<3, 4>
```

For Example: Name Class



```
In [7]: class Name:
            """Class to represent a person's name."""
            __slots__ = ['_f', '_m', '_l']

            def __init__(self, first, last, middle=''):
                self._f = first
                self._m = middle
                self._l = last

            def __str__(self):
                if len(self._m):
                    return '{}. {}. {}'.format(self._f[0], self._m[0], self._l)
                return '{}. {}'.format(self._f[0], self._l)
```

```
In [8]: n1 = Name('Shikha', 'Singh')
        n2 = Name('Iris', 'Howley', 'K.')
```

```
In [9]: print(n1)
        print(n2)

        S. Singh
        I. K. Howley
```

@property

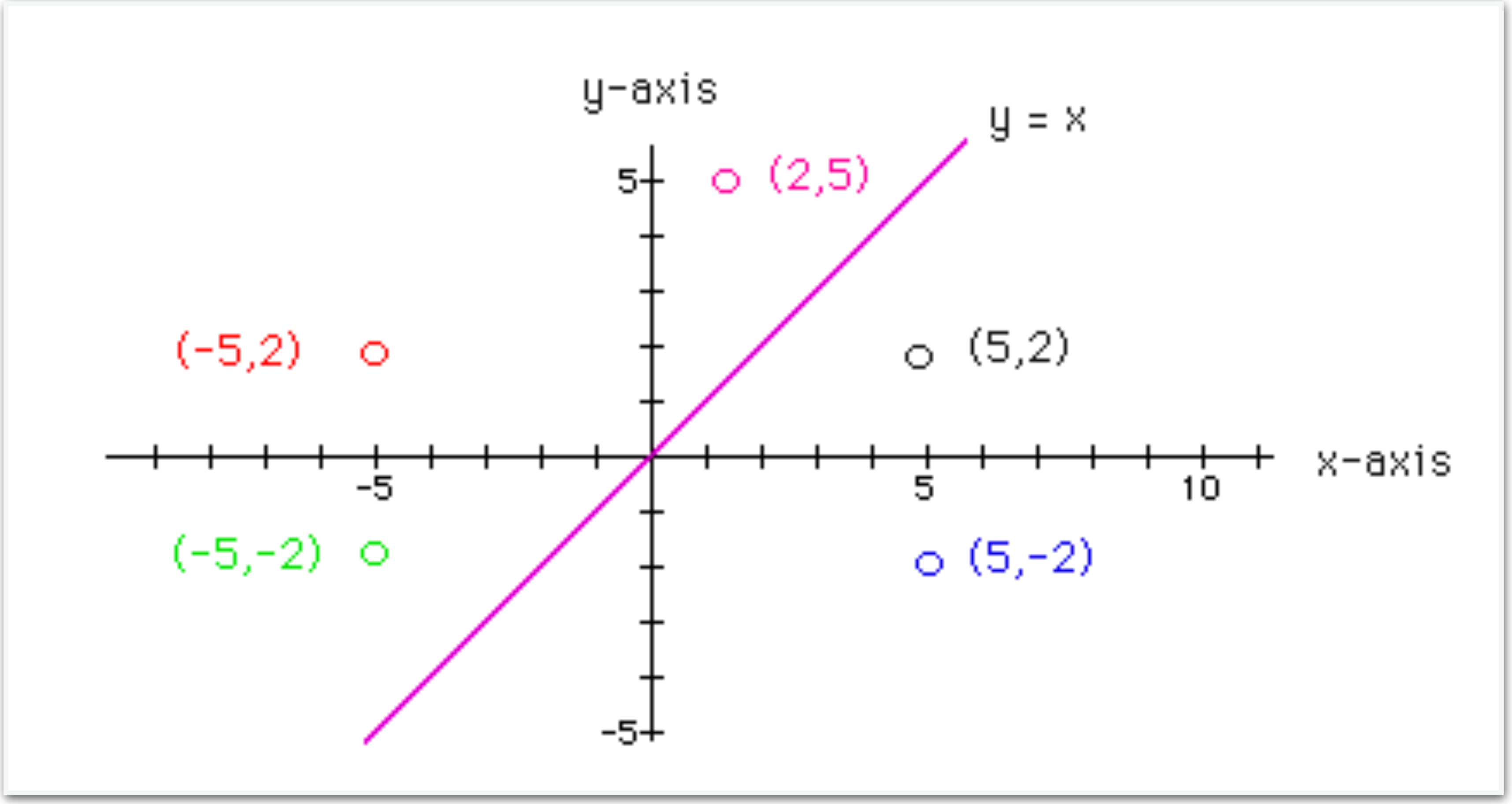
OOP Principle: Encapsulation

- **Encapsulation** is the bundling of data with the methods that operate on that data
- It is often accomplished by providing two kinds of procedural attributes:
  - methods for retrieving or accessing the values of attributes, called **getter methods** or **accessor methods**. Getter methods do not change the values of attributes, they just return the values, and
  - methods used for changing the values of attributes, called **setter methods**.

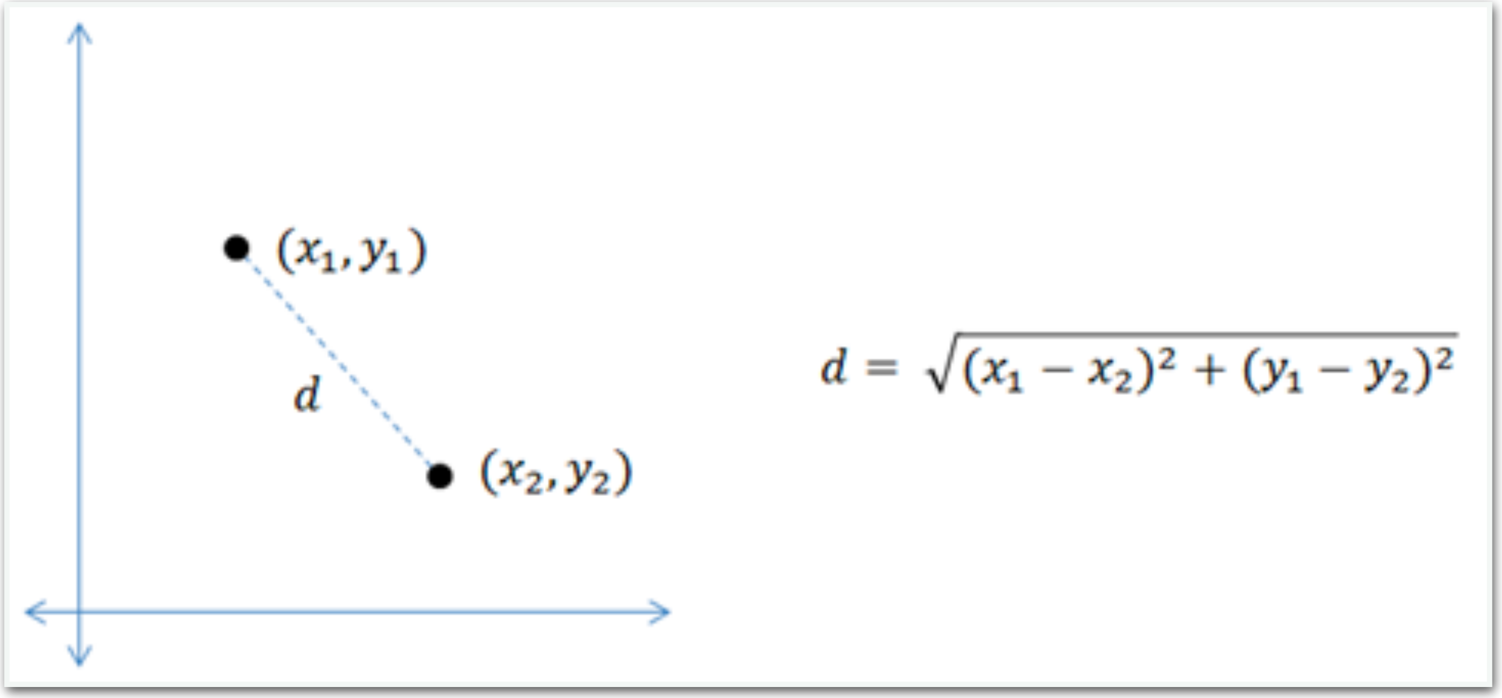
Accessor Methods via @property

- **Annotations @.** Python provides a rich collection of syntactic notes that can change how code is interpreted, called annotations.
- These are typically prefixed with the at-sign (@).
- **Accessor methods** do not change the state of the calling object and are used just to retrieve some information about the object
- **`@property` annotation.** Treat a procedural attribute as a data attribute:
    - If we'd like to treat an accessor method as-if it were a data attribute, we can use the `@property` annotation

Back to the `Coordinate` Class



Euclidean Distance



$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Coordinate Class

- Use the `class` **keyword** to define a new type

Name of class

Parent class

```
class Coordinate(object):
    # define attributes here
    # indented body of class definition
```

- the word object means Coordinate is a Python object and inherits all its attributes (inheritance will be covered in later lectures)
- `Coordinate` is a subclass of `object`
- `object` is a superclass of `Coordinate`

Initializing the Class: `__init__`

- Recall `__init__` lets us initialize some data attributes of the class
- Recall `__slots__` stores the data attribute names as strings in a list
- Single leading underscore signals private data or procedural attribute

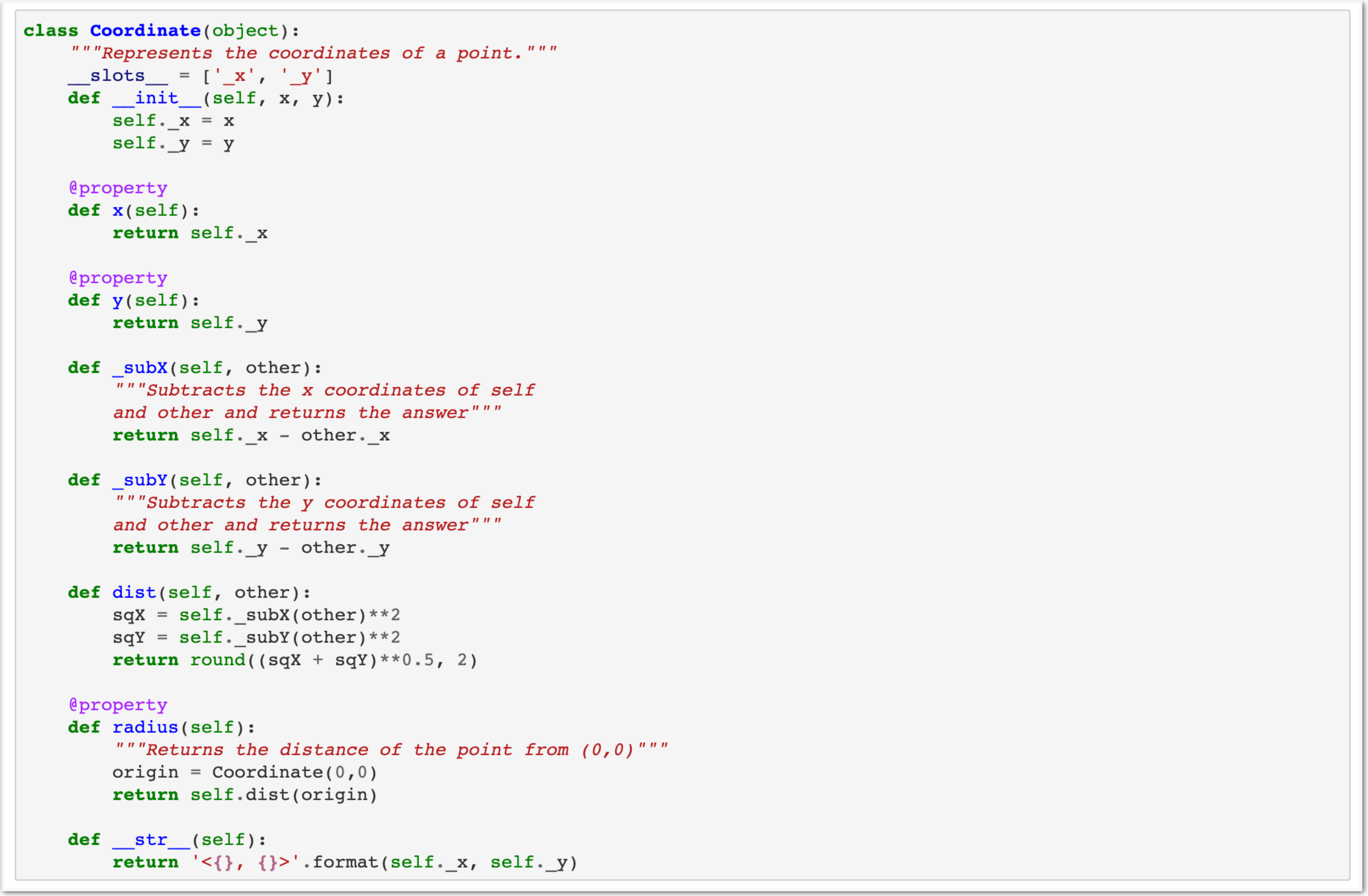
```
class Coordinate(object):
    __slots__ = ['_x', '_y']
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

Single leading underscore: private data attributes

Parameter to refer to an instance of the class

Can assign values to an instance of a class using dot notation.

Other Methods: See Notebook



```python
class Coordinate(object):
    """Represents the coordinates of a point."""
    __slots__ = ['_x', '_y']
    def __init__(self, x, y):
        self._x = x
        self._y = y

    @property
    def x(self):
        return self._x

    @property
    def y(self):
        return self._y

    def _subX(self, other):
        """Subtracts the x coordinates of self
        and other and returns the answer"""
        return self._x - other._x

    def _subY(self, other):
        """Subtracts the y coordinates of self
        and other and returns the answer"""
        return self._y - other._y

    def dist(self, other):
        sqX = self._subX(other)**2
        sqY = self._subY(other)**2
        return round((sqX + sqY)**0.5, 2)

    @property
    def radius(self):
        """Returns the distance of the point from (0,0)"""
        origin = Coordinate(0,0)
        return self.dist(origin)

    def __str__(self):
        return '<{}, {}>'.format(self._x, self._y)
```

Acknowledgments

These slides have been adapted from:

- http://cs111.wellesley.edu/spring19 and
- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/
- https://www.python-course.eu/python3_object_oriented_programming.php