APS106

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classes in classes, functions, and collections.

Week 7 | Lecture 1 (1.1.2)

if nothing else, write #cleancode

Today's Content

- **Lecture 7.1.1**
  - **objects, classes, and methods**
  - **Reading: Chapter 14**
- **Lecture 7.1.2**
  - classes in classes, functions, and collections.
  - Reading: Chapter 14

OOP Recap

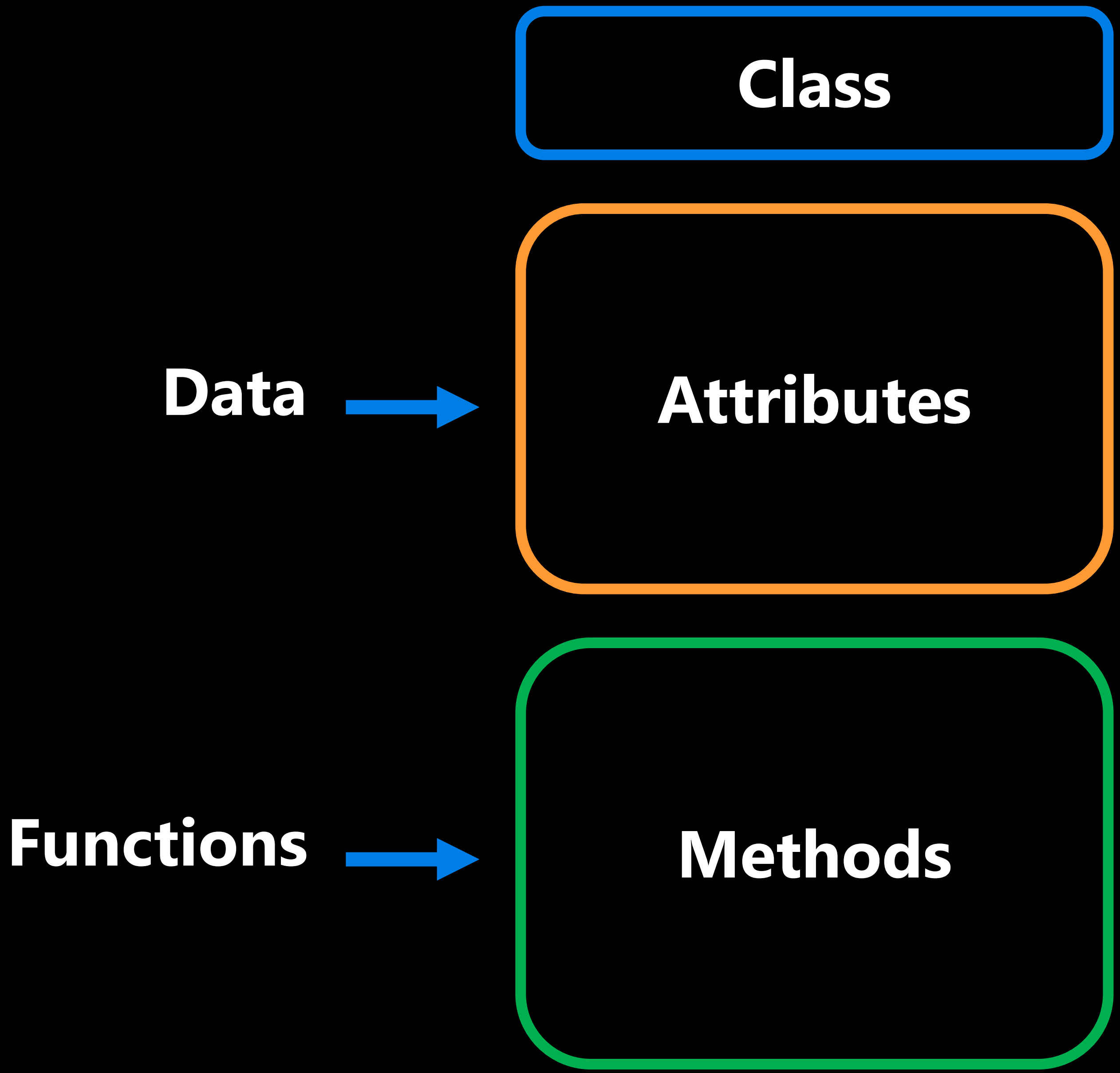
Is **this** an instance of **this** class.

- Everything in Python is an object.

```
>>> isinstance(4, object)
True

>>> isinstance(max, object)
True

>>> isinstance("Hello", object)
True
```

OOP Recap

- A class can be thought of as a template for the objects that are instances of it.



OOP Recap

Instances (objects) of the Turtle class.

name: Susmit
x location: 134
y location: 45

name: Lucy
x location: 24
y location: 35

name: Brian
x location: 92
y location: 62

Turtle

name
x location
y location

move up
move down
move left
move right
go to

OOP Recap

- General form of a Class:
  - Class Name
    - **CamelCase**
    - CourseGrades
    - BankAccount
    - FlightStatus
    - XRayImage
  - Constructor
  - Methods

```
class Name:

    def __init__(self, param1, param2, …):
        self.param1 = param1
        self.param2 = param2
        …
        body

    def method1(self, parameters):
        body

    def method2(self, parameters):
        body

    def method3(self, parameters):
        body
```

OOP Recap

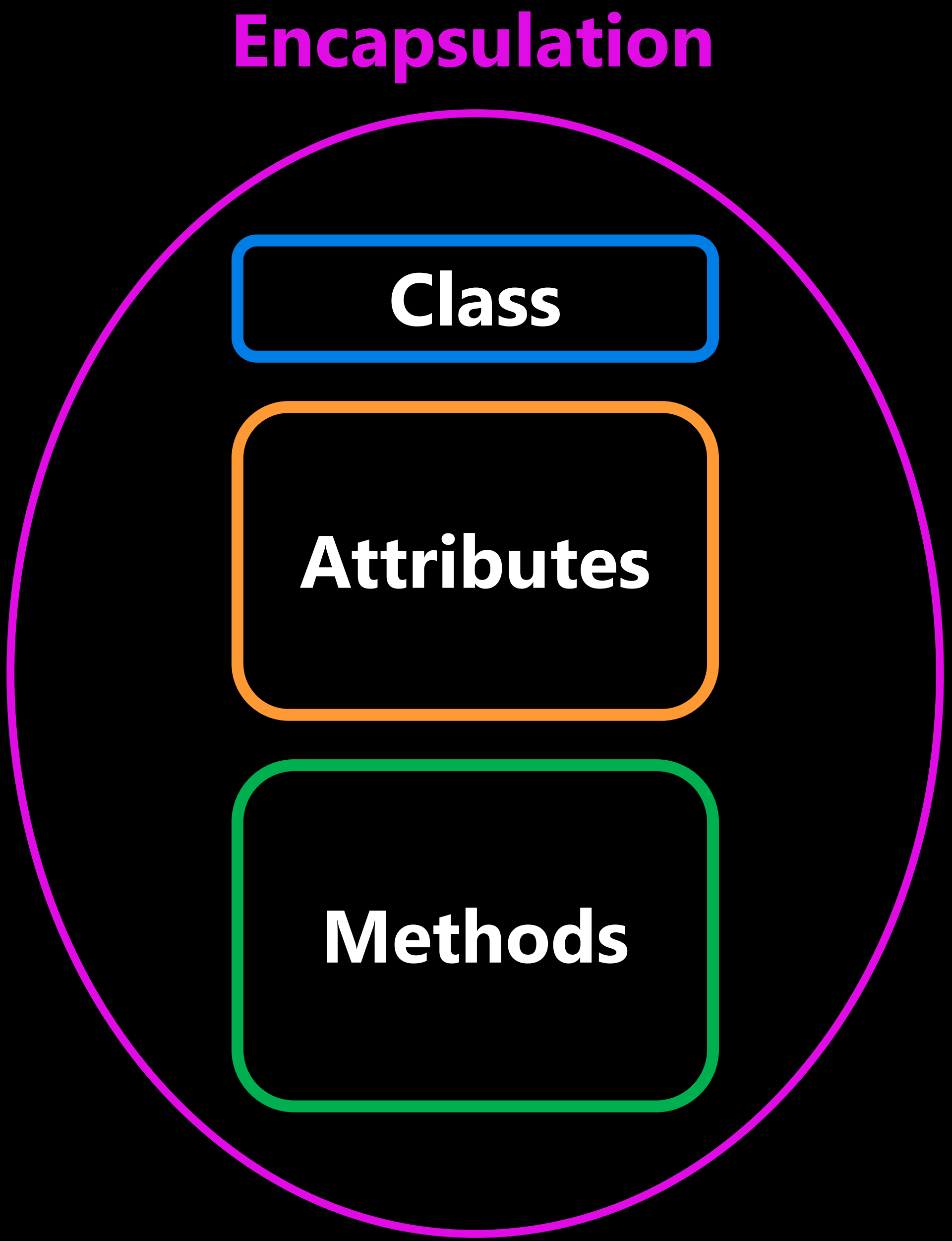
- **Instantiate:** Creating (constructing) an instance of a class.

```
alex = Turtle(0, 0)
```

This is the process of instantiating.

OOP Recap

- The core of object-oriented programming is the organization of the program by **encapsulating** related data and functions together in an object.
- Encapsulation permits objects to operate completely independently of each other as discrete and self-contained bunch of data and code.



OOP Recap

- self
- Reference to the instance of the class.

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def up(self):
        self.y += 1

    def goto(self, x, y):
        self.x = x
        self.y = y

    def get_position(self):
        return self.x, self.y
```

OOP Recap

```
katia = Turtle(0, 0)
```

```
class Turtle:

    def __init__(katia, x, y):
        katia.x = x
        katia.y = y

    def up(katia):
        katia.y += 1

    def goto(katia, x, y):
        katia.x = x
        katia.y = y

    def get_position(katia):
        return katia.x, katia.y
```

OOP Recap

```
ben = Turtle(0, 0)
```

```
class Turtle:

    def __init__(ben, x, y):
        ben.x = x
        ben.y = y

    def up(ben):
        ben.y += 1

    def goto(ben, x, y):
        ben.x = x
        ben.y = y

    def get_position(ben):
        return ben.x, ben.y
```

OOP Recap

```
seb = Turtle(0, 0)
```

```
class Turtle:

    def __init__(seb, x, y):
        seb.x = x
        seb.y = y

    def up(seb):
        seb.y += 1

    def goto(seb, x, y):
        seb.x = x
        seb.y = y

    def get_position(seb):
        return seb.x, seb.y
```

OOP Recap

- Because at the time of designing the class we don't know what these instance names will be, we just chose one.
  - self

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def up(self):
        self.y += 1

    def goto(self, x, y):
        self.x = x
        self.y = y

    def get_position(self):
        return self.x, self.y
```

OOP Recap

- Although you do not technically need to use the word self, it is widely adopted and is recommended.
  - this
  - instance
  - thing
  - self ← Python Standard

(IDE Demo)

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def up(self):
        self.y += 1

    def goto(self, x, y):
        self.x = x
        self.y = y

    def get_position(self):
        return self.x, self.y
```

OOP Recap

- Accessing attributes (Data) and methods (Functions) is different.

```
ben = Turtle(0, 0)

ben.x
```

Attribute.

```
ben.up()
```

A **Method** is a function, and we call functions using parentheses.

```
def my_func():
    print("Hello")
```

```
my_func
```

This function has not been called.

OOP Recap

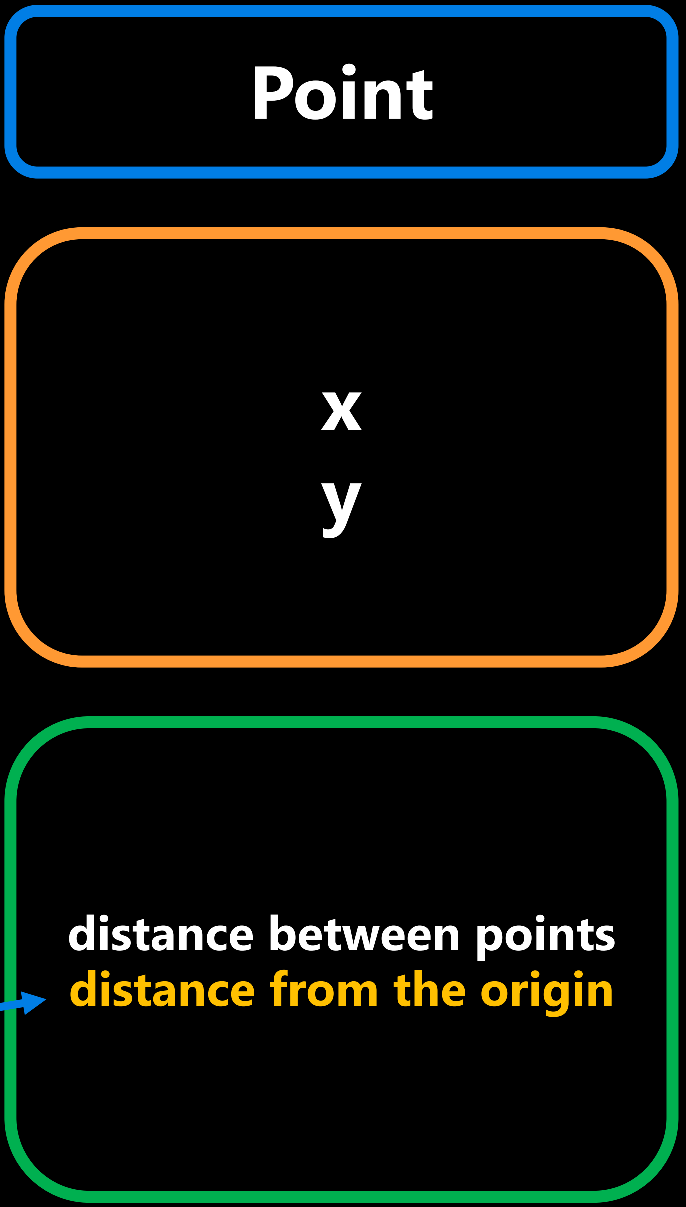
```
seb = Turtle(0, 0)
```

These parameters are passed to the constructor (the `__init__` method).

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def up(self):
        self.y += 1

    def goto(self, x, y):
        self.x = x
        self.y = y

    def get_position(self):
        return self.x, self.y
```

Review `Point` Class

- Our Point class from last lecture:
  - Contain data about the location of a Point instance.
  - Be able to calculate the distance between the Point instance and another point.
  - Be able to calculate distance between the Point and the origin.



Add new method

Review Point Class

- Our Point class from last lecture:
  - Contain data about the location of a Point instance.
  - Be able to calculate the distance between the Point instance and another point.
  - Be able to calculate distance between the Point and the origin.

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Click Link:
1. Point Class

Methods and self

Inside Class Definition

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def goto(self, x, y):
        body
        self.print_location()

    def print_location(self):
        body
```

self refers to the instance inside the class definition.

Outside Class Definition

```
alex = Turtle(10, 12)

alex.print_location()
```

The instance variable name refers to the instance outside the class definition.

Methods and self

Inside Class Definition

```
class Turtle:

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def goto(self, x, y):
        body
        self.print_location()

    def print_location(self):
        body
```

When defining a method, the first parameter refers to the instance being manipulated (**self**).

Outside Class Definition

```
alex = Turtle(10, 12)

alex.print_location()
```

Methods and `self`

Inside Class Definition

```
class Turtle:

    def __init__(x, y):
        self.x = x
        self.y = y

    def goto(x, y):
        body
        self.print_location()

    def print_location():
        body
```

A common error is to omit the **`self`** argument as the first parameter of a method definition.

Outside Class Definition

```
alex = Turtle(10, 12)

alex.print_location()
```

Methods and `self`

Inside Class Definition

```
class Turtle:

    def __init__(x, y):
        self.x = x
        self.y = y

    def goto(x, y):
        body
        self.print_location()

    def print_location():
        body
```

TypeError:

print_location() takes 0 positional arguments but 1 was given.

A method call automatically inserts an instance reference as the first argument.

Outside Class Definition

```
alex = Turtle(10, 12)

alex.print_location()
```

The error only occurs when you call the function.

Defining the methods without `self` will not cause an error.

Methods and self

Inside Class Definition

```
class Turtle:

    def __init__(x, y):
        self.x = x
        self.y = y

    def goto(self, x, y):
        body
        self.print_location()

    def print_location(self):
        body
```

A method call automatically inserts an instance reference as the first argument.

Outside Class Definition

```
alex = Turtle(10, 12)

alex.print_location()
```

Python does this for us.

The error only occurs when you call the function.

Defining the methods without `self` will not cause an error.

Calling Methods

- There are two ways to call methods.
- **Method 1**
- One way is to access the method through the class name and pass in the object.
  - `Class.method(instance_of_class)`
- **Method 2**
- The other is to use object-oriented syntax.
  - `instance_of_class.method()`

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Click Link:
2. Calling Methods

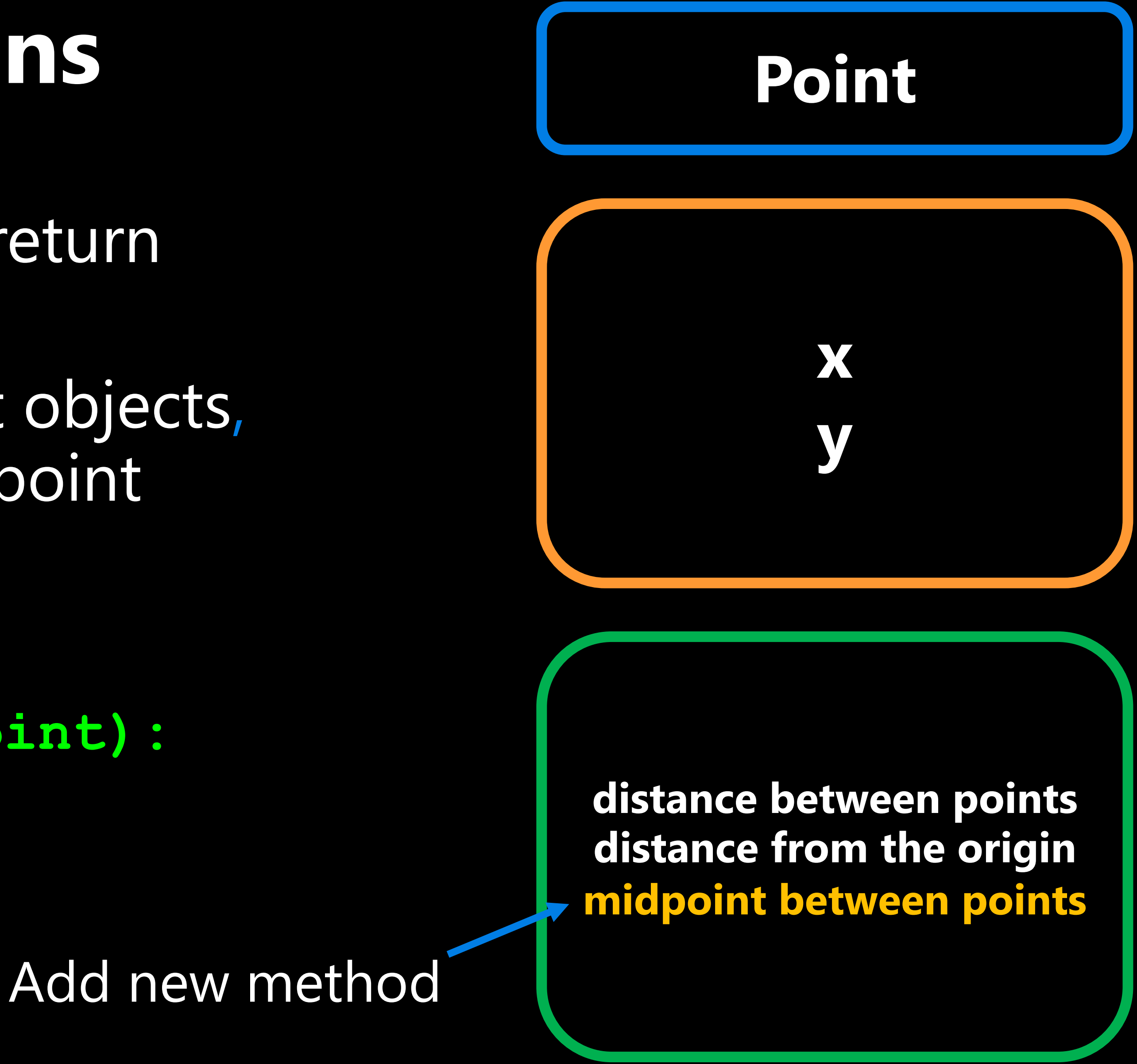
Objects and Functions

- Functions and methods can return instances.
- For example, given two Point objects, what if you want to create a point halfway in between?

```
def calc_midpoint(self, point):

    body

    return Point(x, y)
```



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Objects and Functions

- Functions and methods can return instances.
- For example, given two Point objects, what if you want to create a point halfway in between?

```
def calc_midpoint(self, point):

    body

    return Point(x, y)
```

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3. Add Midpoint Method to Point Class

Variable Declarations Are Optional

- While we can assign each point to a variable, is not necessary.
  - `p1 = Point(3, 4)`
  - `p2 = Point(5, 12)`
  - `p3 = p1.midpoint(p2)`
- Here is an alternative that uses no explicit variables.
  - `p3 = Point(3, 4).halfway(Point(5, 12))`

Instance of Point

Instance of Point

Instance of Point

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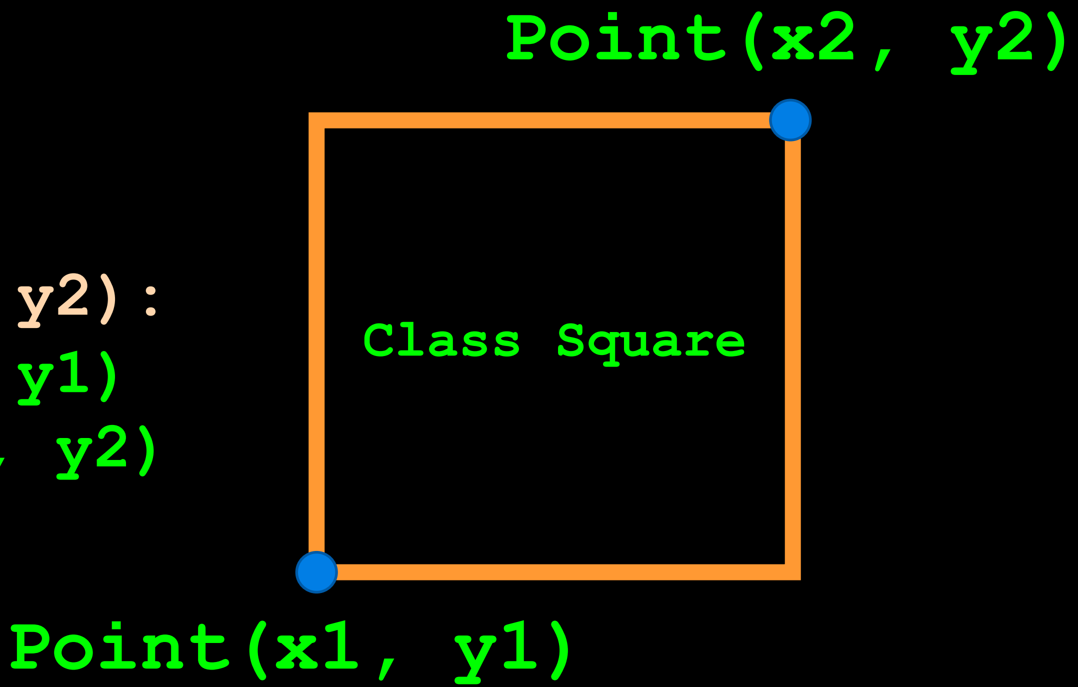
4. Variable Declarations Are Optional

Objects as Data Attributes of Classes

- Objects are programmer-created data types that can be used just like other data types.
- In particular, the data in an object can be in the form of instances of other classes.

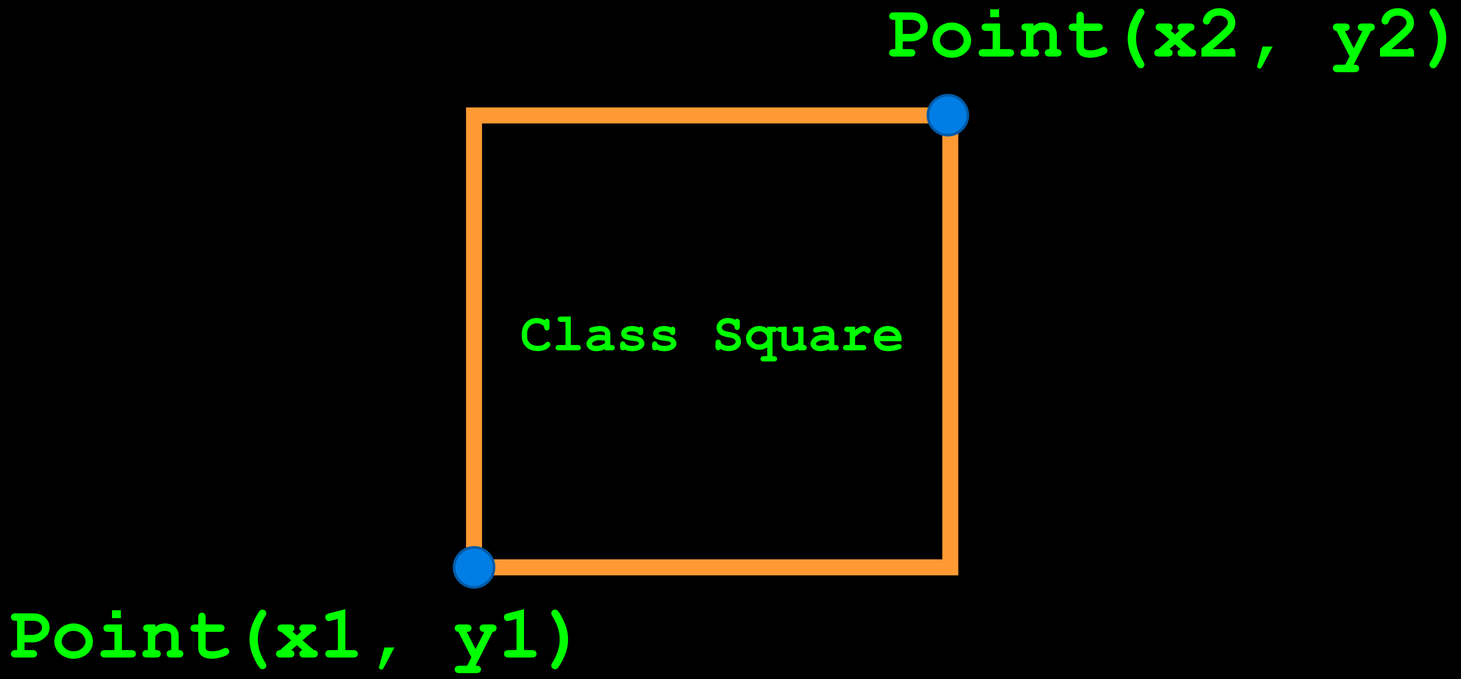
```
class Square:

    def __init__(self, x1, x2, y1, y2):
        self.lower_left = Point(x1, y1)
        self.upper_right = Point(x2, y2)
```



Objects as Data Attributes

- Create a Square class and use Point instances and attributes.



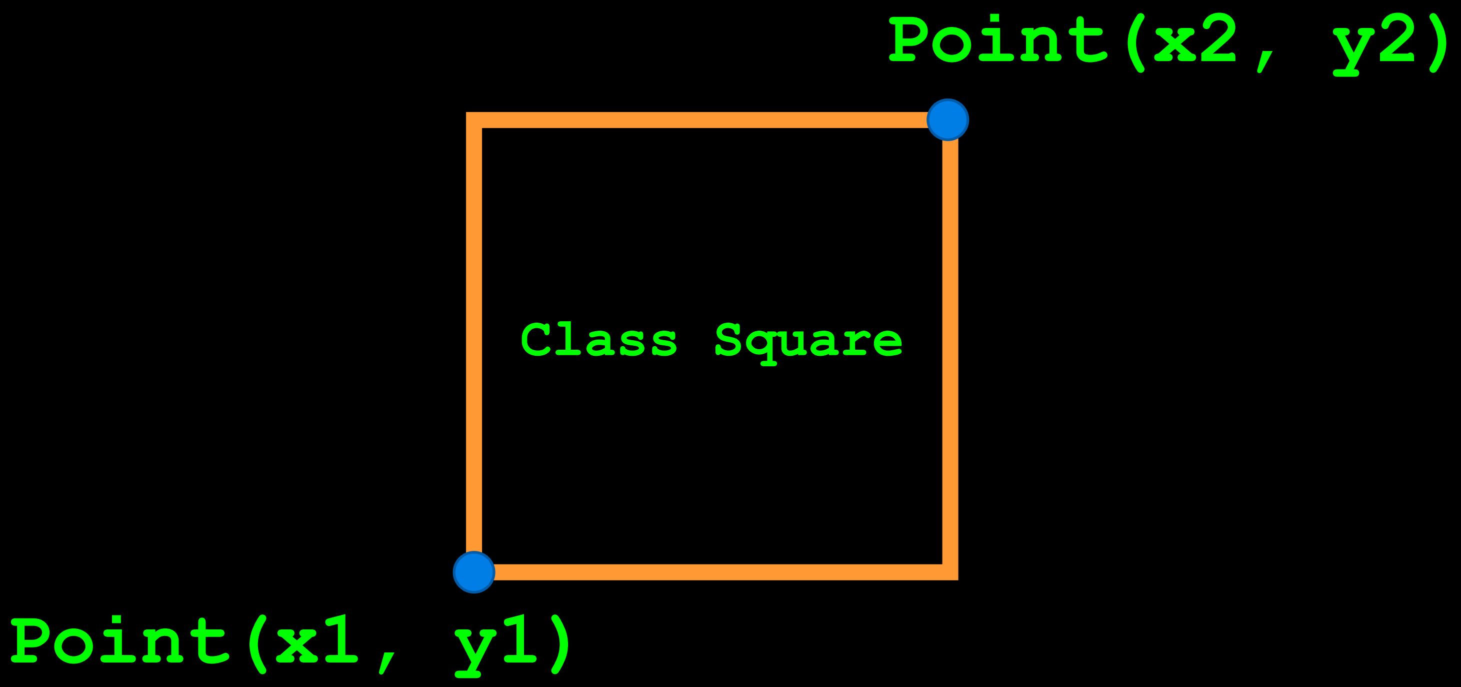
Square

lower_left
upper_right

calculate area
calculate centre

Objects as Data Attributes of Classes

- Create a Square class and use Point instances and attributes.



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Click Link:
5. Objects as Data Attributes of Classes

Objects In Collections

- Of course, you can put objects in Python collections like lists, tuples, etc.

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6. Objects In Collections

Printing Attribute Information

- It would be nice to not have to write a `print` statement each time we want to display some attribute information.
  - `p = Point(3, 4)`
  - `print(p.x, p.y)`
- Is there some way we could encapsulate this process?
- It would be better if we could have a method take care of it.

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7. Printing Attribute Information

Patient Class

- What if you are writing a medical application that needs to keep track of patients and their data.
- Let's create a `PatientData` class.
- **Attributes**
  - `height_cm`
  - `weight_kg`
- **Methods**
  - `print_data()`

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8. Patient Class

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classes in classes, functions, and collections.

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