

objects, classes, and methods.

Week 10 | Lecture 2 (10.2)

if nothing else, write **#cleancode**.

Upcoming Help Resources.

- These times worked best for you!
 - **TIP FOR SUCCESS:** Put these in your calendar!
- Schedule and Online Links are on Quercus

	Time
Online Tutorial	Thursday 5 PM to 6 PM
Online Lab	Tuesday 6 PM to 8 PM
Online Lab	Friday 6 PM to 8 PM

Office Hours	Time	Mode
Michael Tisi	Monday 12 PM to 1 PM	Online
Ali Tohidifar	Monday 6 PM to 7 PM	Online
Behrang Mohajer	Tuesday 11 AM to 12 PM	Online
Tamara Kecman	Thursday 11 AM to 12 PM	Online
Daniel Tovbis	Thursday 3 PM to 4 PM	RS422
Ben & Seb	Friday 2 PM to 3 PM	MY857 March 15 only: MY763

Midterm Review 2:

Tuesday March 18th @ 5 PM – 6 PM (Online – Check Quercus Announcement for Link)

This Week's Content

- **Lecture 9.1**
 - More Containers and Advanced Functions
- **Lecture 9.2**
 - **objects, classes, and methods**
- **Lecture 9.3**
 - Classes in Classes, Functions, and Collections

Procedural Programming

Global Variable

Pedestrian 1
x, y Location

Global Variable

Pedestrian 2
x, y Location

Global Variable

Pedestrian 3
x, y Location

```
x_ped1 = 3  
y_ped1 = 5
```

Global Variable

Traffic Light 1
Color

Global Variable

Car 1
x, y location

```
traffic_light = 'red'
```

Separation of Data and Functions

Function

OK to Cross

Function

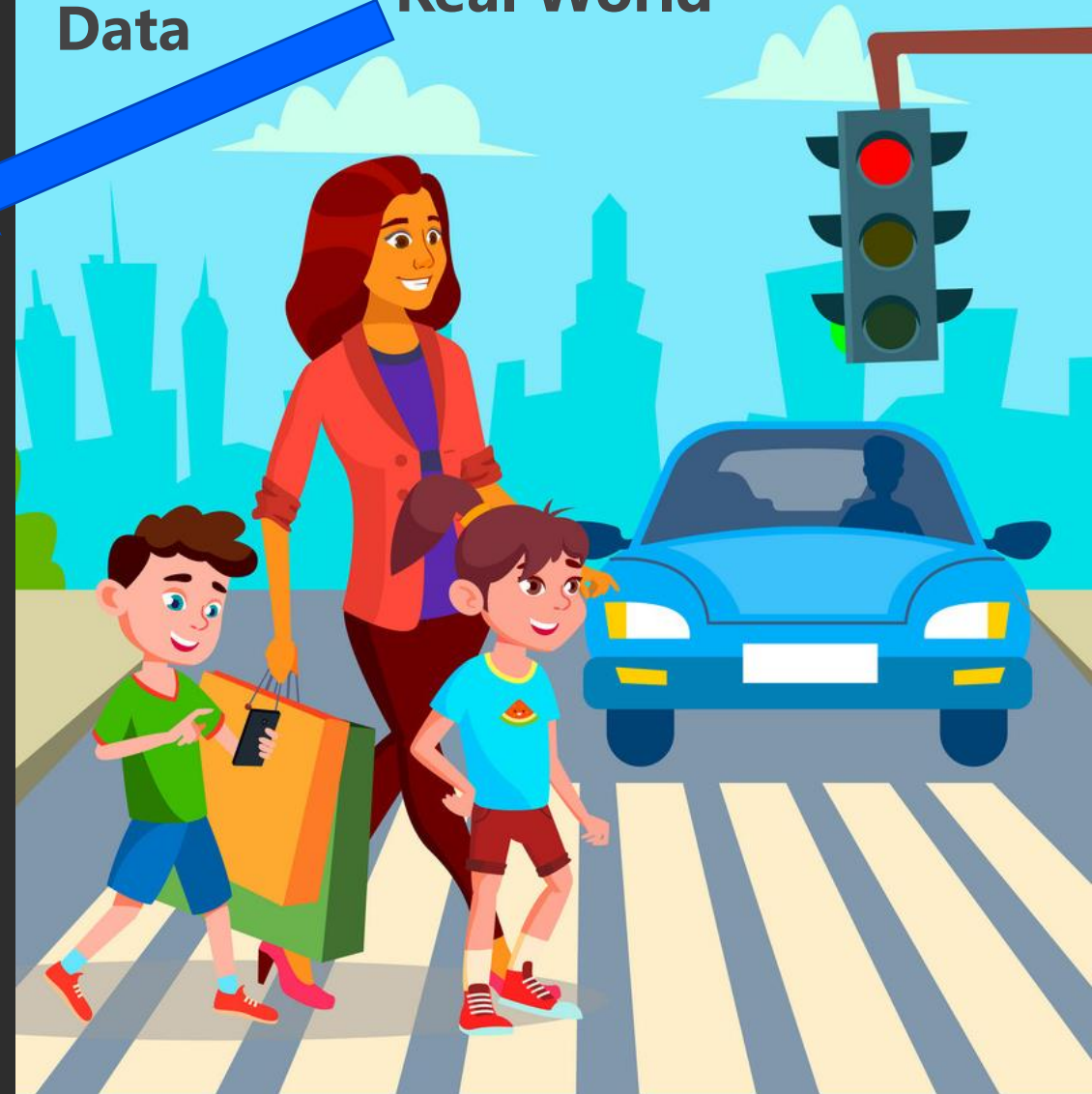
Advance Position

Function

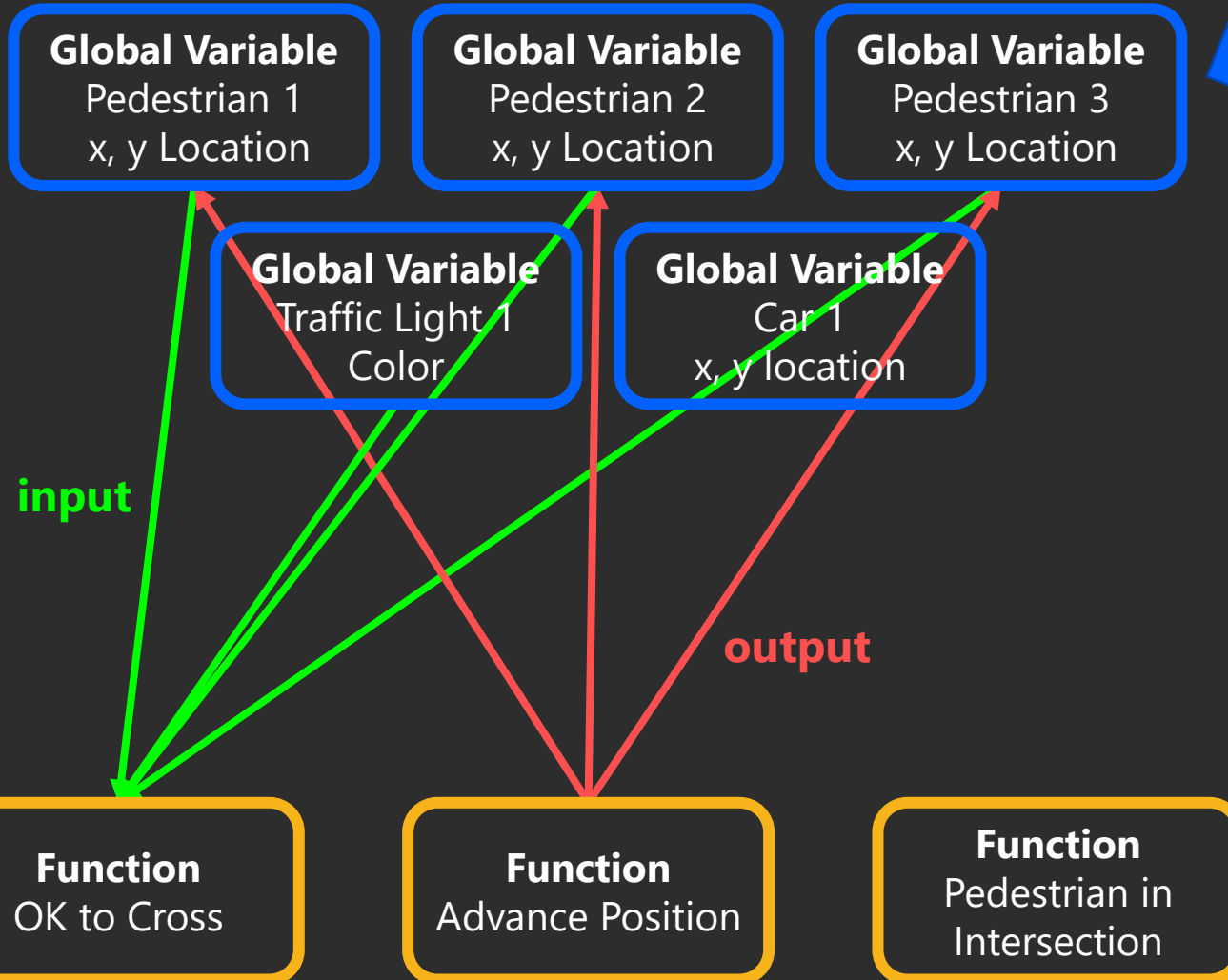
Pedestrian in
Intersection

Data

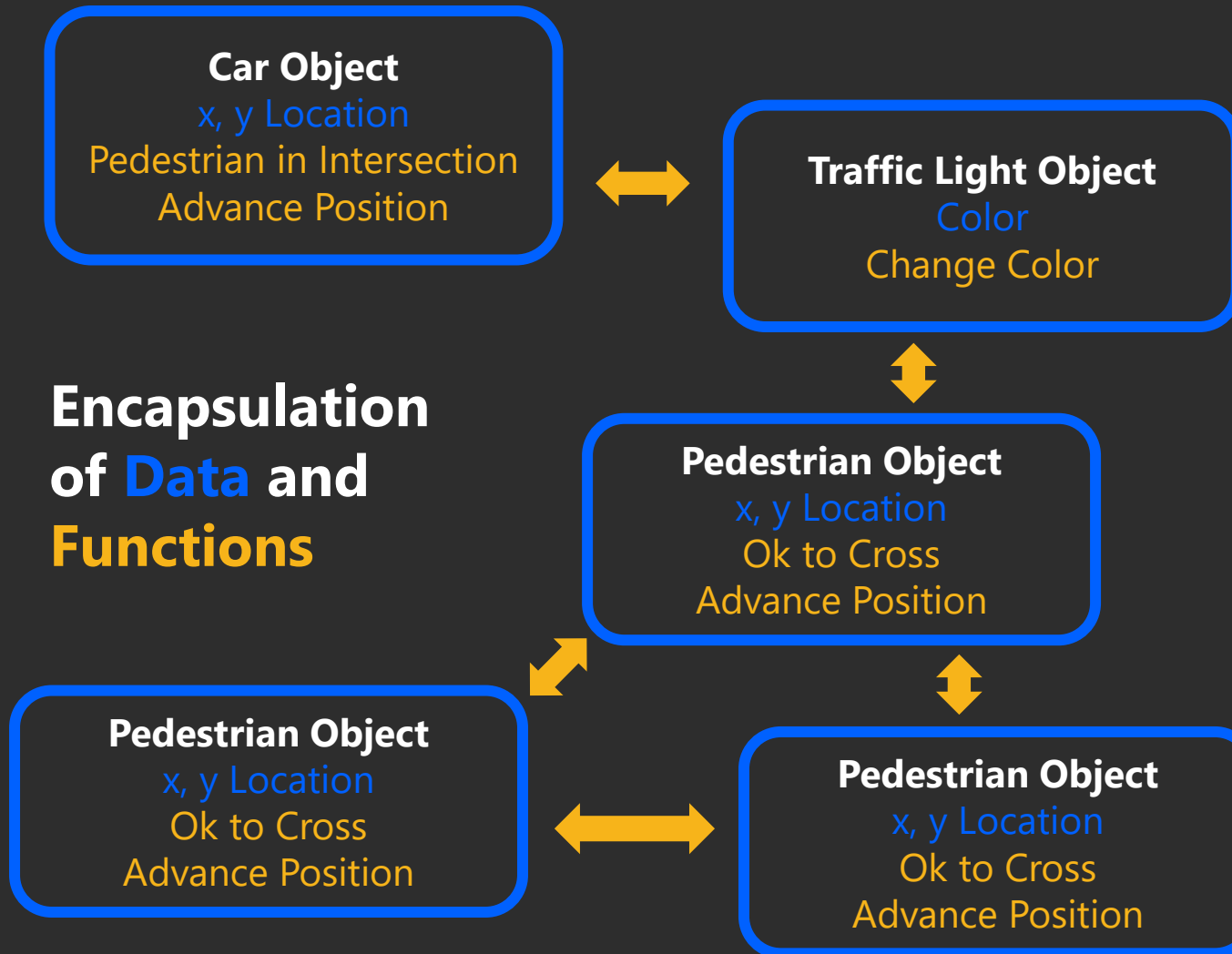
Real World



Procedural Programming



Object-Oriented Programming



Object-Oriented Programming

- Often, an object definition corresponds to some object or concept in the real world.
- The functions that operate on that object correspond to the ways real-world objects interact.
- Examples:
 - **Oven Object:** the oven allows several specific operations, e.g., set the temperature, set a timer, etc.
 - **Cellphone Object:** we use a cellphone's own "methods" to send a text message, or to change its state to silent.
 - **Turtle Object:** we use a turtle's own "methods" to move around a 2D space.

Object-Oriented Programming

Data Functions

Procedural

```
def up(y):  
    return y + 1
```

```
def goto(x_new, y_new):  
    return x_new, y_new
```

```
def right(x):  
    return x + 1
```

```
x = 0
```

```
y = 0
```

```
y = up(y)
```

```
x, y = goto(-150, 100)
```

```
x = right(x)
```

```
print(x, y)
```

Object-Oriented

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

```
alex.up()
```

```
alex.goto(-150, 100)
```

```
alex.right()
```

```
print(alex.x, alex.y)
```


Objects in Python

- **Everything in Python is an object.**
- Every value, variable, function, etc., is an object.
- Every time we create a variable we are making a new object.

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



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

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

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

Objects in Python

- Each object has a type or **class** it is associated with.

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



```
>>> isinstance("Hello", str)
```

```
True
```

```
>>> isinstance(4, int)
```

```
True
```

```
>>> isinstance(4, float)
```

```
False
```

```
>>> isinstance(4.0, float)
```

```
True
```

```
>>> isinstance([1, 2], list)
```

```
True
```

Objects in Python

- Really? Everything is an object?

**Open your
notebook**

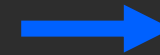
Click Link:

1. Objects in Python

Classes

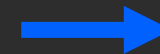
- A class can be thought of as a template for the objects that are instances of it.
- An instance of a class refers to an object whose type is defined as the class.
- The words "instance" and "object" are used interchangeably.
- A **Class** is made up of attributes (**data**) and methods (**functions**).

Data



Attributes

Functions

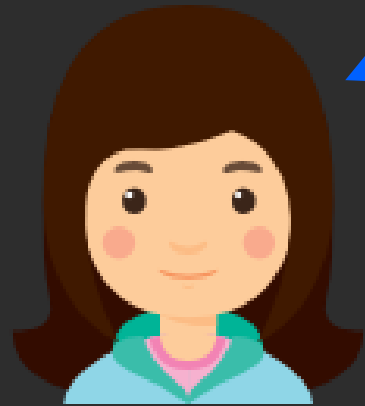


Methods

```
append(list1, list2)
```

```
list1.append(list2)
```

Classes

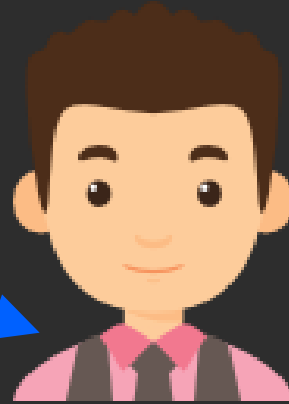


name: June
age: 34
city: Ottawa
gender: she/her

Instances
(objects) of the
Person class.



name: Ted
age: 31
city: Kingston
gender: he/him



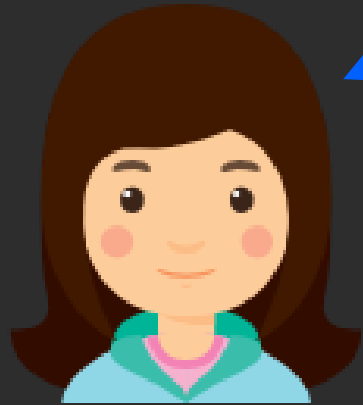
name: Majid
age: 28
city: Toronto
gender: they/them

Person

name
age
city
gender

eat
study
sleep
play

Classes



name: June
age: 34
city: Ottawa
gender: she/her

Instances
(objects) of the
Person class.

Object.
Instance of
the Person
Class.

Class.

```
june = Person('June', 34,  
              'Ottawa',  
              'she/her')
```

```
type(june)  
>>> Person
```

Class.

Person

name
age
city
gender

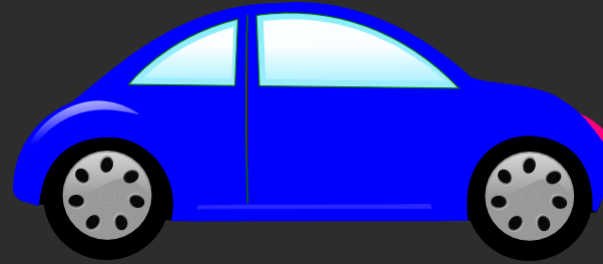
eat
study
sleep
play

Classes



model: Corolla
company: Toyota
year: 1980
color: red

Instances
(objects) of the
Car class.



model: Model S
company: Tesla
year: 2017
color: blue



model: Bus
company: Volkswagen
year: 1976
color: orange

Car

model
company
year
color

brake
accelerate
change oil
open trunk

Classes



Instances
(objects) of the
Car class.

Object.
Instance of
the **Car Class**.

Class.

```
mycar = Car('Corolla',  
            'Toyota',  
            1980,  
            'red')
```

```
type(mycar)  
>>> Car
```

Class.

Car

model
company
year
color

brake
accelerate
change oil
open trunk

model: Corolla
company: Toyota
year: 1980
color: red

Classes

Instances
(objects) of the
Turtle class.



name: Lucy
x location: 24
y location: 35



name: Susmit
x location: 134
y location: 45



name: Brian
x location: 92
y location: 62

Turtle

name
x location
y location

move up
move down
move left
move right
go to

Classes

Instances
(objects) of the
Turtle class.



name: Lucy
x location: 24
y location: 35

Class.

Object.
Instance of
the Turtle
Class.

```
turtle = Turtle('Lucy',  
                24,  
                35)
```

```
type(turtle)  
>>> Turtle
```

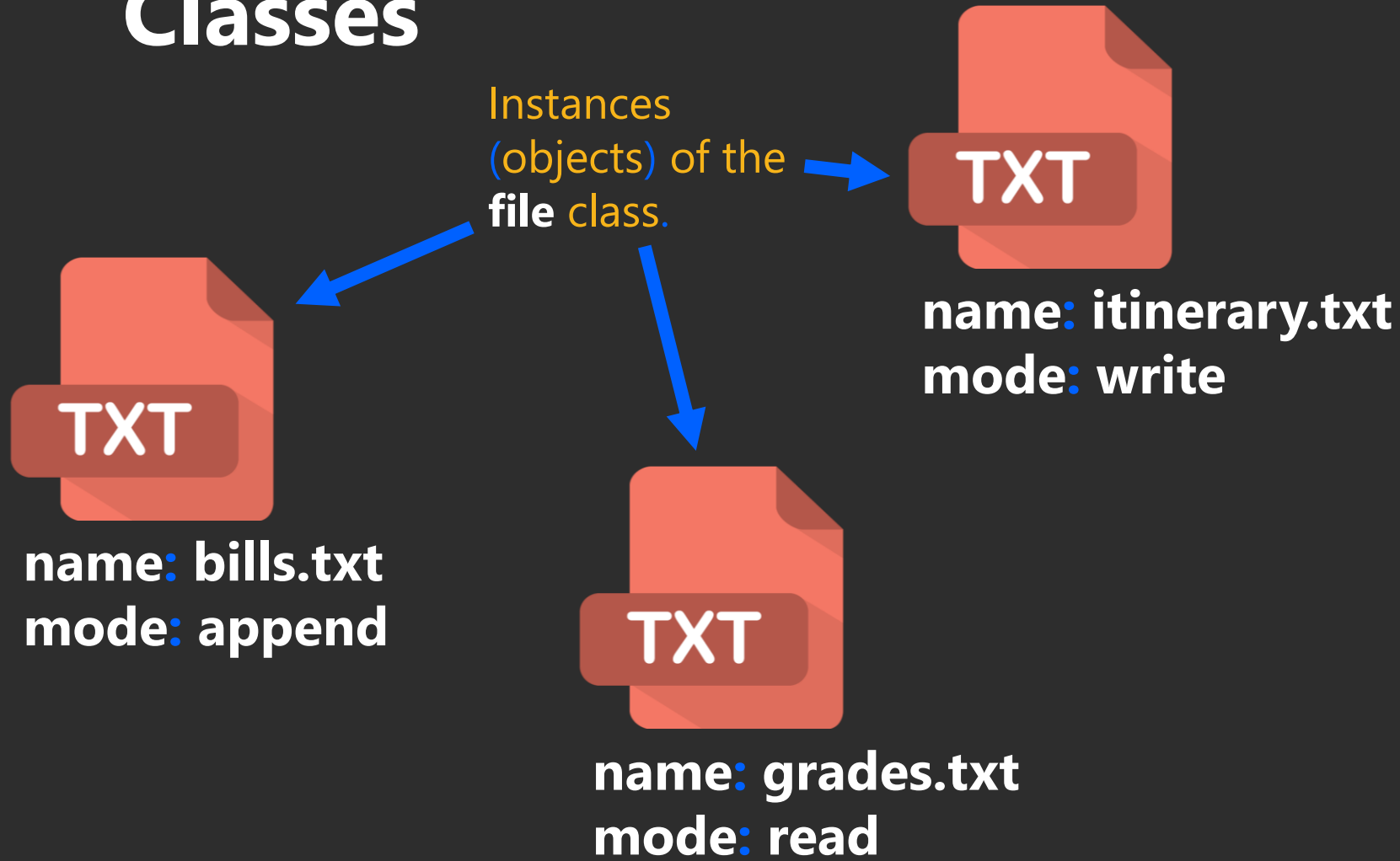
Class.

Turtle

name
x location
y location

move up
move down
move left
move right
go to

Classes

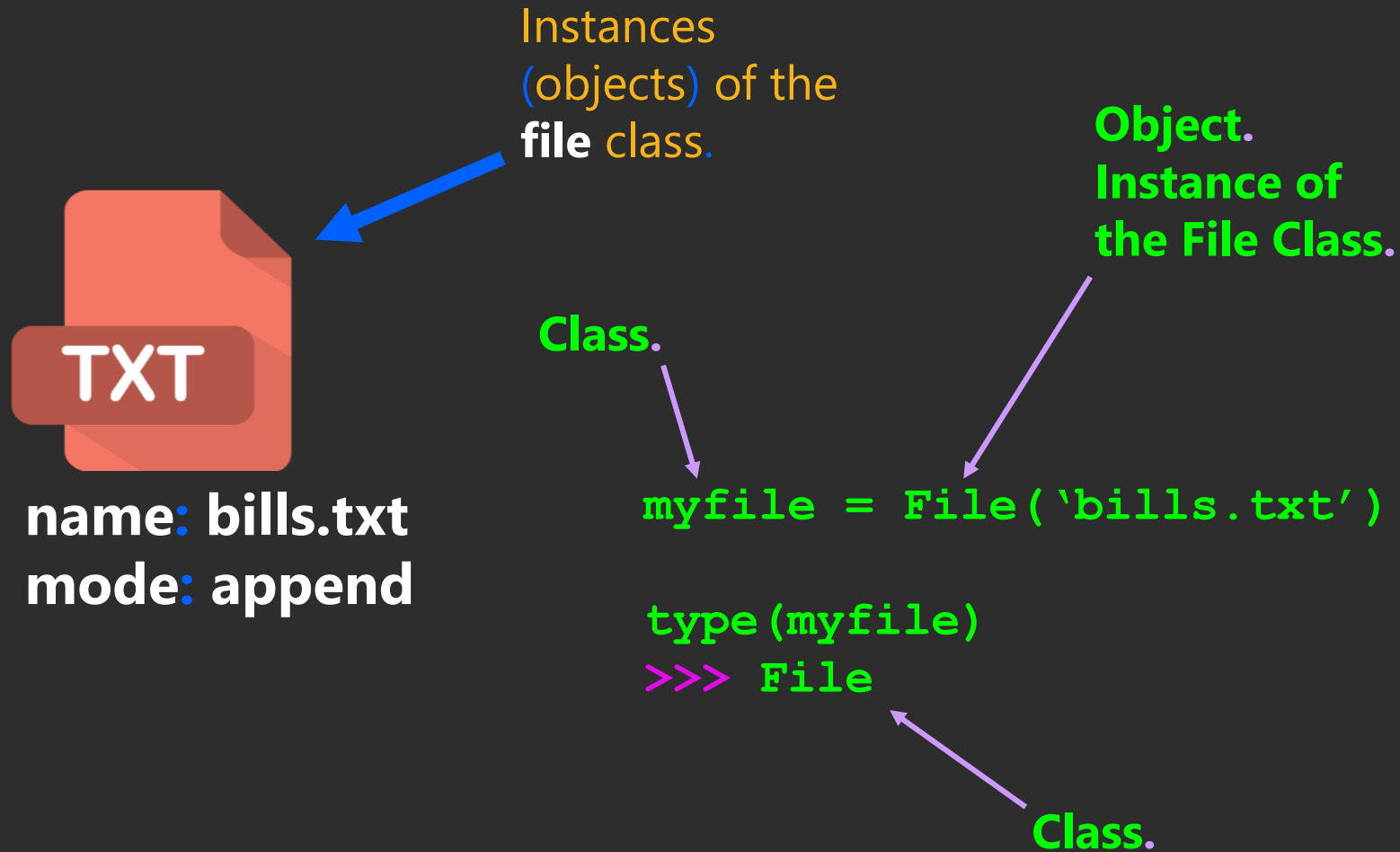


File

name
mode

read
readline
readlines

Classes



File

**name
mode**

**read
readline
readlines**

Classes

- 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
```

Classes



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

```
alex.up()
```

```
alex.goto(-150, 100)
```

```
alex.down()
```

```
print(alex.x, alex.y)
```

```
class Turtle:
```

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

```
    def up(self):  
        body
```

```
    def goto(self, x, y):  
        body
```

```
    def down(self):  
        body
```


Definition Recap

- Let's formally cover some important definitions.

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definition Recap

- Template for creating objects.

```
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
```

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definitions

- An instance of a class.



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

```
class Turtle:
```

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

```
    def up(self):  
        body
```

```
    def goto(self, x, y):  
        body
```

```
    def down(self):  
        body
```

 **alex** is an instance of the **Turtle** class.

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definition Recap

- Creating (constructing) an instance of a class.



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



This is the process of instantiating.

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definition Recap

`print()` is a function
`list.append()` is a method

- A function defined in a class.

```
def goto(x, y):  
    body
```



Function

```
class Turtle:
```

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

```
    def goto(self, x, y):  
        body
```



Method

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definitions

- A variable bound to an instance of a class.



```
alex = Turtle(0, 0)
alex.x
alex.y
```

```
class Turtle:
```

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

```
    def up(self):
        body
```

```
    def goto(self, x, y):
        body
```

```
    def down():
        body
```

```
print(x, y)
print(alex.x, alex.y)
```

Class

Object

Instantiate

Method

Attribute

Constructor

self

Attributes

Definitions

- Responsible for setting up the initial state of a new instance.



```
alex = Turtle(0, 0)
alex.x
alex.y
```

```
class Turtle:
```

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

```
    def up(self):
        body
```

```
    def goto(self, x, y):
        body
```

```
    def down(self):
        body
```

`__init__` method is automatically run during instantiation.

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definitions

- Reference to the instance of the class.
- Although you do not technically need to use the word **self**, it is widely adopted and is recommended.
- Understanding **self** is a challenge for most students so don't worry if you're confused.
- More on **self** in the next lecture.

```
class Turtle:
```

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

```
    def up(self):  
        body
```

```
    def goto(self, x, y):  
        body
```

```
    def down(self):  
        body
```

Class

Object

Instantiate

Method

Attribute

Constructor

self

Definitions

katia is self

Inside Class
self.attribute
self.method

Outside Class

katia.attribute
katia.method

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

```
katia.up()
```

```
class Turtle:
```

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

```
    def up(self):  
        ...
```

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

```
    def get_position(self):  
        ...
```

```
    def print_position(self):  
        ...
```

self

Definitions

katia is self

Inside Class
self.attribute
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Outside Class

katia.attribute
katia.method

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

```
katia.up()
```

```
class Turtle:
```

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

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

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

```
    def get_position(self):  
        ...
```

```
    def print_position(self):  
        ...
```

self

Definitions

`katia is self`

Inside Class
`self.attribute`
`self.method`

Outside Class

`katia.attribute`
`katia.method`

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

```
katia.up()  
katia.goto(-2, 10)
```

```
class Turtle:
```

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

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

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

```
    def get_position(self):  
        ...
```

```
    def print_position(self):  
        ...
```

self

Class
Object
Instantiate
Method
Attribute
Constructor

Definitions

`katia is self`

Inside Class
`self.attribute`
`self.method`

Outside Class

`katia.attribute`
`katia.method`

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

```
katia.up()  
katia.goto(-2, 10)
```

```
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):  
        ...
```

```
    def print_position(self):  
        ...
```

Class
Object
Instantiate
Method
Attribute
Constructor

self

Definitions

katia is self

Inside Class
self.attribute
self.method

Outside Class

katia.attribute
katia.method

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

```
katia.up()  
katia.goto(-2, 10)  
x, y = katia.get_position()
```

```
pint(x, y)  
>>> (-1, 10)
```

```
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):  
        ...
```

```
    def print_position(self):  
        ...
```

self

Definitions

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Outside Class

katia.attribute
katia.method

```
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```

```
katia.up()  
katia.goto(-2, 10)  
x, y = katia.get_position()
```

```
pint(x, y)  
>>> (-1, 10)
```

```
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
```

```
    def print_position(self):  
        ...
```

self

Definitions

`katia is self`

Inside Class
`self.attribute`
`self.method`

Outside Class

`katia.attribute`
`katia.method`

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

```
katia.up()  
katia.goto(-2, 10)  
x, y = katia.get_position()
```

```
pint(x, y)  
>>> (-1, 10)
```

```
katia.print_position()  
>>> -1 10
```

```
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
```

```
    def print_position(self):  
        ...
```

self

Class
Object
Instantiate
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Attribute
Constructor

Definitions

katia is self

Inside Class
self.attribute
self.method

Outside Class

katia.attribute
katia.method

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

```
katia.up()  
katia.goto(-2, 10)  
x, y = katia.get_position()
```

```
pint(x, y)  
>>> (-1, 10)
```

```
katia.print_position()  
>>> -1 10
```

```
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
```

```
def print_position(self):  
    print(self.x, self.y)
```

self

Definitions

`katia is self`

Inside Class
`self.attribute`
`self.method`

Outside Class

`katia.attribute`
`katia.method`

```
katia = Turtle(0, 0)

katia.up()
katia.goto(-2, 10)
x, y = katia.get_position()

print(x, y)
>>> (-1, 10)

katia.print_position()
>>> -1 10
```

```
class Turtle:

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

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

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

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

    def print_position(self):
        print(self.x, self.y)
```

self

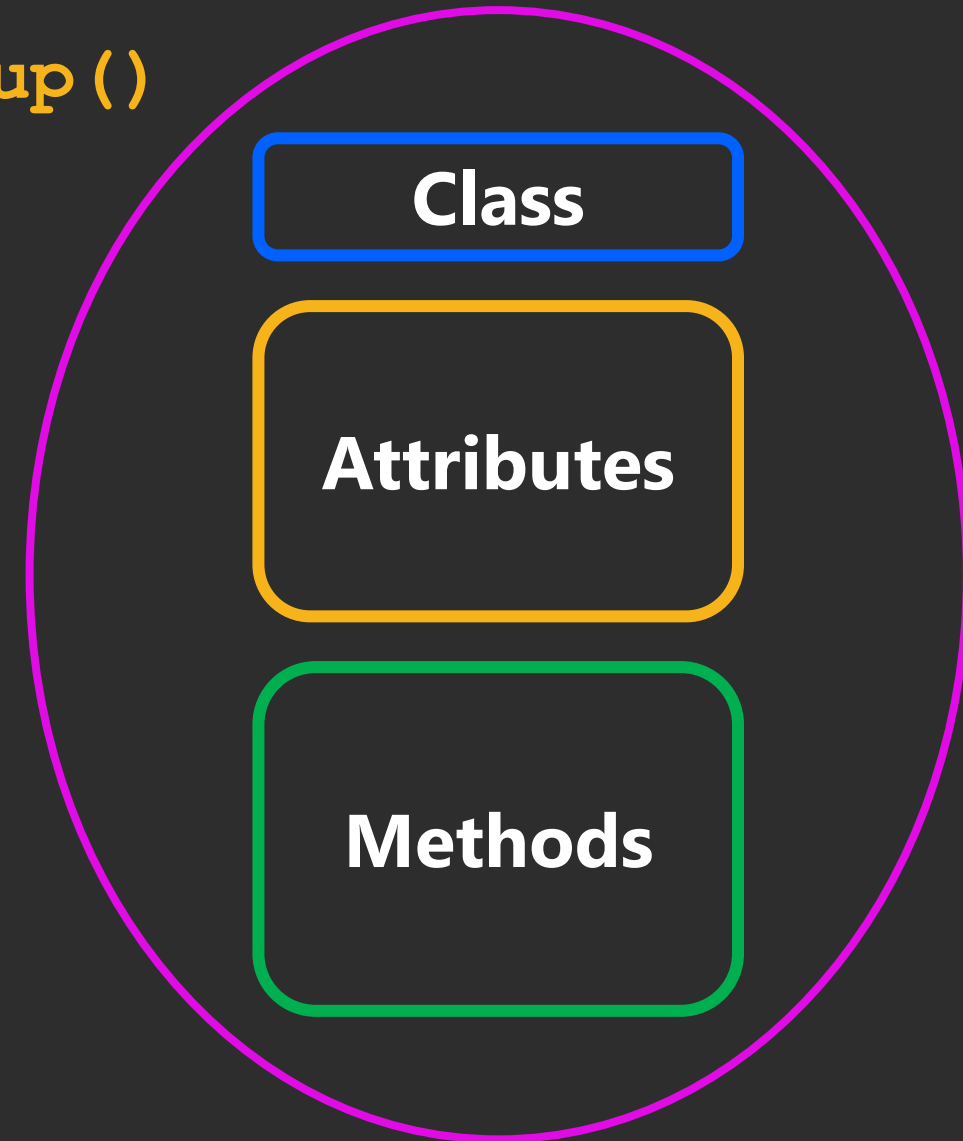
Class
Object
Instantiate
Method
Attribute
Constructor

Encapsulation

`y = up(y)` `alex.up()`

- The core of object-oriented programming is the organization of the program by **encapsulating** related **data** and **functions** together in an object.
- To encapsulate something means to enclose it in some kind of container.
- In programming, encapsulation means keeping **data** and the **code** that uses it in one place and hiding the details of exactly how they work together.

Encapsulation



Point Class: Constructor

- Create a Point class to:
 - Contain data about the location of a Point instance.
 - Be able to calculate the distance between the Point instance and another point.

Point

x
y

distance between points

Point Class: Constructor

- Create a Point class to:
 - Contain data about the location of a Point instance.
- Let's start with the **attributes** and the **constructor**.

**Open your
notebook**

Click Link:

**2. Write a Point
Class: Constructor**

Point Class: Methods

- Our Point class needs to:
 - Be able to calculate the distance between the Point instance and another point.
- Let's now write the **method**.

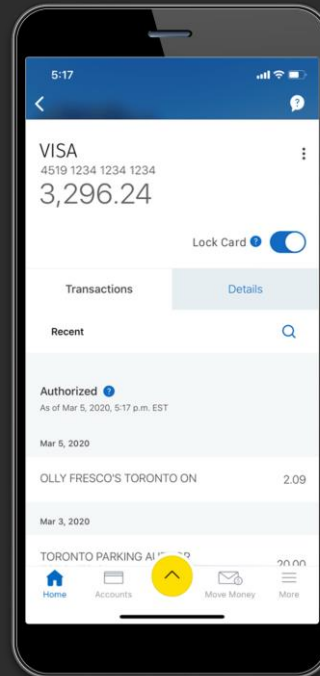
**Open your
notebook**

Click Link:

**3. Write a Point
Class: Methods**

Encapsulation

- Let's highlight the value of encapsulation with a bank **Account** class.
- Attributes:
 - Account owner's name.
 - Current account balance.
- Methods:
 - Deposit money.
 - Withdraw money.
 - Print account balance.



Open your
notebook

Click Link:
**4. Bank Account
Class**

objects, classes, and methods.

Week 10 | Lecture 2 (10.2)

if nothing else, write **#cleancode**.