UNIVERSITY OF TORONTO

introduction to Object Oriented Programming, and the file object.

Week 3 | Lecture 3 (3.3)

While waiting for class to start:

Download and open the Jupyter Notebook (.ipynb) for Lecture 3.3.1

You may also use this lecture's JupyterHub link instead (although opening it locally is encouraged).

Upcoming (Today!):

- Reflection 3 released Friday @ 11 AM
- Lab 3 **deadline** this Friday @ 11 PM
- PRA (Lab) on Friday @ 2PM this week (ONLINE)
- **Midterm** - May 31 in lecture @ 9:10 AM

if nothing else, write #cleancode

This Week's Content

- **Lecture 3.1**
  - Objects & Strings: Operators and Methods
  - Strings: Conversions, Indexing, Slicing, and Immutability
- **Lecture 3.2**
  - For Loops
  - Looping over Strings
- **Lecture 3.3**
  - **Introduction to Object-Oriented Programming and the File Object**

Procedural vs Object-Oriented

- *"Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which may contain data, in the form of fields, often known as attributes; and code, in the form of procedures, often known as methods."*
  — Wikipedia
- *"Procedural programming is a programming paradigm, derived from structured programming, based upon the concept of the procedure call. Procedures, also known as routines, subroutines, or functions, simply contain a series of computational steps to be carried out."*
  — Wikipedia

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'
```

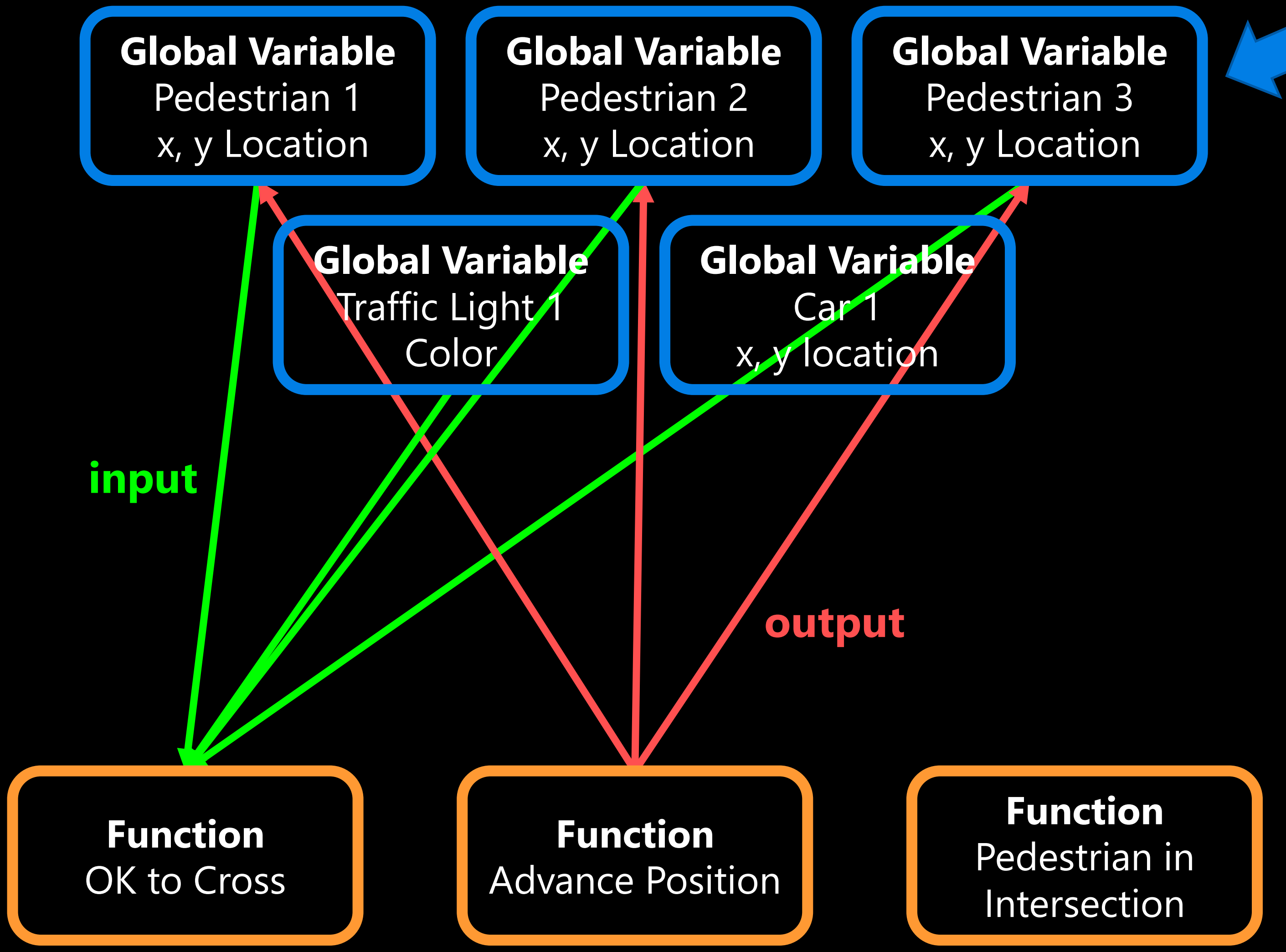
Separation of Data and Functions

Function
OK to Cross

Function
Advance Position

Function
Pedestrian in Intersection

Procedural Programming



Global Variable
Pedestrian 1
x, y Location

Global Variable
Pedestrian 2
x, y Location

Global Variable
Pedestrian 3
x, y Location

Global Variable
Traffic Light 1
Color

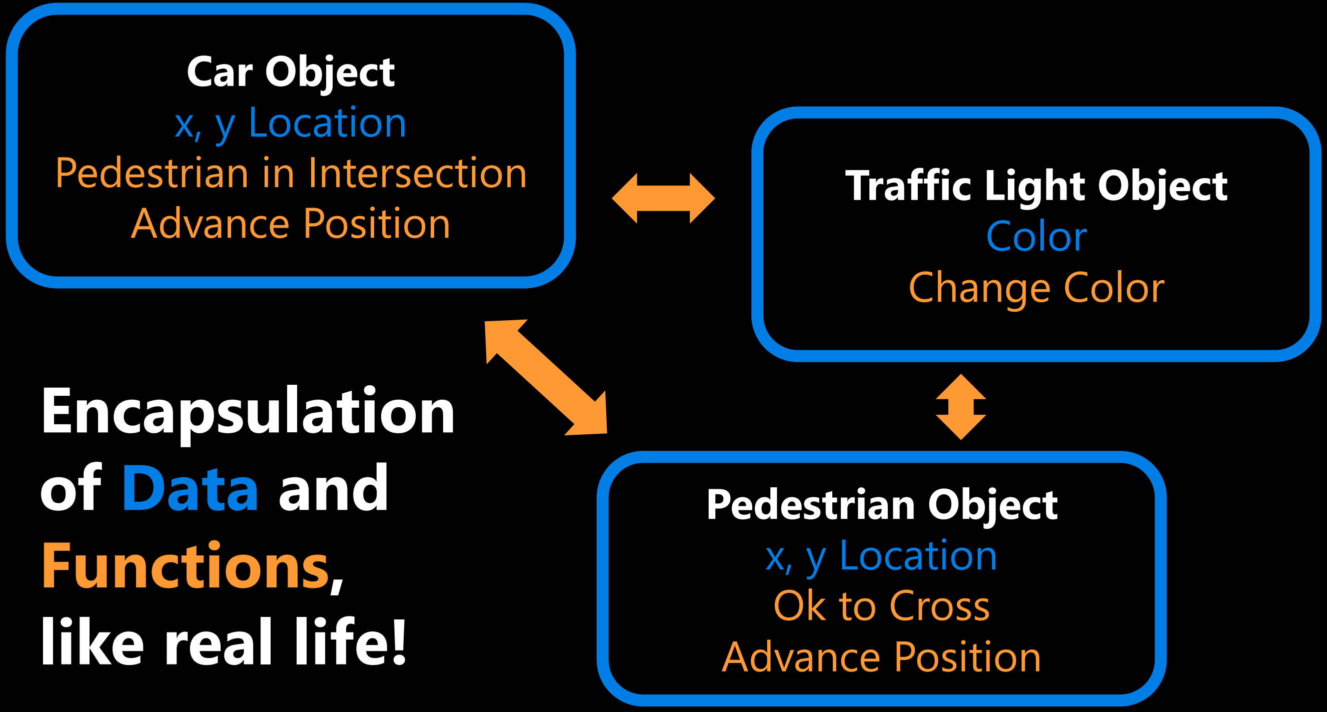
Global Variable
Car 1
x, y location

Function
OK to Cross

Function
Advance Position

Function
Pedestrian in Intersection

Object-Oriented Programming



Car Object
x, y Location
Pedestrian in Intersection
Advance Position

Traffic Light Object
Color
Change Color

Pedestrian Object
x, y Location
Ok to Cross
Advance Position

Encapsulation of Data and Functions, like real life!

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.

- Models our real-life thinking
  - Sandwich – ingredients, freshness, etc.
  - Car – model, year, fuel level, forward, reverse etc.
  - Cat – weight, name, colour, scratch, meow, sleep, etc.
  - Turtle Object – x_position, y_position, forward, up, left, etc.

Object-Oriented Programming

Data

Functions

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

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

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

Procedural

```
alex_x = 0
alex_y = 0

alex_y = up(alex_y)
alex_x, alex_y = goto(-150, 100)
alex_x = right(alex_x)

print(alex_x, alex_y)
```

Object-Oriented

```
alex = Turtle(0, 0)


alex.up()
alex.goto(-150, 100)
alex.right()

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

Objects in Python

Is this an instance of this class.

- **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.

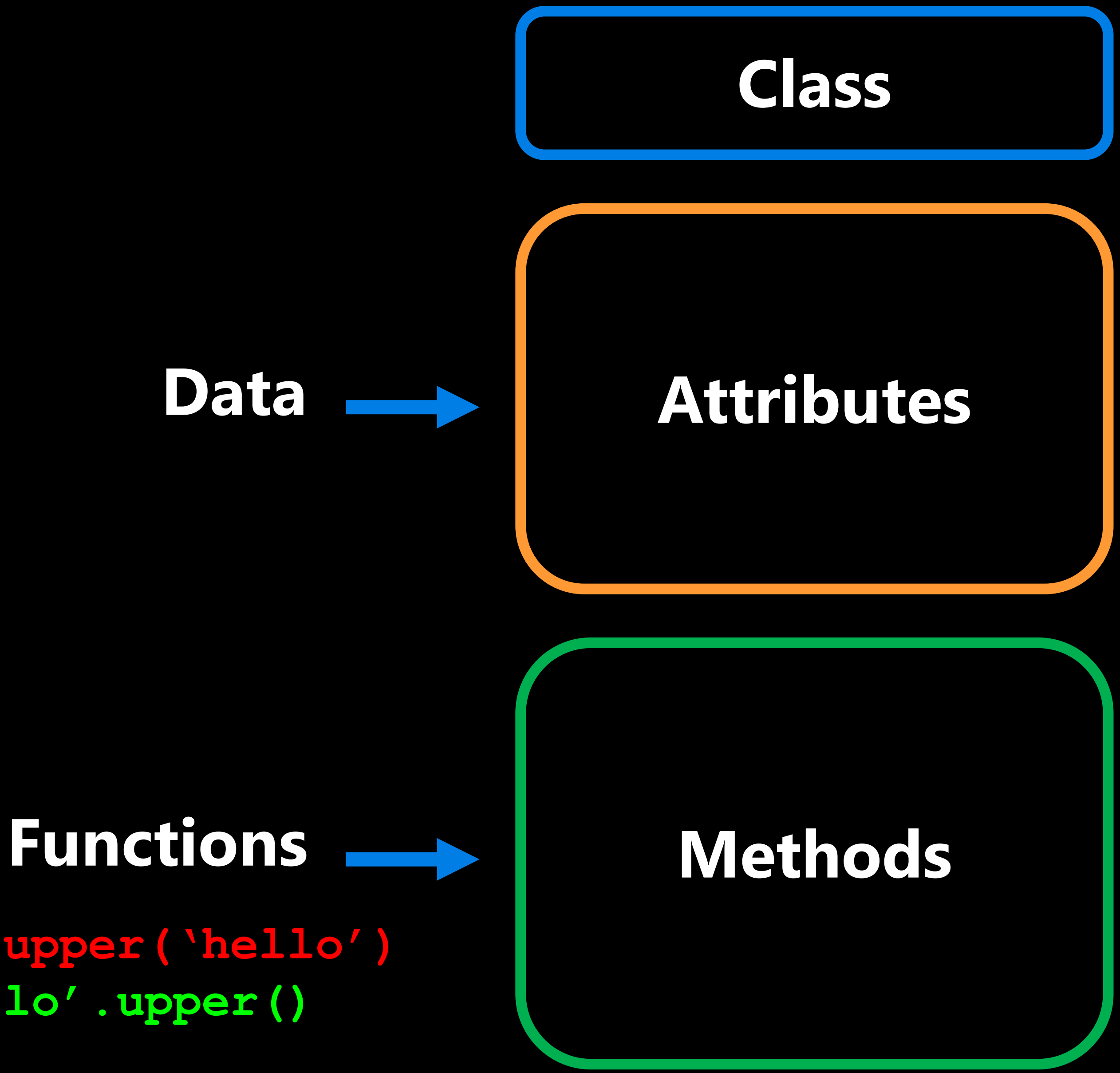
```
>>> isinstance(4, object)
True

>>> isinstance(max, object)
True

>>> isinstance(“Hello”, object)
True
```

Classes

- A template or blueprint for object types
- An instance of a class refers to one 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**).



```
str.upper('hello')
'hello'.upper()
```

Classes

Instances (objects) of the Person class.

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

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

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

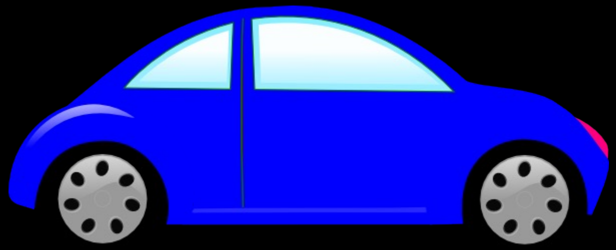
Person

name
age
city
gender

eat
study
sleep
play

Classes

Instances (objects) of the Car class.



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

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

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

Car

model
company
year
color

brake
accelerate
open trunk

Classes

Instances (objects) of the Turtle class.

name: Vinodh
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

We’ve already been using objects!

integer

is_integer
as_integer_ratio
to_bytes
from_bytes
bit_count
…

string

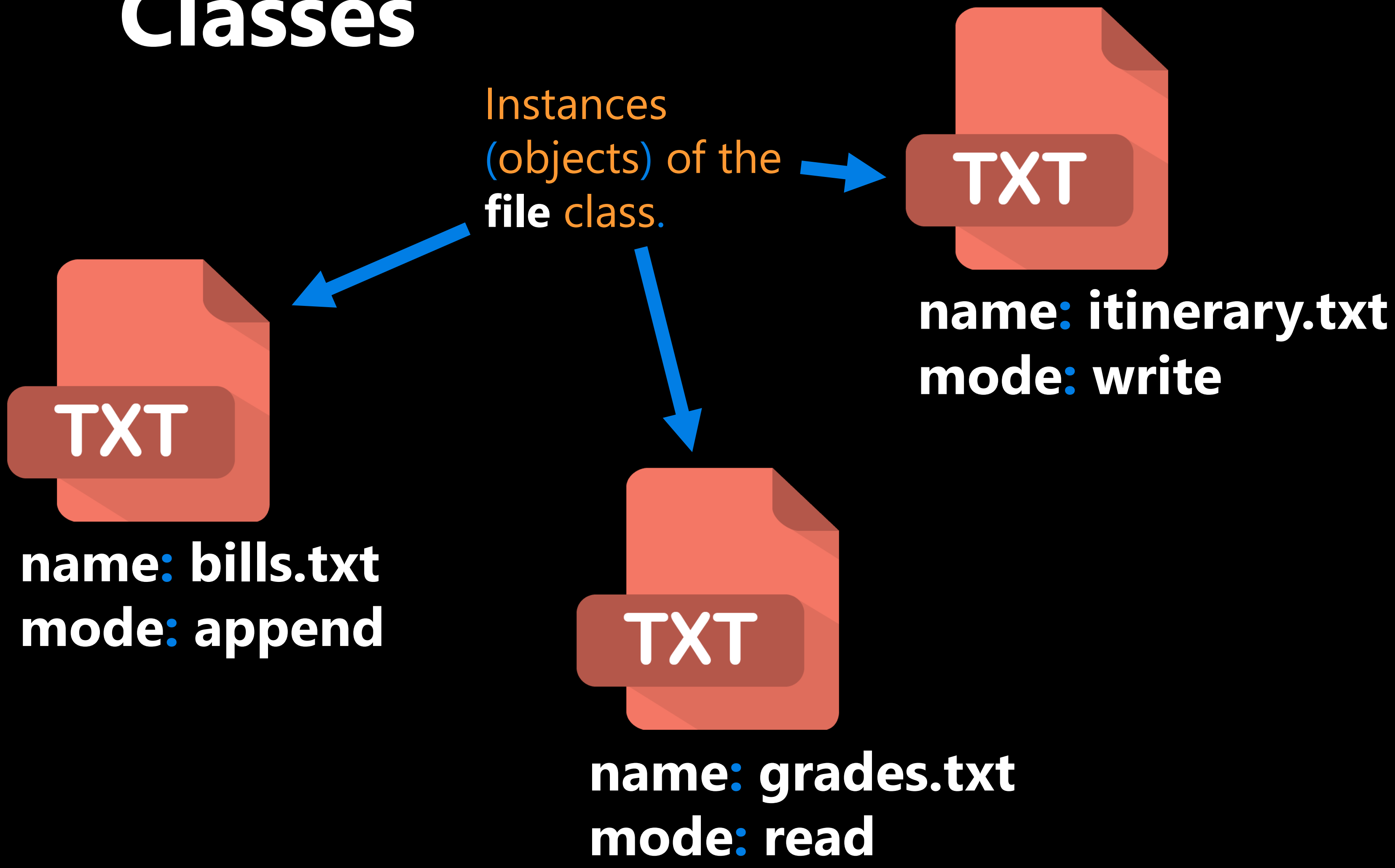
replace
find
rfind
upper
isupper
islower
capitalize
count
…

math

pi
e
inf
…

factorial
ceil
floor
isfinite
log
…

Classes



Instances (objects) of the file class.

name: itinerary.txt
mode: write

name: bills.txt
mode: append

name: grades.txt
mode: read

File

filename
mode (ex: read or write)

read
readline
write
close
...

Classes

```
alex = Turtle(0, 0)



alex.up()
alex.goto(-150, 100)
alex.down()

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

This code existed somewhere when you wrote Lab 1, but we didn’t need to know the details to be able to use them!

We will learn more about building custom classes later (Week

```
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
```

Let’s Code!

- Let’s take a look at how this works in Python!
  - Objects in Python
  - One potential ACORN design

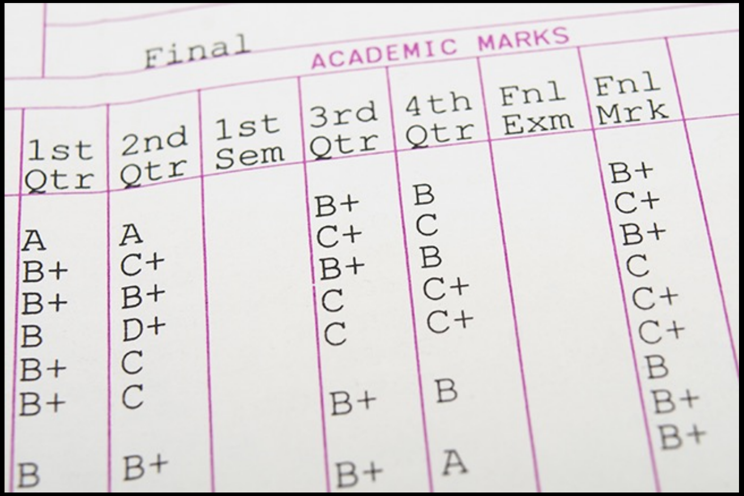
Breakout Session!

Click Link:

1. Objects in Python

Why do we care about files?

- Everything we’ve done so far is essentially deleted when our program ends
- What if we wanted to store information?


Final ACADEMIC MARKS

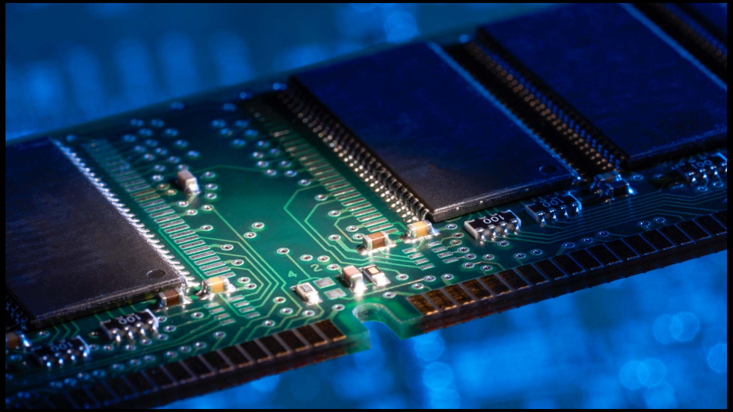
1st Qtr	2nd Qtr	1st Sem	3rd Qtr	4th Qtr	Fnl Exm	Fnl Mrk
A	A		B+	B		B+
B+	C+		C+	C		C+
B+	B+		B+	B		B+
B	D+		C	C+		C
B+	C		C	C+		C+
B+	C					C+
			B+	B		B
B	B+					B+
			B+	A		B+

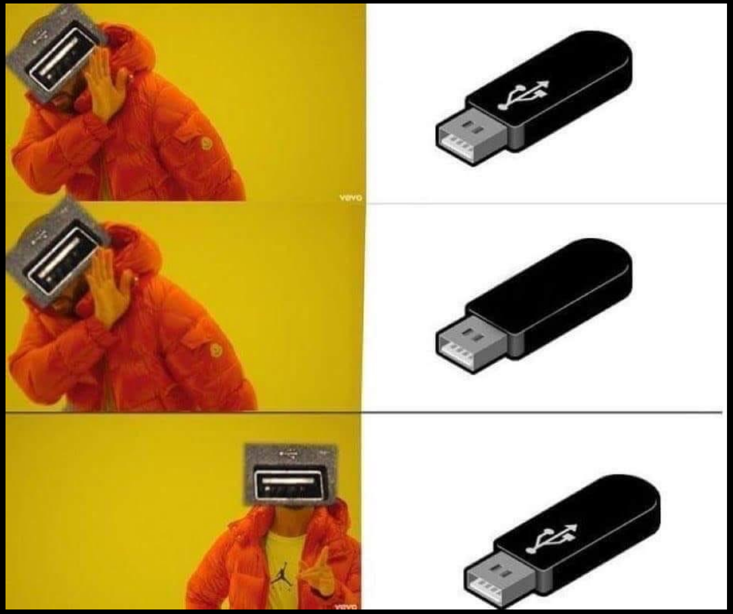
Why work with files?

- Recall from Week 1:

  While a program is running, its data is stored in random access memory (RAM). RAM is fast and inexpensive, but it is also volatile, which means that *when the program ends data in RAM disappears*.

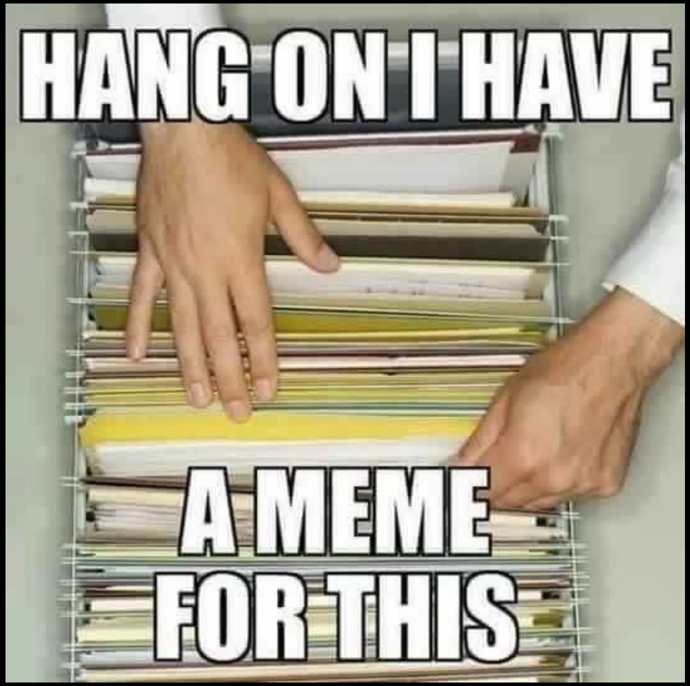
- To make data available the next time the program is started, it must be written to a non-volatile storage medium, such a hard drive, USB drive, cloud storage, or CD-R.

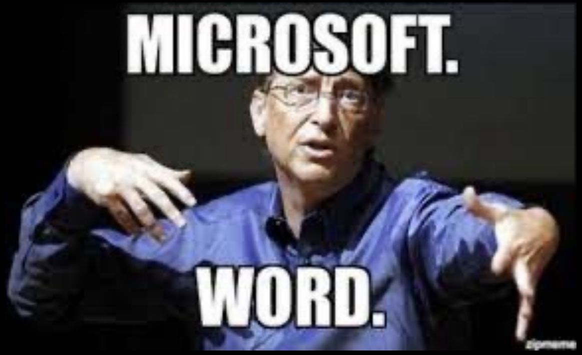




Why work with files?

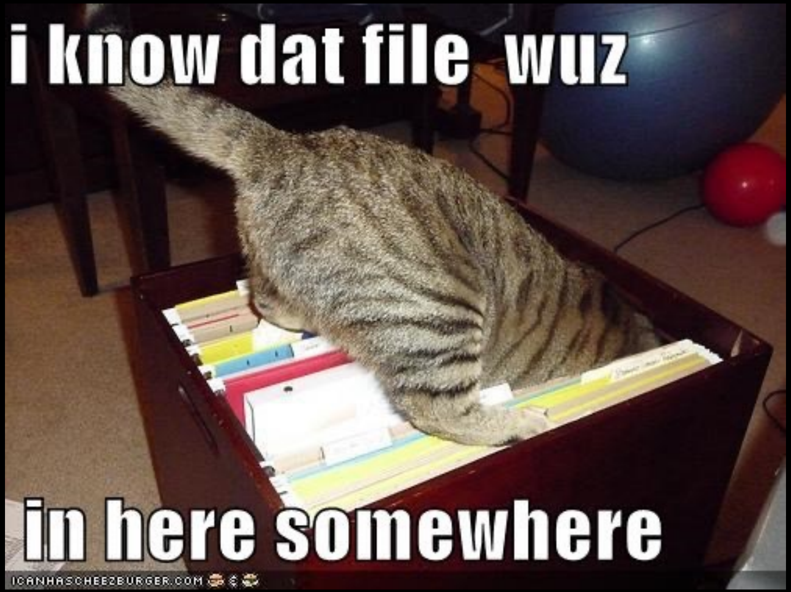
- Data on non-volatile storage media are stored in named locations on the media called **files**.
- By **reading** and **writing** files, programs can save information between program runs.





It's like working with a notebook!

- A file must be **opened**.
- When you are done, it has to be **closed**.
- While the file is open, it can either be **read from or written to**.
- Like a bookmark, the file **keeps track of** where you are reading to or writing from.
- You can read the whole file in its **natural order** or you can **skip** around



Opening a File

- Python has a built-in function `open` that creates and returns a file object with a connection between the file information on the disk and the program.
- The general form for opening a file is:

```
open(filename, mode)
```

- where **mode** is `'r'` (to open for reading), `'w'` (to open for writing), or `'a'` (to open for appending to what is already in the file).
- **filename** is an external storage location.

Writing to a File

- The following statement opens the file `test.txt` in write mode `‘w’`.

```
myfile = open(‘test.txt’, ‘w’)
```

- If there is no file named "`test.txt`" on the disk, it will be created. *If there already is one, it will be replaced by the file we are writing*.
- The file information will be assigned to the file object `myfile`.

Writing to a File

- To write something we need to use the `write` method as shown:

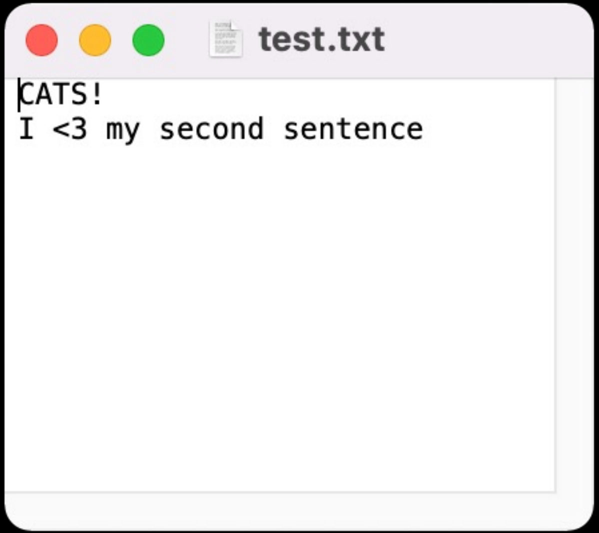
```
    myfile.write(‘CATS!…’)
```

- The `write` method does not attach a new line character by default.

```
myfile.write(‘\n’)
myfile.write(‘I <3 my second line… \n’)
```

- Every time we use `myfile.write()` a string is added to file “`test.txt`” where we left off.

```
myfile = open(‘test.txt’, ‘w’)
myfile.write(‘CATS!…’)
myfile.write(‘\n’)
myfile.write(‘I <3 my second sentence… \n’)
```



```
CATS!
I <3 my second sentence
```

Closing a File

- Once you have finished with the file, you need to close it:

```
myfile.close()
```

- This tells the system that we are done writing and makes the disk file available for reading or writing by other programs (or by our own program).

Let’s Code!

- Let’s take a look at how this works in Python!
  - Writing to your first file
  - Figure out where your files are getting saved!
    - Current working directory
  - Try playing with “w” and “a” mode!

Breakout Session!

Click Link:
2. The File Object

CLOSE THE FILE!

```
myfile.close()
```

- Always close a file that you've opened!
  - Many changes don't occur until **after** the file is closed
  - Leaving open is a waste of a computer's resources
    - Slows down program, uses more space in RAM, impacts performance
  - Other files may treat the file as "open" and won't be able to read the file
  - Could run into limits about how many files you have open
  - Not #cleancode

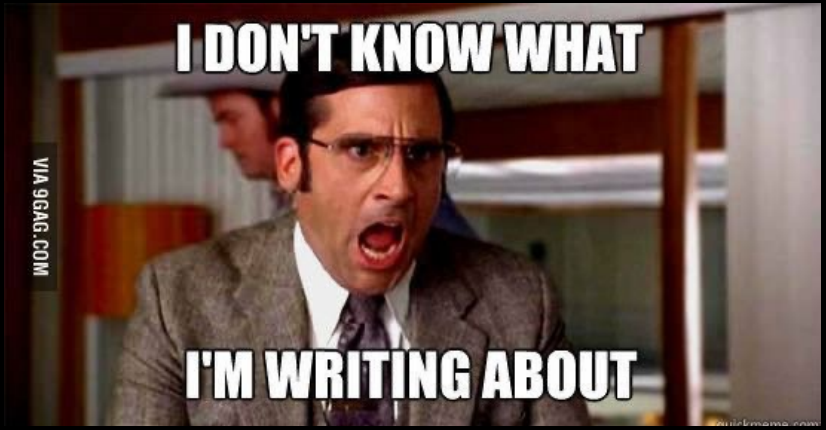
The "Writing to Files" Recipe

go together

```
# open/create a file
myfile = open("grades.txt", "w")


# write to a file
myfile.write(’string’)


# close the file
myfile.close()
```



Example: Writing to Files

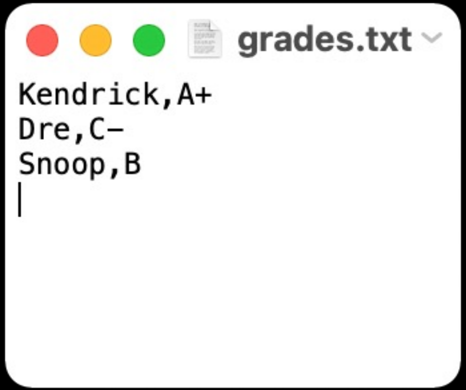
- How would we write a string to a file?

```
students = ‘Kendrick,A+\nDre:C-\nSnoop:B\n’

# create a file
myfile = open("grades.txt", "w")

# store string to the file
myfile.write(students)

# close the file
myfile.close()
```

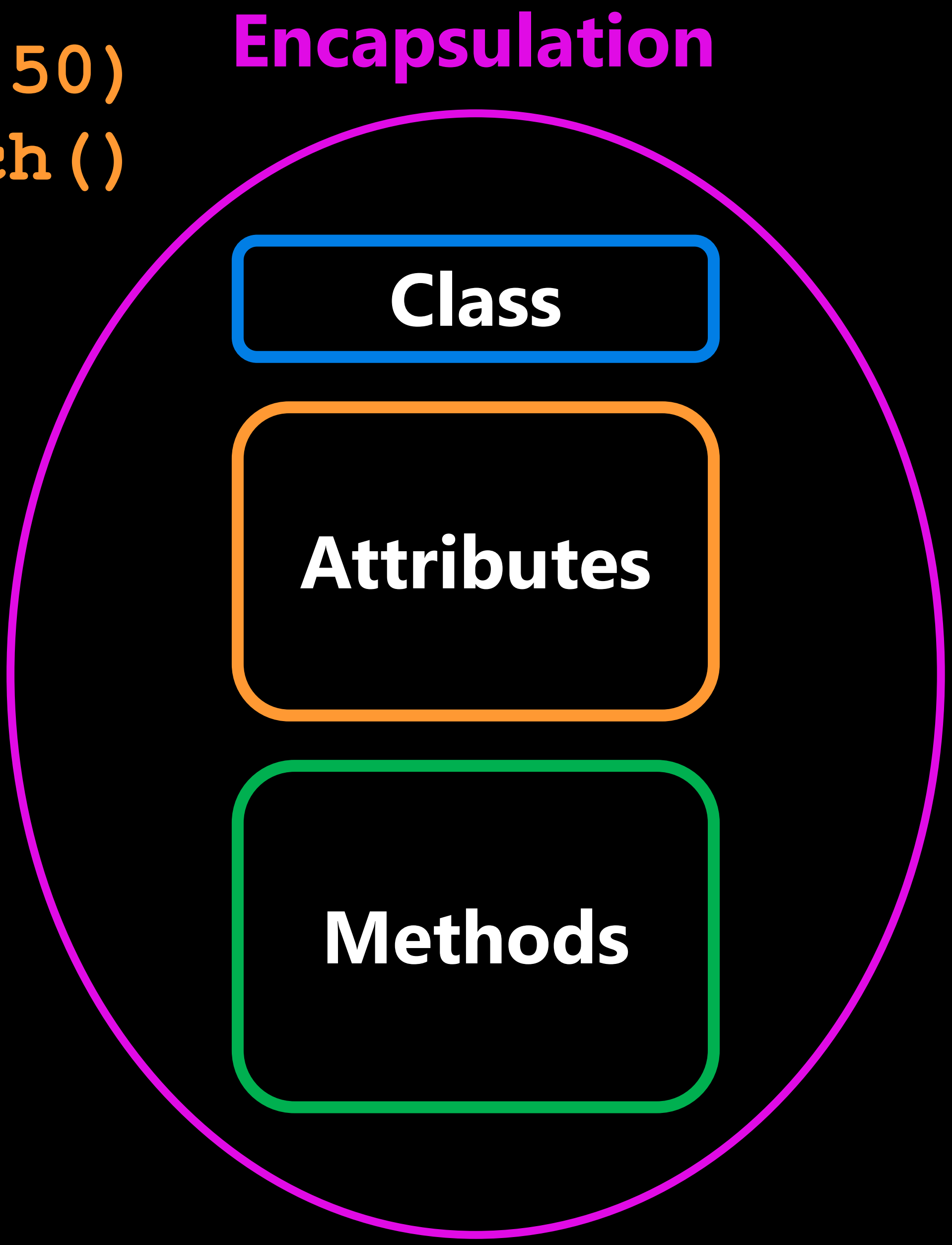


```
Kendrick,A+
Dre,C-
Snoop,B
```

Encapsulation

```
seb.forward(50)
kitty.scratch()
```

- 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

Class

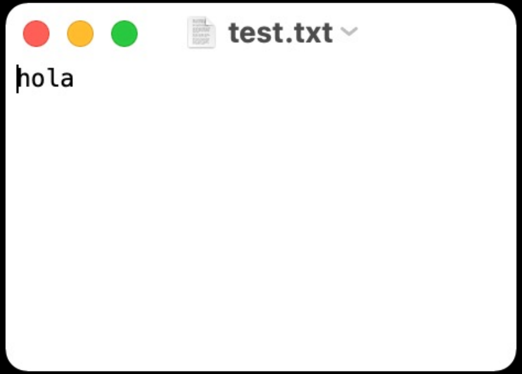
Attributes

Methods

Encapsulate it!

- For example, each instance of class `file` keeps track of which file on the disk it is reading/writing and where it currently is on that file.
- The class hides the details of how it is done, so we (as programmers) can use it without needing to know how it is implemented

```
f = open('test.txt','w')
f.write('hola')
f.close()
```



test.txt

```
hola
```

```
print(f)
```

```
<_io.TextIOWrapper name='test.txt' mode='w' encoding='UTF-8'>
```

✓ ?

Writing and Reading

Can be any name!

```
myfile = open(‘test.txt’, ‘w’)
```

'w’ OR ‘a’

```
myfile = open(‘test.txt’, ‘a’)
```

```
myfile.write(‘CATS!…’)
```

Different ways of Reading a File

- Reading a file is similar to writing a file. First we need to open a file for reading (“**r**”):

```
myfile = open(‘test.txt’, ‘r’)
```

- If file doesn’t exist? **ERROR**
- Then to read a file we apply one of the following approaches which take advantage of various read methods:

1. The `read` approach
2. The `readline` approach
3. The `for line in file` approach
4. The `readlines` approach

No correct approach!
Multiple methods to help
with contexts and purposes

Different ways of Reading a File

Approach	Code	When to use it

The read approach	myfile = open(filename, 'r')
	contents = myfile.read()
	myfile.close()
		When you want to read the whole file at once and use it as a single string.

The readline approach	myfile = open(filename, 'r')
	contents = ''
	line = myfile.readline()
	while line != '':
	    contents += line
	    line = myfile.readline()
	myfile.close()
		When you want to process only part of a file. Each time through the loop line contains one line of the file.

The for line in file approach	myfile = open(filename, 'r')
	contents = ''
	for line in myfile:
	    contents += line
	myfile.close()
		When you want to process every line in the file one at a time.

The readlines approach	myfile = open(filename, 'r')
	lines = myfile.readlines()
	myfile.close()
		When you want to examine each line of a file by index.

TODAY

FUTURE

Let’s Code!

- Let’s take a look at how this works in Python!
  - Different read approaches
    - read()
    - readline()
    - for line in file
    - readlines()

Open your notebook

Click Link:
3. Reading Files

- Madlibs is a story game
- A story is written, and a few important words are taken out, replaced by blanks
- The blanks are labelled with their part of speech or other category ("noun", "adjective", "an animal", and so on)
- Replace the categories with specific words without knowing the story
- When all the blanks have been filled in, the story is read out, usually with comic results
- Example: https://youtu.be/kM9Wuzj4k24

Let's Code!

- Let's take a look at how this works in Python!
  - Bringing it all together with Madlibs!

Open your notebook

Click Link:
4. Madlibs

APS106

UNIVERSITY OF TORONTO

introduction to Object Oriented Programming, and the file object.

Week 3 | Lecture 3 (3.3)

While waiting for class to start:

Download and open the Jupyter Notebook (.ipynb) for Lecture 3.3.1

You may also use this lecture's JupyterHub link instead (although opening it locally is encouraged).

Upcoming (Today!):

- Reflection 3 released Friday @ 11 AM
- Lab 3 **deadline** this Friday @ 11 PM
- PRA (Lab) on Friday @ 2PM this week (ONLINE)
- **Midterm** - May 31 in lecture @ 9:10 AM

if nothing else, write #cleancode