Class 7 - Classes

Berkeley
SCHOOL OF INFORMATION

W200-Python
Fall 2018

Course Content | moving into OOP

Unit 1 | Introduction, the Command Line, Source Control

Unit 2 | Starting Out with Python

Unit 3 | Sequence Types and Dictionaries

Unit 4 | More About Control and Algorithms

Unit 5 | Functions

Unit 6 | Modules and Packages

Unit 7 | Classes

Unit 8 | Object-Oriented Programming

Week 7 | Agenda

Homework Review and Admin

Project 1 Proposal

Classes (Objects) Structure and Purpose

Attributes and Methods

Initialization (and “self”)

Getters, Setters and Decorators

Project 1 Breakout and Recap

Midterm review (10% of grade)

Mid Semester Survey!

- These surveys are a way you as students can give direct feedback to the administration and instructors.
- We read each one and change the course based on your comments!
- Examples of changes that came about because of student feedback:
  - Hiring a TA!
  - Ensuring grading and feedback is given in a timely manner
  - Course structure and lecture areas (numpy & pandas)
- SURVEY LINK:
  - Posted in chat!

Assignment Review | Week 6

Refresher:

1. Pseudocode for scrabble?
2. Scrabble implementation
3. PEP 8 reading

Week 7 | Polls

Discuss: What was the hardest part of HW6?

Poll: How long did you spend on this week's assignment?

Poll: what were your times for the scrabble assignment

Homework 5 Grading

- Overall: Good work!

- Printing inside functions:
  - Generally not done - functions should return the answer rather than print from inside.
  - Reasoning: The user can't turn the printing off or modify the output if they want to print something different. If the function returns the value the user/programmer can decide how to use it.
  - One way to do both - make a Flag for the printing (some functions use a verbose flag as an argument to signal if the user wants the printing to happen or not)
  - If you printed inside a function for scrabble homework - don't worry about changing it but keep it in mind for future functions!

Homework 5 Grading

- Error checking inside functions:
    - Also usually not done; functions have docstring comments that tell a programmer what inputs the function requires.
    - Functions are used by programmers; there is some expectation that a programmer will be able to read the docstring and figure out what to send to a function.
    - Reasoning: Error checking on every argument on every function adds a lot of lines of code + processing time.
- BL: Need to error check a user's inputs but generally not a programmers.

Homework 7: Classes

There are 3 programming questions:

- Deck of Cards, Galton's Box, Sorting Marbles
- Please do any 2 of the 3

Python for Data Science: Fall 2018						All due dates are tentative and may be changed by instructors. Homework due dates are 11:59pm PST the night before live session.					
Mon	**Tues**	**Weds**	**Thurs**	**Async Unit**	**Sync Week**	**Async to Review (Prior to Class)**	**Projects (20% each)**	**Exams (10% each)**	**HW Assigned (30% total)**	**HW Due**	**Notes**
Sep 3	Sep 4	Sep 5	Sep 6	1	1	Introduction to Programming, the Command Line, and Source Control			unit 1		A make-up class will be scheduled for Monday class.*
Sep 6									unit 1		[This is the make-up for Monday 4 pm session.]
Sep 10	Sep 11	Sep 12	Sep 13	2	2	Starting Out with Python			unit 2	unit 1	
Sep 17	Sep 18	Sep 19	Sep 20	3	3	Sequence Types and Dictionaries			unit 3	unit 2	9/17/2018 - Last day to add or drop a class
Sep 24	Sep 25	Sep 26	Sep 27	4	4	More About Control and Algorithms			unit 4	unit 3	
Oct 1	Oct 2	Oct 3	Oct 4	5	5	Functions			unit 5	unit 4	
Oct 8	Oct 9	Oct 10	Oct 11	6	6	Complexity	Project 1 Assigned		scrabble	unit 5	
Oct 15	Oct 16	Oct 17	Oct 18	7	7	Classes			unit 7	scrabble	
Oct 22	Oct 23	Oct 24	Oct 25	8	8	Object-Oriented Programming/<text a	Project 1 Final Proposal Due	Exam 1 Start	x	unit 7	
Oct 29	Oct 30	Oct 31	Nov 1	9	9	Working With Text and Binary Data/numpy		Exam 1 Due	x		
Nov 5 - 9 Fall Break & Immersion											
Nov 12	Nov 13	Nov 14	Nov 15	10	10	NumPy	Project 1 Presentations		unit 9 / HW10		A make-up class will be scheduled for Monday Class
Nov 19	Nov 20	Nov 21	**Nov 22**	11	11	Data Analysis With Pandas	Project 2 Assigned		unit 10 / HW11	unit 9 / HW10	A make-up class will be scheduled for the Thursday Classes
Nov 26	Nov 27	Nov 28	Nov 29	12	12	Plotting and Visualization	Project 2 Proposal Due		unit 11 / HW12	unit 10 / HW11	
Dec 3	Dec 4	Dec 5	Dec 6	13	13	Pandas Aggregation and Group Operations		Exam 2 Start	x	unit 11 / HW12	
Dec 10	Dec 11	Dec 12	Dec 13	14	14	Testing	Project 2 Presentations!	Exam 2 Due	x		Last Day of Class. bring beer Congratulations!
Last Day of Instruction - December 14											

Week 7 | Agenda

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Project 1 Proposal
Classes (Objects) Structure and Purpose
Attributes and Methods
Initialization (and "self")
Getters, Setters and Decorators
Project 1 Breakout and Recap

Midterm review (10% of grade)

The Project | Proposal (Due before next class)

Describe your project concept

Pseudocode your major classes and functions

1. Briefly describe the purpose of each class
2. List expected functions belong to each class
3. List inputs and outputs for each function

Instructors will “approve” your draft proposal

Coding is **iterative**. Your final code may not match the proposal exactly

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Classes (types) | ready to go vs custom

We are familiar with base python classes:

- **ints** and **strs**, to **lists**, **sets** and **dicts**.

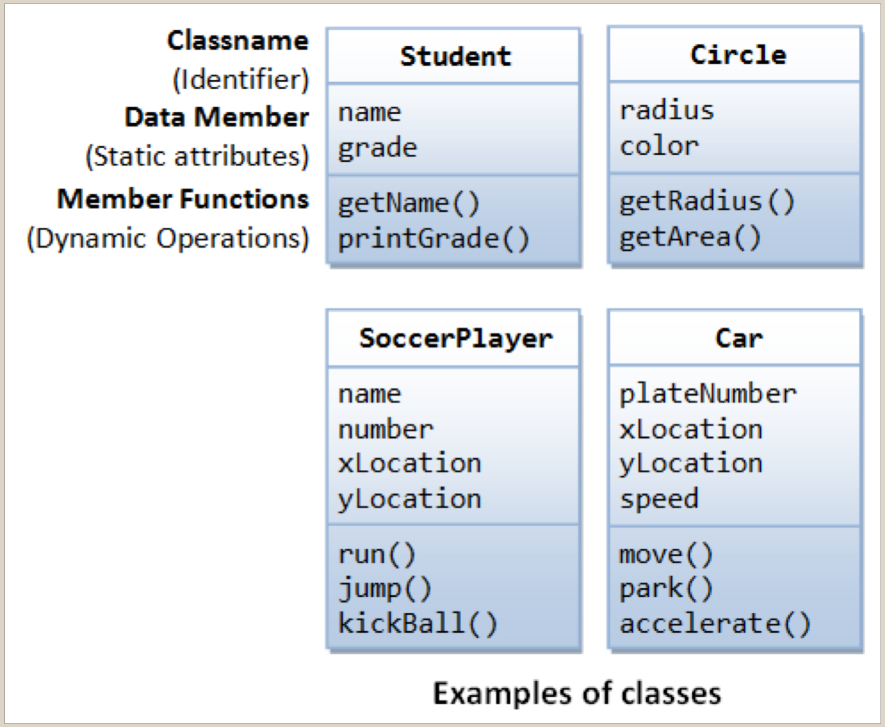
- What are Classes?
  - Templates conferring a shared form
  - Instantiation uses a class definition to make a distinct **object**
  - Objects of a common class(type) contain distinct data

Classes | ready to go vs custom

Why create your own types?

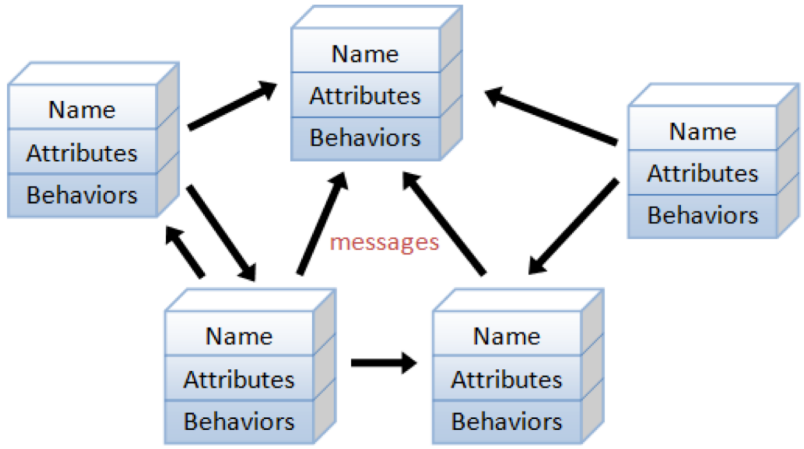
- Keep the "data" (attributes) with the "functions" (methods)
- Extend the language
- Can be tailored to hold new data or execute new tasks
- Don't just store data – objects interact:
  - Execute internal functions (class methods)
  - Manage other objects (Creation, Modification, Execution, Interaction)

Classes: data & functions



Examples of classes

Classes: sending messages to each other



An object-oriented program consists of many well-encapsulated objects and interacting with each other by sending messages

Class construction | the basics

- Now we can form a **base class**

```
class Drone:
    """Base class for all drone aircraft"""
```

- **Instantiate** individual objects from the **base**

```
d1 = Drone()
d2 = Drone()
print("d1 has type", type(d1), " d2 has type", type(d2))
```

```
d1 has type <class '__main__.Drone'>  d2 has type <class '__main__.Drone'>
```

- Modify **attributes** for all instances

```
Drone.power_system = "Battery"
```

- Modify **attributes** of individual instances

```
d1.power_system = "Gasoline"
```

*Notice the "**D**rone.power_system" versus the **d1**.power_system*

Class information |

- dir(d1) # class methods
- d1.__dict__ # attribute information

```
d1.__dict__
```

```
{'altitude': 100, 'power_system': 'Gasoline'}
```

- ?Drone # class documentation

```
?Drone
```

Which will print out as follows:

```
Type:        type
String Form:<class '__main__.Drone'>
Docstring:   Base class for all drone aircraft
```

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Attributes | class vs. individual

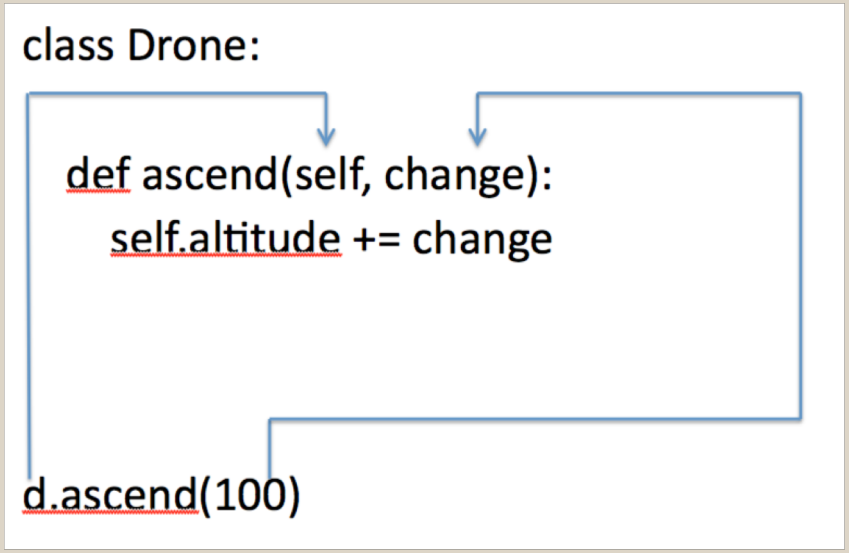
Class Attribute

```
class Drone:

    num_drones = 0

    def __init__(self, altitude = 0):
        self.altitude = altitude
        self.ascend_count = 0
        Drone.num_drones += 1

    def fly(self):
        print("The drone is flying at", self.altitude, "feet.")

    def ascend(self, change):
        self.altitude += change
        self.ascend_count += 1
```

Instance Attribute

Methods | class-specific functions

- The **method** "ascend" is a like a function bound to objects of the class Drone
- You call ascend on **instance d**, a type **Drone object**
- The first argument (self) is required and binds the method and result to the instance d



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Initialize | require attributes at instantiation

- Instantiation runs the **__init__** method
- Altitude is established at initialization and has a default value

```
class Drone:

    def __init__(self, altitude = 0):
        self.altitude = altitude

    def fly(self):
        print("The drone is flying at", self.altitude, "feet.")

    def ascend(self, change):
        self.altitude += change

d1 = Drone(100)
d1.fly()
d2 = Drone()
d2.fly()
```

```
The drone is flying at 100 feet.
The drone is flying at 0 feet.
```

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Get and set | require attributes at instantiation

- More explicit than direct attribute access
- We can add code into the get and set method

Direct a attribute specification

```
def __init__(self, altitude = 0):
    self.altitude = altitude
    self.ascend_count = 0
    Drone.num_drones += 1
```

Using get and set for attributes

```
def get_altitude(self):
    return self.altitude

def set_altitude(self, new_altitude):
    if new_altitude < 0:
        raise Exception("Drone cannot have a negative altitude.")
    self.altitude = new_altitude
```

Hidden names | access, modify

You can use the "__" prefix to "require" programmers to use your setter and getter methods

- It uses `set_altitude` automatically
- They can override it via: `d1._Drone__altitude`

```
def __init__(self, altitude = 0):
    self.__altitude = altitude
    self.ascend_count = 0
    Drone.num_drones += 1
```

```
def get_altitude(self):
    return self.__altitude

def set_altitude(self, new_altitude):
    if new_altitude < 0:
        raise Exception("Drone cannot have a negative altitude.")
    self.__altitude = new_altitude
```

```
d1 = Drone(100)
print("The Drone's altitude is", d1.__altitude)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-12-0fd06e938d36> in <module>()
     25
     26 d1 = Drone(100)
---> 27 print("The Drone's altitude is", d1.__altitude)

AttributeError: 'Drone' object has no attribute '__altitude'
```

Properties and decorators |

- Properties allow you to apply a setter and getter “after the fact”
- Decorators start with @ and flag certain functions. You can use them to flag properties.
  - “set” is implicit

```
def get_altitude(self):
    return self.__altitude

def set_altitude(self, new_altitude):
    if new_altitude < 0:
        raise Exception("Drone cannot have a negative altitude.")
    self.__altitude = new_altitude

altitude = property(get_altitude, set_altitude)
```

```
@property
def altitude(self):
    return self.__altitude

@altitude.setter
def altitude(self, new_altitude):
    if new_altitude < 0:
        raise Exception("Drone cannot have a negative altitude.")
    self.__altitude = new_altitude
```

Other method types | declared with decorators

- These decorators don't do anything except **tell us what to expect** from the method

```
class Drone:

    __num_drones = 0
```

- **Class methods** affect class - level attributes

```
@classmethod
def get_num_drones(cls):
    return cls.__num_drones
```

- **Static methods** do not affect attributes

```
@staticmethod
def feet_from_meters(meters):
    return meters * 3.28084
```

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Class | A quick discussion

- You will learn about "Inheritance" and "Polymorphism" this week. The plan you've created today may need to be modified to take advantage of these two concepts.

Inheritance - Allows a "child" class to inherit attributes and functions from a "parent" class. The child class can be customized, but you can change all children classes at once by modifying the parent.

Polymorphism - Allows a function to work on multiple types of object. Different classes can share the same interface, which allows a single function to accept multiple types of object.

Class | Breakout 1 discuss your plan in words

- Read the the first part of this:
  - http://web.archive.org/web/20160816041541/http://learnpythonthehardway.org/book/ex43.html
- Think of your classes;
  - objects as *nouns*
  - methods as *verbs*
  - How will objects *interact*

Class | Breakout 1 discuss your plan in words

- Think about managing classes:
  - Do you need classes that organize / score object interactions?
  - (e.g., a 'battle engine' object? A 'scoreboard' object?)
- Think about your user:
  - What will they be tasked with
  - What data will they be able to get
- Critique, question, respond …

The Project | Your Mission

Create a small, object-oriented program of your choosing:

Examples:

- An ATM
- A flower shop
- An adventure game
- Something relating to your everyday work

The Project | Code

Python 3 code, 300-500 lines (750 max)

All code should be **well commented**!

Must use Object Oriented design and classes (**OOD, OOP**)

Demonstrate **various control-of-flow statements & data types**

Robust to common user **errors and exceptions**

The Project | Your Mission

The user will interact with your program via Terminal/Shell

Three documents due before your class on 3/13 or 3/15:

1. Proposal (10%)
2. Code(s) (80%)
3. Reflective Summary (10%)

You will demo your progress in a breakout room

Please only use Python libraries that come installed with Anaconda

The Project | Proposal

Describe your project concept

Pseudocode your major classes and functions

1. Briefly describe the purpose of each class
2. List expected functions belong to each class
3. List inputs and outputs for each function

Instructors will “approve” your draft proposal

Coding is **iterative**. Your final code may not match the proposal exactly

The Midterm | Content

All work done in a Jupyter Notebook

Covers Units 1 - 6

Many questions are theory based (short answer)

Also some coding problems

Designed to be completed in a couple of hours

The Project | Questions

The Project | Reflection

Submit a 1-page reflection with your code

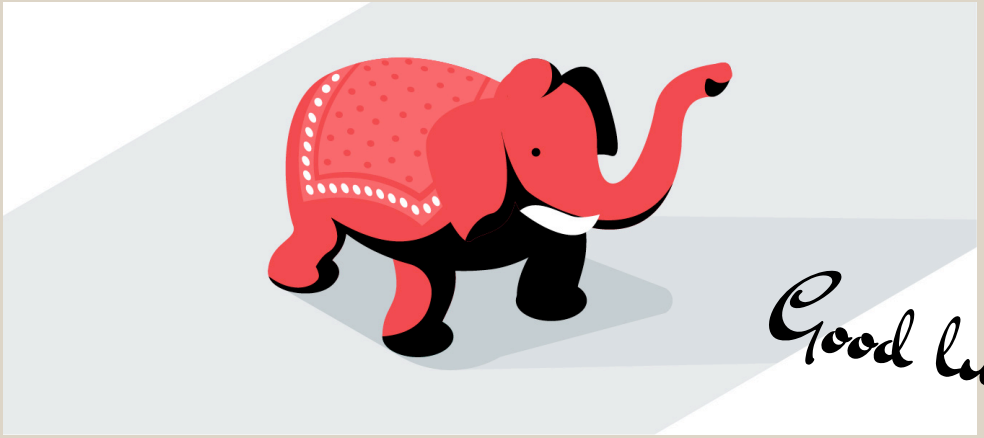
Instructors will read your reflection before grading your project

Tell us how to use your project!

Discuss challenges you faced and how you overcame them

The Project | Demo

As time allows, show 1-2 examples of strong projects from last semester.



Midterm Review

Live Q & A using Poll Features