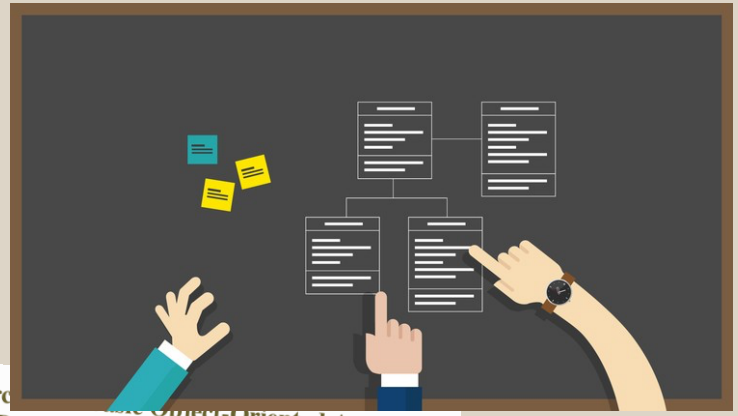
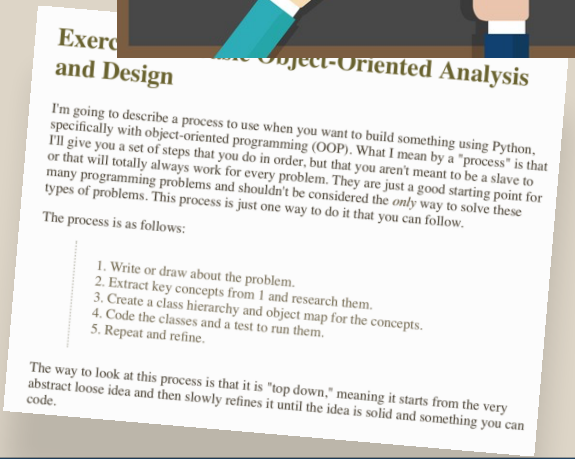
# Class 7 - Classes

[W200] MIDS Python





**and Design**

I'm going to describe a process to use when you want to build something using Python, specifically with object-oriented programming (OOP). What I mean by a "process" is that I'll give you a set of steps that you do in order, but that you aren't meant to be a slave to or that will totally always work for every problem. They are just a good starting point for many programming problems and shouldn't be considered the *only* way to solve these types of problems. This process is just one way to do it that you can follow.

The process is as follows:

1. Write or draw about the problem.
2. Extract key concepts from 1 and research them.
3. Create a class hierarchy and object map for the concepts.
4. Code the classes and a test to run them.
5. Repeat and refine.

The way to look at this process is that it is "top down," meaning it starts from the very abstract loose idea and then slowly refines it until the idea is solid and something you can code.

# 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

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# **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)

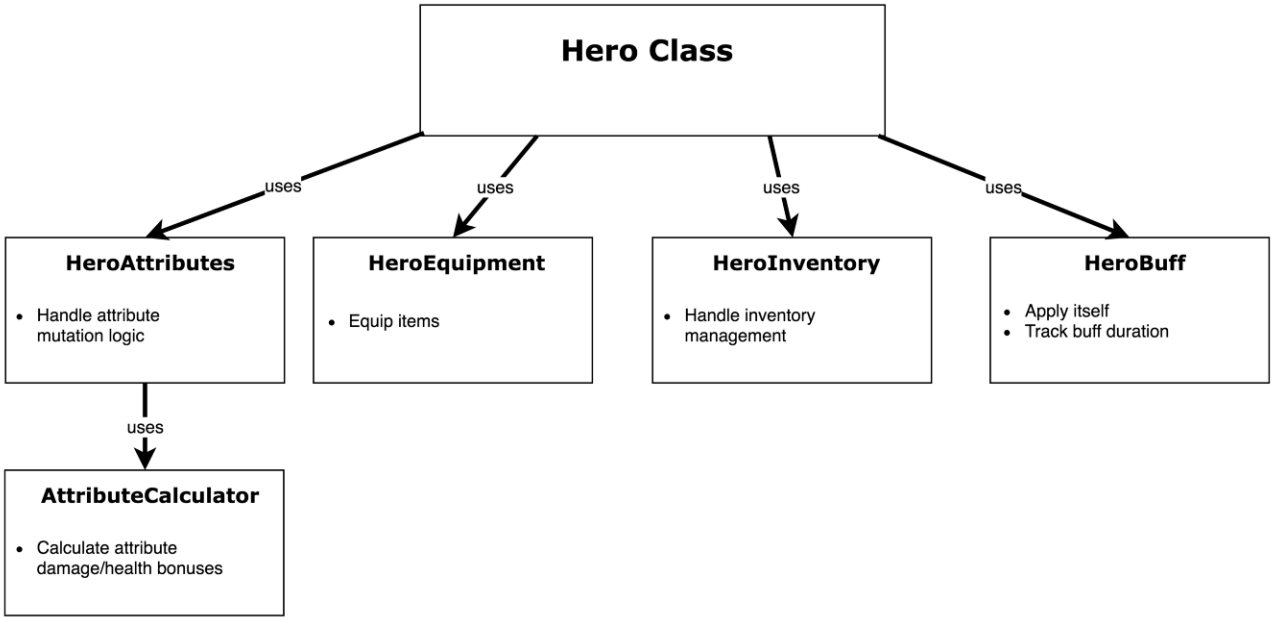
## Before Decomposition

### Hero Class

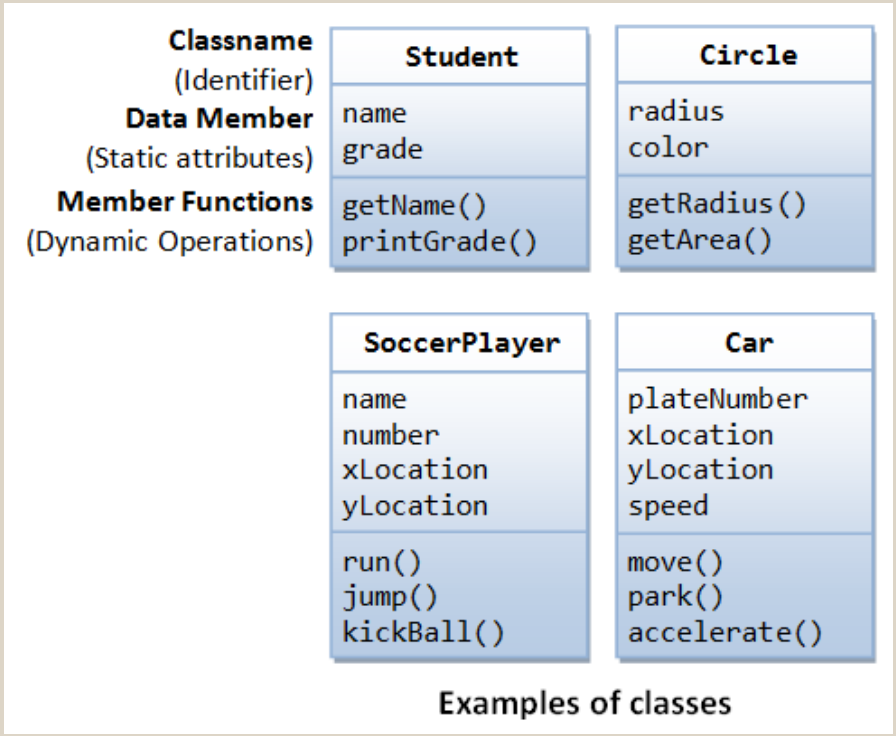
**Functionality:**

- Apply Buffs
- Handle attribute mutation logic
- Calculate attribute damage/health bonuses
- Handle inventory management
- Equip items (+ modify attributes)
- Track buff duration

## After Decomposition

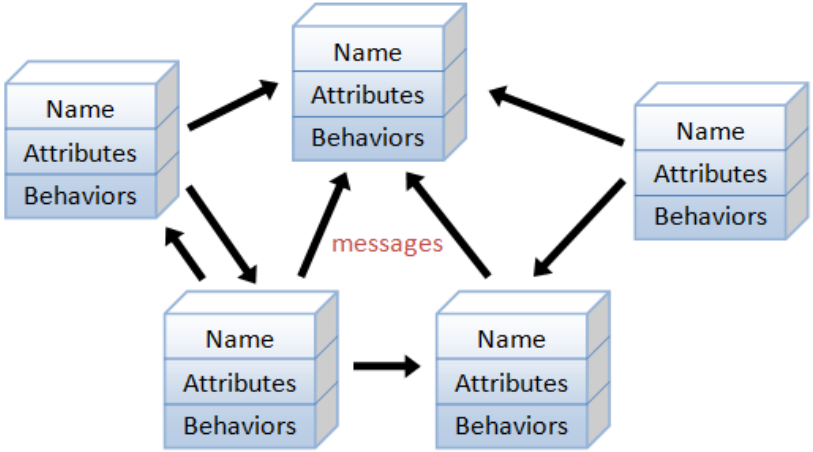


## Classes: data & functions




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 cla
- Instantiate individual objects from the base
- Modify attributes for all instances
- Modify attributes of individual instances

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

```
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'>
```

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

```
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

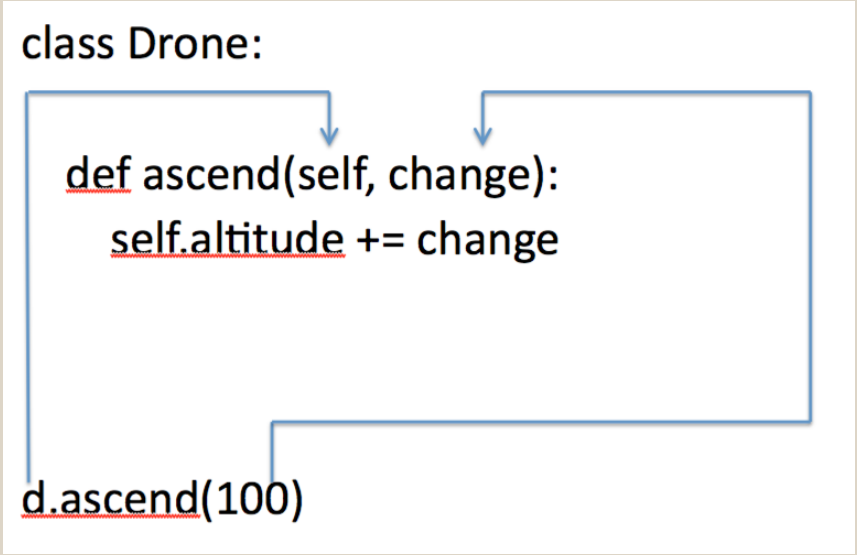
Class Attribute

```
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

Direct a attribute specification

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

- We can add code into the get and set method

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

Added a copy in .pdf in the resources folder

## **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

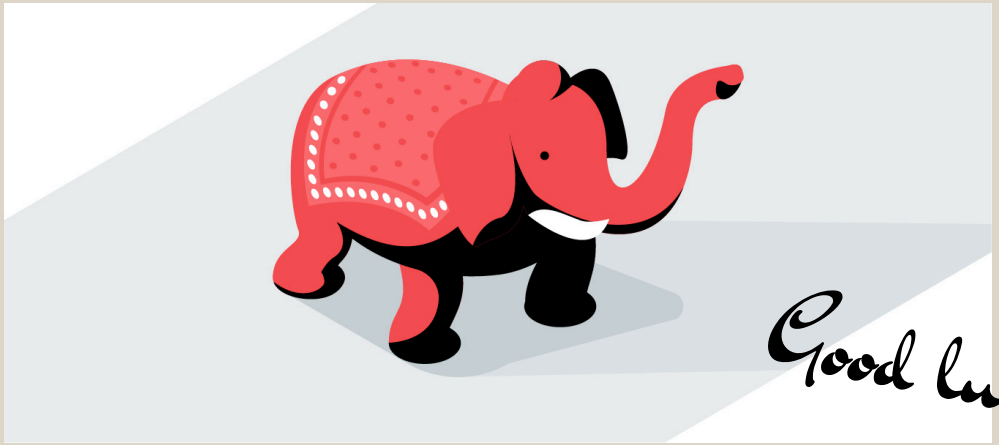
Instructors will read your reflection before grading your project

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