Oklahoma Drone workshop

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What Are We Doing Today?

- Programming drones!
  - The drones will be entirely autonomous. No RC!
- Learning python
  - Python is supported by the wallaby's and can be used by your botball teams as well
  - Python is an extremely flexible language in use by a variety of industries

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Today's Full Schedule

- Morning:
  - Drone catching
  - Connecting to the drones
  - Learning to fly and turn
  - Variables and objects
- Afternoon:
  - User input
  - Conditionals
  - Looping
  - Sensors
  - Vision

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KIPR and Drones

- This is the FIRST K-12 Drone competition for KIPR!
  - Will spread to other regions in future years
- **KIPR Drone Challenge day: Dec 10, 2018**
- GCER has an aerial competition for all ages (K-12 and adults)
  - GCER is in Norman: July 7-11, 2019
  - You are welcome to participate 2019 using what you have learned here!
  - Our team is the Flying Twisters

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December Challenge Day Tasks

Regular challenges (red means we will work on them today)

1. Take off, fly a short distance, land
2. Take off, fly to a precise location
3. Take off, fly to the hospital, land, take off again, turn, fly to the second hospital, land.
4. Take off, fly a specific geometric pattern in the air in the horizontal plane, land.
5. Take off, fly a specific geometric pattern in the air in the vertical plane, land.
6. Take off, fly a n-sided polygon in the horizontal plane, land.
7. Take off, fly a n-sided polygon in the vertical plane, land.
8. Take off, fly a specific user specified distance, land at the location (or within a radius).

Advanced challenges

1. Take off, fly until you see a specific vision marker, land.
2. Take off, fly to a specific marker, use the marker to take a specific action, land when you see the landing marker.
3. Take off, Find the hidden object (using markers), fly back home.

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Safety First!

- Drones can cause injury!!
- Safety rules:
  1. No flying in the classroom
  2. Only trained adults may catch drones in the flying room
  3. Anyone in the flying room must be wearing safety glasses
  4. The trained catcher must be wearing gloves (critical for Bebop catchers!)
  5. Youth in flying room must be against the wall/out of the main flying zone
  6. Flying room is only open when there are two adults in it

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Examining Your Drone

- Each group should have a drone and a laptop
  - Mambo FPV:
    - Camera/wifi router, four propeller guards, a small battery, and the drone
  - Bebop 2:
    - All-in-one package with battery and camera and NO guards
- Propeller guards will help save fingers and walls
  - Blades stop automatically when they touch something but they still HURT!
  - We have extra guards for both types of drone to borrow, as needed

Parrot Mambo FPV

Parrot Bebop 2

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Getting Started: Work Together If Possible!

- Pair programming is really a great way to learn and to help each other!
  - Driver: person at the keyboard, typing, listening to navigator, asking questions, ensuring code is clean
  - Navigator: tells the driver what to type, ensures syntax and logic are correct
  - Both: actively listen, work together to accomplish the goal, achieve more together than alone
- Pair programming not required today but highly encouraged

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Catcher Training

- We need volunteers!
- All adults and youth proceed to the flying room! We will train adults and youth can watch/learn
- Mambos are quite easy to catch
- Bebops are harder and more dangerous to catch

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Powering Your Drone Throughout The Day

- Mambo:
  - ~8 minutes of flight
  - We have many extra batteries and and a rapid charging station. We need all our batteries back at the end of the day (all are labeled OU and have green tape)!
    - Batteries do wear out. If you find a distended one, please give it to us for safe disposal
  - Notes:
    - Mambo will turn itself off after several minutes of no flight
    - Mambo's camera turns off after 1 minute of no flight but restarts if you fly
  - How do you know the battery is dead?
    - Red blinking eyes!
- Bebop:
  - ~25 minutes of flight
  - We do not have extra bebop batteries. Please keep your bebop charged!
  - How do you know the battery is dead?
    - Emergency landing/refusal to take off/ beeping

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Preparing your Bebop

When flying indoors, your Bebop can behave erratically!

- Bebop 1: turn off GPS
- Bebop 2: add a tin foil hat

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Connecting To Your Drone: Part 1

- Turn the drone on
  - Mambo: Small power button on bottom
  - Bebop: Large power button on back
- Mambo:
  - Eyes will blink
  - Camera light will blink then turn solid green
- Bebop:
  - Red light will blink
  - Drone will make a small set of four noises (checking each motor)

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Renaming your network: Steps 1 and 2

- Each drone runs a wifi network of its own! Let's rename them to make life easier!

1. Download the app
   - Mambo: Free Flight Mini
   - Bebop: Free Flight Pro
   - **OUWIFIGUEST – connect here to download**
2. Connect your phone's wifi to YOUR drone's network

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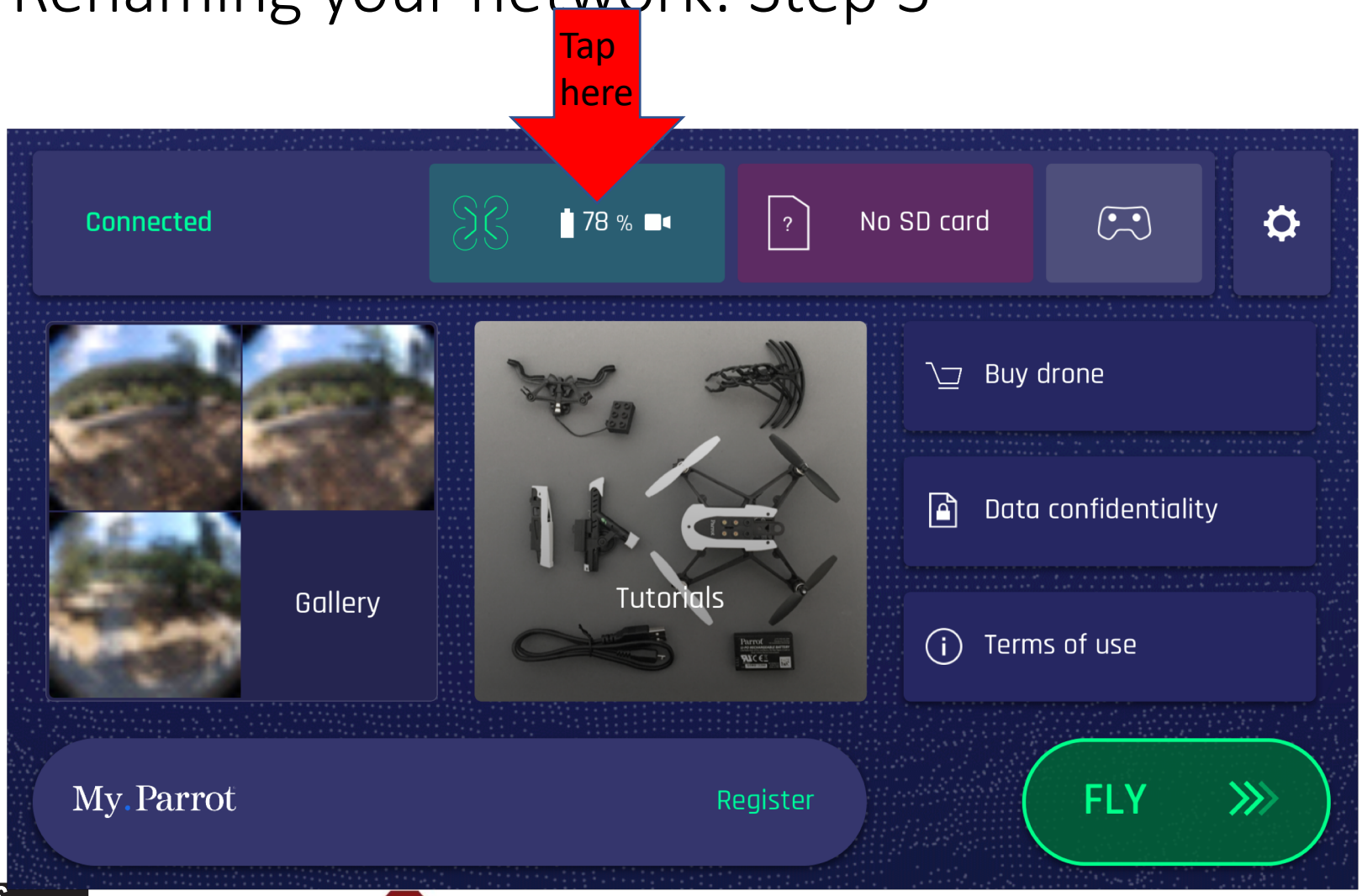
Renaming your network: Step 3



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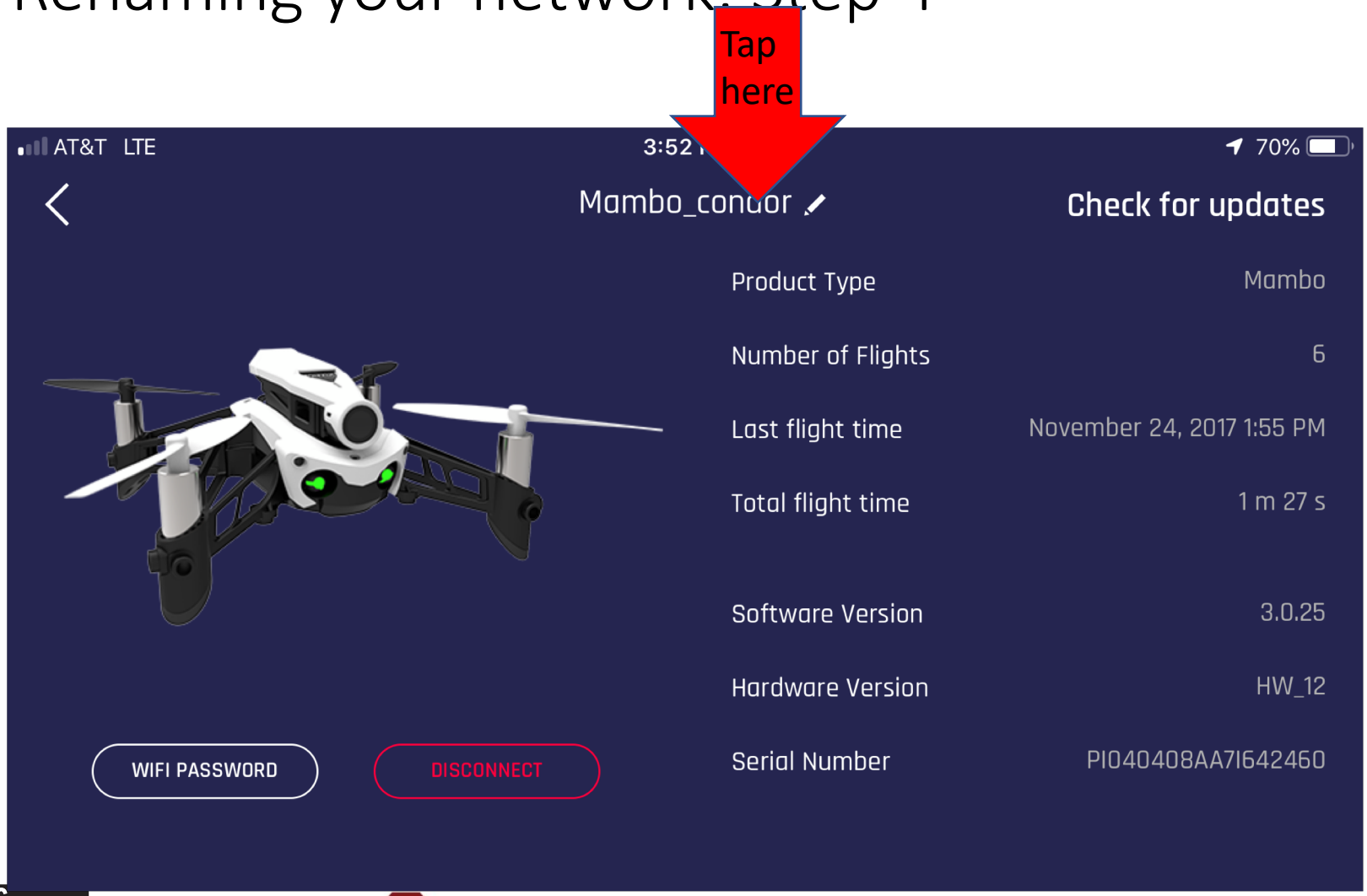
Renaming your network: Step 4



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Renaming your network: Step 5

- When you are connected, bring up the app and press and hold on the name in the app
  - Suggestion: Mambo_yourteamname or Bebop_yourteamname
  - Must be G-rated and appropriate for broadcasting at a K-12 event
  - Nothing racist, offensive, sexist, etc

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Software Requirements – WE WILL HELP

- Python 3 (USE anaconda)
  - https://www.anaconda.com/download/
- Pyparrot version **1.5.9 or later**
  - Windows:
    - `Bring up anaconda prompt and type:`
    - `pip install pyparrot`
  - `Linux or mac:`
    - `Bring up terminal window and type:`
    - `pip install pyparrot`
- zeroconf
  - `Type: pip install zeroconf`
- A python software editor. I recommend pycharm community edition
  - https://www.jetbrains.com/pycharm/download/

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Connecting Your Laptop To Your Drone

- You must connect your laptop to your drone's wifi to control it!
- Remember, this will NOT give you an internet connection!
  - It may give you an error saying you have limited connectivity, no internet connection, etc.
  - Ignore that!

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Drones Can Be used to Save Lives

- http://www.flyzipline.com

https://hitconsultant.net/2016/11/11/zipline-medical-drone-delivery-funding/

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First exercise: Deliver blood to the hospital

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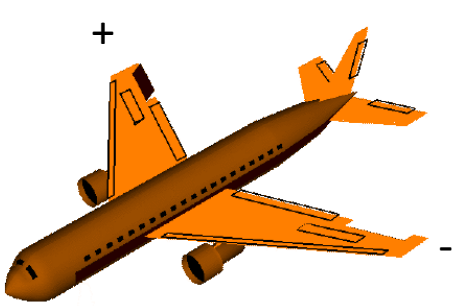
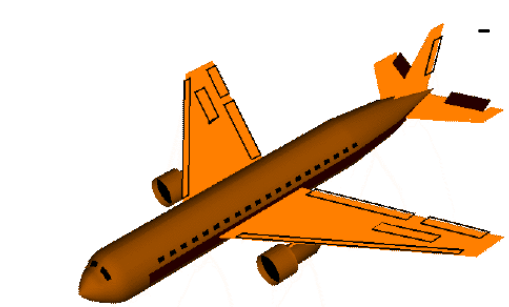
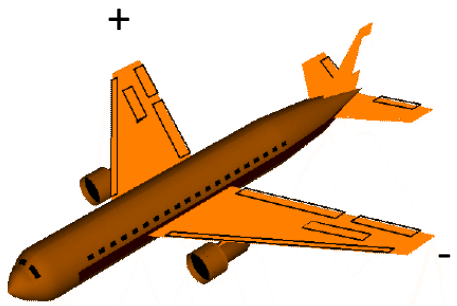
Simon says: Roll Pitch Yaw



Roll



Pitch



Yaw

GIFS from https://commons.wikimedia.org/wiki/Category:Roll,_Pitch_and_Yaw

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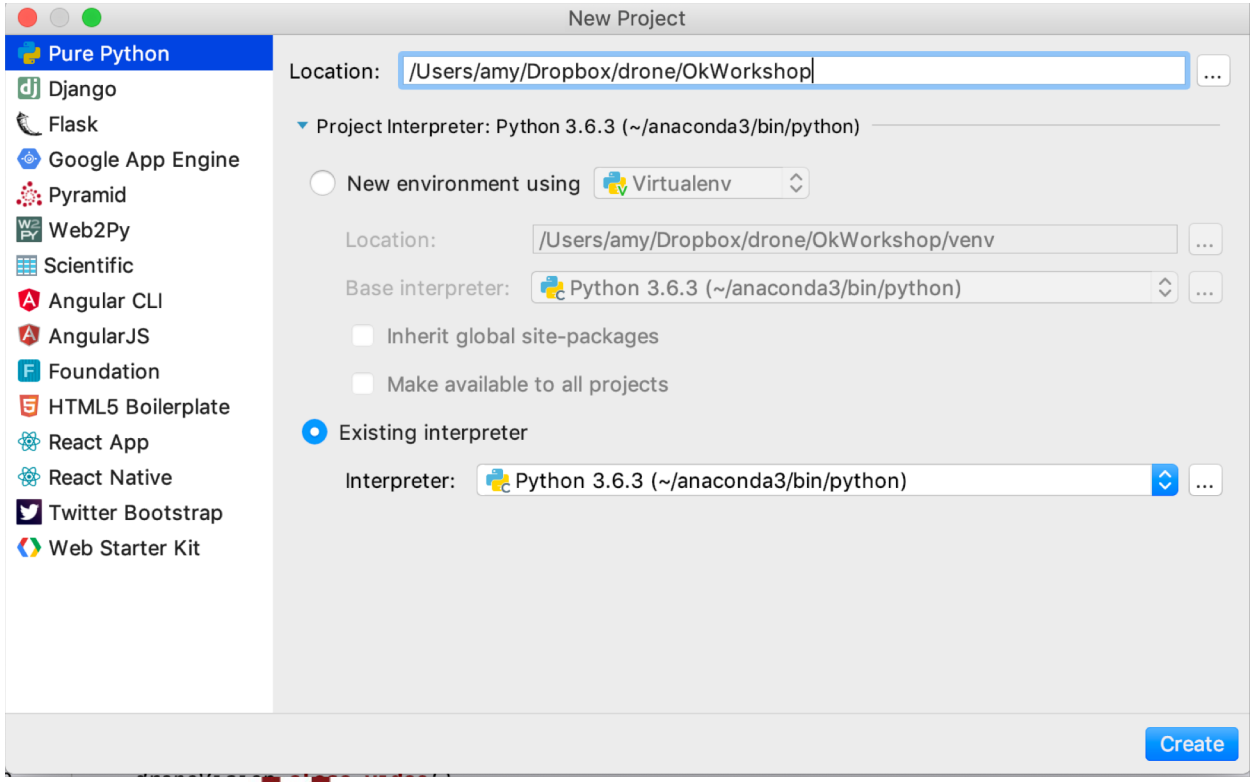
Getting started: Programming

- Open your python software editor (I recommend PyCharm!)
- Make a new project



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Python versus C

Python

- Case sensitive
- Tabs matter!
- No semicolons
- Variables don't need to be declared up front
  - i = 0
- Interpreted line by line

C

- Case sensitive
- Tabs don't matter
- All lines end with semicolons
- Variables must be declared with types
  - int i = 0;
- Compiles entire program

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Getting started: Programming

- First line:

```
from pyparrot.Minidrone import Mambo
```

or

```
from pyparrot.Bebop import Bebop
```

- What does this mean?
  - Python needs to know where the related packages are
  - From <the name of the package file> import <the things that you need out of the file>
  - pyparrot = the package
  - Mambo/Bebop are the parts of the pyparrot package we need
  - Mambo/Bebop are also the specific classes (data types) we need

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Variables

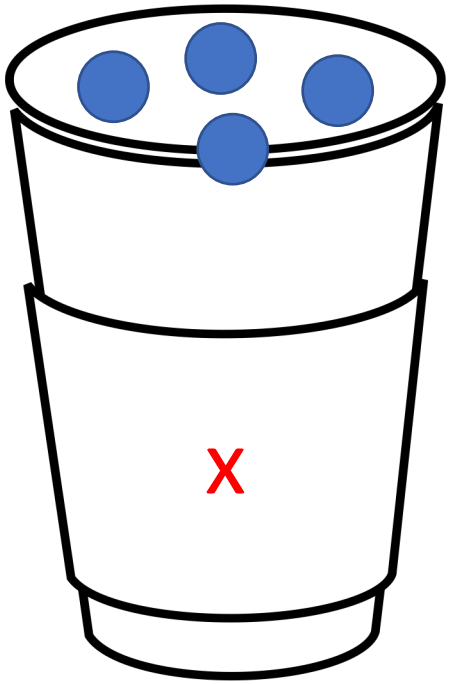
- Stores a value for later use

```
x = 3
```

- Can be changed throughout the program

```
x = x + 1
```

- Equals is assignment
  - NOT algebra



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Python Primitive Variable Types

- Like other programming languages, Python provides a standard set of primitive variable types: integer, float, boolean, string …
- One difference: the type of a variable is not explicitly declared, it is inferred by the context. For example:

```
foo = 5
```

Automatically creates a variable that contains an int and assigns the value *5*

Going beyond the primitives

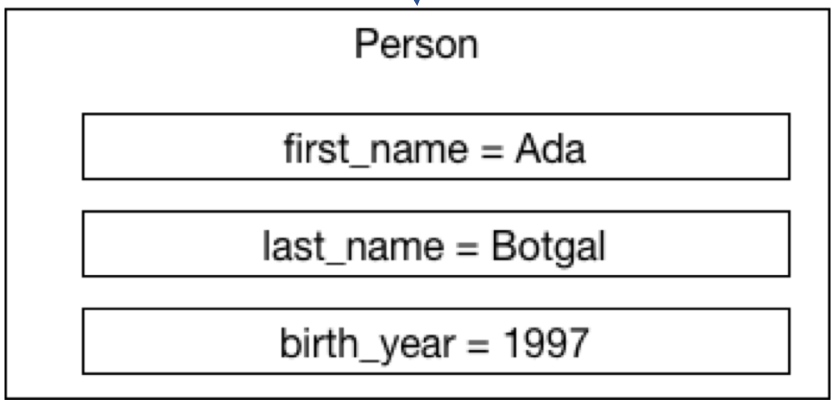
- We often want to represent higher-level concepts that cannot be captured with a primitive variable type
- For example: Person
  - Data:
    - First Name
    - Last Name
    - Birth Year
  - Method:
    - Compute age

Classes in Python

```
class Person:
    def __init__(self, firstName, lastName, birthYear):
        self.first_name = firstName
        self.last_name = lastName
        self.birth_year = birthYear

    def compute_age(self, year):
        return (year - self.birth_year)


botgal = Person("Ada", "Botgal", 1997)
age = botgal.compute_age(2018)
print("Age of %s is %d" % (botgal.first_name, age))
```



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Drone Objects/Classes

- Next line of your code:

```
drone = Mambo(use_wifi=True)
   or
drone = Bebop()
```

- You must create an object using the name of the class (Mambo or Bebop) and () which calls the __init__ function
  - Mambo() takes two arguments. Address can be ignored for wifi. use_wifi must be set to ***True*** to use the wifi!
  - Bebop() only works on wifi and requires no arguments

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Mambo and Bebop classes

- Both drone classes are designed to have VERY similar interfaces
  - Documentation at https://pyparrot.readthedocs.io
- Common and useful commands for today:

```
connect(num_retries)
disconnect()
safe_takeoff(timeout)
safe_land(timeout)
set_max_tilt(degrees)
set_max_vertical_speed(speed)
flat_trim()
smart_sleep(seconds)
fly_direct(roll, pitch, yaw, vertical_movement, duration)
```

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Your first program

- TURN OFF YOUR DRONES
- We will run them in the flying room!

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Your First Mambo program: A Short Flight

```
from pyparrot.Minidrone import Mambo

# create the drone object and connect
drone = Mambo(use_wifi=True)
drone.connect(num_retries=3)

# maximum speeds - DO NOT CHANGE
drone.set_max_tilt(10)
drone.set_max_vertical_speed(1)

drone.flat_trim()

# takeoff
drone.safe_takeoff(5)

# fly forward a small amount for one second
drone.fly_direct(roll=0, pitch=10, yaw=0, vertical_movement=0, duration=1)

# land and disconnect
drone.safe_land(5)
drone.disconnect()
```

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Your First Bebop program: A Short Flight

```
from pyparrot.Bebop import Bebop

# create the drone object
drone = Bebop()

# connect
drone.connect(num_retries=3)

# set the maximum speed - DO NOT CHANGE THESE
drone.set_max_tilt(5)
drone.flat_trim()

# takeoff
drone.safe_takeoff(5)

# fly a small amount
drone.fly_direct(roll=0, pitch=10, yaw=0, vertical_movement=0, duration=1)

# land
drone.safe_land(5)

# disconnect
drone.disconnect()
```

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Errors

- Red underlines mean there is an error! What is the error here?

```
# fly forward a small amount for one second
drone.fly_direct(roll=0, pitch=10, yaw=0, vertical_movement=), duration=1)
```

- Yellow is a warning. What is the error here?

```
# maximum speeds - DO NOT CHANGE
drone.set_max_tilt2(10)
```

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Your turn!

Get those drones delivering blood to the hospital!

Figure out how to change your pitch parameters to get to the hospital

Pitch ranges from -100 to 100

Duration is in seconds

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Turning

- Mambo/Bebop

  `fly_direct(roll=0,pitch=0,yaw=#,vertical_movement=0,duration=#)`

  You can combine roll/pitch/yaw to fly curves

- Mambo

  `turn_degrees(degrees)`

- **BEBOP SPECIAL NOTE:**

  `drone.move_relative(dx, dy, dz, dradians)`

  Remember that you need to disable GPS!

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Sample code

```
from pyparrot.Minidrone import Mambo

# create the drone object and connect
drone = Mambo(use_wifi=True)
drone.connect(num_retries=3)

# maximum speeds - DO NOT CHANGE
drone.set_max_tilt(10)
drone.set_max_vertical_speed(1)

drone.flat_trim()

# takeoff
drone.safe_takeoff(5)

# fly forward a small amount for one second
drone.fly_direct(roll=50, pitch=10, yaw=0, vertical_movement=0, duration=1)

# land and disconnect
drone.safe_land(5)
drone.disconnect()
```

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Your turn!

Explore parameters

Test:

roll , yaw, vertical_movement

from -100 to 100

Duration is in seconds (max of 2)

Explore turn_degrees

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Multiple Takeoffs/Landings/Turning

- Goal: deliver blood to two hospitals
- Task analysis:
  - Fly to first hospital
  - Land
  - Take off after first landing
  - Turn
  - Fly to the 2nd hospital
  - Land at 2nd hospital
  - Disconnect

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Your turn!

Get those drones delivering blood to BOTH hospitals in the same program! No touching your drone mid-way and no restarting your program after the first landing. Write ONE program to land at both hospitals.

Use what you just learned about turning and roll/pitch/yaw to move from the first hospital to the second

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Lunch Break

Come back at 1pm

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