ROBOT PY

# Robot programming & simulation using Python

Dustin Spicuzza (Team 2423)
January 9, 2015

NEU Kickoff Seminar

## Agenda

- Why Python?
- Quick Simulation Demo
- Quick Python Primer
- Putting it all together
  - Robot code
  - Encoder demo
- RoboRIO Demo

## Intended Audience

- Some familiarity with WPILib in C++/Java
- For maximum benefit, you should have some programming experience
  - If you don’t, that’s ok too

## Who Am I?

- Software engineer at BBN Technologies
- Mentoring FRC since 2009
- Co-maintainer of RobotPy since 2010
- My contributions have helped win awards for my teams:
  - 2012 Boston Regional; Innovation in Control
  - 2013 Boston Regional; Innovation in Control
  - 2014 Virginia Regional; Innovation in Control
  - 2015 Greater DC Regional; Innovation in Control

## What is Python/RobotPy?

- Python is a widely used general purpose, high-level programming language
  - It's pretty sweet
- RobotPy is the project that packages python for the cRio and RoboRIO
  - And maintains various other FRC related python packages

## Why Python?

- Simple language syntax
  - Fewer brackets and semicolons
  - Indentation is mandatory
  - Very understandable and readable
- Designed for Rapid Development
  - Quick iteration, no compilation
  - Dynamic typing
- Cross platform
  - Windows, OSX, and Linux

## Why RobotPy + Python?

- Mature, proven codebase on high performance robots
  - RobotPy project started in 2010
- Supported for FRC teams by FRC teams
  - Quick bugfixing, because we're using this code too
  - Have you ever submitted a bug report to WPILib? They don't respond quickly.
- Good documentation

## Why RobotPy + Python?

- Superior support for running your code without a robot
  - Integrated unit testing (with builtin tests)
  - Zero-configuration low fidelity simulator

## Why Not Python?

- Not officially supported by FIRST
- Community isn't as big as official languages
- Support at competitions is low
  – However, because WPILib is the same, other teams can help you with problems that aren't specific to python
  – Most problems are WPILib problems, not python problems
  – I'll be CSA at Reading and Boston district events

## Why Not Python?

- Spacing matters
  - Indentation is syntax
- Requires that you actually test your code
  - Syntax error or mistyping something could crash your code
  - You DO test your code, right?

## Quick Demo

- Team 1418’s robot code for 2015
  - Same code runs on the Robot & on your PC
  - Running as simulation with pyfrc
  - Supports connection to UI on driver station laptop
  - Innovation in Control award @ DC Regional

## How does this work?

- Dashboard is HTML/Javascript
- Robot code is written in python
- Pure python implementation of WPILib
- Communications via pynetworktables
  - Compatible with SmartDashboard/SFX
- Simulation engine is pyfrc

## pyfrc

- A python library designed to make developing robot code easier

## pyfrc

- Easy to use testing framework you can use to test your robot code at home
- Tool to upload code to the robot
  - Integrated with testing framework to prevent uploading bad code
- Low fidelity robot simulator

Python syntax compared to Java

# PYTHON PRIMER

## Python primer: comments

**Python**

```
# This is a comment

‘’’This is sometimes
   used as a multiline
   comment’’’
```

**Java**

```
// This is a comment

/* This is a multiline
   comment */
```

# Python primer: variables

**Python**

```
a = 13
b = False

c = ‘foo’
c = “foo”

d = None

e = Bar(c)
```

**Java**

```
int a = 13;
boolean b = false;

String c = “foo”;


Object d = null;

Bar e = new Bar(c);
```

## Python primer: operands

ROBOT PY

| Python | Java |
|---|---|
| `a and b` | `a && b` |
| `x == 3 and y == 7` | `x == 3 && y == 7` |
| `a == x or b == y` | `a == x \|\| b == y` |
| `x == “string”` | `x.equals(“string”)` |
| `o is None` | `o == null` |

# Python primer: functions

**Python**

```
def hello():
    print(“Hi”)

def add2(a):
    return a + 2


# Call the function
hello()
r = add2(2)
```

**Java**

```
private void hello(){
    System.out.println(“Hi”);
}

public int add2(int a){
    return a + 2;
}


// Call the function
hello();
int r = add2(2);
```

# Python primer: if/else

**Python**

```
if a:
    do_something()

elif b == 4:
    doit(b)

else:
    done = False
```

**Java**

```
if (a == true) {
   do_something();

} else if (b == 4) {
   doit(b);

} else {
   done = false;
}
```

# Python primer: objects

**Python**

```python
class Obj:


  def __init__(self):
    super().__init__()
    self.x = 2


  def getX(self):
    return self.x
```

**Java**

```java
public class Obj {
  int x = 1;

  public Obj(){
    super();
    x = 2;
  }

  public int getX(){
     return x;
  }
}
```

Putting it all together

## REAL ROBOT CODE

## Real robot code

- python uses WPILib
  - Robot code isn’t that different from C++/Java, same principles still apply
- Let’s create a robot that changes a solenoid based on a joystick trigger

## Real robot code: robot.py

- Create a file called robot.py
- First, import WPILib so you can use it

```
import wpilib
```

## Real robot code: MyRobot

- Next, need to define a robot object
  - We'll use IterativeRobot for simplicity

```
class MyRobot(wpilib.IterativeRobot):

    def robotInit(self):
        '''Called at startup'''
```

# Real robot code: MyRobot

- Create a joystick and some devices in the robotInit function

```
    # Note this is still indented..
    self.joystick = wpilib.Joystick(1)

    self.dio = wpilib.DigitalInput(1)

    self.solenoid1 = wpilib.Solenoid(1)
    self.solenoid4 = wpilib.Solenoid(1)
```

## Real robot code: MyRobot

- Next, define your teleoperated code

```
def teleopPeriodic(self):
  # control solenoid 1 via joystick trigger
  self.solenoid1.set(self.joystick.getTrigger())

  # control solenoid 4 via digital input
  self.solenoid4.set(self.dio.get())
```

## Real robot code: the end

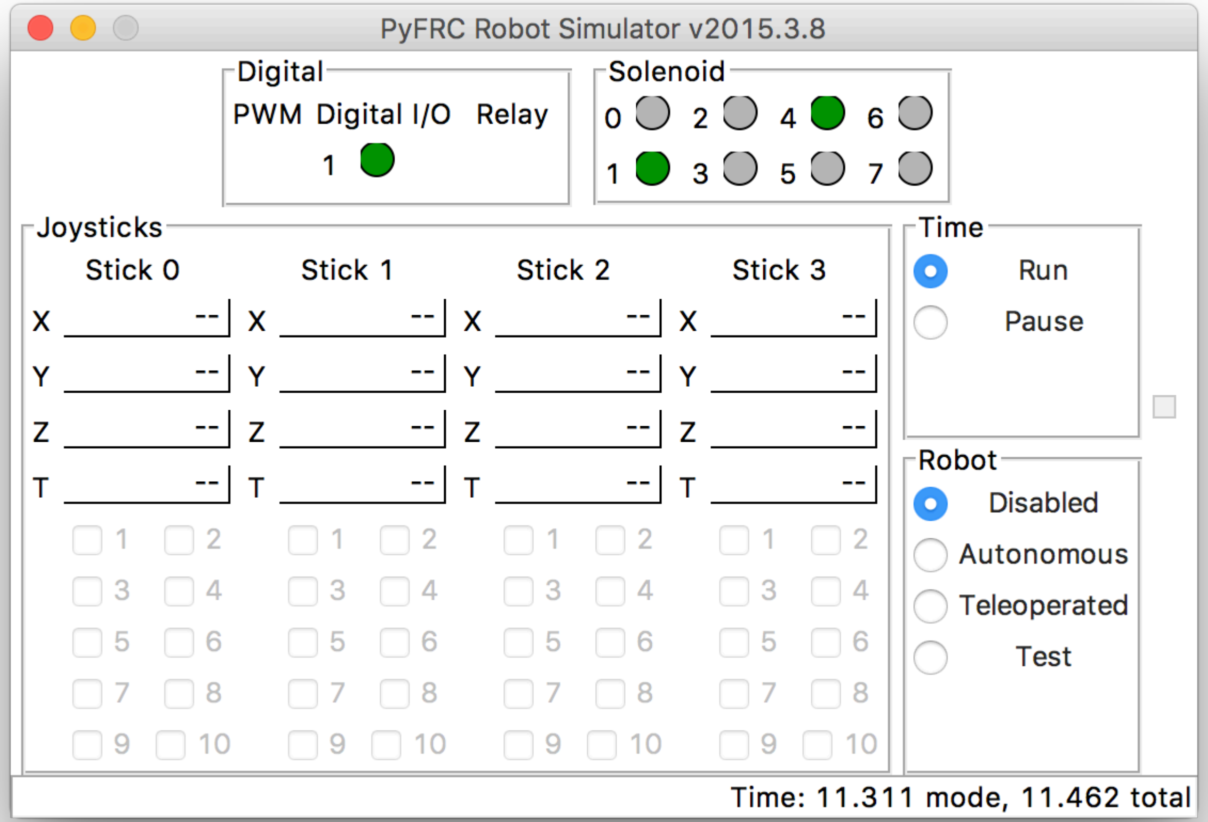
- Finally, robotpy needs some stuff to run your code correctly

```
if __name__ == '__main__':
    wpilib.run(MyRobot)
```

# Real Robot Code: Running it

- Use python3 to execute robot.py, and pass it the ‘sim’ argument
- Windows: Open cmd, and…
  - cd path\to\robot
  - py -3 robot.py sim
- OSX: Open Terminal, and…
  - cd path/to/robot
  - python3 robot.py sim

## The result



Time [✓ Run] Pause

Robot [✓ Disabled] Autonomous Teleoperated Test

Time: 11.311 mode, 11.462 total

Putting it all together

## ENCODER DEMO

## Encoder Demo

- A small snippet of code that:
  - Runs on a RoboRIO
  - Runs in simulation
  - Connects to a webpage

## Encoder Demo

- This is the robot code that does the work

```
sd = wpilib.SmartDashboard
sensor = wpilib.AnalogInput(0)
...

sd.putDouble('sensor', sensor.getVoltage())
```

## Encoder demo

- Let’s make a webpage!
  - Javascript to interact with pynetworktables2js

```
var nt = NetworkTables;
var key= '/SmartDashboard/sensorDegrees’

nt.addKeyListener(key, onValueChanged, true);

function onValueChanged(key, value, isNew) {
  // do something with it
}
```

## Encoder demo

- Let’s run this code!

## Want More?

- pyfrc has ‘physics’ support
  - Allows you to adjust various robot objects on the fly to make the simulation more useful
  - There might be a web-based simulator in 2016
- There are more pyfrc samples on github
  - https://github.com/robotpy/pyfrc/tree/master/samples

## Want More?

- This presentation + code available online
  - https://github.com/virtuald/frc-robotpy-workshop
  - https://github.com/frc2423/encoder-demo

# Learn RobotPy

- Anatomy of a robot
  - http://robotpy.readthedocs.org/en/latest/guide/anatomy.html
- pyrobottraining
  - https://github.com/robotpy/pyrobottraining

## Learn Python

- Code Academy
  - http://www.codecademy.com/tracks/python
- Wikibooks Python Tutorial
  - https://en.wikibooks.org/wiki/Non-Programmer's_Tutorial_for_Python_3
- Official Python Tutorial
  - https://docs.python.org/3.4/tutorial/

## Resources

- RobotPy mailing list
  - https://groups.google.com/forum/#!forum/robotpy
- ChiefDelphi Forums
  - http://www.chiefdelphi.com/forums/forumdisplay.php?f=187

## Code Links

- RobotPy github site
  - https://github.com/robotpy
- pyfrc documentation
  - http://pyfrc.readthedocs.org/
- Team 1418's 2015 code
  - https://github.com/frc1418/2015

## Questions

ROBOT PY

???

## Special Thanks

- Team 1418 Programming Team
- Tim Winters for python tutorial help