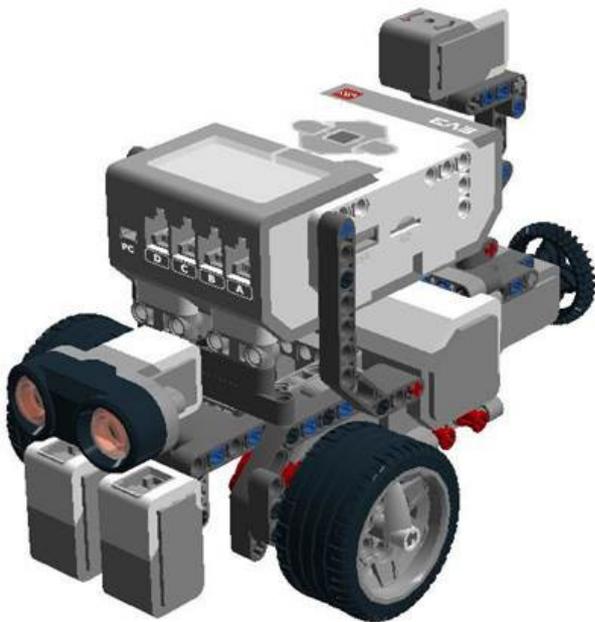




MINDSTORMS
EV3

PYTHON ON EV3DEV

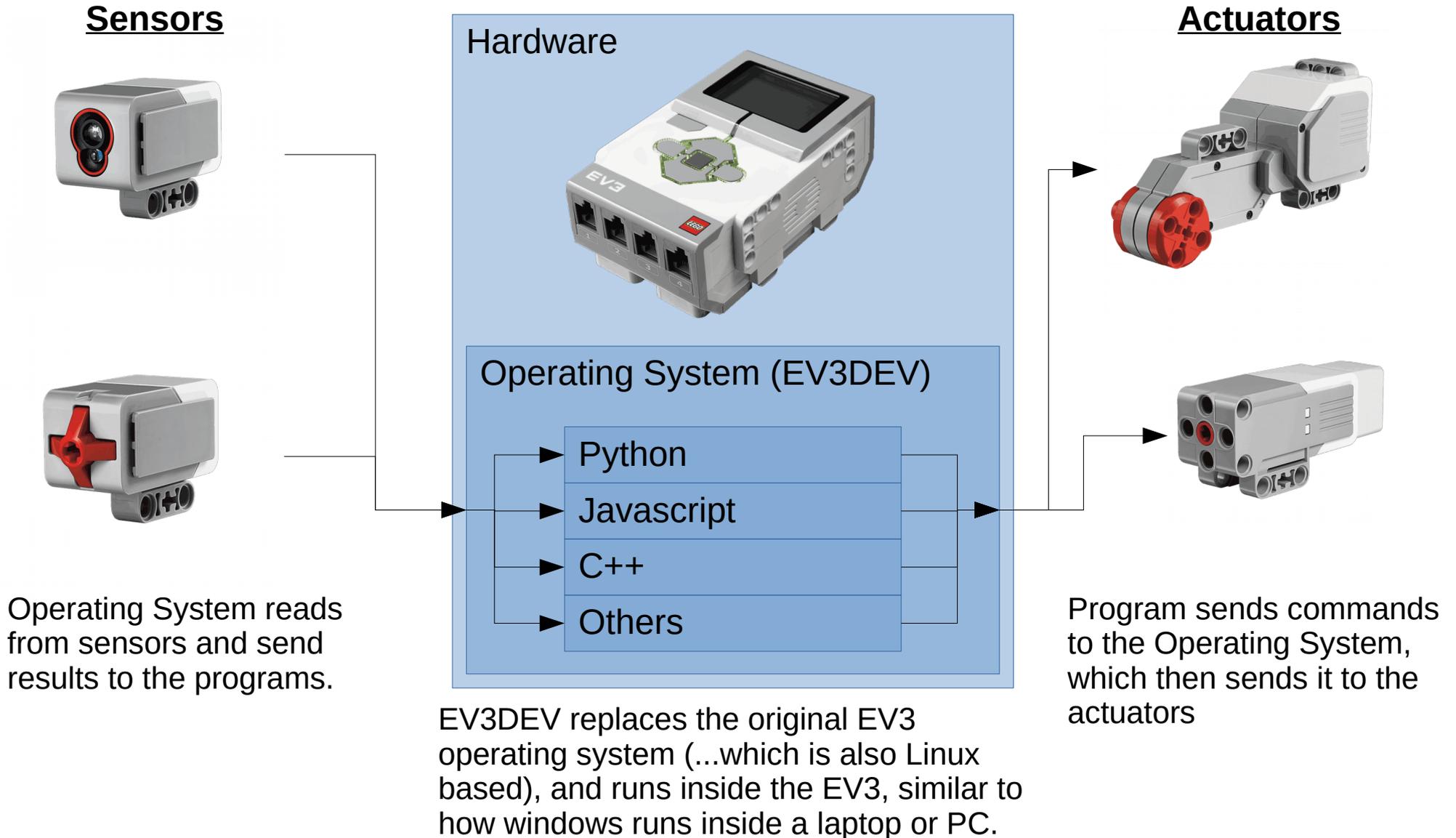


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What is EV3DEV?

- A Linux-based operating system that runs on the Lego EV3
- Runs from a microSD card
- Can run programs written in Python, Javascript, Java, Go, C++, C, and many others
- After setup, you can connect to the EV3 and...
 - Send commands to the EV3
 - Upload programs and run them on the EV3

How EV3DEV works?



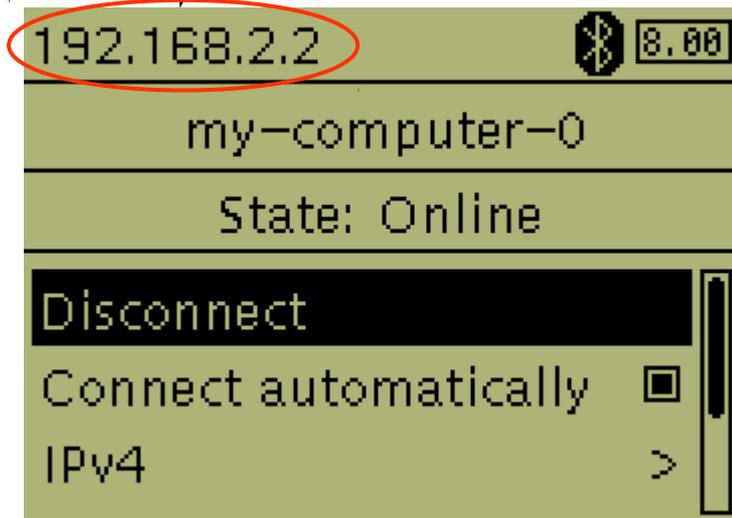
Setup

- Plug-in microSD card loaded with ev3dev and boot EV3
- Connect EV3 to your laptop
 - <http://www.ev3dev.org/docs/tutorials/connecting-to-the-internet-via-bluetooth/>
 - <http://www.ev3dev.org/docs/tutorials/connecting-to-the-internet-via-usb/>
- Install...
 - PuTTY (SSH Client. Facilitate testing.)
 - <https://www.putty.org/>
 - WinSCP (SFTP Client. Transfer Python files from computer to EV3.)
 - <https://winscp.net>
 - Notepad++ (Text Editor. Write Python programs.)
 - <https://notepad-plus-plus.org>

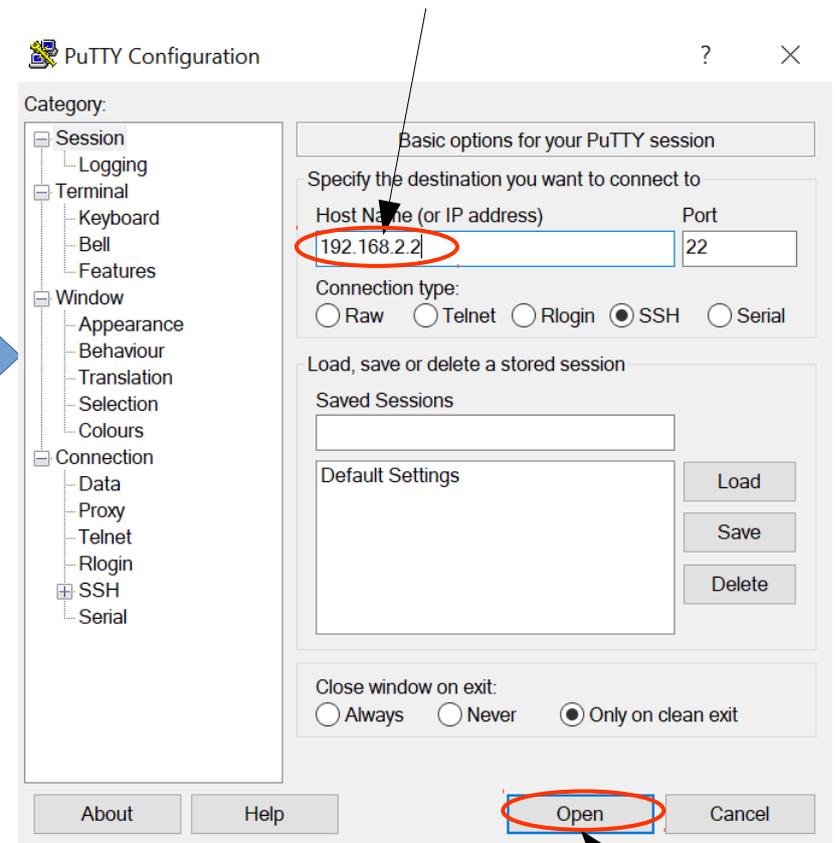
Testing Python on EV3

- Login to the EV3 using PuTTY

Check the EV3's IP address...



...and enter it here



When prompted for a login name and password, use...

Login: **robot**
Password: **maker**

Click "Open"

Testing Python on EV3

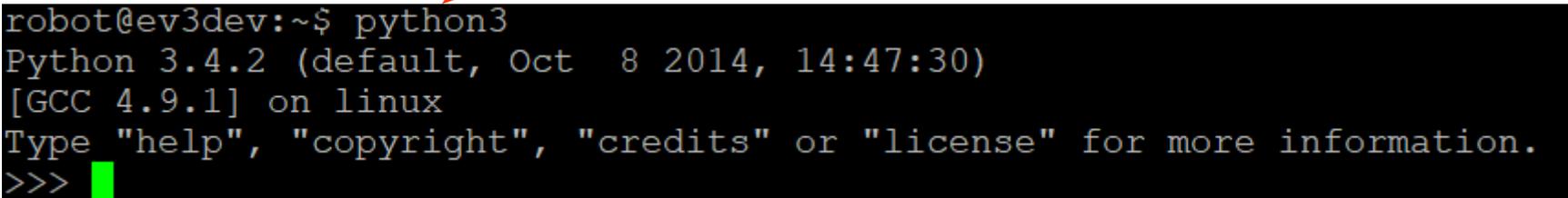
- Run Python
 - Type in “python3” and press “Enter”
 - This will start up Python (version 3) in interactive mode
 - You’ll be able to type in Python commands and run them immediately

Linux command prompt

Type this in

```
robot@ev3dev:~$ python3
Python 3.4.2 (default, Oct  8 2014, 14:47:30)
[GCC 4.9.1] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

Python command prompt



Testing Python on EV3

- Connect a large motor to port A
- Try running the following commands in Python

```
>>> from ev3dev.ev3 import *
>>> m = LargeMotor('outA')
>>> m.time_sp = 1000
>>> m.speed_sp = 500
>>> m.run_timed()
```

Load the library that reads/writes the EV3 sensors and motors

Loads “LargeMotor” class into a new instance called “m” (...you can use any name)

Set the duration to 1000 milliseconds and speed at 500. (“sp” stands for “set point”)

Run the motor in time mode using the settings that we have just set.

Short Form

```
>>> from ev3dev.ev3 import *
>>> m = LargeMotor('outA')
>>> m.run_timed(time_sp=1000, speed_sp=500)
```

Set the time and speed parameters and run the command in the same line

Testing Python on EV3

- Connect a light sensor to port 1
- Try running the following commands in Python
 - It should increase the motor speed when you bring the light sensor near a white object

If continuing from the previous exercise, you can skip the first two lines

Loads “ColorSensor” class into a new instance called “s” (...you can use any name)

Loops forever

Set motor speed to 10 times light intensity and run motor forever (...doesn't stop based on time or position)

```
>>> from ev3dev.ev3 import *
>>> m = LargeMotor('outA')
>>> s = ColorSensor('in1')
>>> while True:
...     m.speed_sp = s.reflected_light_intensity * 10
...     m.run_forever()
... 
```

Press “Enter” one more time when on the last line with 3 dots. This will start the loop.

To exit the loop, press “Ctrl + c”.

If the motor is still running when you exit the loop, run “**m.stop()**” to stop the motor

Where to Find Commands?

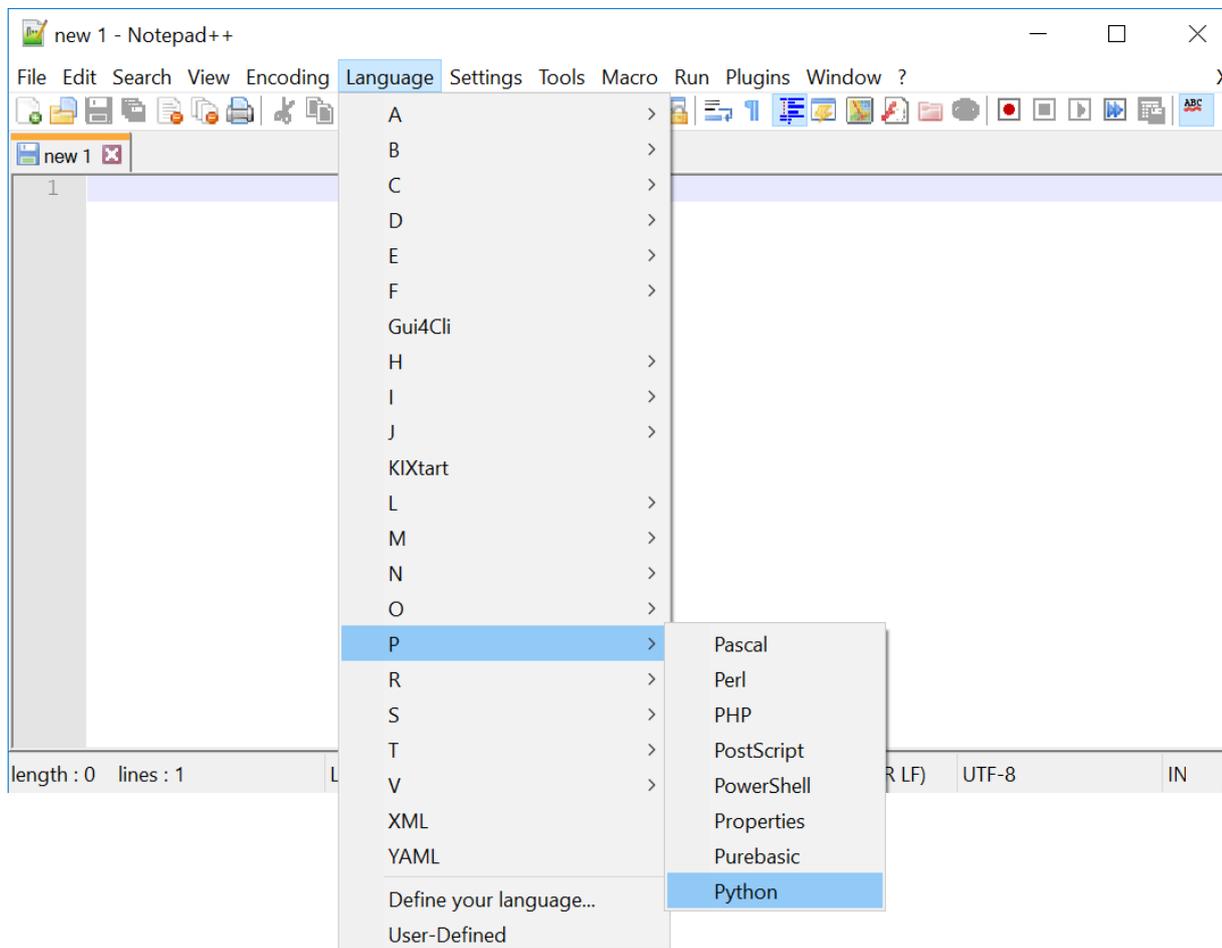
- Full list of commands can be found here...
 - <http://python-ev3dev.readthedocs.io/en/stable/spec.html>
 - It may be overwhelming for students new to Python...
- We've selected some common commands and simplified them here...
 - <http://aposteriori.com.sg/resources>
 - Look for “Python commands on EV3DEV”

Permanent Programs

- Running commands directly on Python is good for testing only
- Better to use a proper editor (eg. Notepad++) for any serious work
- Need to...
 - Write and save program on your computer
 - Transfer it to the EV3
 - Select and run it on the EV3

Permanent Program

- Write your program in Notepad++ (...or any other text editor)



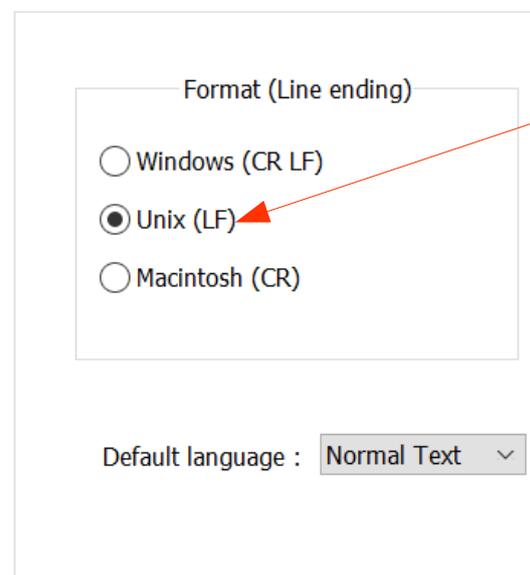
Select "Language -> P -> Python"

This sets the color highlighting accordingly (...makes it easier to read the code).

Permanent Program

- Set the Line ending under “Settings -> Preference -> New Document”

Preferences



Ensure this is set to “Unix (LF)”

* EV3DEV runs on Linux, and Linux is a Unix based system.

** CR stands for Carriage Return and LF stands for Line Feed. These line ending characters were used in the past to control the print head and paper roller on printer terminals.

Close

Permanent Program

- Try this simple 2 states line following program

```
C:\Users\Cort\Desktop\ev3\line follower.py - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? X
line follower.py
1  #!/usr/bin/env python3
2
3  import time
4  from ev3dev.ev3 import *
5
6  s = ColorSensor('in1')
7  leftMotor = LargeMotor('outA')
8  rightMotor = LargeMotor('outB')
9
10 startTime = time.time()
11
12 while time.time() < startTime + 5:
13     if s.reflected_light_intensity > 50:
14         leftMotor.speed_sp = 200
15         rightMotor.speed_sp = 0
16     else:
17         leftMotor.speed_sp = 0
18         rightMotor.speed_sp = 200
19         leftMotor.run_forever()
20         rightMotor.run_forever()
21
22 leftMotor.stop()
23 rightMotor.stop()
```

This tells the operating system that this is a Python 3 program

Import the “time” library and the ev3 library

Initialize the color sensor and two large motors (...check the ports!)

Record the start time (...in seconds)

Run for 5 seconds only

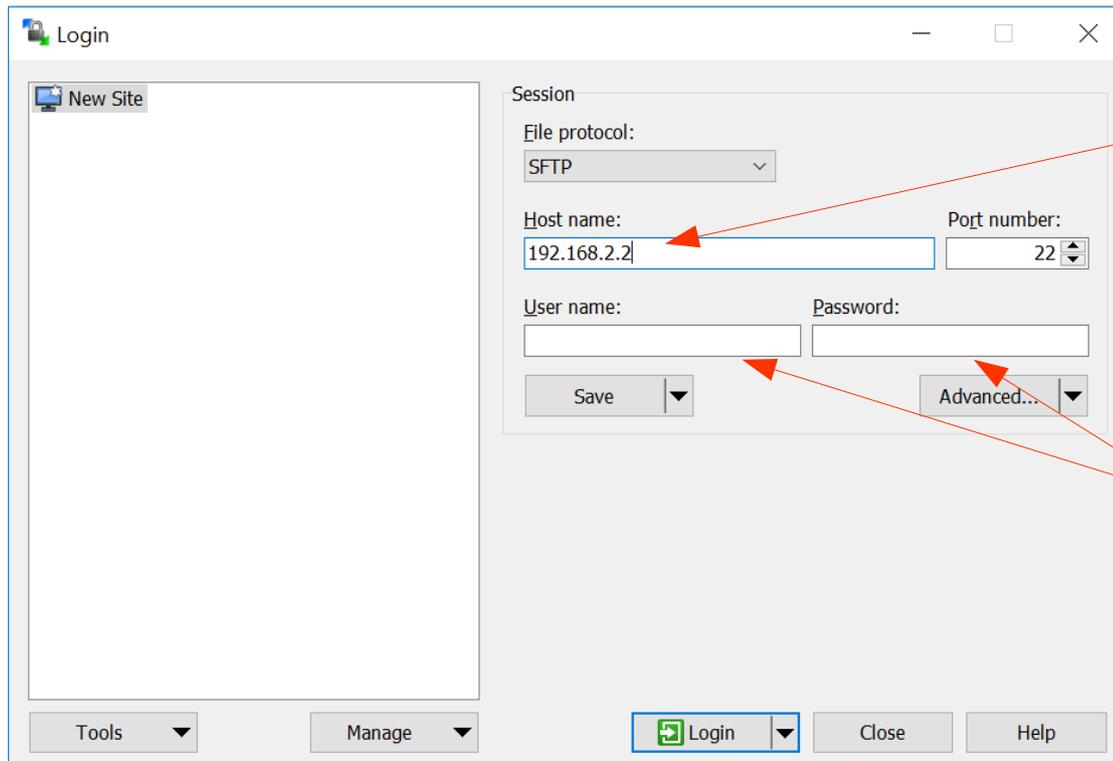
Check if the light value is greater or less than 50, and set speed accordingly

Run motors according to previously set speed

Stop both motors at the end of the program

Permanent Program

- Open WinSCP and connect to the EV3



Ensure the host name matches your EV3

User name: **Robot**
Password: **Maker**

Permanent Program

- Using WinSCP, transfer your Python file to the EV3

The screenshot shows the WinSCP interface with two panels. The left panel shows the local file system at `C:\Users\Cort\Desktop\ev3\` with a file named `line follower.py` (1 KB, PY File) selected. A red arrow points from this file to the right panel. The right panel shows the remote file system at `/home/robot/` with a red arrow pointing to the directory name. A text box with an arrow pointing to the right panel contains the instruction: "Make sure your right panel is in the /home/robot directory".

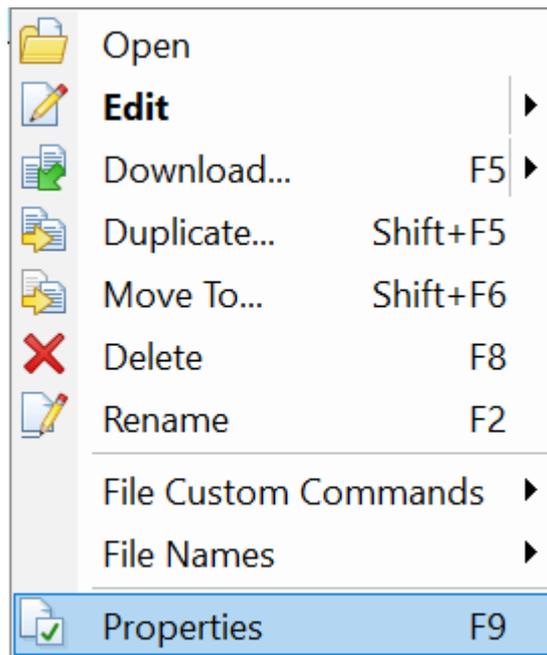
Name	Size	Type	Changed	Rights	Owner
..		Parent directory	17/2/2018 2:45:07 AM		
line follower.py	1 KB	PY File	17/2/2018 2:45:07 AM		

Name	Size	Changed	Rights	Owner
..		15/9/2017 3:01:33 AM	rw-r-xr-x	root

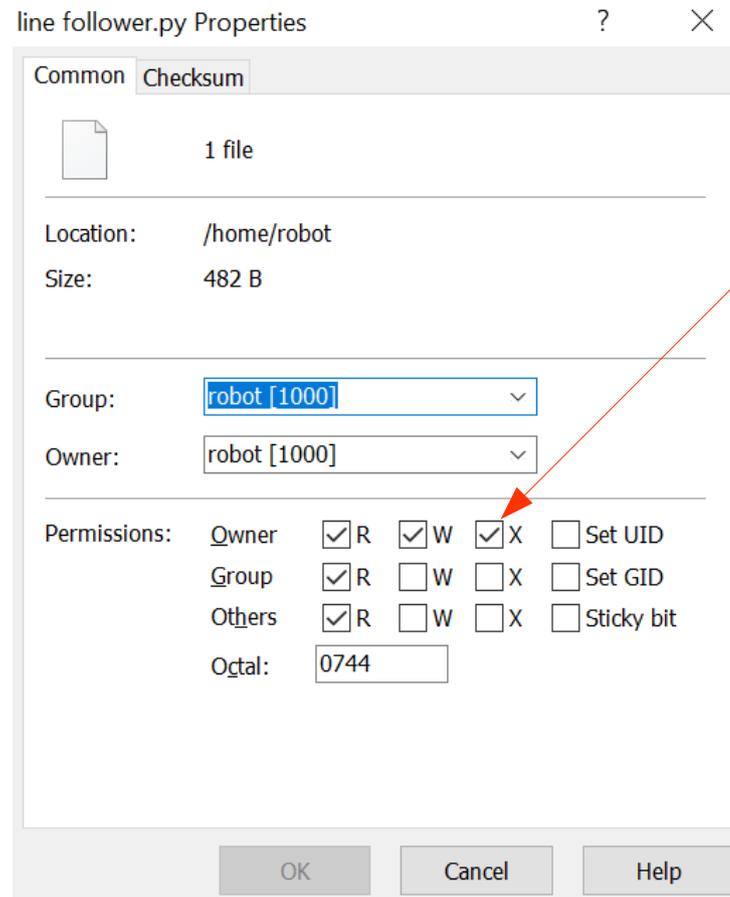
477 B of 477 B in 1 of 1 0 B of 0 B in 0 of 0 5 hidden SFTP-3 0:06:01

Permanent Program

- Make your program executable
 - This tells EV3DEV that the file is a program that it can run



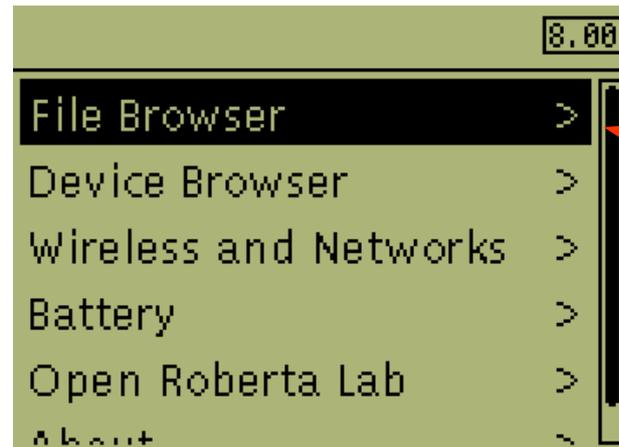
Right click the file and select "Properties"...



Make sure "X" is selected for Owner

Permanent Program

- Use the File Browser from the EV3 to select and run your program...



Use the file browser to select your program file.

It will take a few seconds for the program to start.

- ...or connect to the EV3 using SSH and run the program on the command line using...

```
robot@ev3dev:~$ ./line\ follower.py
```

The “./” at the beginning of the filename means “look for the file in the current directory”, while the “\” before the blank space tells the operating system that the blank space is part of the filename.

Running from the command line allows you to see any Python error messages.

Challenges

- Try writing the following programs...
 - 3 states line follower
 - 5 states line follower
 - 2 sensors line follower
 - Proportional control line follower

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