SYSC3010 Lab 1

Getting Started with the Raspberry Pi

OBJECTIVES

- Teams are formed.
- Teams get their lab kit.
- Each individual runs their Raspberry Pi standalone and headless (lab machine and/or personal laptop).
- A first Python program is written and run on the RPi.

Note: Those without Linux and Python experience are expected to work extra before the next lab period to explore and read the suggested resources to practice the basic tasks taught.

SUBMISSION

Each individual will submit two programs: **Lesson 3.2 MasterPy** and **Lesson 3.3 Roman Numerals** from the Raspberry Pi Education Manual. Details below.

OVERVIEW OF LAB TASKS

This lab is a low-pressure but chaotic beginning to our term. Please enjoy the time by getting to know your peers.

1. The TAs will lead your through an exercise to mingle with your colleagues. At the end of which, you will self-form into groups of four (groups of three are not permitted for choice; only when handling uneven numbers in the total lab size)
2. Teams will register in CULearn, and receive their lab kits. Please be patient, be sociable or start reading ahead.
3. Using the two Raspberry Pis within the lab kit, the team will work in pairs to ensure that the RPis are working. Details are below.

REFERENCES

All references below are electronic resources available through Carleton's library:

1. Login into Carleton's MacOdrum Library using your Carleton credentials.
2. Search for this book (or search just for *Raspberry Pi* and see lots of other resources)
3. You will be prompted to log into the O'Reilly site (and activate an account). <u>Use your real email address, not your alias.</u>
   - From [Carleton CMAIL website](#): Your **real** email address is firstnamelastname@cmail.carleton.ca but you will also receive email addressed to your email **alias**: firstname.lastname@carleton.ca.

Lee, Assam. *2019 Ultimate Guide to Raspberry P: Trips, Tricks and Hacks*. Packt Publishing 2019.

- Videos on Getting Started
- Chapter 1: Introduction (What is RPi)
- Chapter 2: Setting up the Hardware
- Chapter 3: SD cards (if you need to install a new O/S image)
- Chapter 4: Configuring your Raspbian OS Installation
- Chapter 5: Connecting Remotely (Minimally SSH)

Donat, Wolfram. *Learn Raspberry Pi Programming with Python: Learn to Program on the World's Most Popular Tiny Computer*. Apress 2018.

- Chapter 1: Introducing the Raspberry Pi
- Chapter 2: Linux by the Seat of Your Pants
- Chapter 3: Introducing Python:
  - Make sure you are aware of Python 2 versus Python 3. A lot of RPi libraries uses Python

Warren, Gay. *Advanced Raspberry Pi: Raspbian Linux and GPIO Integration*. Apress 2018**.**

- Better for theory, rather than concrete examples.

Rao, Manessh. Internet of Things with Raspberry Pi 3. Packt Publishing. April 2018.

- Setting up the Raspberry Pi
- Setting up headless Raspberry Pi

DETAILED INSTRUCTIONS FOR YOUR FIRST RPI PROGRAM

1. Set up the RPi as a **Standalone** computer (connecting a monitor, keyboard and mouse)
   - [Assam, Chapter 1 & 2 and 4]
   - Hopefully you will all be given a clean SD card with the newest version of Raspbian Operating System (a version of Linux). If not, you will have to install it yourself. See Appendix A and/or [Assam Chapter 3].
   - Important: Follow along Chapter 4 to properly configure your Pi, including enabling the Wifi. Try CU-Wireless, but if there are problems, use your phone's hotspot. Doing so, will ensure that you can download any necessary updates as well as import python libraries.

2. **Take the time now** to explore the environment, especially if you are new to Linux – find the Nano editor , find Java, find Python.
   a) New to Linux? [Assam, Chapter 6] or [Donat, Chapter 2]
   b) New to Python? [Donat, Chapter 3]
   c) For future reference, consider other tutorials listed at this site, including
      - How to run Python programs (when needing installed libraries with pip)

3. Write a trivial demonstration Python program
   - Alert: At the bottom of the given tutorial is a subtle note: "…*you can write the program on a different computer (such as Windows) and then transfer the program to the Pi when it's ready to run…*" This ability will be useful within your team, allowing you to work even if you don't have the Pi at the moment.

4. Run a *Headless* RPi using Remote Access (using another machine's monitor,keyboard,mouse)
   - Involves setting a Static IP address for your RPi which will also be required next week
   - Option 1: https://learn.sparkfun.com/tutorials/headless-raspberry-pi-setup
      i. Ignore the hardware approach (**Serial Terminal**). Instead, scroll down to **Ethernet with Static IP Address**. Once you get this approach working, try **WiFi with DHCP** (but only with you phone as a hotspot).
   - Option 2: [Assam, Chapter 5, SSH]. Later take a look at VNC
   - Option 3: See Appendix

5. Run two new Python programs on the headless Pi but also
   a) Write and run the program on the RPi
   b) Write the program **on a lab machine** or your laptop **and then** transfer the program to the RPi for execution (See Appendix)

The two programs to be written are described in the Raspberry Pi Education Manual, **Lesson 3.2 MasterPy** and **Lesson 3.3 Roman Numerals**. These two programs are to be submitted on CULearn. You are working in pairs, so the two of you will have the same files. To make tracking easier for the

TAs, please submit the same file TWICE on CULearn, once under each person's account. This practice is for the labs only. For project deliverables, there will be just ONE submission, one per group.

For now, we are avoiding programs that use the internet. That lesson is next week.

Appendix : Installing a Clean Version of the Raspbian Operating System

The lab machines do not have SD card slots. The procedure must be done on your own laptop.

URL for downloading image of the Raspbian Operating System:
https://www.raspberrypi.org/downloads/
URL for in-depth instructions for installing
https://www.raspberrypi.org/documentation/installation/installing-images/windows.md

1. Format your SD card

   Download, install and run the SD Card Formatter from https://www.sdcard.org/downloads/formatter_4/

2. Download the image for Raspbian onto a local folder (not on the SD card). Unzip.

3. Download and install the **Win32DiskImager** utility from SourceForge .
   a. URL https://sourceforge.net/projects/win32diskimager/
   b. Run-as-administrator .
   c. Point its browser to the unzipped Raspbian image.

4. Put the SD card in the RPi(without the power plugged in)

APPENDIX - SETTING A STATIC IP ADDRESS FOR YOUR RPI

This step is actually just a preliminary preparation for running your RPi headless. It is also needed next week when we connect our RPis together over the internet.

This part is always error-prone and changes yearly. Ask for help.

URL: http://www.modmypi.com/blog/tutorial-how-to-give-your-raspberry-pi-a-static-ip-address

Introduction

1. This procedure is to be done while your RPi is running as a standalone machine, connected to a monitor, keyboard and mouse.
2. You will need to have a unique static IP address for every RPi in your group.
   a. The last number in the IP address must be 2 or more.
   b. In our lab, there are "special" lab machines that have been set up with two network cards, that use the IP address range of 10.0.0.x when they are booted in Linux
      i. IPs in the range of 10.0.0.**xxx** where **xxx** is greater than 2 (not 1!)
      ii. Group **1** will use **xxx** = 1**1**, 1**2**, 1**3**, 1**4** (for members 1, 2, 3, 4)
      iii. Group 2 will use **xxx** = 2**1**, 2**2**, 2**3**, 2**4** (and so on).
   c. If you're interested, visit www.subnet-calculator.com to see which IP addresses are safe.

Detailed Instructions – With Raspbian Jessie (July 2016)

Check URL for any changes: https://www.raspberrypi.org/forums/viewtopic.php?p=859763#p859763

On your Raspberry Pi, in a terminal window
1. Type "sudo –i "   to put you in supervisor (admin) mode
2. Edit /etc/network/interfaces
   - Type "nano /etc/network/interfaces"
   - Ensure that you have this line "iface eth0 inet **manual**"
     - (eth with a zero, not a letter o)
   - Type <CTL-x> to save and exit.
3. Edit /etc/dhcpcd.conf
   - Type "nano /etc/dhcpcd.conf"
   - At the bottom of this file, add the following lines
         interface eth0   (that's a zero, not a letter o at the end)
         static ip_address=10.0.0.**2**1   (or your particular IP, NO SPACES around =)
         static routers=10.0.0.1   (NO SPACES around =) (1 is used in the labs)
         static domain_name_servers=10.0.0.1 (NO SPACES around =)
           (1 matches the gateway on the lab's Linux machines)
   - Type <CTL-x> to save and exit.

4. Edit /etc/networks by typing "nano /etc/networks"
   - Change the number for "link-local" to "link-local 10.0.0.0"
5. Reboot by typing "reboot"
6. Confirm that you have the assigned static IP address by typing "ifconfig".

TESTING YOUR STATIC IP: We do this by linking your standalone RPi to another machine, so that they can ping each other.

- Connect an Ethernet cable to the Ethernet ports of your RPi and a lab machine.
- If using your own laptop, there may be an extra step needed, written below *******

1. On the RPI, **enable SSH**. In a terminal window:
   a. Type "sudo raspi-config"
   b. Select Advanced Options -> SSH -> SSH Enable
   c. Hit ESC to exit
2. On your desktop machine, open a Command Prompt window.
3. In the Command Prompt window, type "ping 10.0.0.**2**". This will verify that your desktop machine can connect with your RPi. Use <CTRL-c> to exit.If you got a nice ping, you're ready for Step 4.

Appendix - Running a Headless RPi using Remote Access

A Headless RPi is one without a monitor, keyboard or mouse. Instead, you connect it to your laptop, so you can simply use its monitor, keyboard and mouse.

URL: https://learn.adafruit.com/adafruits-raspberry-pi-lesson-6-using-ssh/overview
Alternate URL: http://www.modmypi.com/blog/tutorial-how-to-give-your-raspberry-pi-a-static-ip-address
Alternate URL: https://pihw.wordpress.com/guides/direct-network-connection/

Prerequisite: You need a static IP address for your RPi. (Go back to Step 3)

1. Wire the desktop machine to the RPi using the Ethernet cable. Verify the connection by **pinging your RPi**.Verify that you have a connection.
2. On your desktop machine, in a Command Prompt window, type "ping 10.0.0.2"
3. On the desktop machine, download **putty** from http://www.putty.org/
4. Run putty. Enter the IP address of your RPi. (and make sure that Port is 22). Wait and hit enter (maybe a couple of times, be patient).
5. Login using the default username **pi** and password **raspberry**.
6. From here, you can run any Linux commands including Python (as if in a single terminal window)

APPENDIX : TIPS FOR DEVELOPING PROGRAMS ON YOUR RASPBERRY PI.

You can write your programs directly on the Raspberry Pi, using either Python or Java.   You may find this a bit cumbersome (with the funny small keyboard) or slow (remotely from your laptop). Alternatively, you can – with a little cleverness – write the bulk of the programs on your laptop, fix up most errors, even run some programs (that don't depend on the hardware, for instance) … and then send the file to the RPi for execution.

Let's say you have a file containing your program on your laptop.

1. Turn the power off on your RPi.
2. Eject the SD card
3. Put the SD card in your laptop.
4. Use File Explorer to browse the SD card.
5. Create a Folder called Programs, for instance.
6. Store your files in this folder.
7. Eject the SD card
8. Put the SD card back in the RPi (with the power turned off)
9. Turn the power on. Let the system start up.
10. Open up the **File Manager**. Where are your files?
11. Browse to the root directory "/". It should be down at the bottom of the folders listed.
12. Find the Boot folder. Your folder will be in this folder.
13. You cannot run your programs from this sub-folder of Boot. It is a write-protected directory. You must move your files to a user directory.   Copy it somewhere under **/pi/Documents/**
14. Now use Python or Java to run your file.

ARCHIVE – NO NEED TO GO PAST HERE EXCEPT FOR LEARNING

The Old Way to set up Static IP addresses, with previous versions of Raspbian and other Linux platforms

1. On the RPI, in a terminal window, type "ifconfig"
    a. Write down the inet-addr (the static address you gave it)
    b. Write down Bcast (the broadcast IP range)
    c. Write down mask (subnet mask address)
2. On the RPi, in a terminal window, type "netstat –nr"
    a. Write down gateway
    b. Write down destination
3. Edit the network configuration file. Type "sudo nano /etc/network/interfaces"
    a. Find the line with "iface eth0 inet". If it ends in "manual" or "dhcp", change that word to "static"
    b. Immediately after this line, add

       Address 10.0.0.2   ; Your static address
       Netmask 255.255.0.0   ; Your mask
       Network 10.0.0.0   ; Your destination
       Broadcast 10.0.255.255   ; Your bcast
       Gateway 0.0.0.0   ; Your gateway

    c.
    d. Save the file using <CTRL-X>
4. Refresh by typing "sudo rm /var/lib/dhcp/*"
5. Reboot to install the new changes: "sudo reboot"
6. Once it has restarted, verify the changes by typing "ifconfig". Again try pinging it from your laptop.

Tip for Temporarily Setting a Static IP on your RPi (for testing)

1. On your RPI, in the terminal window, type "sudo ifconfig eth0 10.0.0.**2**". This assigns the given IP address to the "eth0" network connection. (Note it is eth followed by a zero, not a letter o). Use whatever number you have decided to use for your particular RPi.
2. Verify your static address. Type "hostname –I" (Uppercase Letter i). You should see your IP address returned to you.