

Term Project

WORKING WITH THE RASPBERRY PI

The term project component of the course requires you to leverage the Raspberry Pi. The project involves multiple deliverables to ensure that you are making sustained progress on your term project throughout the semester.

Unlike other assignments in the course, this is a team effort. You are required to work in groups of 2-3 for this assignment. Solo projects and teams comprising 4 members are disallowed.

CS370 also has a distance/online section. Teams comprising a mix of on-campus and distance students are allowed, and in fact, encouraged. You can use the "Search for teammates" feature on Piazza to find teammates. If you are not able to find team members, please let the GTAs know so that team members can be assigned.

DUE DATE: The term project has three deliverables. TP-D1 does not have any points associated with it.

TP-D1 due 8/29/2018
 TP-D2 due 10/17/2018 [3 points]
 TP-D3 due 12/05/2018 [7 points]

1 Raspberry Pi and Models

The Raspberry Pi is a resource constrained, credit card-sized single-board computer designed and developed in the United Kingdom. All Raspberry Pis include the same VideoCore IV GPU, either a single-core ARMv6-compatible CPU or quad-core ARMv7/8-compatible CPU, and 1 GB or 512 MB or 256 MB RAM depending on the model. Some of the Raspberry Pi models that are currently available are listed in the table below.

	Pi Model A	Raspberry Pi 1 Model A+	Raspberry Pi 1 Model B	Raspberry Pi 1 Model B+	Raspberry Pi 2 Model B	Raspberry Pi Zero W	Raspberry Pi 3 Model B	Raspberry Pi 3 Model B+
CPU	700 MHz single-core ARM1176JZF-S				900 MHz quad-core ARM Cortex-A7	1 GHz ARM1176JZF-S single-core	1.2GHz 64-bit quad-core ARMv8	1.4GHz 64-bit cortex-A53 (ARM v8)
GPU	Broadcom VideoCore IV @ 250 MHz							
Memory (SDRAM)	256 MB		512 MB		1 GB	512 MB	1 GB	1 GB
Built-in WiFi	NO					Yes	Yes	Yes
Cost	\$25	\$20	\$35	\$25	\$35	\$5	35\$	\$35

We will be using Raspberry Pi 3 model B+. This is the latest and the most powerful model. If you would like to use Model 2 or 1 and are confident of resolving all issuing by yourself, please do so.

1.1 Raspberry Pi Peripherals

The Raspberry Pi has peripherals like USB ports, GPIO pins, Full HDMI port, Ethernet port, 3.5 mm audio jack and composite video, Camera Interface (CSI), Display Interface (DSI), Micro SD card slot etc. The Raspberry Pi can be operated with any generic USB keyboard and mouse, and can be connected to monitor or display via Full HDMI.

Basic peripherals that you are required to have for this term project are the Micro SD Card and a power connector. If you are using an older Pi without built-in WiFi, you will also need to buy a USB Wi-Fi adapter. It is also possible to buy these all these peripherals as a package along with the Raspberry Pi.

Please pay attention to the guidelines given [here](#) when purchasing the SD card and USB power adapter. Also spend some time researching the marketplace.

A list of compatible USB WiFi adapters for the Raspberry Pi can be found at http://elinux.org/RPi_USB_Wi-Fi_Adapters – a popular choice is the Edimax EW-7811Un 150Mbps wireless nano-size adapter.

1.2 Sellers of Raspberry Pis

Below are the recommended sellers of Raspberry Pi,

- [Element14](#)
- [Allied Electronics](#)
- [RS Components](#) (UK)
- [Amazon](#) and [eBay](#)

Note: Plan to order early; it takes around one week for delivery in the case of Element14. Amazon/eBay can be faster.

2 Deliverables

2.1 TP-D1: Team composition and Placing an Order for the Pi

This deliverable involves you confirming two elements. First, you must identify the composition of your team. The team can involve 2-3 team members. Each team member also must include their e-mails along with their primary e-mail for academic communications; not responding to your team's e-mail communications in a timely fashion is unacceptable. Second, one of the team members must confirm that you have placed an order for the Raspberry Pi and the required peripherals (listed in section 1.1).

TP-D1 must be submitted as a PDF document using Canvas. There are no points for TP-D1 but there is a penalty (of 1 point) for not submitting this by the due date.

2.2 TP-D2.A: Installing and Configuring Raspbian

This deliverable targets installation of the Raspbian OS Jessie (kernel v4.4) with Pixel desktop on your Pi. This guide assumes you have a Raspberry Pi 3 model B, but the instructions are quite similar to other versions as well. Please choose an appropriate version of Raspbian if you are using an older version of Raspberry Pi.

TP-D2.A accounts for 1-point towards your cumulative grade.

2.2.1 What You Will Need:

- Raspberry Pi 3 model B+
- Power supply adapter: It's recommended that you use a 5V micro USB power supply adapter to power your Raspberry Pi. The power supply adapter should be at least 5V – Raspberry users have reported problems when this is not the case.
- Card: The recommended card is a class-4 8GB microSD.
- Display and Connectivity Cables: Any HDMI/DVI monitor or TV should work as a display for the Raspberry Pi. You can use a standard Ethernet cable for access to the Internet.
- Keyboard and Mouse: Any standard USB keyboard and mouse will work with the Raspberry pi.

2.2.2 Downloading the Raspbian OS

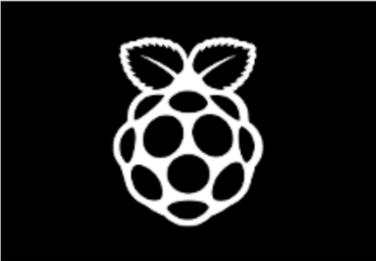
Raspbian is the default operating system on Raspberry Pi. It is free and continually updated with new features. You can install third party operating systems on the Raspberry Pi such as Windows 10 IoT Core, PIDORA, Ubuntu Mate, Snappy Ubuntu Core, OSMC, OPENLEC, PINET, RISC OS etc.

You can download Raspbian at raspberrypi.org/downloads/. Click on Raspbian and download the .zip file and unzip it. This will create the IMG file and that's the file that you will install on you microSD card.

There is simple and popular way of getting the OS with NOOBS (New Out Of the Box Software), which lets you install different flavors of OS on the Raspberry Pi.

DOWNLOADS

Raspbian is the Foundation's official supported Operating System. Download it [here](#), or use **NOOBS**, our easy installer for Raspbian and more.



NOOBS



RASPBIAN

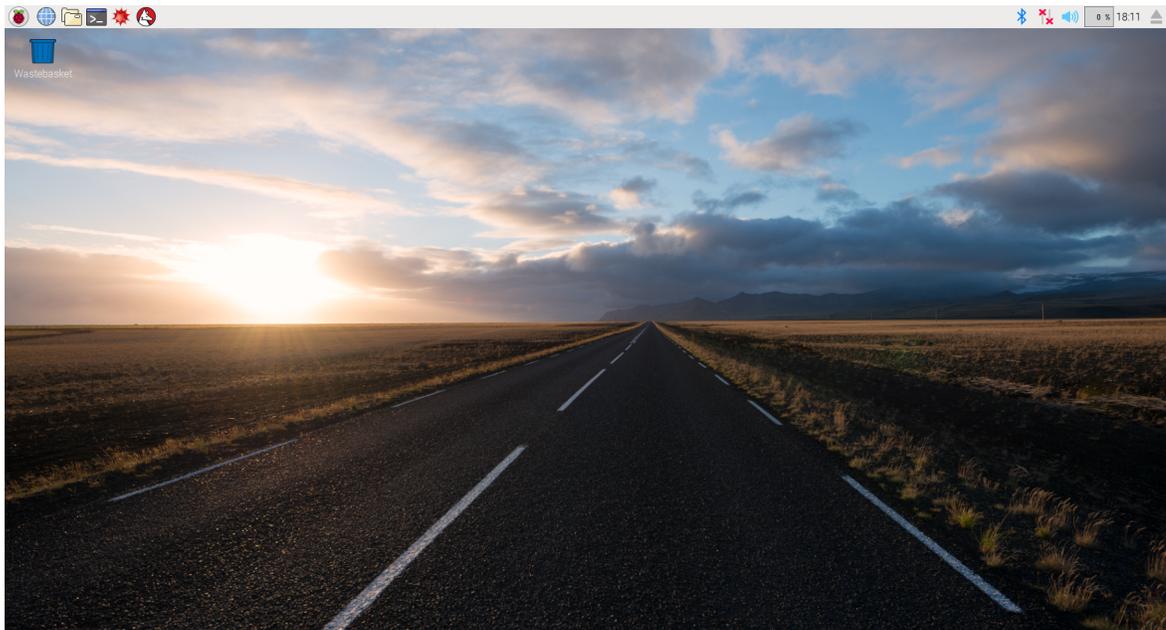
2.2.3 Installing the OS on the microSD card:

The microSD card is also your Rapsberry Pi's hard drive. If you are not using NOOBS, you have to install Raspbian IMG on the microSD card. There are software available to write the IMG file on the microSD card. The official guide for setting up the microSD card is available [here](#). Please follow the section corresponding to the operating system of your computer which is used to setup the microSD card.

2.2.4 Powering up your Raspberry Pi:

Make sure you have all the required elements with you and follow the instructions below:

- Insert the microSD card (where you installed OS) in the slot provided on the Raspberry Pi.
- Plug in the USB keyboard and mouse into the USB slots on the Raspberry Pi.
- Connect display (monitor or TV) to the correct input HDMI or DVI and turn on the display.
- If you want to connect your Raspberry Pi to the Internet, connect it to the router using a standard Ethernet cable. This feature allows you to update and upgrade the OS.
- Once you are sure that you have connected everything, you can connect the micro USB power cable to power up the Raspberry Pi.
- Once the start-up is complete, you will see the home screen depicted below.



- If the home screen doesn't show up and you are in the terminal window mode, you have to log in with default username *pi* and password *raspberry*.
- Then to load graphical user interface, type *startx* and press Enter on your keyboard.

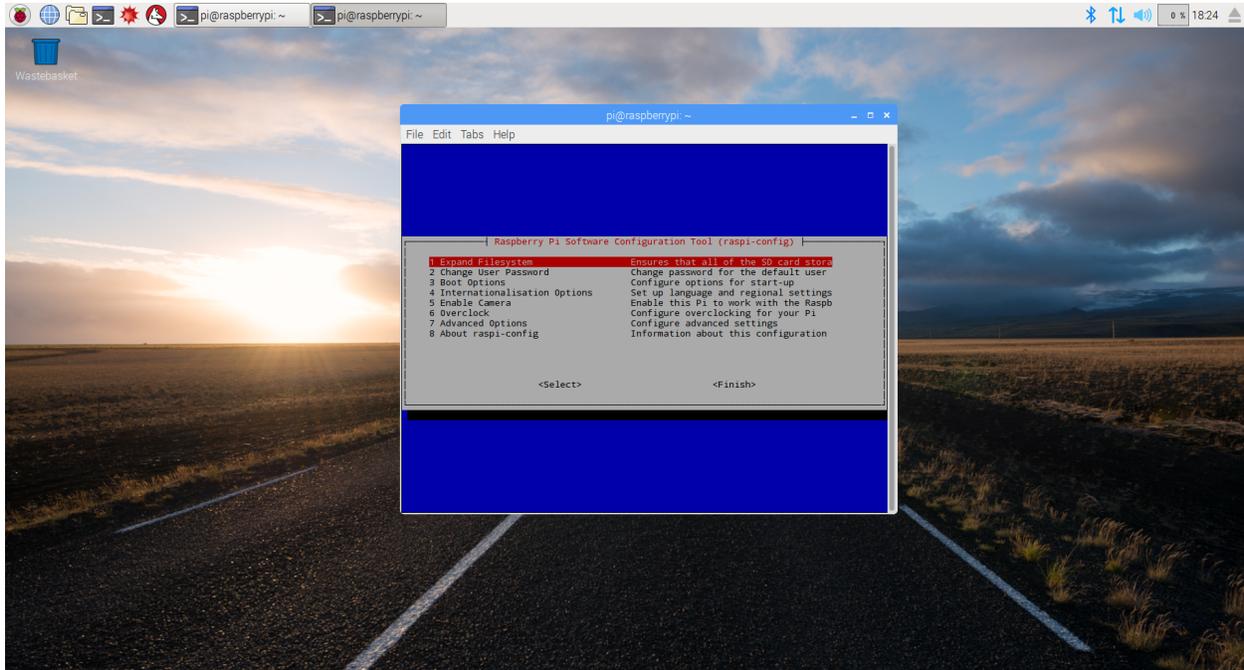
If you are using NOOBS, you can alternatively refer to this [video](#).
Install the sample software to know how to install software using web user interface.

This part accounts for 0.5 points.

2.2.5 Configuration

If you are in the home screen, open the terminal window and write *sudo raspi-config* to launch the configuration window. You will see various options in the *raspi-config* such as:

- Expand File system (Not an option for OS installed with NOOBS)
- Change Password
- Boot Options
- Language
- Enable Camera
- Overclock
- Advanced Options



Selecting Time Zone, Language, Changing Hostname and Password etc. are mandatory steps. You should also append your *EID* to the default hostname.

Please do not overclock your Raspberry Pi as it may void the warranty on your Pi.

Once you are done with configuration, exit out of *raspi-config* by selecting *<finish>*.

This accounts for 0.5 points.

2.3 TP-D2.B: Support for SSH

For various applications we are required to access a Raspberry Pi without connecting a monitor to it. Suppose, we have installed a Raspberry Pi at a remote location, it's inconvenient to physically connect a monitor/keyboard etc. to the Pi to change configurations.

As part of TP-D2.B You will get access to a terminal on the Raspberry Pi, not the full-fledged GUI. You can install VNC to gain full remote desktop access. **TP-D2.B accounts for 1-point** towards your cumulative grade.

2.3.1 Configuration:

SSH can be enabled/disabled on your Raspberry Pi by using raspi-config.

Make sure you have connected your Raspberry Pi to the network using an Ethernet cable.

Please enter `sudo raspi-config` in terminal, then navigate to `ssh` and select `Enable/disable SSH server`.

2.3.2 How to get IP address of Raspberry Pi:

If you are working with your home network, you can access your router in the browser by using <https://10.0.0.1> and get your IP address.

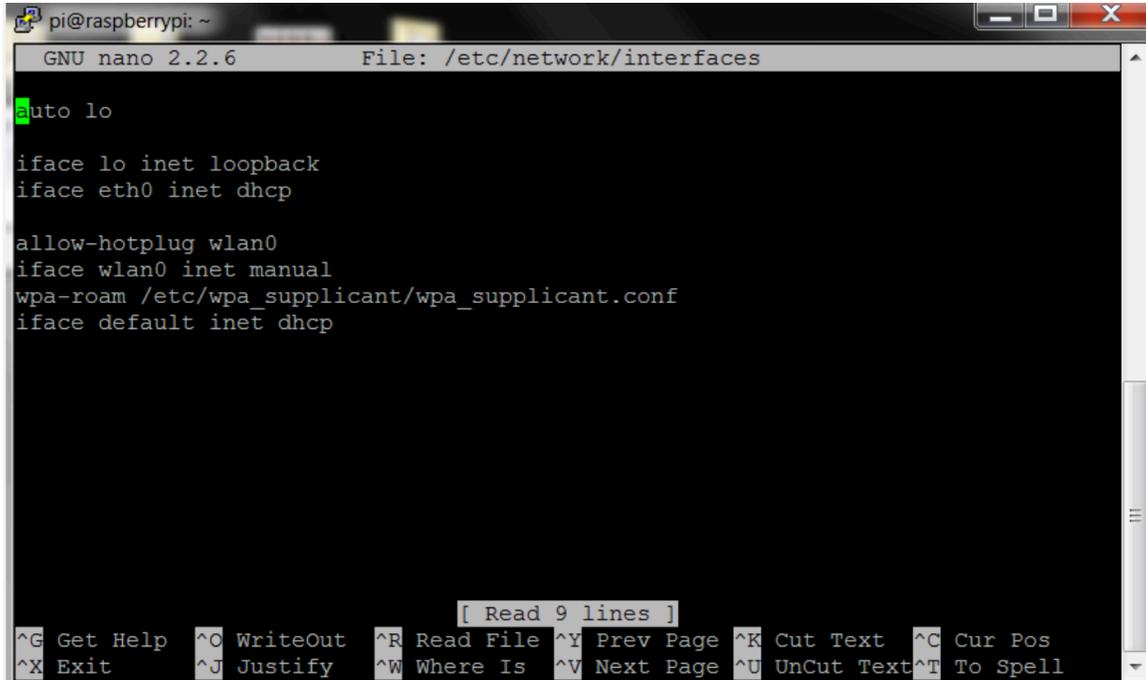
Another way to know the IP address is to run `arp -a` on the terminal of your laptop before and after connecting the Raspberry Pi to the network. The new IP that appears in the output could be used as the IP address for the Raspberry Pi.

Try to SSH to it.

OR

If you are using the CS building network, please use NetSec Lab (CS 315) whenever it's free, mostly in evening. In that case, you need to configure Raspberry Pi IP address to static IP addresses. Since static IP addresses are scarce, we have been advised by sys-admins to not advertise the available ranges. Please get the static IP address assigned to you from the GTAs and follow the instructions below:

- Connect the Raspberry Pi to the network and run `ifconfig` on terminal to gather information about IP address, Netmask, Gateway, and Broadcast etc.
- To plug information in the Raspberry Pi's network configuration, `sudo nano /etc/network/interfaces`



```
pi@raspberrypi: ~
GNU nano 2.2.6 File: /etc/network/interfaces
auto lo

iface lo inet loopback
iface eth0 inet dhcp

allow-hotplug wlan0
iface wlan0 inet manual
wpa-roam /etc/wpa_supplicant/wpa_supplicant.conf
iface default inet dhcp

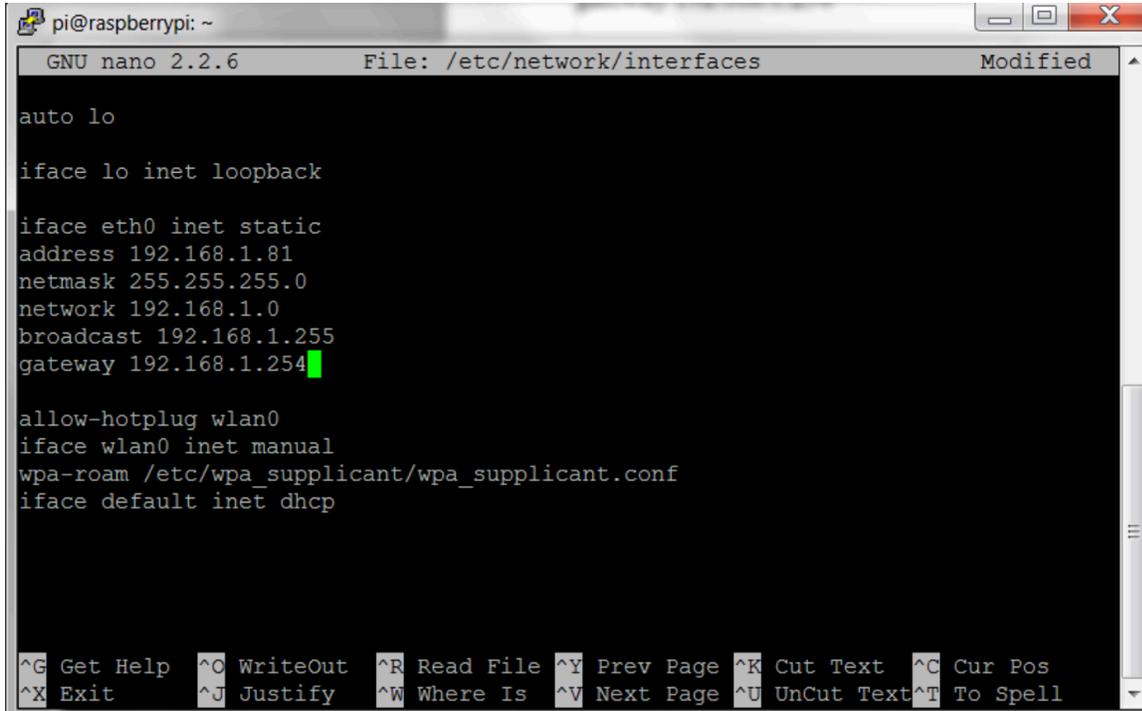
[ Read 9 lines ]
^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^T To Spell
```

- Change line `iface eth0 inet dhcp` to `iface eth0 inet static`.
- Write the following lines above the edited line, and save contents using CTRL+X and then yes to save changes.

```
address 192.168.110.130
netmask 255.255.255.0
network 192.168.110.0
broadcast 192.168.110.255
gateway 192.168.110.1
```

- Then remove any existing leases from dhcp or dhcpd5,
`sudo rm /var/lib/dhcp/*` or `sudo rm /var/lib/dhcpd5/*`
- Reboot the Raspberry pi and check the IP address,
`sudo reboot`
`ifconfig`

Note: Sometimes, this won't work, and won't reflect the change in network configuration as above; however, you will be able to ssh to Raspberry Pi by knowing its IP address in the network.



```
pi@raspberrypi: ~
GNU nano 2.2.6 File: /etc/network/interfaces Modified
auto lo

iface lo inet loopback

iface eth0 inet static
address 192.168.1.81
netmask 255.255.255.0
network 192.168.1.0
broadcast 192.168.1.255
gateway 192.168.1.254

allow-hotplug wlan0
iface wlan0 inet manual
wpa-roam /etc/wpa_supplicant/wpa_supplicant.conf
iface default inet dhcp

^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^T To Spell
```

2.3.3 Things to submit:

For TP-D2. B, you need to submit a PDF document (using Canvas) with screenshots of your laptop or desktop terminal (Linux and Mac users) or putty(windows users), showing the following:

- ssh to Raspberry Pi
ssh <username>@<hostname>
- Content of interfaces file
cat /etc/network/interfaces

2.3.4 Grading:

- Enabling ssh using raspi-config : 0.5 points
- Screenshots as specified in the assignment (This should be part of the PDF document that you submit): 0.5 points
 - There will be deductions if you don't show each step in the screenshots as specified.

2.4 TP-D2.C: Support for WiFi

TP-D4 targets adding WiFi to your Raspberry Pi. It's recommended that you SSH to the Raspberry Pi and then enable interfaces for WiFi. It is possible to use the full web GUI to enable WiFi, but this is not recommended. **TP-D2.C accounts for 1-point** towards your cumulative grade.

2.4.1 Configuration:

- Open the wpa-supPLICANT configuration file using nano.
 - `sudo nano /etc/wpa_supplicant/wpa_supplicant.conf`
- Add the following to the bottom of the file,
 - ```
network={
 ssid="csu-guest"
 psk=""
}
```
- Please use ESSID csu-guest ... this does not require a password.
- Save the file by CTRL+X and then say yes.
- It will reflect the changes and start network using WiFi.
- If not, manually restart the interface with `sudo ifdown wlan0` and `sudo ifup wlan0` or reboot the Raspberry Pi `sudo reboot` .

### 2.4.2 Things to submit:

Please submit a PDF of the screen shot demonstrating the WiFi set up.

### 2.4.3 Grading:

- Enabling WiFi – 1 point

## 2.5 TP-D2 Submission Recap

Please submit a single PDF containing screenshots demonstrating capabilities outlined for elements A, B and C for TP-D2. There is ONE submission per group.

### 3 TP-D3: Project and Report

As part of TP-D3 you will be doing a project of your choice and an accompanying report.

#### 3.1 Project [5 points]

You are free to formulate any project with your Raspberry Pi. Two constraints are imposed on this project:

1. The Raspberry Pi must be the key enabler of the project.
2. There should be at least 3 components involved in the project. Your term project must involve ONE of the following:
  - a. A single Raspberry Pi and 2 desktops OR
  - b. 2 Raspberry Pis and one regular desktop OR
  - c. 3 Raspberry Pis OR
  - d. A Raspberry Pi, a desktop, and a sensor OR
  - e. A Raspberry Pi and 2 sensors

#### 3.2 Report [2 points]

You are required to submit a report describing your project. This report should be between 2500-3000 words excluding references. The report must include several elements, each of which will be a separate section. These include:

- Introduction
- Problem characterization
  - This is a technical description of the problem. Your audience is your peers so express it in a way that they can appreciate.
- Proposed solution and implementation strategy
  - Methodology
  - Include a description of the libraries that you have used and what you did on your own.
- Conclusions
- Bibliography

#### Use of Citations

Citations have a specific purpose, they: (1) relate to work that has been published elsewhere, (2) substantiate your claims, and (3) could be used by readers to dig a little deeper. Remember to number your references and list them in your bibliography in the order they are referenced throughout the paper. If an article is in your bibliography, it must be cited in the main text. Citing at the right location indicates what your source is for a particular piece of information, and also demonstrates that you have read the article. Make sure that you cite all your references including Wikipedia and Online lecture notes that you may have perused. References that are not cited should not be in your bibliography.

#### Other Notes Regarding the Report

In your discussions, be aware of when you digress and the importance of tying it to the overall narrative. If you go off on too many tangents, the paper will tend to be dull, unorganized, and ambiguous.

If you are looking at your topic from the software prism, it might be worthwhile to see if the software choices were constrained or motivated by the underlying hardware. An article is much more compelling if it lays out the trade-off space. Identify the confines within which things happen. If a system has achieved a certain feature what are the other things (both hardware and software) that make this feature possible. Try to address both the advantages and disadvantages of support for specific features.

### **3.3 Things to submit:**

The report must be submitted as a PDF document using Canvas. There is ONE submission per team. Every document must list ALL team members (including their full names and email addresses).

## **4 Grading**

This assignment will account for a maximum of 10 points towards your cumulative course grade.

## **5 Late Policy**

Click here for the class policy on submitting [late assignments](#).