

ECE 1778 – Creative Applications for Mobile Devices
February 2019
Specialist Assignment S3

Understanding Parts of the Mobile/Software ‘Canvas’

One of the goals of this course is to give experience in reaching across disciplines in a meaningful way (on the way towards our goal of creating a novel application of a mobile device). In this assignment, you will be asked to engage in a learning process about the capabilities of the computers that are part of the mobile devices, with your programming partners, and then to continue your learning on your own.

There is much to be gained by reaching across disciplines, and learning some of the language and basic understanding in other disciplines. As a Specialist, you will be teaching the programmers some of the key terms in your field – including the meaning and the underlying concepts behind those terms. In this Assignment, we are asking the programmers to teach you some of the key terms and understandings in the Computer Engineering and Computer Science fields.

Key Capabilities of Computation

The broad field of computer science and engineering can be broken down into many different sub-fields, at least one of which you’re sure to be using in your project. Below is a list of different capabilities along with a small amount of context in which it is used. As you will read below in Section 2, you are to choose **one** of these areas – one that you are not already familiar with, but your programming partners are - and to engage in a two-step learning process about it, aided by your programming partners. Here are the areas:

1. **Fast Searching.** Computers are very good at organizing data in many clever ways that make it easy to find something that you’re looking for very quickly. A ground-breaking example of this is something called a Hash Table which is also called an *Index*. Google, for example, has ‘indexed’ the entire public Web so that it can be searched very quickly. Ask your programming partners to explain what kinds of problems a Hash table is used to solve, and how it cleverly does it better than the more obvious methods.
2. **Back-End Cloud Servers and Frameworks.** Many of the functions that are presented to regular users of the internet and computers are now done ‘elsewhere’ in the ‘cloud’ on computer servers connected through the internet. Learn what those servers actually are, and then get your programming partner to describe a Framework that they are familiar with (perhaps Firebase from assignment P2) and explain what functionality it provides to them as programmers. Examples of this functionality include ‘bucket storage’ for large files, databases, authentication, machine learning frameworks, and analytics. For generality, get a quick

description of a different framework/cloud vendor, (perhaps some services provided by Amazon Web Services) that illustrates both the differences between offerings, and the complexity of figuring out which one to choose for any given situation.

3. **Machine Learning.** A field that has come to prominence in the last few years is one where computers have become able to perform classification tasks at a level equal to or better than humans – called Machine Learning, a sub-field of Artificial Intelligence. If your partners have taken courses in this area, get them to explain the essential aspects of ‘learning from data’ and what makes it different from regular programming. Learn what it means to convert quantities in the physical world – such as intensity of light in a portion of a picture – into their representation in the digital world (the value of a set of pixels). Get them to explain how ‘generalization’ happens, and is observed to happen. Finally, try to get a sense of two other new capabilities have arisen – in Natural Language Processing (starting with “Word Vectors”) and Generative models, which don’t classify, but create!

4. **Optimization.** Given a few choices, a human being is pretty good at selecting among those choices, which of those choices might be the best. Given millions, billions or trillions of possibilities, computers can do a great job of sorting through these and choose the best, whereas a human has little hope of success. There is a very large field that concerns automatic ‘optimization’ for which many different methods have been invented in mathematics, computer science, and engineering. Optimization could perhaps be divided into two sub-categories:
 - **‘Combinatorial’** - in which there are many different combinations of possible things to look at – for example, selecting the best route between two points on a map, in the presence of traffic data. Example techniques in this area include ‘greedy’ methods, ‘hill-climbing’ methods, dynamic programming, and the ‘branch and bound’ method.
 - **‘Continuous’** - here the set of possible ‘choices’ is represented as a set of real numbers, which can take on any value. This might be used to select locations of water-bomber planes in anticipation of the summer fire season for cross-Canada forest-fire fighters. Example techniques in this area include Linear Programming and Convex Optimization methods.Ask your programming partners to describe one application of these methods, and get a rough sense of how they actually work. Make sure to spend some time understanding the ‘complexity’ of the approach, and what that means.

5. **Internet Communication.** The modern world is now predicated on vast communication networks that connect our wired desktops and wireless mobile devices to everyone! Having some sense of the layers of communication, both physical and virtual, that connect us could well enhance some of the projects you will do. For example, you should learn about the Domain Name Server (DNS) that is part of the Internet address translation. Ask your programming partners to

describe what happens from an entry of a search term on the Google web search page and where it goes, after you press 'enter'. They will have to speculate some, but it would be good if you had a clearer sense of all that is involved in that action. This should include some level of technical detail that includes notions of client/server, the nature and connectivity of the network (get the programmer to show you how many 'hops' and the average latency in the network it takes to go from your computer to Google's servers), but need not be concerned with actual search process itself (#1 above). Get them to show you how the 'traceroute' command works and what its output means.

Part 1: Learn from Your Partner

Choose **one** of the areas listed above (again: one that you are not already familiar with, but your programming partners are) and have your programming partners teach it to you. Ask the programmers to use one or two concrete examples of the concept that you have selected to help you understand it. Each of the concepts can be quite broad so if you select examples, this will help to focus your understanding. Take notes. Then, go away from them and write up a 2-page (500 words plus pictures; *it is really important to use pictures here*) description of the concepts involved. While you may connect with them and ask questions, do not have them edit your document in any way. Include a section in which you detail the things that you don't fully understand, or would like to understand better.

It is very important that you convey your understanding of what you've learned in your own words, not those of your partners. We will be looking for the synthesis of the concepts that happens in your own mind.

VERY IMPORTANT: DO NOT USE THE INTERNET IN PART 1, THAT IS THE GOAL OF PART 2 BELOW.

Submit this document online on Quercus (under Specialist Assignment 3 Part 1) on Monday February 4th by 6pm, before moving on to the next step.

Part 2: Take A Few Steps on Your Own

Using the Internet, pursue a deeper understanding of the topic you have chosen. Look up the things that you didn't understand or wanted to know more about. Write a new document, also 500 words in length that conveys this deeper understanding. **In addition, write a single paragraph on your view of this learning process – how it went, how much you learned from Part 1 vs. Part 2, and what would have made it better.**

Submit this document online on Quercus (under Specialist Assignment 3 Part 2) on Thursday February 7th, at 6pm.

Due Date Summary:

For Part 1: Monday February 4th, at 6pm, 0.5 marks off every hour late.

For Part 2: Thursday February 7th, at 6pm, 0.5 marks off every hour late.

Grading Guidelines/Rubric:

Total Marks: 10

Part 1: 5 marks

- 2 marks for clarity and logical flow
- 2 marks for re-synthesis of the information into your own words. Make use images/metaphors/examples.
- 1 mark for describing in detail the things that you don't fully understand

Part 2: 5 marks

- 1 mark for clarity and logical flow
- 2 marks for re-synthesis of the information into your own words. Use images/metaphors/examples.
- 2 marks for reflection on how this learning process went, how much you learned, and what would have made it better