University of Waterloo
CS240, Spring 2015
Assignment 0

Due Date: Monday, May 11, at 5:00pm

Please read `http://www.student.cs.uwaterloo.ca/~cs240/s15/guidelines.pdf` for guidelines on submission. For problems 1 – 6, submit your solutions electronically as a PDF file using MarkUs. This assignment is worth up to 6 bonus marks, which will be added to your total mark for assignment 1.

A0 is designed to introduce you to LaTeX. We strongly encourage students to create all their assignment solutions using LaTeX, as it will strongly benefit both you and your markers. Learning LaTeX is a great asset to have for any course, and also especially for those of you planning to go into academia. LaTeX, like HTML, is best learned by example. To complete the problems below, open the LaTeX file used to make this PDF. Inside the file you will find the code used to write this file along with comments explaining the code to help you get through the assignment. If you get stuck there are also many on-line resources you can use. Searching for "fraction example LaTeX" is acceptable. Searching for "LaTeX proof of summation from 1 to n" is **not** acceptable. To compile the .tex file provided simply type "pdflatex a0.tex" in the school's Linux environment. LaTeX compilers are also free to download on-line. **Submit both a0.pdf and a0.tex to Markus**.

Problem 1 - Assignment Guidelines

At the top of this page is the URL to the assignment guidelines for CS240, it can also be found from the course webpage from the Assignments tab. Please answer the following questions about the assignment guidelines:

a) If an assignment question asks you to design an algorithm, what must you do in addition to describing/writing the pseudocode for the algorithm?
Solution: If an assignment question asks you to design an algorithm, you must give a correctness proof/argument if it not immediately obvious, and include an analysis (usually of the running time), in addition to describing/writing the pseudocode for the algorithm.

b) For programming questions, which function can you use to read input?
Which functions can you use to output the answer?
Solution: For programming questions, you can use **cin** to read input, and use **cout** to output the answer.

Problem 2 - Mathematics

In CS 240, you will be using many mathematical concepts. It is important to be able to typeset mathematics in your assignments. This will include sums, fractions, subscripts & superscripts, etc.
Example:

$$\bar{f}(n) := \sqrt{\sum_{i=0}^{\lg n} 4^i \left(\frac{n_0}{2^i}\right)^{\theta}}.$$

In order to practice this skill, write a proof showing:

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$

Solution: We will prove this by induction.
Base Case
For n=1 the equation is true, since

$$\sum_{i=1}^{1} i = 1 = \frac{1(1+1)}{2}$$

Induction Hypothesis
Assume the equation is true for $n = k$, for some $k \geq 1$
Induction Step
Prove that the equation is true for $n = k + 1$

$$\sum_{i=0}^{k+1} i = \sum_{i=0}^{k} i + (k+1)$$

$$\sum_{i=0}^{k+1} i = \frac{k(k+1)}{2} + (k+1) \text{ (by Induction Hypothesis)}$$

$$\sum_{i=0}^{k+1} i = \frac{k(k+1)}{2} + \frac{2(k+1)}{2}$$

$$\sum_{i=0}^{k+1} i = \frac{(k+1)(k+2)}{2} = \frac{(k+1)((k+1)+1)}{2}$$

Therefore, by induction the equation is true for all $n \geq 1$

Problem 3 - Trees

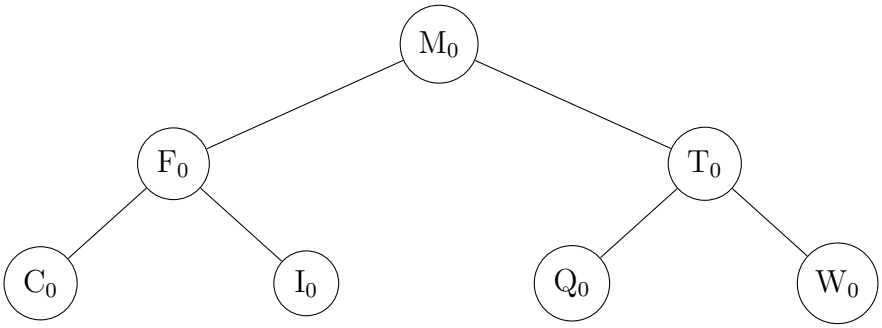
CS 240 introduces many tree data structures. Here is a balanced BST on 7 letters of the alphabet. Insert the first three letters of your first name into the tree (if your first name is shorter than 3 letters, simply insert all the letters), starting with the first letter of your name. If you are inserting duplicate letters:

a) Find the largest index of the letter you are inserting.

b) Insert your letter, with an index one larger than the index you found.

c) When comparing to an equal value, follow the left branch.

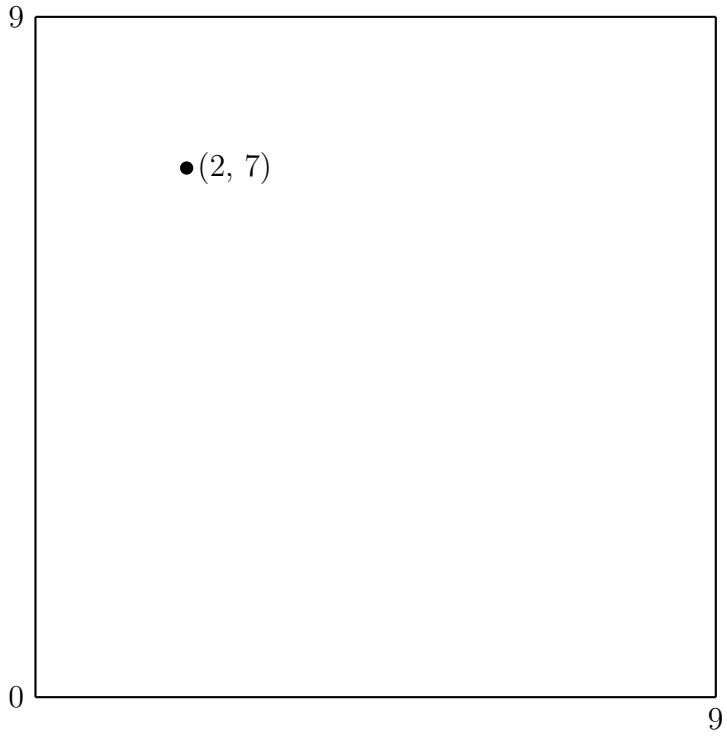
For example, if you were to insert a 'M' into the tree below, it would be entered as M_1 and it would become the right child of I_0. Only show the resulting tree.



Hint: For nodes with only one child, you may wish to use "child[missing]" for the non-existent child.

Problem 4 - Plots

CS 240 also deals with many graphs and plots. Plot the following points below, the first one has already been done for you. Only show the resulting plot.
Points: (2,7), (7,1), (4,5), (1,3), (3,2), (6,6), (0,9), (9,8), (8,0), (5,4)



Problem 5 - Tables

Occasionally, you may want to present information in a table. In LaTeX you can easily present data in well structured tables. Fill in the table below with any animal you like.

Animal's Name	Avg. Weight	Longevity	Avg. Temperature	Conservation Status
Polar Bear	350-700kg	25 years	37°C	Vulnerable

Problem 6 - Images

You may find it too time consuming to do parts of your assignment in LaTeX, at which point you may want to include an image of your work. LaTeX also supports images. Please keep your image sizes small both for this assignment and future assignments; however, be sure that your images can be easily read by your markers, or you run the risk of losing marks.

Figure 1: Polar bear

For this question, include an image of the animal you entered in the table above.