1. **[Performance Evaluation] Why and When Do I Need C? [50 pts]**
   In this problem, you will evaluate performance between `C` and `Java`. Two programs, written in `C` and `Java`, generate N random vectors whose dimension is M and output all vector pairs whose cosine similarity is above t. Parameters are hard-coded in the program ($N = 10000$, $M = 30$ and $t = 0.6$), but you are free to adjust them. Each program will output the running time.

   (a) Download `a1.tar.gz` from CMS [1].

   (b) Uncompress the file use the following commands.

   ```
   $ gunzip a1.tar.gz
   $ tar -xvf a1.tar
   ```

   (c) Compile and run `Java` program.

   ```
   $ cd a1/java
   $ javac Calculate.java
   $ java Calculate
   ```

   (d) Compile and run `C` program without optimization.

   ```
   $ cd a1/c
   $ gcc -lm calc.c -o calc
   $ ./calc
   ```

   (e) Compile and run `C` program with optimization.

   ```
   $ gcc -O -lm calc.c -o calc
   $ ./calc
   ```

   (f) Replace the option flag "`-O`" with "`-O2`" and "`-O3`". Repeat the experiment.

   What do you notice? Write a report discussing the performance of `C` and `Java` programs. In your report, include your running time of these five experiments. Discuss what you have learned from this experiment. (Don't write a long report, one or two paragraphs are enough!) Finally, submit your report to CMS.

2. **[Basic Syntax] Operation on String [50 pts]**
   Write a function `int htoi(char s[])`, which converts a string of hexadecimal digits (including an optional `0x` or `0X`) into its equivalent integer value. The allowable digits are `0` through `9`, `a` through `f`, and `A` through

[1] `https://cms.csuglab.cornell.edu`

F. You should create three files, a header file "`str.h`", a program file "`str.c`" and a "`Makefile`". In "`str.c`", include `main` function and your test cases. Compress them into a zip file called "`code.zip`" and submit it to CMS.

3. **[Bonus] How Many Valid Numbers? [20 pts]**
Write a program that can compute the number of unique, valid phone numbers with the following constraints.

   (a) A valid phone number is seven digits in length. Only digits are allowed.

   (b) A valid number doesn't begin with a zero or a one.

   (c) A valid number is a sequence of digits that can be traced by the movements of a knight on a normal telephone keyboard.

1	2	3
4	5	6
7	8	9
*	0	#

   (d) Knight movement is illustrated below. Legal movements for • are marked as ×. For example, successors of number 8 could only be 1 or 3.

	×		×	
×				×
		•		
×				×
	×		×	