Assignment 1

1 Summary

This first assignment is theoretical. There are five questions below, all related to topics from Chapter 1 and 2. The detailed instructions explain where you'll answer them and how you'll submit the answers.

2 Questions

1. (20%) Suppose that a hardworking hardware development team in a computer manufacturing company increases the speed of a particular CPU every day by a constant factor and that as a result, the speed doubles every 100 days. Suppose that its current speed is denoted s_0. Then after 100 days its speed is $2s_0$. After how many days will it have a speed of $6s_0$? (Hint – this is like a bank interest problem.)

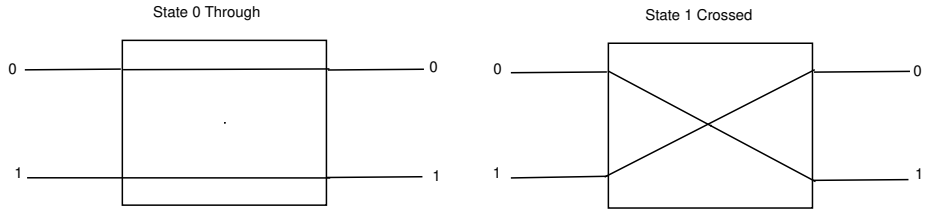
2. (20%) Consider the inverse of the previous question – suppose that this same company continues to speed up its CPU every day by some factor and that they don't know how many days it takes the speed to double anymore, but they do know that every 400 days, the speed is 24 times faster. Assuming that the increase in speed each day is a constant multiple of the speed the day before, how many days does it take to double now?

3. (20%) How many distinct *shortest* paths are there between the node in the lower left corner and the node in the upper right corner of a square mesh with n nodes in each row and column? A path is shortest if there is no other path between the two nodes that is shorter.

4. (20%) Recall from Chapter 2 of the Lecture Notes that the distance between two nodes in a graph is the length of the shortest path between the two nodes, where the length is the number of edges in the path. Given a hypercube with 2^N nodes and a single fixed starting node s, how many nodes are at a distance of exactly d from s, assuming $0 \leq d \leq N$?

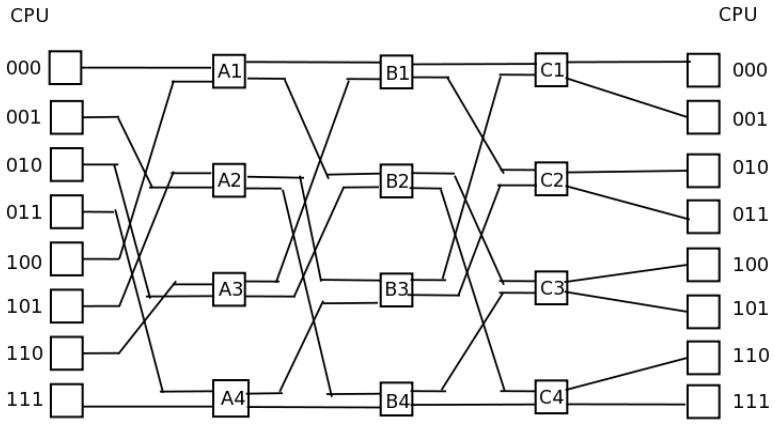
5. (20%) Consider the interconnection network pictured below. In the picture, the leftmost and rightmost columns represent processes running on their own dedicated processors. The binary numbers that label these nodes are the IDs of the processors. The leftmost and rightmost columns represent the same set of processors. In other words, the node labeled 100 in the leftmost column is the same as the node labeled 100 in the rightmost column. It is as if the picture is really a cylinder that's been cut and laid flat on the paper.

   This interconnection network that connects the processors consists of columns of switches. Each switch has identical input connections and except for the rightmost column, the same output connections. In this network, a message travels from the left to the right. When it arrives at a switch it has two possible outputs it can take, the top or the bottom. If the switch is in a crossed state, input 0 connects to output 1 and vice versa. If it is in pass through, then input 0 connects to output 0, and 1 to 1.



   Every switch is identical. The input and output rows are numbered 0 through 7 in binary from the top down. The output from row j in any column, including the leftmost CPU column, but not counting

the column with the C switches, is to the row whose binary representation is a *left cyclic rotation* of j. A left cyclic rotation of a binary number is a left-shift in which the leftmost bit is copied into the rightmost position. For example, if j is 010 then a left-cyclic rotation of j is 100. When j = 010 it connects to 100. Similarly when j = 100 it connects to 001. Row 000 always connects to 000. In the last column, the output of switch C_j connects the two outputs to processors $2j-2$ and $2j-1$.



Answer the following questions. Write the paths as a space separated list of nodes, such as 101 A2 B4 C4 111

(a) (5%) Write the path that a message takes to go from processor 6 to processor 7.

(b) (5%) Write the path that a message takes to go from processor 2 to processor 4.

(c) True or False: Without changing the state of any switches, messages from any two processors can be sent to any two other processors at the same time. Answer True or a False.

(d) True or False: There is just a single path between any pair of processors. Answer True or a False.

Detailed Instructions

1. Using any ***ssh client*** on your computing device, remotely login to `eniac.cs.hunter.cuny.edu`.
2. After you login successfully, ssh to **any `cslab` host.** For example, to ssh to `cslab8` you would type:

   ```
   $ ssh cslab8
   ```

3. The remaining instructions assume that you have logged into some `cslab` host.
4. Copy the file `/data/biocs/b/student.accounts/cs493.65/hwks/hwk1_answers` to your home directory using the command

   ```
   $ cp /data/biocs/b/student.accounts/cs493.65/hwks/hwk1_answers   ~/
   ```

5. Answer the above questions by putting the answers immediately after the colon ":" on each line corresponding to the question number. You will need to use a text editor to do this. ***Do not use a word processor to do this.*** If you do, the file will not be readable and you will get a zero on the assignment. Instead, if you edit it on Linux, use an editor such as `vim`, `emacs`, `pico`, `nano`, `gedit`, or `geany`. Make sure that you follow the instructions for how to write the answers in order to receive full credit.
6. Save your file and make sure that you ***do not add an extension to its name***. It can be named anything, but do not add an extension such as ".txt".

7. Assuming the file is named `my_hwk2_answers`, to submit it, run the command

   ```
   submithwk_cs49365  -t  1  my_hwk2_answers
   ```

   The program will copy your file into the directory

   ```
   /data/biocs/b/student.accounts/cs493.65/hwks/hwk1/
   ```

   and if it is successful, it will display the message, "`File hwk1_`*`username`*` successfully submitted.`" where *`username`* is your username. You will not be able to read this file, nor will anyone else except for me.

8. ***You can do step 7 as many times as you want. Newer versions of the file will overwrite older ones.***

Grading Rubric and Deadline

This assignment is 10% of your final grade. Each question is 20% of the grade for the assignment. Partial credit may be given, at my discretion, for partially correct answers. Again, the deadline is **Monday, February 12 at 7:00 PM**.