COS 116
The Computational Universe
Final Exam

This exam is 3 hours long and <u>closed book and closed notes</u>, except that you may refer to the pseudocode handout from earlier in the semester. The maximum possible score is 100. All questions can be answered in a few lines, but you should feel free to write longer answers. No collaboration or discussion is allowed. Print and sign the honor pledge on the front page of your answers:

"I pledge my honor that I have not violated the Honor Code during this examination."

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1. (6 points) Mention two positives and two negatives of Turing's proposal for what it means for a machine to be "intelligent."

2. (6 points) Moore's law states that number of transistors per square inch of silicon doubles every 18 months. From a consumer's perspective, the performance increase is usually in terms of increased clock speed. Explain why the second is related to the first.

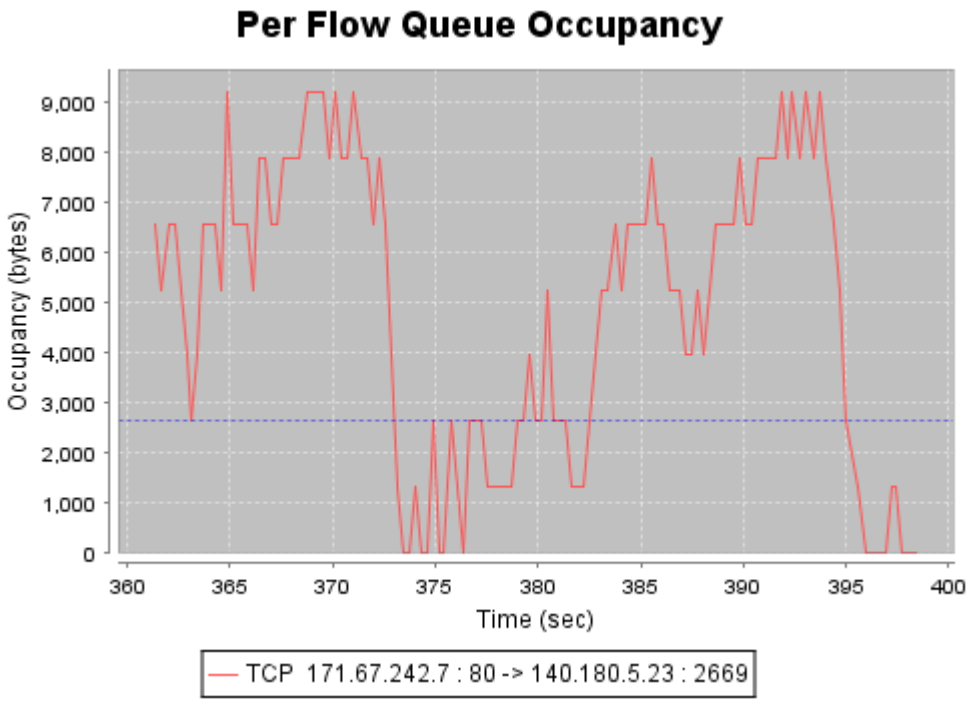
3. (8 points) Explain at a conceptual level how computers predict the weather. Why can they not predict the weather 100 days in advance? Why can the principles of weather simulation not be applied to simulate the human brain at the present time?

4. (8 points) You see that your friend is about to put on a mismatched pair of socks: a red sock and a green sock. You point this out to her, but she thinks you are pulling her leg. Suddenly you remember that she is color blind, and cannot distinguish between red and green. How can you convince her that the socks are different? Explain clearly why your method works.

5. (7 points) What is behaviorism? Why is behaviorism not a big help in designing algorithms for machine learning?

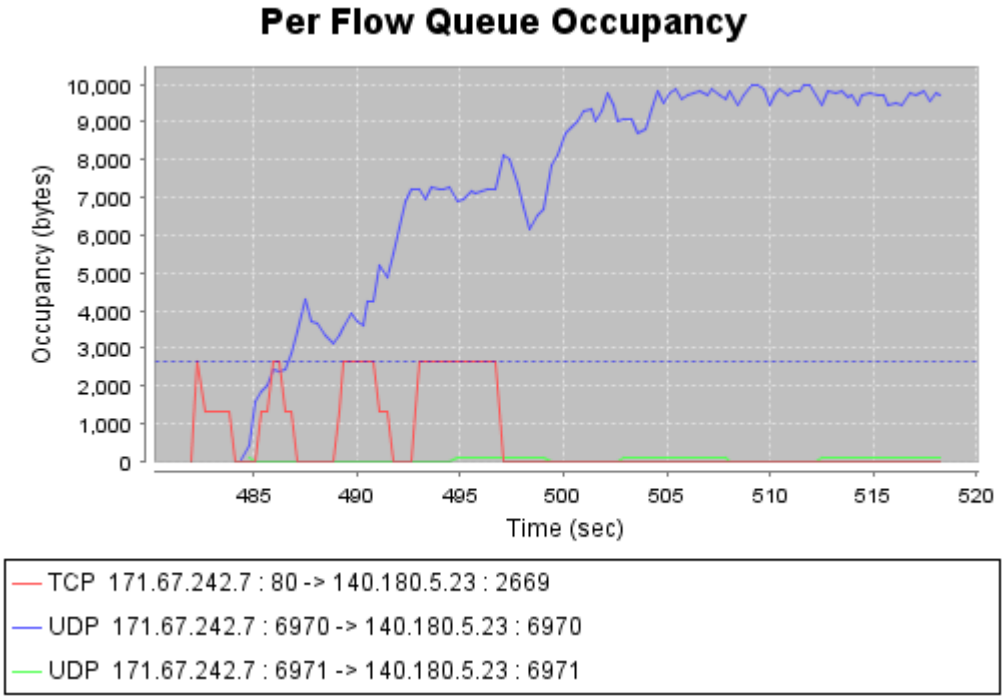
6. (a) (6 points) The Internet often drops packets, and usually does not deliver them in order. Describe in a line each any three mechanisms used in the TCP/IP protocol to ensure reliable communication in spite of these difficulties.

   (b) (6 points) A typical graph of the network traffic for a certain router might look like the following:



Explain in a few lines why the shape of the graph is like this, and how it is related to Internet congestion control

A different but also common graph might look like the following: (focus only on the blue and red lines)



We saw in lab an example of this kind of traffic pattern. Explain in a couple of lines why this is different from the previous pattern, and why both occur on the Internet.

7. (9 points) What is a bot net (also called "zombie net")? How does a large bot net usually come into being? Mention two things that bot nets are used for by their creators.
8. (18 points) Describe in words what the following two pseudocode programs do, stating precisely what they print and in what order:

Program 1:

```
i = 1
Do while i < 1000
{
    Print i
    i ← i * i
}
```

Program 2:

```
i = 2
Do while i < 1000
{
    Print i
    i ← i * i
}
```

9. (8 points) Suppose we have a computer that supports processor cache, memory, and disk storage. The relative speed and cost of the different types of storage are given in the table below.

Type	Speed	Cost
Cache	20 GB/s	$500/MB
Memory	4 GB/s	$1/MB
Disk	1 GB/s	$1/GB

   (a) Suppose 97% of requests are fulfilled by cache, 2.9 % are fulfilled by memory, and 0.1% are fulfilled by disk. On average, how fast is memory accessed?
   (b) How much would a system with 1 MB of cache, 500 MB of memory, and 100 GB of disk cost?
10. (20 points) The following synchronous circuit represents a finite state machine:

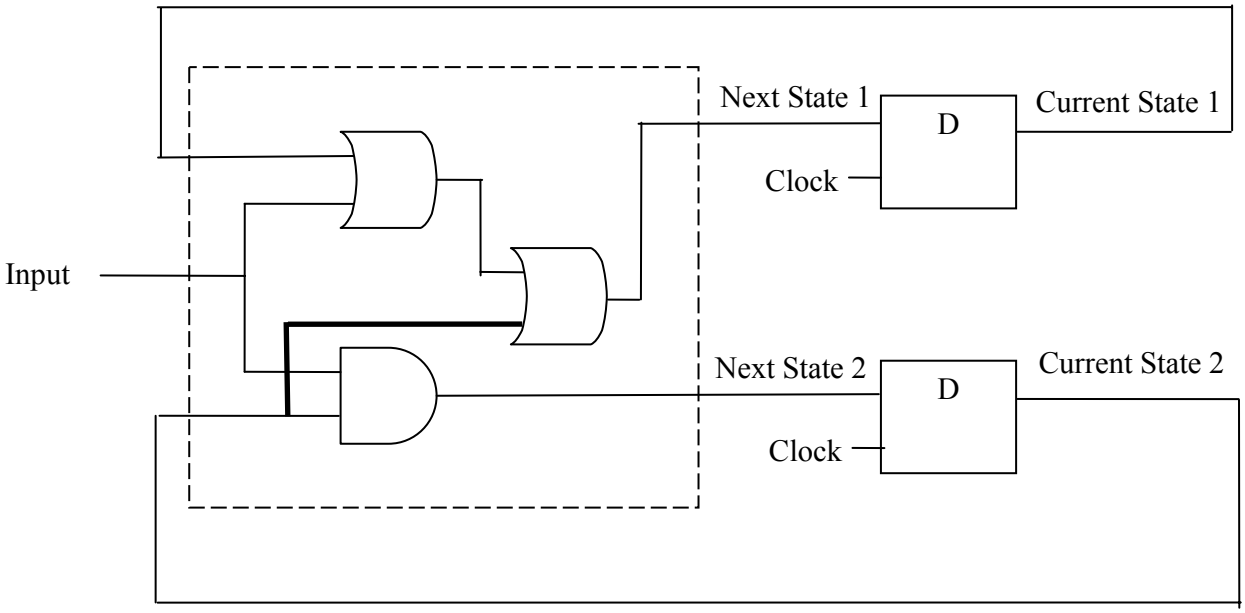


Figure 1.

The boxes labeled "D" are D flip-flops.

(a) Write down the truth table, describing the next state produced for each current state and input bit. (Write your table in the exam book; the blank table below is just to get you started.)

Current State 1	Current State 2	Input	Next State 1	Next State 2

(b) Draw the transition diagram for the FSM.