COS 116
The Computational Universe
Homework 6

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1. The notion of exponential growth is mentioned in each of the following excerpts from a magazine or newspaper. Which of them use the notion correctly and which don't? Justify each answer in a line. Note that a quantity has "exponential growth" in terms of a parameter *T* if it grows as c^T, where *c* is any positive real number. (In class we used $c = 2$ for simplicity.)

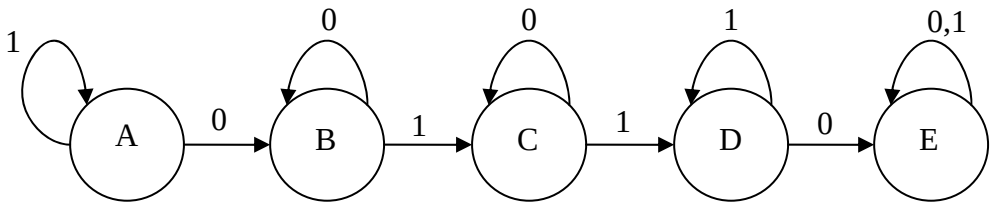
    a. "**Exponentially** less expensive than a 20-hour flight to the Bushveld of South Africa or the remote rain forests of Costa Rica, domestic safaris can be nearly as exciting – and far more accessible for families with kids."

    b. "But a small number of others, knowing that their chance of success with PGD is **exponentially** better, are becoming pioneers in the newest form of family planning."

    c. "The country desperately needs to upgrade its roads and seaports, and to **exponentially** increase agricultural and manufactured exports."

    d. "Injury rates [for cheerleaders] are '**exponentially** higher for a flier than for a footballer,' says NCCSI's Robert Cantu."

2. See the finite state machine diagram below. We will consider what happens when the machine is presented various strings of inputs. For example, if we say that the input string is *01*, this means that *0* is the input during the first time step, and then *1* during the second time step. We'll assume the machine always starts in state A. So, for input string *01*, the sequence of states visited by the machine is A, B, C.



    Describe the set of input strings that cause the machine to end up at state E. Use the "*" symbol to denote "zero or more inputs of either type (i.e. *0* or *1*)". For example, **11** describes the set of strings that begin with zero or more

inputs of either type, followed by two *1*'s, and then zero or more inputs of either type again (in other words, the input strings containing the substring *11*). Examples of input strings belonging to this set are: *11*, *011*, and *01110*.

(This way of using finite state machines is helpful for gene finding, as you learned in the lecture on bioinformatics.)

3. Do a web-search for "NP-complete" and describe in 2-3 lines one NP-complete problem that was not mentioned in class. (You have thousands to choose from!) Explain in a line or two why this problem is in NP – it is not enough to say that some website said so.

4. Briefly describe some everyday setting in which you use the notion of "reduction" in the sense it was used in class.

5. Decipher the following text, which has been encoded with a Caesar cipher (the one used by the captured Mafioso). Note: you need to figure out the "shift amount" on your own; do not assume it is the same as the examples given in lecture.

   RFHMNSJX YFPJ RJ GD XZWUWNXJ BNYM LWJFY KWJVZJSHD