**Discussion Week of 2/4: Finite Automata**

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1   DFA and NFA

Finite state automata (FSA) are abstract machines that feature states and guarded transitions from one state to another. An FSA can only be in one state a time, and its total number of states is *finite*. The machine takes transitions in response to inputs it receives sequentially; if an input matches the guard of a transition that departs from the current state that transition is said to be *enabled*; only enabled transitions can be taken. FSA that have an accepting state provide the machinery to determine whether an input string is in a regular language. If no transitions are enabled by a given input then the entire input string gets rejected. If all inputs are processed and the FSA is in an accepting state then the entire input string is accepted. Deterministic finite state automata (DFA) can only have one enabled transition at a time while a non-deterministic finite state automata (NFA) can have multiple.

1. What language is accepted by the following DFA?
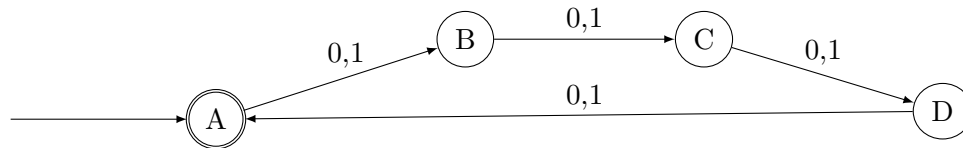
2. What language is accepted by the following NFA?
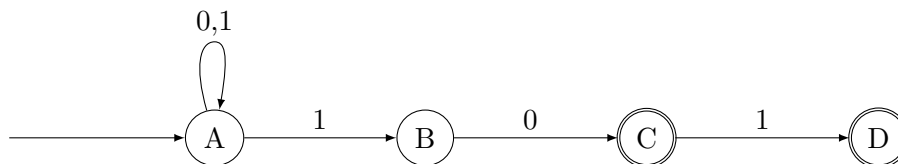
3. Construct a DFA that accepts binary strings of any length, except 3.

4. Construct a NFA that accepts:

    (a) The language denoted by x(zy?|(yz)*).

    (b) The language denoted by (10)*1*01*0.

5. Convert the NFA in Exercise 4b to a DFA.

2 Pumping Lemma

Pumping Lemma: For any DFA (or NFA or regular expression) that accepts an infinite number of strings, there is some minimum length, M, such that any string with length greater than or equal to M that the machine accepts must have the form uxv, where u, x, and v are strings, x is not empty, the length of ux is $\leq M$, and the machine accepts all strings of the form $ux^n v$, for all $n \geq 0$.

6. Let $A = \{1^j z | z \in \{0,1\}^*$ and z contains at most j 1's, for any $j \geq 1\}$. Prove, by the pumping lemma, that A is not regular.