CSE 311 Foundations of Computing I

Lecture 24

Finite State Machines

Autumn 2012

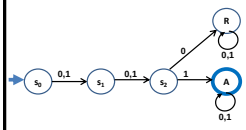
Announcements

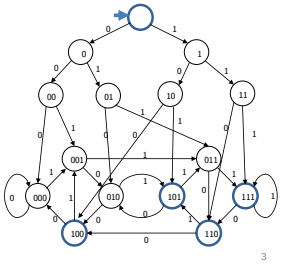
- Reading assignments
  - 7th Edition, Sections 13.3 and 13.4
  - 6th Edition, Section 12.3 and 12.4
  - 5th Edition, Section 11.3 and 11.4

Last lecture highlights

Finite state machines

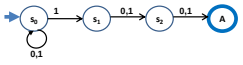
- States, transitions, start state, final states
- Languages recognized by FSMs





Non-determinism

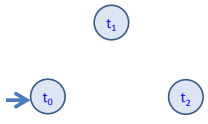
- A non-deterministic finite automaton (NFA) allows multiple outputs to have the same label
- A string s is accepted by a NFA if there is some path through the NFA with labels s that reaches an accepting state



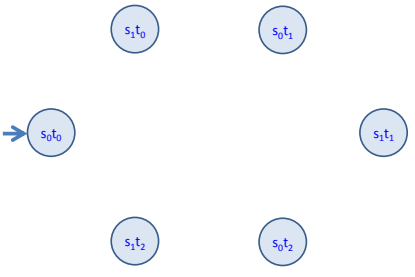
Strings over {0, 1, 2}*

M_1: Strings with an even number of 2's

M_2: Strings where the sum of digits mod 3 is 0



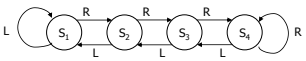
Recognize strings with an even number of 2's and a mod 3 sum of 0



State machines with output

	Input		Output
State	L	R	
S_1	S_1	S_2	Beep
S_2	S_1	S_3	
S_3	S_2	S_4	
S_4	S_3	S_4	Beep

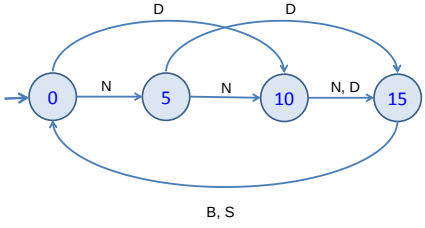
"Tug-of-war"



Vending Machine

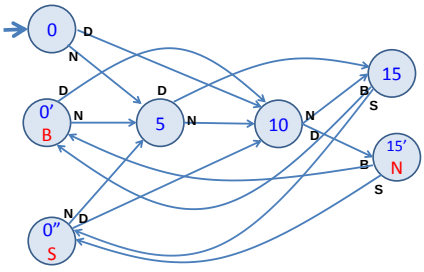
Enter 15 cents in dimes or nickels
Press S or B for a candy bar

Vending Machine, Version 1



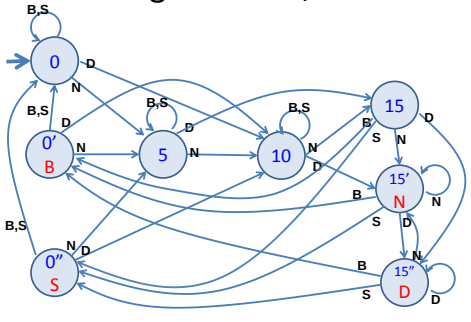
Basic transitions on N (nickel), D (dime), B (butterfinger), S (snickers)

Vending Machine, Version 2



Adding output to states: N – Nickel, S – Snickers, B – Butterfinger

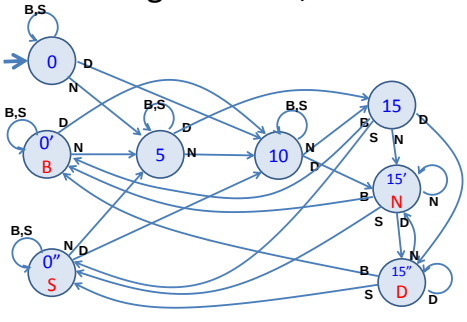
Vending Machine, Final Version



Adding additional "unexpected" transitions

Slide from Nov 21, 2011 Lecture

Vending Machine, Final Version

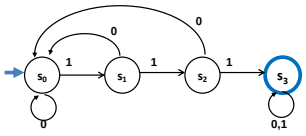


Find the bug!

Another way to look at DFAs

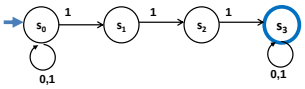
Definition: The label of a path in a DFA is the concatenation of all the labels on its edges in order

Lemma: x is in the language recognized by a DFA iff x labels a path from the start state to some final state



Nondeterministic Finite Automaton (NFA)

- Graph with start state, final states, edges labeled by symbols (like DFA) but
  - Not required to have exactly 1 edge out of each state labeled by each symbol - can have 0 or >1
  - Also can have edges labeled by empty string λ
- Definition: x is in the language recognized by an NFA iff x labels a path from the start state to some final state



Design an NFA to recognize the set of binary strings that contain 111 or have an even # of 1's

Three ways of thinking about NFAs

- Outside observer: Is there a path labeled by x from the start state to some final state?
- Perfect guesser: The NFA has input x and whenever there is a choice of what to do it magically guesses a good one (if one exists)
- Parallel exploration: The NFA computation runs all possible computations on x step-by-step at the same time in parallel