CSE 311 Foundations of Computing I

Lecture 21

Finite State Machines

Autumn 2011

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
- HW 8 is on-line

Last lecture highlights

Let R be a relation on a set A. There is a path of length n from a to b if and only if $(a,b) \in R^n$

Let R be a relation on a set A. The connectivity relation R* consists of the pairs (a,b) such that there is a path from a to b in R.

Transitive-Reflexive closure: Add the minimum possible number of edges to make the relation transitive and reflexive

The transitive-reflexive closure of a relation R is the connectivity relation R*

Finite state machines

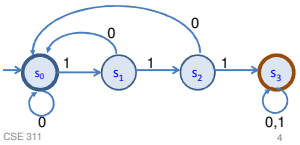
States

Transitions on inputs

Start state and final states

The language recognized by a machine is the set of strings that reach a final state

State	0	1
s_0	s_0	s_1
s_1	s_0	s_2
s_2	s_0	s_3
s_3	s_3	s_3



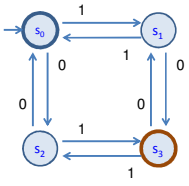
Applications of Finite State Machines (a.k.a. Finite Automata)

- Implementation of regular expression matching in programs like **`grep`**
- Control structures for sequential logic in digital circuits
- Algorithms for communication and cache-coherence protocols
  - Each agent runs its own FSM
- Design specifications for reactive systems
  - Components are communicating FSMs

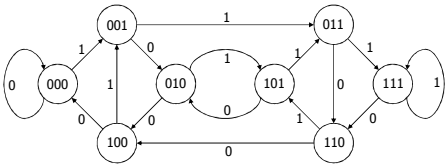
Applications of Finite State Machines (a.k.a. Finite Automata)

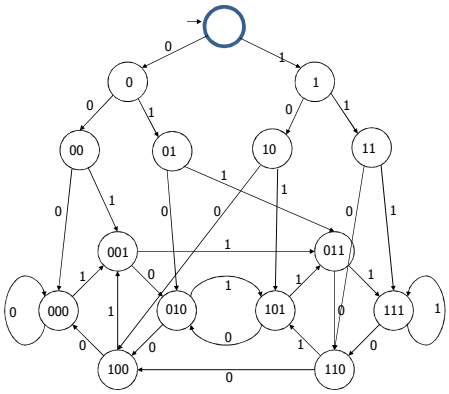
- Formal verification of systems
  - Is an unsafe state reachable?
- Computer games
  - FSMs provide worlds to explore
- Minimization algorithms for FSMs can be extended to more general models used in
  - Text prediction
  - Speech recognition

What language does this machine recognize?



3 Bit Shift register





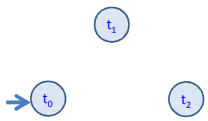
Design a DFA that accepts strings with a 1 three positions from the end

How does the size of a DFA to recognize "10th character is a 1" compare with the size of a DFA to recognize "10th character from the end is 1"?

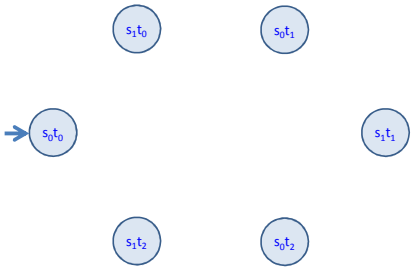
Strings over {0, 1, 2}*

M_1: Strings with an even number of 2's

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



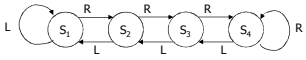
Recognize strings with an even number of 2's and a mod 3 sum of 0



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

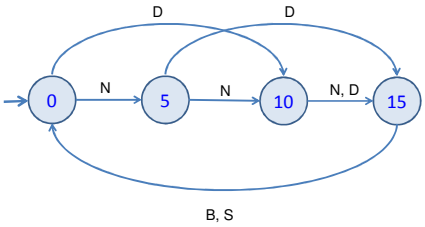
"Tug-of-war"



Vending Machine

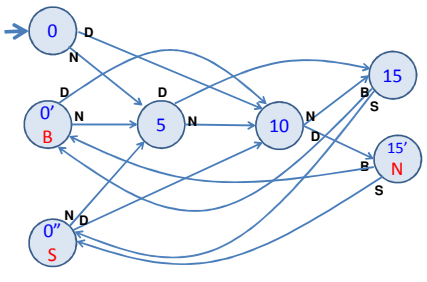
Enter 15 cents in dimes or nickels
Press S or B for a candy bar

Vending Machine, Version 1



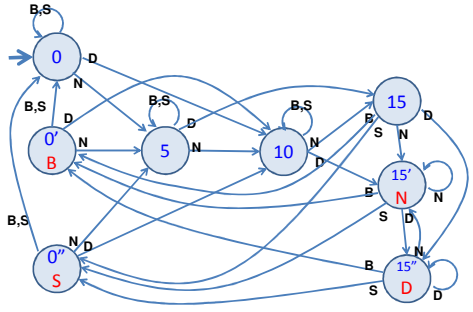
Basic transitions on N (nickel), D (dime), B (butterfinger), S (snickers)

Vending Machine, Version 2



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

Vending Machine, Final Version



Adding additional "unexpected" transitions