11.2 Finite State Automaton

1.1–1.2

11.2 Finite State Automaton

- **What is an FSA**
- Examples of FSAs
- Language recognized by FSA
- FSA Reduction
- Complement of an FSA

Introduction

Many kinds of machines, including components in computers, can be modeled using a structure

Several types of finite-state machines are commonly used in models.

- All these versions of finite-state machines include a finite set of states, with a designated starting state, an input alphabet, and a transition function that assigns a next state to every state and input

Applications. finite-state machines are the basis for programs for
- spell checking
- grammar checking
- indexing or searching large bodies of text
- recognizing speech
- Transforming text using markup languages such as XML and HTML
- network protocols that specify how computers communicate etc etc

Finite State Automata

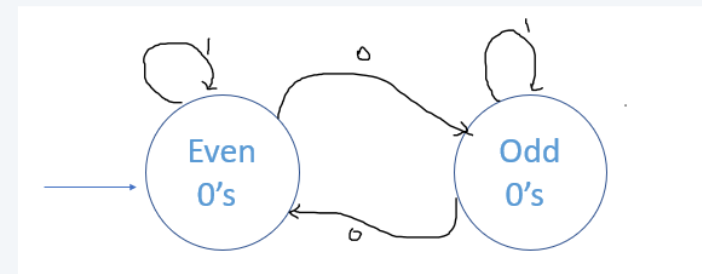A finite state machine (FSM) with no output is called a finite state automata (FSA)

FSA's can solve decision problems.

Finite State Machine (with output)
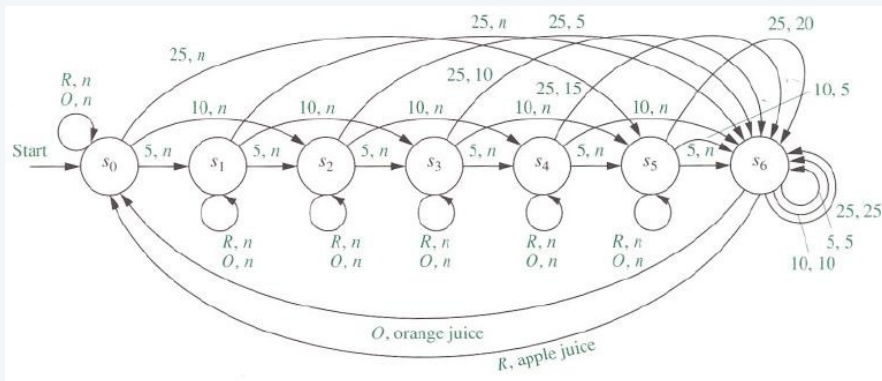
A simulated vending machine

Finite State Automata (decision based)

A machine that identifies patterns with properties

Definition

Finite State Automaton.

a machine M = (S, I, f, s0, F), where

  S is a set of states

  I is the input alphabet

  f is a transition function

  F is a set of final states

Example. Design an FSA that can recognize if a given string has even or odd number of 0's

  Challenge. cannot count

FSM for vending machine

Draw few states of this machine with transitions

TABLE 1 State Table for a Vending Machine.

	Next State					Output				
	Input					Input				
State	5	10	25	O	R	5	10	25	O	R
s_0	s_1	s_2	s_5	s_0	s_0	n	n	n	n	n
s_1	s_2	s_3	s_6	s_1	s_1	n	n	n	n	n
s_2	s_3	s_4	s_6	s_2	s_2	n	n	5	n	n
s_3	s_4	s_5	s_6	s_3	s_3	n	n	10	n	n
s_4	s_5	s_6	s_6	s_4	s_4	n	n	15	n	n
s_5	s_6	s_6	s_6	s_5	s_5	n	5	20	n	n
s_6	s_6	s_6	s_6	s_0	s_0	5	10	25	OJ	AJ

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Workshop

Design an FSA to determine if a given string has even number of 0's and odd number of 1's

Hint. S = {ee, eo, oe, oo} where e(ven), o(dd) and ee for example represent the state of even 0's and even 1's

workshop

Build an FSA that recognizes all numbers divisible by 2

workshop

Build a FSM that recognize strings of the form ab*a+ (where + means 1 or more, and * means zero or more)

String parsing

Given a very long string, build a machine that can recognize all strings of the form aabaa

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Definition

A string x is recognized by machine M = (S, I, f, s0, F) if the machine transition from initial state to a final state when given x as an input.

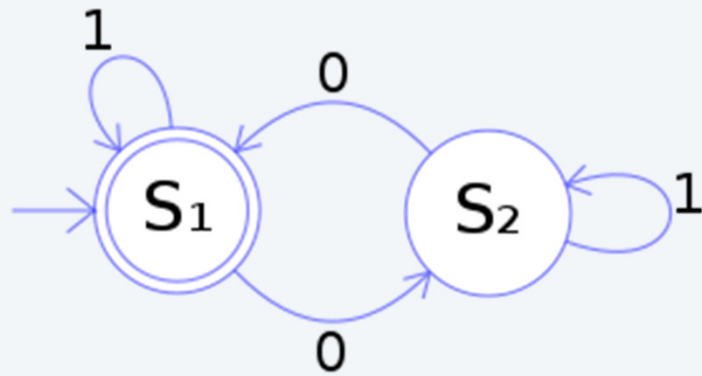There are many string x's that can be accepted by the machine M

The language L accepted by machine M is called

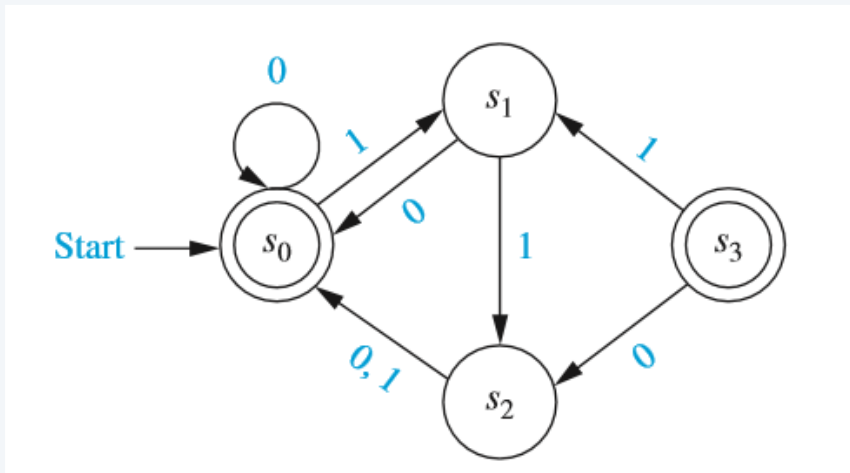L(M) ={set of all strings recognizable by the machine}

Workshop

What language is recognized by this machine?

Hint. write few strings recognized by this machine and find a general pattern
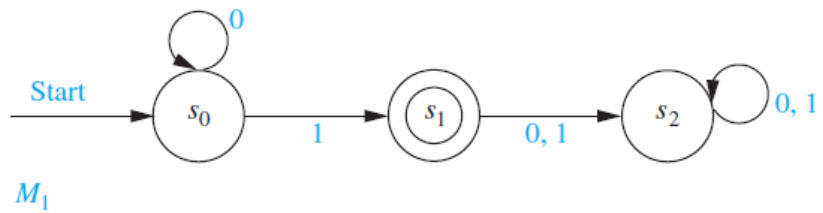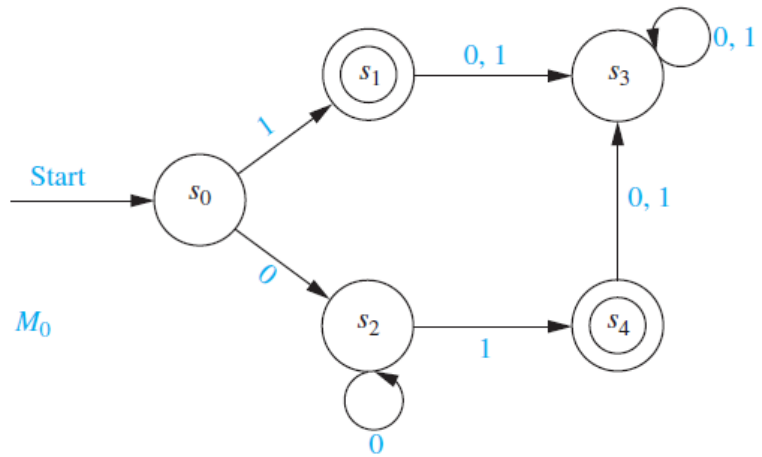
workshop

What is the language recognized by the following machines?

Write a few strings that is recognized by this machine and express them as general patterns
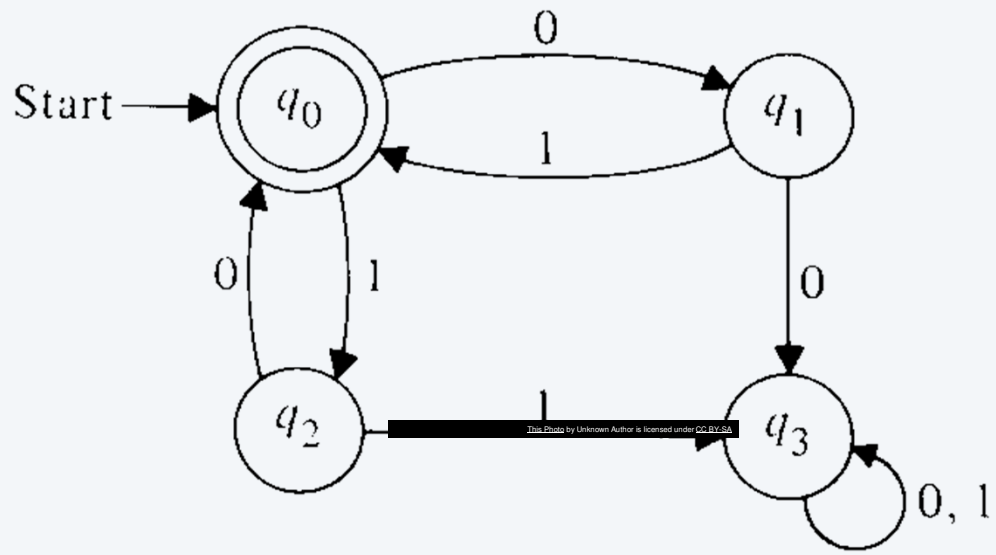
workshop

What strings are recognized by the following machines?

workshop

What language is recognized by the following machine?

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FSA Reduction

What is the minimum number of states to solve a specific problem by an FSA?

Question. Given an FSA, is it possible to reduce the FSA to an equivalent one with fewer states?

Answer: Yes, if two states have the same transition states, then they can be combined to form one state. For example if states A and C have the same outcome (say, they both go to B) for all symbols in the alphabet, then A and C can be combined to one state, say AC.

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The complement of a FSA

Suppose a given DFA accepts a language L. Then the **complement** of the FSA accepts all Strings in V* - L

How to create a complement of a language L.

    Build a machine that accept the language

    Switch accept states and start state

Exercise: Design an FSA that only accepts strings that do not end with two 0's

workshop

Design the following FSA's

- • FSA to accept all strings that begins with any number of 0's followed by 1

- • FSA to accept any string that contains two consecutive one's

- • FSA to accept strings that do not contain two consecutive zeros

- • FSA to accept strings that contains at least even number of zeros and odd number of 1's

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