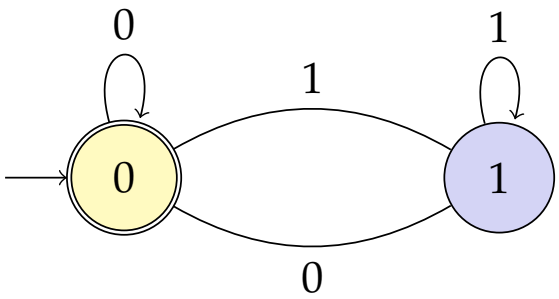
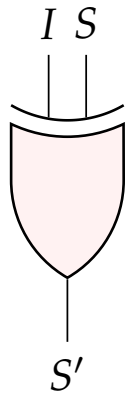
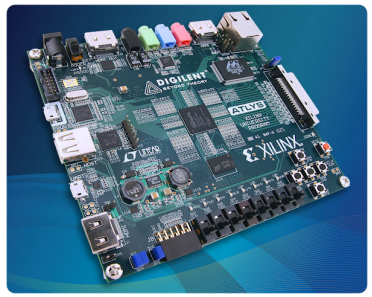
CS 226: Digital Logic Design

Lecture 1: An Introduction

Ashutosh Trivedi







Department of Computer Science and **Engineering**,
Indian Institute of Technology Bombay.

Logistics

- Instructor:
  - Ashutosh Trivedi (trivedi@cse)
- Friendly TAs:
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  - Divyan Bansal (Divyambansal93@gmail)
  - Nishit Bhandari (nishitb@cse)
  - Mohit Gupta (mohit12071994@gmail)
  - Nilesh Kulkarni (nileshsatishkulkarni@gmail)
  - Srikanti Praneeth (svpraneethnaidu@cse)
  - Devdeep Ujjal Ray (devdeep@cse)
  - Darsh Shah (darshs@cse)

Logistics: Contd.

- Course Web-page:
  `http://www.cse.iitb.ac.in/~trivedi/courses/cs226.html`
- Piazza:
  `https://piazza.com/iitb.ac.in/autumn2015/cs226/home`
- Lectures:
  - Tuesday (6:35 pm — 8:00 pm)
  - Friday (6:35 pm — 8:00 pm)
- Labs:
  - TBA Wednesday/Thursday (2:00 pm — 5:00 pm)
- Office hours:
  - Friday (2:00am–3:00am)
- Venue
  - Lectures: SMA 206 (Class Room IC 4)
  - Labs: TBA
  - Office hours: SIA 108, 1st floor, 'A' Block, KReSIT building

Logistics: Contd.

Textbook:

- *M. Morris Mano and Michael Ciletti*. Digital Design. Low priced paperback edition published by Pearson Education.
- *Stephen Brown and Zvonko Vranesic*. Digital Logic with VHDL Design. McGraw Hill Education. Indian Edition.
- *Douglas L. Perry*. VHDL: Programming by Example. McGraw-Hill.

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Grading:

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- Surprise Quizzes + Class Participation: 20%

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- Zero tolerance (FR/DAC) for dishonest means like copying solutions from others and cheating.

Digital Logic Design: Motivation

Discussion

- Computer Science and Engineering — Difference?
- Digital Logic Design — what does it mean?
- What do you think this course is about?
- What really are computers? and how to they work?

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Definition of a Computer

An electronic device which is capable of

1. receiving information (data) in a particular form and
2. of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program)
3. to produce a result in the form of information or signals.

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What is the most simple model of general computer (computation)?

CS Definition: Computers are Automata!

What is an Automaton?

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Dictionary Definition of an Automaton

noun (plural automata)

1. A moving mechanical device made in imitation of a human being.
2. A machine that performs a function according to a predetermined set of coded instructions.

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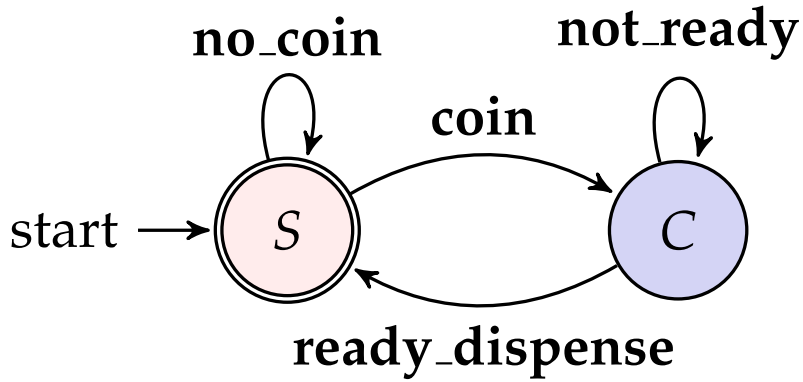
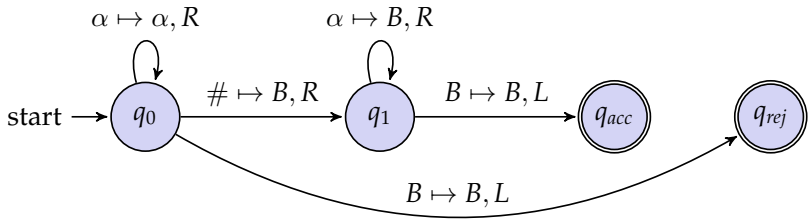
Introduction

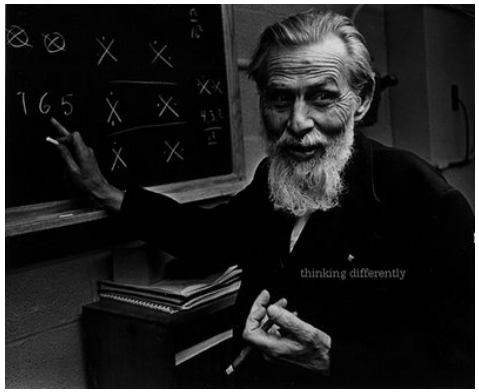
Finite instruction machine with finite memory (Finite State Automata)

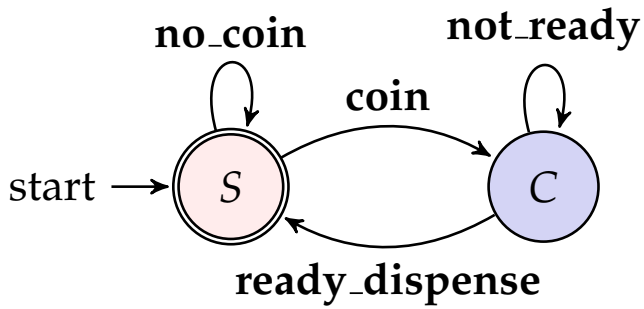


Finite instruction machine with unbounded memory (Turing machine)



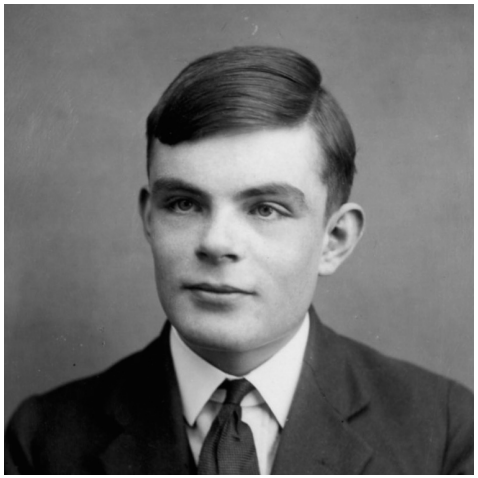
Finite State Automata

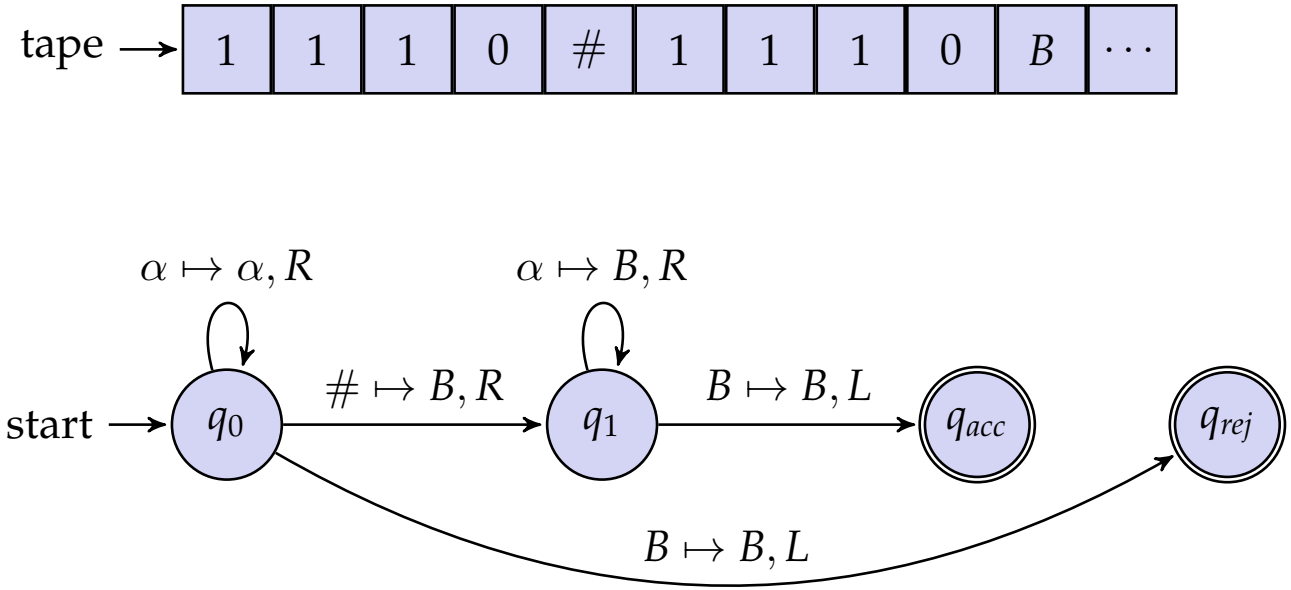




- Introduced first by two neuro-psychologists Warren S. McCullough and Walter Pitts in 1943 as a model for human brain!
- Finite automata can naturally model microprocessors and even software programs working on variables with bounded domain
- Capture so-called regular sets of sequences that occur in many different fields (logic, algebra, regEx)
- Nice theoretical properties
- Applications in digital circuit/protocol verification, compilers, pattern recognition, etc.

Turing Machine





- Introduced by Alan Turing as a simple model capable of expressing any imaginable computation
- Turing machines are widely accepted as a synonyms for algorithmic computability (Church-Turing thesis)
- Using these conceptual machines Turing showed that first-order logic validity problem [1] is non-computable.
- I.e. there exists some problems for which you can never write a program no matter how hard you try!

[1] (Entscheidungsproblem—one of the most famous problem of 20th century posed by David Hilbert)

Videos

- Turing Machine: Turing Machine by Mike Davey
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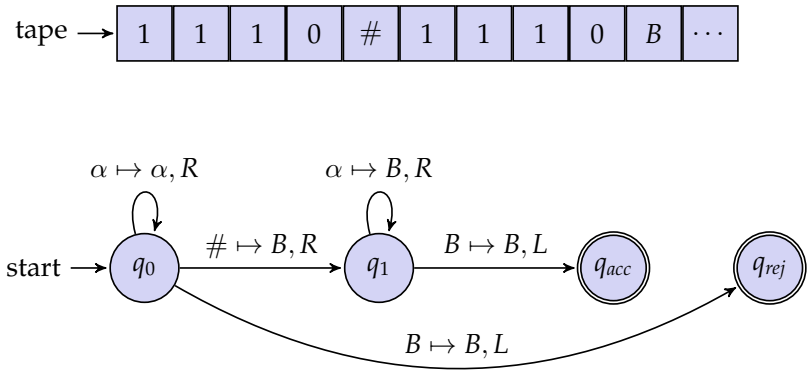
Blocks needed to design a digital computer



Ingredients:

1. A way to distinguish between 0's and 1's (called Binary digits)
2. A way to store information (Memory)
3. A way to encode Finite state instructions (Boolean functions)

Videos

- Vacuum Tubes (Diode) by Westinghouse Electric Corporation.
- ENIAC — the first computer made using Vacuum tubes
- Transistors by Veritasium.
- Semi-conductors Turing Machine
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