

CSE 105—Theory of Computability

Lecture 12—May 11, 2006
Turing Machines

Instructor: Neil Rhodes

Turing Machine

Has a one-way infinite tape

- Input is written on the tape, with blanks afterward

Has a current location on the tape (head)

Has a state-machine

- Based on the symbol under the head:
 - Writes a new symbol
 - Moves left-or-right
- Has two final states
 - Accept
 - Reject

Can't go off the left-hand-side of the tape

Example Turing Machine

$$L = \{0^n 1^n \mid n \geq 0\}$$

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Example Turing Machine

$$L = \{0^n 1^n 2^n \mid n \geq 0\}$$

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Church-Turing Thesis

Turing thesis

- Turing machines can do anything that could be described as “purely mechanical” or “rule of thumb”
- Mechanical algorithm
 - Finite set of simple, precise instructions
 - Always produces the result in a finite number of steps
 - Can in principle be carried out by a human with pencil and paper
 - Requires no intelligence of the human being (just follow instructions)

Church thesis

- Similar to Turing thesis, but regarding calculating on positive integers using the λ -calculus

Two models are the same

Extended thesis

- A Turing machine can simulate any model of computation

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Different models of Turing machine

Equivalent power:

- Head can stay in one place
- Two-way infinite tape
- Multiple tapes
- Non-determinism

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Example Turing Machine

$L = \{x+y=z \mid x, y, z \in \{0,1\}^*, z \text{ is binary representation of sum of binary representations of } x \text{ and } y\}$