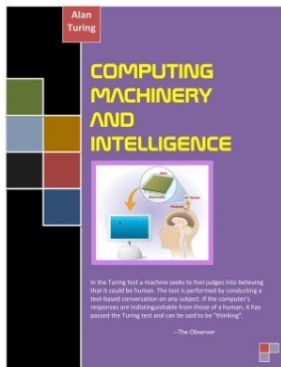


Turing Test II

Wednesday, November 5

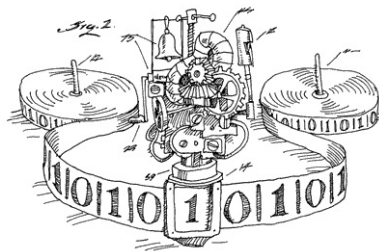
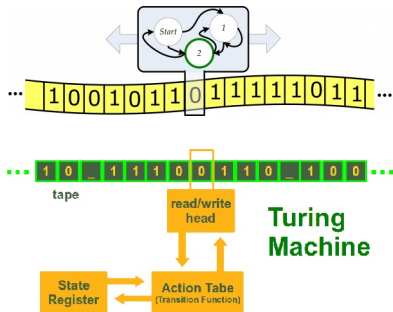


Handouts:

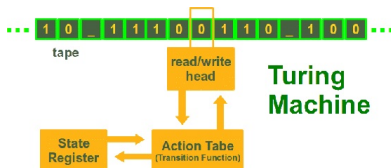
Assignment 22
Term Paper Topics

COMING ATTRACTIONS

Assignment 22: Turing Machine "Doubler"



What Exactly is a Turing Machine?



$$T = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$$

Where :

Q = Set of states

Σ = Input alphabet

Γ = Tape alphabet ($\Sigma \subseteq \Gamma$)

δ = Transition function

$\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$

q_0 = Start state

B = Blank symbol

F = Set of accepting states ($F \subseteq Q$)

Turing Machine Definition

1. a finite input **alphabet** Σ (used to create strings to be processed)
2. a finite **tape alphabet** Γ that contains Σ as well as a special blank symbol $\#$ (or $\square$ or $\clubsuit$) in Γ but not in Σ
3. a finite set of **states** Q
4. an **infinite tape** with cells (infinite to the left and right and indexed as ... $\#, \#, -3, -2, -1, 0, 1, 2, 3, \#, \# \dots$)
5. a **tape head** that can move left (**L**) or right (**R**) over the tape, reading and writing symbols onto tape cells as it proceeds
6. a special **start state** q_0
7. a special **accept (or yes) state** q_{yes} (or q_{acc})
8. a special **reject (or no) state** q_{no} (or q_{rej}) with $q_{acc} \neq q_{rej}$
9. a special **transition function** $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$ that describes how the **TM** operates on a specific input string.

Some Comments

- ▶ Everything is finite except for the tape.
- ▶ We shall view the special accept and reject states as final in the sense that once the TM enters one of these "halting" states the machine stops.
- ▶ We shall assume the tape cells are indexed by the integers . . .
. #, #, -3, -2, -1, 0, 1, 2, 3, 4, #, #, . . .
- ▶ And that each of the cells contains the special blank symbol just before we place any input string onto the tape.
- ▶ We will always place an input string to be "processed" onto the tape with its left end at cell 0.

So, for example, if the input string is *abcd* the contents of the tape will be

$$\{\dots\#, \#, \#, a, b, c, d, \#, \#, \dots\}$$

(with *a* at cell 0).

Note that, given this assumption, we are guaranteed to have a blank symbol at each end of the input string.

More Comments

- ▶ The TM machine's tape head always starts at cell 0.
- ▶ The TM machine always starts in state q_0 .
- ▶ This is often called the **start configuration**.
- ▶ It is the transition function $\delta()$ that determines the *action* of a specific TM.

How do you read $\delta(q, a) = (q', b, L)$

given the definition $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$?

Answer: when in state q scanning symbol a on the tape, write b over the tape cell, move the head left by one cell, and enter state q' .

How it Works

A Turing machine begins in its start state with its tape head at cell 0 scanning the leftmost symbol in the string. At each step, it reads the symbol under its head, and, depending on that symbol and its current state, it

- ▶ writes a new symbol on that cell (possibly the same),
- ▶ moves its head either left or right one cell, and
- ▶ enters a (possibly) new state.

The action is determined by the **transition function**

$\delta(q, a) = (q', b, L)$ given as part of the description for the machine.

A TM **accepts** its input (saying **yes**) by entering the accept state and **rejects** its input (saying **no**) by entering the reject state.

Friday



David Leavitt

Preview of Coming Attractions

- ▶ Week of November 11:
Team Presentations on Responses to *Mind* Paper
- ▶ Monday Evening, November 17: Exam 2
- ▶ Friday, November 20:
Team Written Reports

Monday November 10

1950–1959	Allegra Alfaro	Edie Huffard
1960–1969	Emma Borden	Skylar Knoop
1970–1979	Adelle Davies	Amy Li

Wednesday November 12

1980–1989	Jake Forrest	Paul Marzella
1990–1999	Alexandra Gannon	Devin Merker
2000–2009	Abrahm Geissinger	Cassius Reed

Friday November 14

2010–2019	Annie Gilliam	Niovi Singh
2020–2025	Sarah Hall	Alexis Zhai