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The basic model for Turing machines (TM)

Chapter 4: Turing machines

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Turing Machine

- A Turing Machine is an accepting device which accepts the languages (recursively enumerable set) generated by type 0 grammars. It was invented in 1936 by Alan Turing.
- Turing Machines (TM) play a crucial role in the Theory of Computation (TOC). They are abstract computational devices used to explore the limits of what can be computed.
- Turing Machines help prove that certain languages and problems have no algorithmic solution.
- A Turing Machine (TM) is a mathematical model which consists of an infinite length tape divided into cells on which input is given.
- It consists of a head which reads the input tape. A state register stores the state of the Turing machine..

Turing Machine

- After reading an input symbol, it is replaced with another symbol, its internal state is changed, and it moves from one cell to the right or left.
- If the TM reaches the final state, the input string is accepted, otherwise rejected.
- In the context of automata theory and the theory of computation, Turing machines are used to study the properties of algorithms and to determine what problems can and cannot be solved by computers.
- They provide a way to model the behavior of algorithms and to analyze their computational complexity, which is the amount of time and memory they require to solve a problem.
- A TM can be formally described as a 7-tuple (Q, X, ∑, δ, q0, B, F)

Definition of a Turing Machine

A TM can be formally described as a 7-tuple (Q, X, ∑, δ, q_0, B, F) where –

- Q is a finite set of states
- X is the tape alphabet
- **∑** is the input alphabet
- **δ** is a transition function; δ : Q × X → Q × X × {Left_shift, Right_shift}.
- q_0 is the initial state
- B is the blank symbol
- F is the set of final states

Tape and Head

- The tape is infinite in one or both directions
- The head moves left (L) or right (R)
- Can read, write, and move

TM vs Finite Automata

Feature	Finite Automaton	Turing Machine
Memory	Finite	Infinite Tape
Rewrite Tape	No	Yes
Move Head	Right only	Left & Right
Recognizes	Regular Langs	RE Languages

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