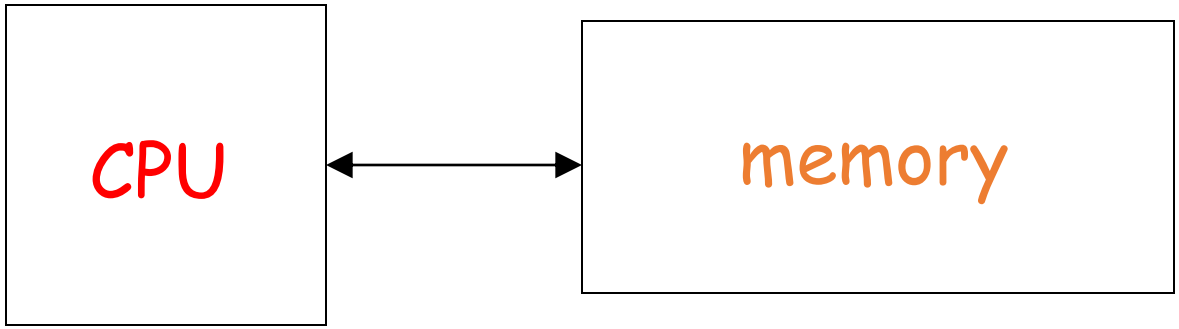
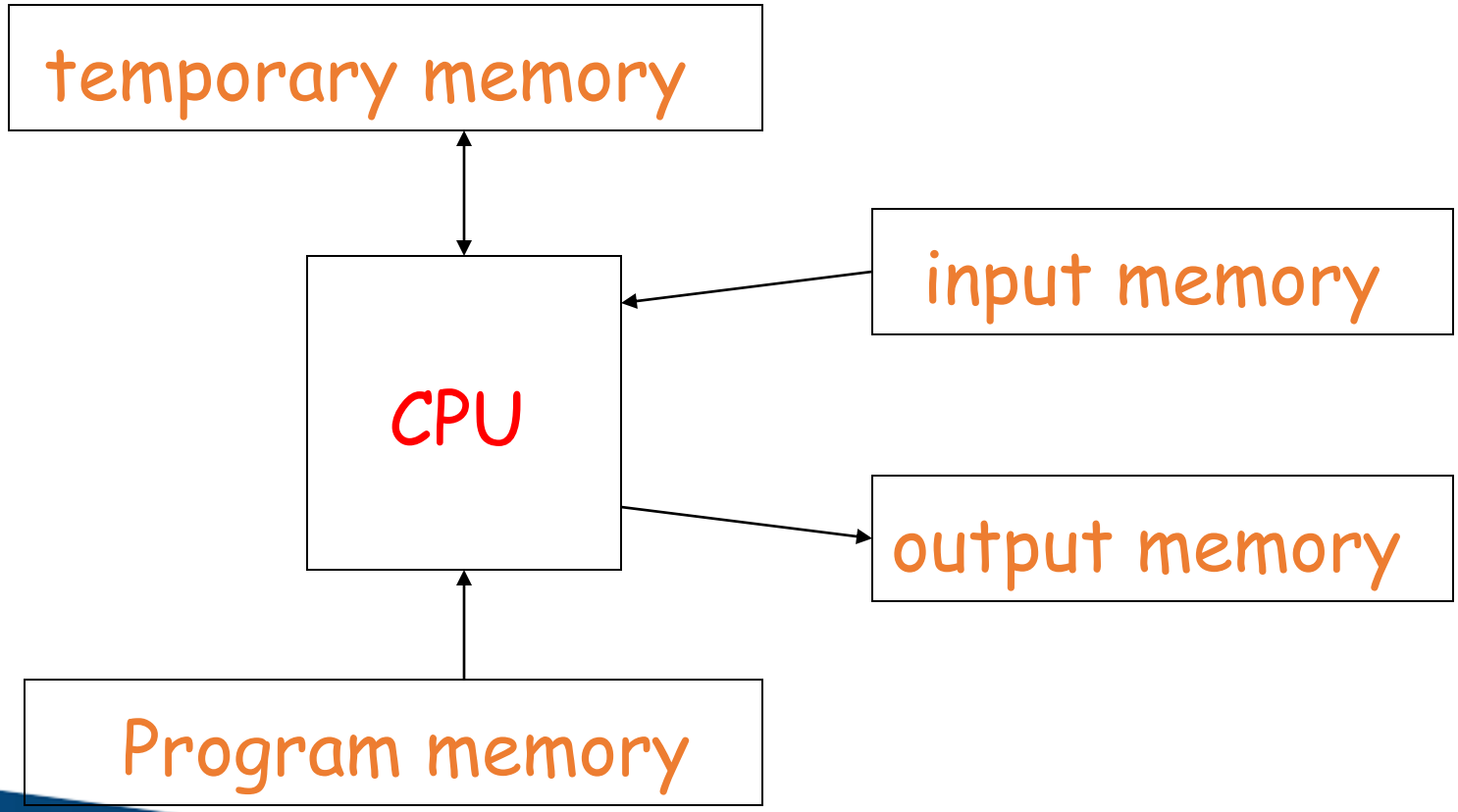
# Module-1

# Introduction to Automata Theory

# Models of Computation

# Computation




temporary memory
CPU
input memory
output memory
Program memory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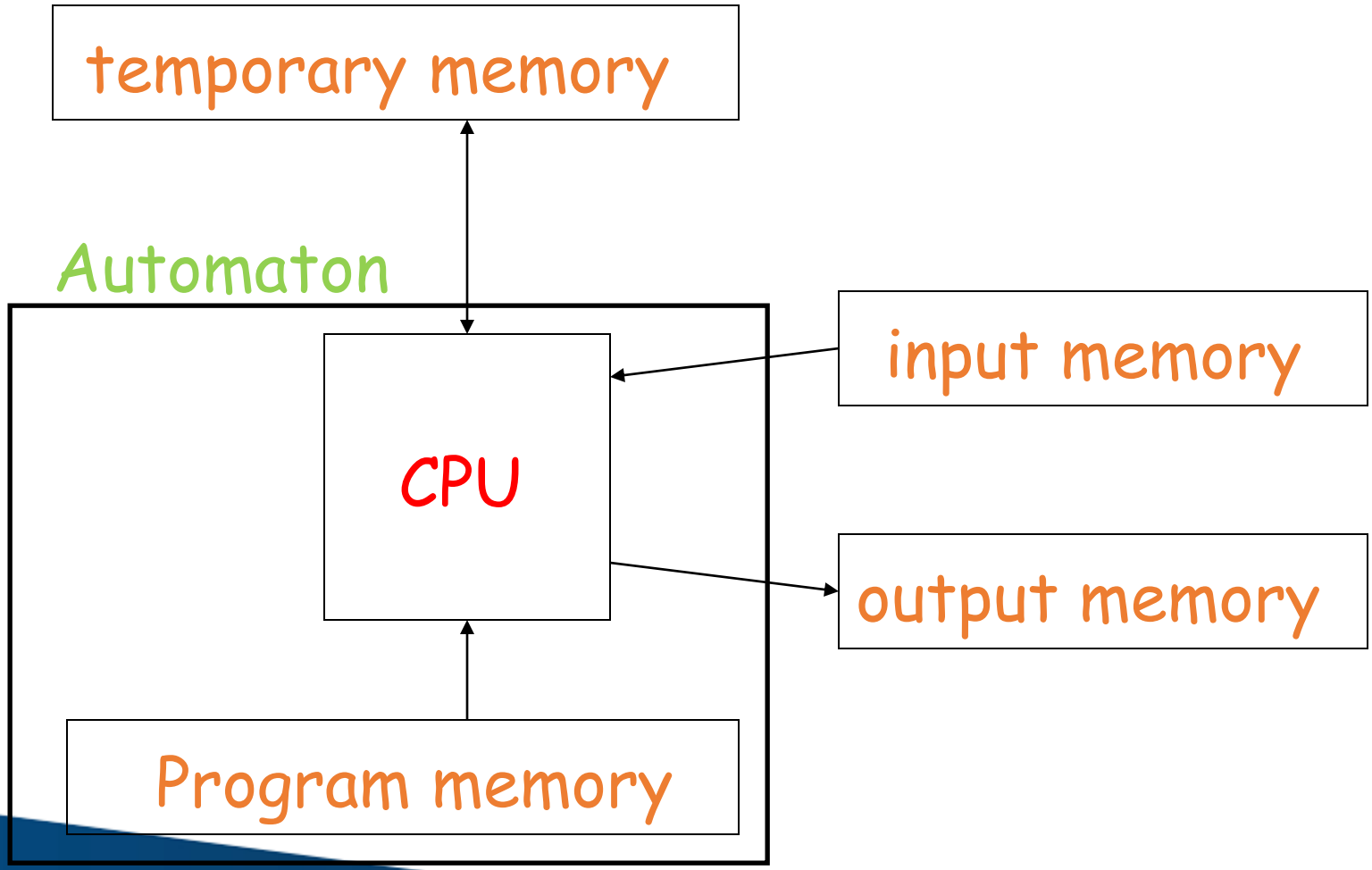
**Automata theory** is the study of abstract machines and automata.

The computational problems can be solved using them.

It is a theory in theoretical computer science and discrete mathematics

# Automaton

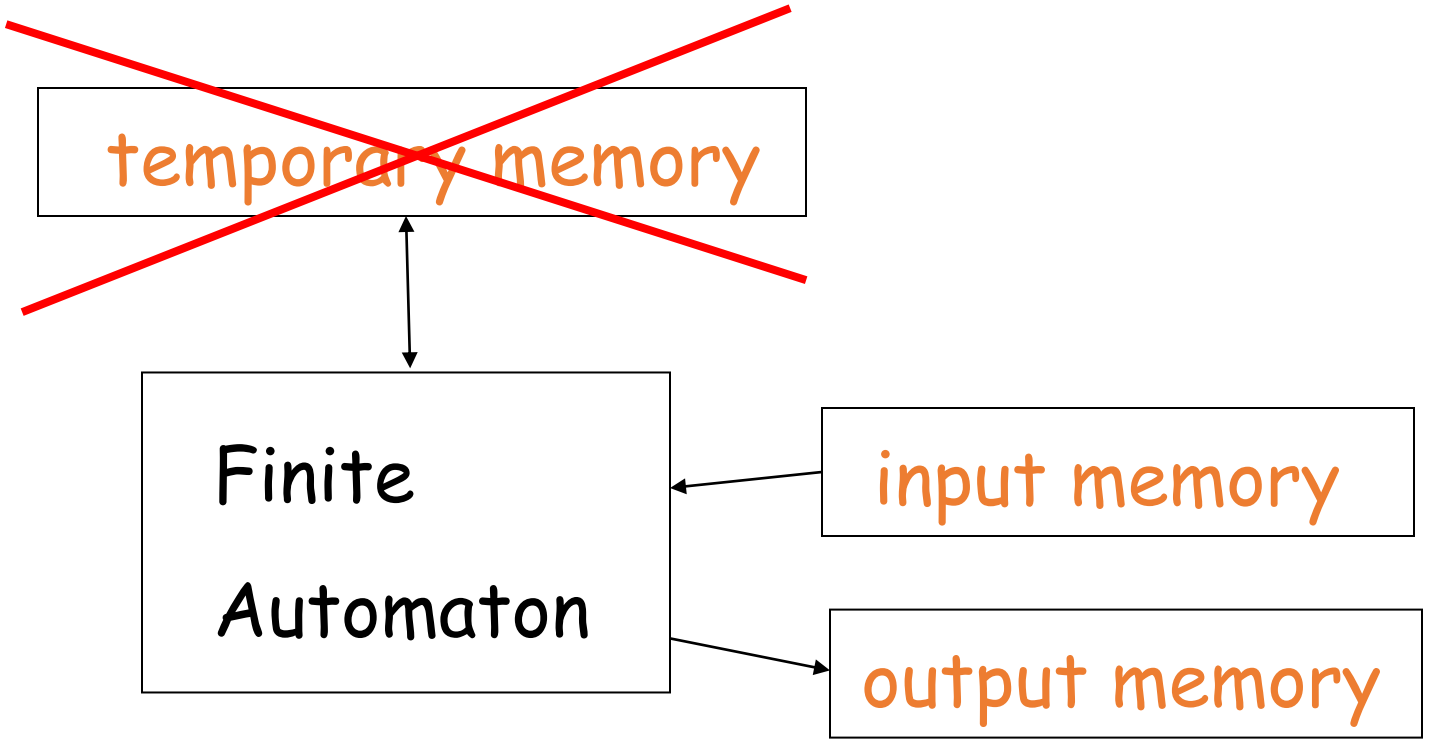

temporary memory
Automaton
CPU
input memory
output memory
Program memory

# Different Kinds of Automata

Automata are distinguished by the temporary memory

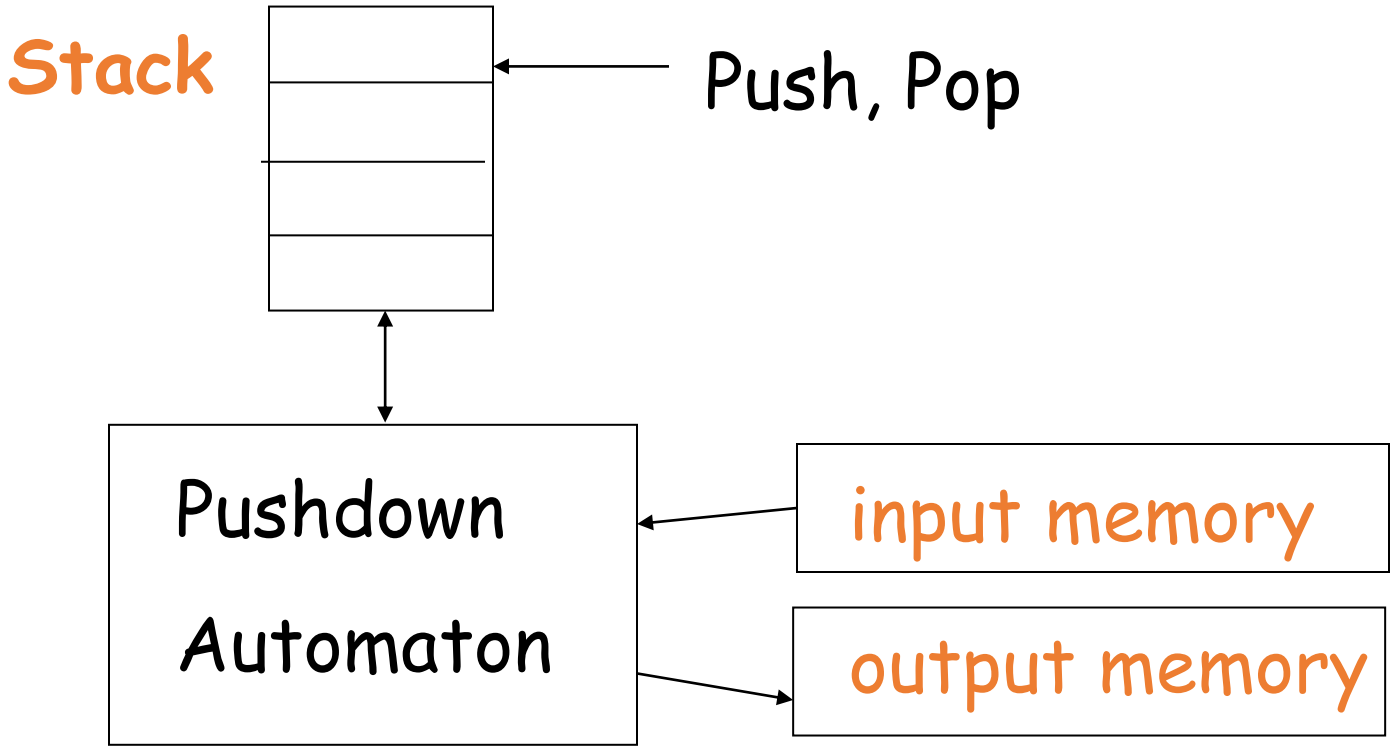
- **Finite Automata:** no temporary memory
- **Pushdown Automata:** stack
- **Turing Machines:** random access memory

# Finite Automaton



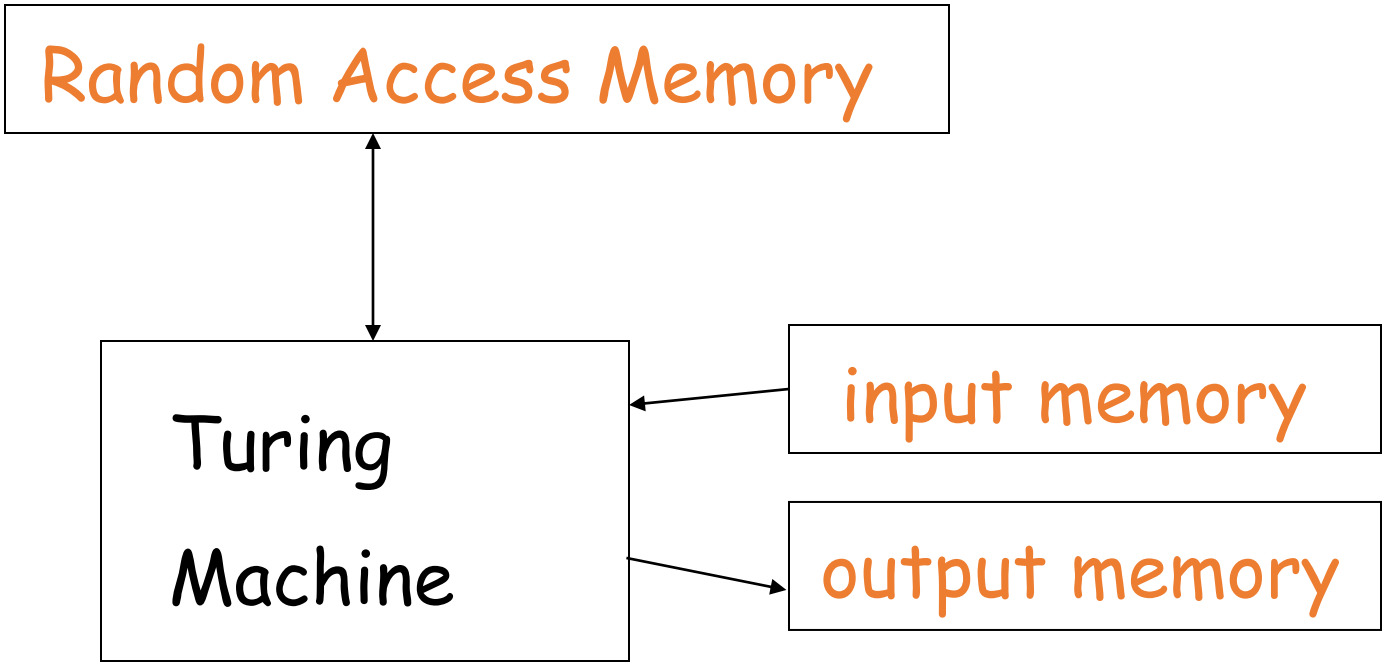

Example: Vending Machines (small computing power)

# Pushdown Automaton



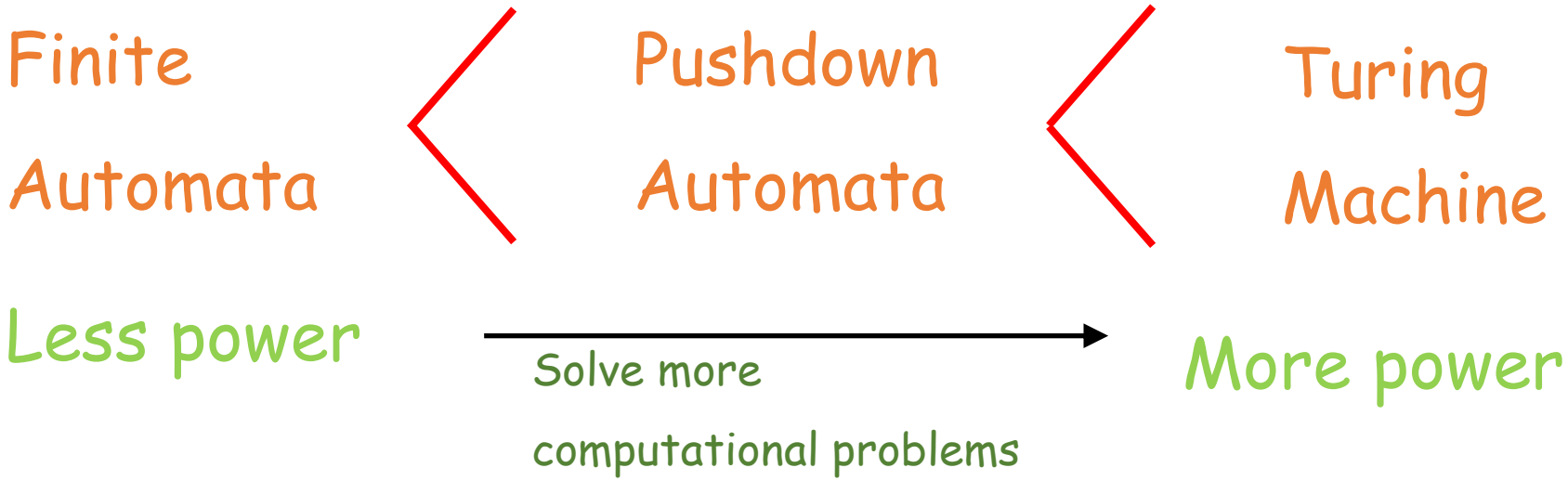

Example: Compilers for Programming Languages (medium computing power)

# Turing Machine




Examples: Any Algorithm (highest computing power)

# Power of Automata



# Applications of finite automata

- For the designing of lexical analysis of a compiler which breaks the input text into logical units like identifiers, keywords etc.
- For recognizing the pattern using regular expressions.
- For the designing of the combination and sequential circuits.
- Software for designing and checking the behavior of digital circuits.
- Used in text editors.
- For the implementation of spell checkers.
- Software for scanning large bodies of text like web pages to find occurrence of words, phrases and other patterns.
- Software to verify all types that have finite number of distinct states such as communications protocols for secure exchange of information.

# Applications of Push Down Automata

- For designing the parsing phase of a compiler (Syntax Analysis).
- For implementation of stack applications.
- For evaluating the arithmetic expressions.
- For solving the Tower of Hanoi Problem.

# Applications of Turing machine

- For solving any recursively enumerable problem.
- For understanding complexity theory.
- For implementation of neural networks.
- For implementation of Robotics Applications.
- For implementation of artificial intelligence.

# Basic Definitions

Three fundamental concepts used in Automata theory are:

- Languages
- Grammars
- Automata

# Languages

- A Finite, non empty set $\Sigma$ of symbols, is called the alphabet.
- From the individual symbols, strings can be constructed which are finite sequences of symbols from the alphabet.
- Thus, a language L is defined as a subset of $\Sigma^*$.
- A string in a language L is called as a sentence of L.

# Example:

- Language for the string in the set

{a, aa, aab}

L = $\{a^n b^n : n \geq 0\}$

- The reverse of a language is the set of all string reversals is:

$L^R = \{w^R : w \in L\}$

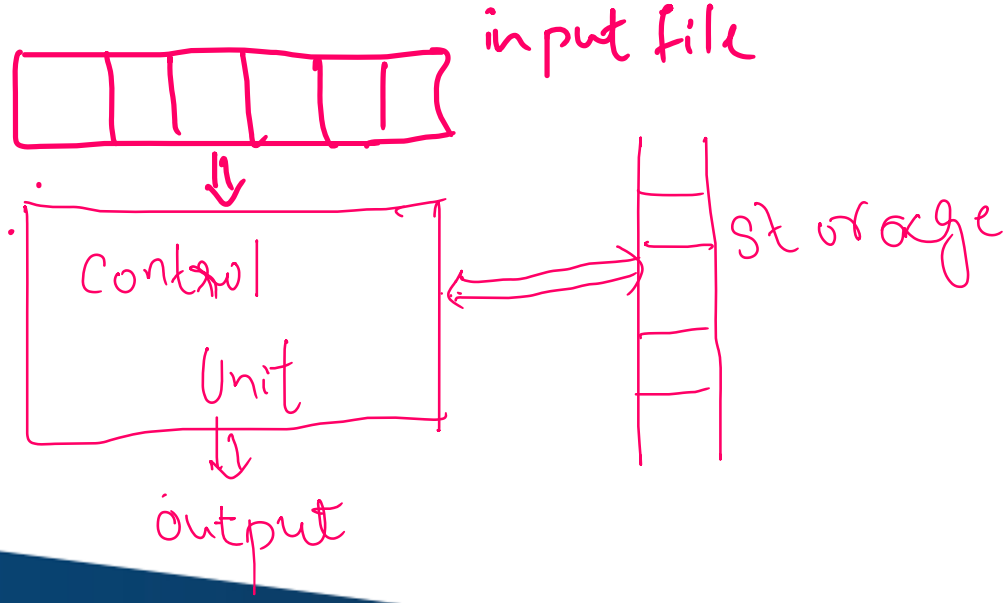
# Grammars

- A grammar G is defined as a quadruple that consists of finite set of variables, terminal symbols, start variable and finite set of productions.

- Example: S→ aAb | λ

# Automata

- An automata is an abstract model of a digital computer and has the mechanism for reading input. It also has input as a string over a given alphabet written in an input file.



# General Concepts of Automata Theory

- Symbol
- Alphabet
- Strings
- Empty Strings
- Length of the string
- Power of an Alphabet
- Concatenation of two strings
- Languages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