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BSCS – 3

**Turing Machine: Structure and Function**

**Introduction**

What is a Turing machine? Turing machine is a concept that serves as model for a CPU like machine that controls all of the data. Turing machine is our base structure for modern application and system that we use. It can process finite data that is getting input into it. It solves problem mathematically like a real machine that uses ones and zeros. Given enough memory that it can use, it will solve some problems that a computer usually solves like mathematical equations. Turing machine is much superior compared to its other similar concept such as finite automata and pushdown automata

Turing machine solves the problems by calculating a strip that has command on it in a form of ones and zeroes, just like modern machines today, it relies on reading weather the information is ones and zeroes and then analyze it or decodes it, those ones and zeroes has a value to them that will convert to either a letter or a command, depends on the data on the strips in which it reads. The Turing machine uses a head that reads those symbols or commands until it’s unsolvable or unreadable, until then it will scan the whole strip that is given to it.

As a result, Turing machine is used in almost every computer related solving machine, without Turing machine, modern applications such as compilers or even a modern computer itself will have a hard time or have a much slower computing power, Turing machine became the standard and has been improved in modern days as the computing power in modern days are required to be much better and faster due to high demand in data computing.

**Method**

Turing Machine and the Conceptual Problems of Computational Theory by: Edward E. Ogheneovo compared other computing machine such as Finite Automata (FA), non-deterministic finite automata (NDFA), deterministic finite automata (DFA), non-deterministic finite automata with –transition, pushdown automata (PDA), and deterministic pushdown automata (DPDA) to Turing machine.

**Finite Automata** (FA) is the simplest machine to recognize patterns. It is used to characterize a Regular Language, for example: /baa+!/. Also, it is used to analyze and recognize Natural language Expressions. The finite automata or finite state machine is an abstract machine that has five elements or tuples. It has a set of states and rules for moving from one state to another but it depends upon the applied input symbol.

In Non-Deterministic Finite Automata **(NDFA)**, for a particular input symbol, the machine can move to any combination of the states in the machine. In other words, the exact state to which the machine moves cannot be determined. Hence, it is called Non-deterministic Automaton.

In A **Deterministic Finite Automato**n (DFA) is a mathematical model that is used to recognize patterns in strings of symbols123. A DFA has a finite number of states and a transition function that maps each state and symbol to a next state

**Pushdown Automata** (PDA) is a finite automata with extra memory called stack which helps Pushdown automata to recognize Context Free Languages.

A **Turing machine** is a finite automaton that can read, write, and erase symbols on an infinitely long tape. The tape is divided into squares, and each square contains a symbol. The Turing machine can only read one symbol at a time, and it uses a set of rules (the transition function) to determine its next action based on the current state and the symbol it is reading.

**Results**

As a result, the Turing machine is the most accurate model for personal computers. A Turing machine is capable of solving every problem that a real computer can do. There are also some problems which cannot be solved by Turing machines because these problems are beyond the theoretical limits of computation. Turing machine became the standard and model for modern computers but in comparison to modern computers, Turing machines are quite primitive and limited.

Following are some key differences between Turing machines and modern computers as follows: -

1. Memory: Turing machines have a very limited memory compared to modern computers. They are based on a tape that can only store a single bit of information at each position. Modern computers, on the other hand, have vast amounts of memory including both RAM and hard drives.
2. Processing speed: Turing machines are very slow in comparison to modern computers. They operate sequentially one step at a time whereas modern computers can perform many operations simultaneously.
3. Complexity: Turing machines are very simple machines that can only perform very basic computations. Modern computers, however, are much more complex and capable of performing a wide range of operations and computations.
4. Input/Output: Turing machines only have the capability to read and write to their tape whereas modern computers have a wide range of input/output devices including keyboards, mouse, displays and more.
5. Programmability: Turing machines are not programmable in the same sense that modern computers are. They are designed to perform specific computations and cannot be programmed to perform new tasks. Modern computers, on the other hand, are highly programmable and can be used to perform a wide range of tasks through software.

Despite these differences, Turing machines remain an important part of the history of computer science and continue to be studied and discussed today.

**References:**

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