

Turing Machines

Entscheidungsproblem

- Was a question of decidability posed by the German mathematician, David Hilbert, in 1928.
- He asked if in principle, there is any definite mechanical method or process by which all mathematical questions would be decided?

Alan Turing

- In 1936, Alan Turing, a British mathematician, published a paper called "On Computable Numbers with an Application to the Entscheidungsproblem."
- The paper introduced the concept of the Turing Machine which has become the foundation of the modern theory of computation and computability.

Turing Machine

- Turing showed that what we generally mean by computation could be satisfied by a machine that consisted of a **tape** of unlimited length with little square cells, and a device with a finite number of states that could read symbols from the tape.
- Based on that symbol and current state, it could write another symbol over the current symbol and change the current state.

The Tape

- The tape is unlimited in length.
- It is one dimensional and divided into a sequence of squares.
- Each square is capable of holding any symbol, or a blank
- Though infinite in length, the Turing Machine tape contains a finite number of non-blank square.

The Tape

- All remaining squares are assumed to be blanks.
- Obviously, the number of non-blank squares can change during the execution of a program.
- The tape is basically used for recording input and output.

Read-write head

- Is a device that at any instant is scanning a single square of the tape and obeying one of the program's instructions in a single step.
- It has a finite number of states.
- It can read symbols from the tape, and based on that symbol and current state it would write another symbol over the current symbol, change the current state, and move left or right on the tape.

Read-write head

- Initially, the first symbol that serves as input to a program is recorded in the leftmost tape square, and initially, the read-write head is positioned there.

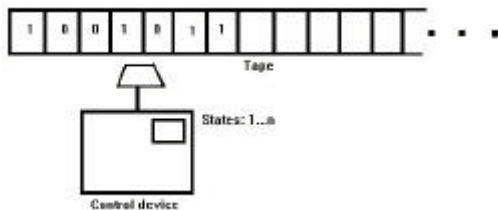
The program

- Is a finite sequence of instructions.
- The program tells the read-write head what to write and how to move, based on the symbol on the tape, and the states of the program.
- The Turing machine normally obeys the instructions in the order that they occur.

The program

- The sequence could be broken by an instruction that requires a Jump to another location.
- When there is no rule for a state/symbol combination that the Turing Machine encounters, the machine will just halt and make no further moves.

The Machine



Defining the Program

Present State	Present Symbol	Write	Move	New State
1	0	0	Right	2
2	0	0	Right	3
2	1	1	Right	2
3	0	Blank	Left	5
3	1	0	Left	4
4	0	1	Right	2

Computability

- It should be deterministic and cannot require infinite computations within itself, and it should be finite in itself.

Resources

- [Alan Turing Home Page](#)
- [Turing Simulator](#)