

Universal Turing Machine

Chapter 5: Undecidability

Prof. Riddhi Atulkumar Mehta
Assistant Professor
Department of Computer Science and
Engineering

Content

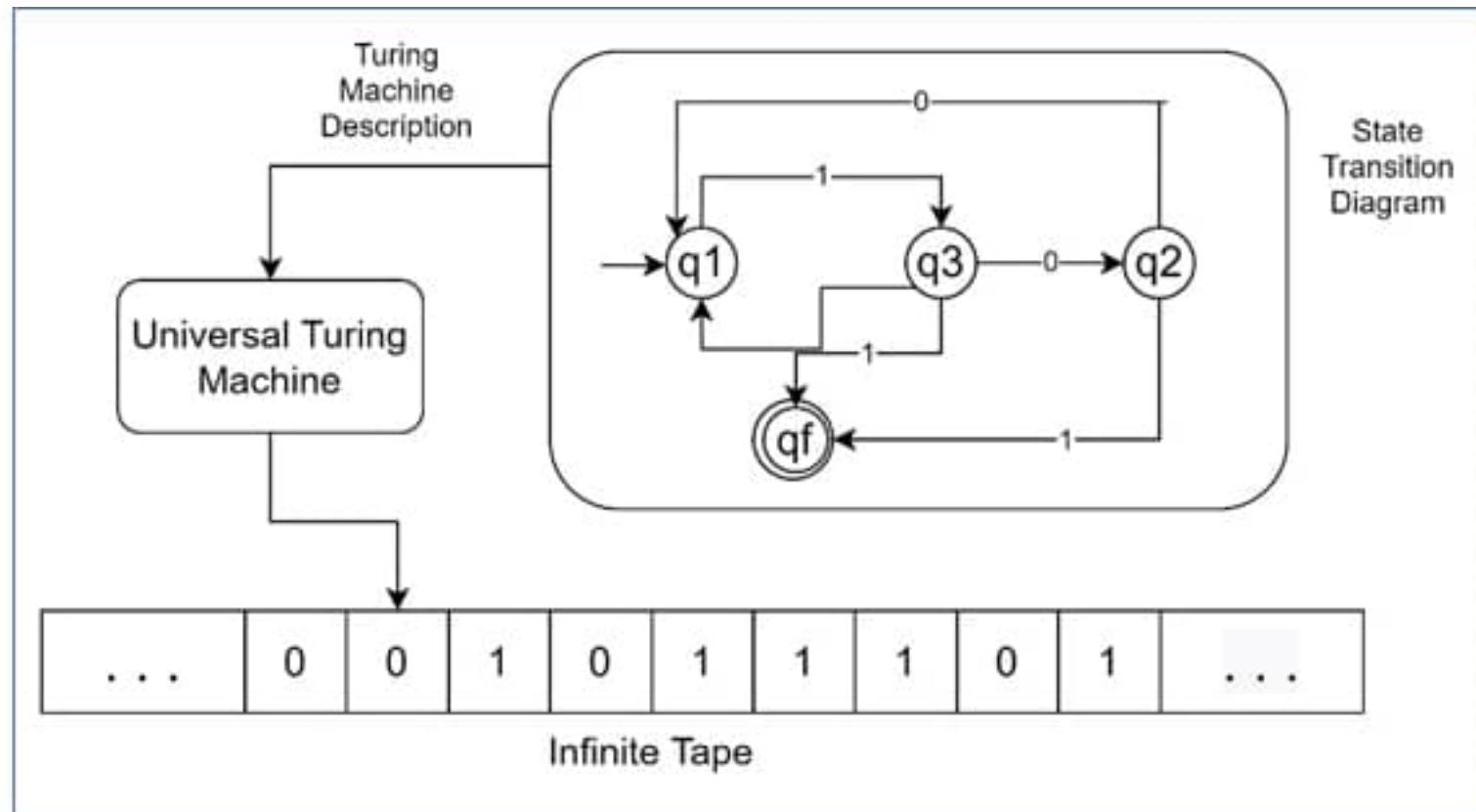
1. Universal Turing Machine.....	1
2. Implications of the term "Universal"	2
3. How Does a Universal Turing Machine Work?.....	3

Universal Turing Machine

- A Universal Turing Machine is a theoretical model that can simulate any other Turing machine. Which is little complicated but we will see how it actually works.
- If we think about a regular Turing machine as a device built to perform one specific task. So, for example, we might have a Turing machine to add two numbers together or check if a word is a palindrome or not. These machines are task-specific; they do one thing and do it well.
- On the other hand, a Universal Turing Machine can perform any task that a regular Turing machine can do. By taking a description of that machine (let us call it M) and the input for that machine (let us call it X). The Universal Turing Machine, which we will denote as U , processes M and X and then outputs the result of M operating on X .

Universal Turing Machine

- The functional block diagram of the machine looks like this –



Implications of the term "Universal"

- The term "universal" states the machine's ability to simulate any other Turing machine. Like having a single device that can mimic all other devices, just by changing the instructions it follows.
- It is similar to our modern days' computer, it can run a word processor, a web browser, or even a game, all because it can take the code (which is just instructions) for these programs and execute it. The computer, in this way, is a practical example of a Universal Turing Machine.

How Does a Universal Turing Machine Work?

To understand how a Universal Turing Machine works, let us break down its process:

- Inputs – The Universal Turing Machine takes two inputs:
 - A description of another Turing machine (M),
 - The input that this machine should process (X).
- Processing – The Universal Turing Machine reads the description of M and interprets it as a set of instructions.
- Simulation – Using these instructions, the Universal Turing Machine simulates the operations of M on the input X.
- Output – The result of this simulation is what M would produce when given X as input.

Parul[®]
University

NAAC
GRADE **A++**



<https://paruluniversity.ac.in/>

