

Problem

A **Turing machine with doubly infinite tape** is similar to an ordinary Turing machine, but its tape is infinite to the left as well as to the right. The tape is initially filled with blanks except for the portion that contains the input. Computation is defined as usual except that the head never encounters an end to the tape as it moves leftward. Show that this type of Turing machine recognizes the class of Turing-recognizable languages.

Step-by-step solution

Step 1 of 2

To prove the double infinite tape Turing machine D is equals to Normal ordinary Turing machine M .

In order to show the equivalence between D and M , it is necessary show the following two things:

- First one is, any language L that can be recognized by M can be recognized by D as well, and
- Second part is, any Language L' that can be recognized by D can be recognized by M .

This can be showed by simulation. That is, simulate D to act like M and vice-versa.

(i) **Simulating M by D :**

Step 1: Mark the left hand end of D .

Step 2: Prevent D from moving its head to the left of the mark.

In this way D simulates M .

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Step 2 of 2

(ii) **Simulating D by M :**

To simulate the doubly infinite tape TM(Turing machine) D by an ordinary TM M , simulate it with a 2-tape TM.

As the 2 tape TM was already equivalent is power to an ordinary TM.

Simulation of doubly infinite tape TM ' D ' with 2-tape TM ' M_1 ':

The first tape of M_1 is written with input string and the second tape is blank.

Now cut the tape of doubly infinite tape Turing machine D into two parts, at the starting cell of the input string.

- One part containing input string and all the blank spaces to its right.
- Second part containing left of the input string appears on the second tape, in reverse order.

In this way M simulates D .

Thus from (i) and (ii)

D is equivalent to M i.e., Turing machine with a doubly infinite tape is equivalent to an ordinary Turing machine.

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