

Problem

Explain why the following is not a description of a legitimate Turing machine.

$M_{\text{bad}} =$ "On input $\langle p \rangle$, a polynomial over variables x_1, \dots, x_k :

1. Try all possible settings of x_1, \dots, x_k to integer values.
2. Evaluate p on all of these settings.
3. If any of these settings evaluates to 0, *accept*; otherwise, *reject*."

Step-by-step solution

Step 1 of 2

Consider the steps for the legitimate turing machine:

$M_{\text{bad}} =$ " The input is a polynomial P over variables x_1, \dots, x_k

Step 1: Try all possible values of x_1, \dots, x_k to integer values.

Step 2: Evaluate P on these values

Step 3: If any of these settings evaluates to 0, accept; otherwise, reject"

- From the step 1 to store all the values turing machine require infinite memory location. So, this is not possible to accept the machine.
- For the Step 2, infinite processing time to require all the values for evaluation. So, this step also not possible to accept the machine.
- If the above two steps are not possible, then the step 3 is rejected.

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Step 2 of 2

So, the Turing machine M_{bad} could require **infinite time and infinite steps** to try all of them.

But the above settings are required that every stage in the Turing machine description be completed in a finite number of steps.

Thus, this description is not suitable for the legitimate Turing machine.

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