Low Level Implementation of a Turing Machine

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1 Turing Machine Definition

The following Turing Machine T decides $A = \{a^n b^n c^n d^n e^n | n \geq 0\}$:

T = "on input $\langle M, R \rangle$ where M is a DFA and R is a regular expression:

    0. On empty input string accept, otherwise go to step 1

    1. Mark one a with an u, if there are no more a's go to step 7

    2. Mark one b with an v, if there are not b's to mark reject

    3. Mark one c with an x, if there are not c's to mark reject

    4. Mark one d with an y, if there are not d's to mark reject

    5. Mark one e with an z, if there are not e's to mark reject

    6. Repeat steps 1-5 until no a's remain

    7. If any b's, c's, d's, or e's remain on the tape reject."

    8. If no a's, b's, c's, d's, or e's remain on the tape reject."

2 Turing Machine Implementation

The following descirbes the implementation shown in Figure 1. The implementation files are in the github repository [1].
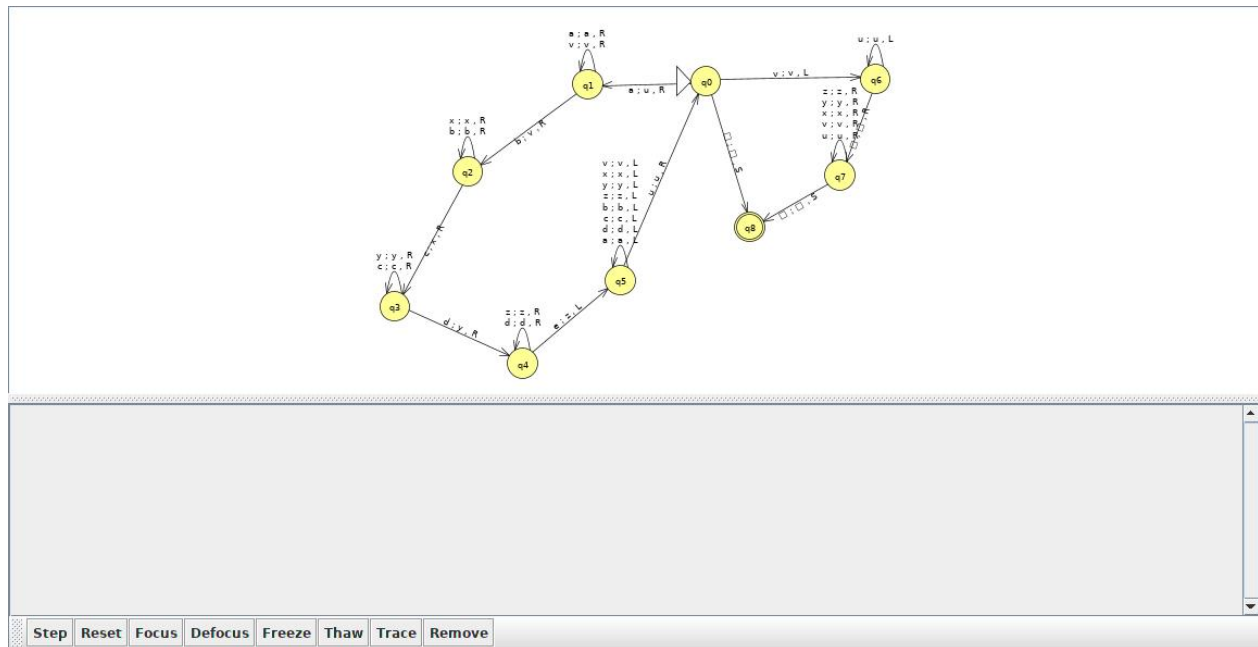

Figure 1: Turing Machine

On the input string, if the tape is blank, go to the accept state. If there is an "a", mark it with a "u" and move the tape right and go to state 1. The next state skips through the rest of the "a's" and any "v's"

(which are marked "b's"). It then finds a "b" on the tape and marks it with a "v". If there is no "b" it is rejected. The following states (2,3,4) do the same operation but for inputs "c,d". To transition to state 5 from state 4, the TM must find an "e" on the tape and move the head left. From this point state 5 moves the head back to the "u" which is the first marked "a" and moves the head right. At this point, the tape head should be on another "a" to mark, or on the first marked "b". If it finds an "a" it goes through the state 0-5 loop until there are no more a's to mark. If it finds a "v", then all "a's" have been marked and it moves the tape head back to the beginning of the tape with state 6. State 7 moves the tape head right across the tape for "u,v,x,y,z", if it encounters anything other than "u,v,x,y,z" it rejects. If it ends up at a blank spot on the tape, it moves to the accept state.

3 Turing Machine Testing

4 Turing Machine Analysis

References

[1] Project github,
https://github.com/rodger79/5700-TuringMachine