Homework Assignment #6
Due: July 8, 2015 at 7:00 p.m.

1. The textbook gives a high-level description of a Turing machine to decide the language $C = \{\mathtt{a}^i\mathtt{b}^j\mathtt{c}^k : i \cdot j = k \text{ and } i, j, k \geq 1\}$ in Example 3.11 on page 174. (If you have the second edition of the textbook, it is on page 146.)

Convert that high-level description into an actual Turing machine. For this question, you will submit your solution electronically as a text file that contains a description of the Turing machine in York University Turing Machine File Format (YUTMFF), which is described below.

YUTMFF

The Turing machines described in YUTMFF use the following conventions, as described in the lectures.

- They use a 1-way infinite tape.
- The tape alphabet has two different special symbols, $\triangleright$ and $\sqcup$ that are not part of the input alphabet.
- Initially, if the input string is w, the tape contains $\triangleright w$ at the left end of the tape, and the rest of the tape contains only $\sqcup$ symbols. The head of the Turing machine is initially positioned at the first character of the input string w (i.e., at the tape's second square).
- Whenever the Turing machine sees the $\triangleright$ symbol, it must leave it unchanged and move right (but it can change state).

We also make some naming conventions. We assume that the state set of the Turing machine is $Q = \{q_0, q_1, \ldots, q_{n-1}\}$ where $n \geq 3$ and the tape alphabet of the Turing machine is $\Gamma = \{c_0, c_1, \ldots, c_{m-1}\}$ where $m \geq 3$. We also assume that q_0 is the initial state, q_{n-2} is the accepting state and q_{n-1} is the rejecting state. We assume that the input alphabet is $\Sigma = \{c_0, c_1, \ldots, c_{k-1}\}$ where $0 \leq k \leq m-2$ and $c_{m-2} = \sqcup$ and $c_{m-1} = \triangleright$.

We now explain how to describe, using YUTMFF, a Turing machine that follows the conventions described above. The first line of the file contains the three integers n, m, and k, separated by single spaces. (Recall that these are the sizes of the state set, tape alphabet and input alphabet, respectively.)

Each character in the tape alphabet has a name. The second line of the file contains $m-2$ strings separated by single spaces that give the names of the characters $c_0, c_1, \ldots, c_{m-3}$. We use the name `blank` to represent $c_{m-2} = \sqcup$ and `leftend` to represent $c_{m-1} = \triangleright$.

The third line contains a non-negative integer T.

Following this, there are T lines. Each of these remaining lines of the description contains five items i, a, i', a', d separated by single spaces, where i and i' are integers with $0 \leq i \leq n-3$

and $0 \leq i' \leq n-1$ (inclusive), a and a' are names of characters in the tape alphabet and d is a single character that is either L or R. This line indicates that $\delta(q_i, a) = (q_{i'}, a', d)$. No two lines should have the same i and a. Note that no transitions are given for situations when the machine is in state q_{n-2} or q_{n-1} since those are the accepting and rejecting states. If no transition is given to describe $\delta(q_i, a)$ for a non-halting state q_i, then it is assumed that $\delta(q_i, a) = (q_i, a, R)$.

Some Java code will be posted on the course web page to assist you with this assignment. If you run the Java programme TM.java on your input file, it will test it on a number of input strings. If it gives you an error message, there is something wrong with your TM description file. Note that your solution will be tested automatically to assign you a grade, so if you submit a solution containing a syntax error, you may be assigned a grade of 0. Therefore, you really should make sure that TM.java runs correctly on your file.

Submission instructions

Type your solution in a plain text file named a6.txt. Be very careful to adhere to the correct file format because your solutions will be checked by a computer programme. To submit it, run the following command from your EECS account:

`submit 2001 a6 a6.txt`

If you wish to declare that you have discussed your solution with other students, type your declaration in a plin text file called declaration.txt and submit it using the command:

`submit 2001 a6 declaration.txt`

If you realize that you would like to change one of your submitted files, just submit the new version of the file using the same command as above; the new version will replace the old version. (Of course, this must be done prior to the assignment deadline.)

You might want to test out submitting a file prior to the deadline, just to make sure that you know how it works, since you can always resubmit later.

If you get an error message when submitting, type

`man submit`

to get an explanation of the error message.