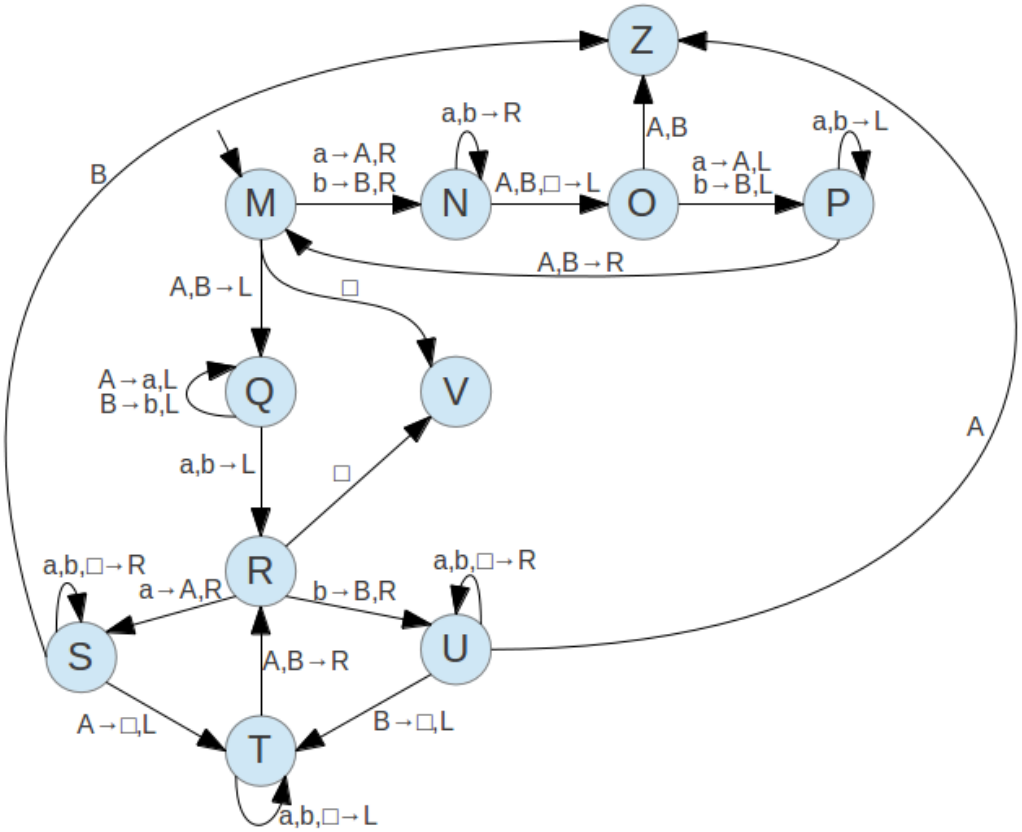
CPSC 326 — Theory of Computation — Spring 2020

Homework #6 – Turing Machines (up to +30XP)

Due: Thursday, April 2nd, midnight

1. Consider the Turing Machine whose state transition diagram is given below:



This machine's accept state is `V` (for "Very good!"), and its reject state is `Z`.

a. What series of configurations does it go through if started with the input `aa`?

b. What series of configurations does it go through if started with the input `aaa`?

c. What if it was started with the input `abaabb`?

d. What if it was started with the input `abaaba`?

e. Now jump outside the system. What does this Turing Machine *do*?

2. For each of the following four problems, you should write a Turing Machine, and express it as a plain-text file whose contents conform to the Stephen Syntax described on p.2 of `http://stephendavies.org/cpsc326/homework5.pdf`. You may (and should) test your Turing Machines using your own Homework #5 solution, or one of these:

   - Stephen's (Julia):
     - `http://stephendavies.org/cpsc326/stephenTM.jl`
     - `http://stephendavies.org/cpsc326/TM.jl`
   - Ben's (Java):
     - `http://stephendavies.org/cpsc326/Bspringe_TM.java`
     - `http://stephendavies.org/cpsc326/BenState.java`
   - Matt's (Python):
     - `http://stephendavies.org/cpsc326/mmorgan4_TM.py`

   The four files you submit should be named `threeas.tm`, `wordhashwordhashword.tm`, `palindrome.tm`, and `unary_subtract.tm`.

   (a) Create an acceptor Turing Machine whose input alphabet $\Sigma = \{\texttt{a}, \texttt{b}, \texttt{c}\}$ and whose language is the set of all strings that have at least three `a`'s. (So `ababa`, `aaabbbccc`, are `bcbcaaaaa` should be accepted, but `abcabc`, `bbbbbbccccc`, `a`, and ϵ should be rejected.)

   (b) Create an acceptor Turing Machine whose input alphabet $\Sigma = \{\texttt{0}, \texttt{1}, \texttt{\#}\}$ and whose language is $\{w\#w\#w \mid w \in \{\texttt{0}, \texttt{1}\}*\}$. (So `01#01#01`, `1101#1101#1101`, `##`, and `0011010#0011010#0011010` should be accepted, but `1101#1101#1111`, `1#1#1#1`, `010#010` and `10#10#100` should be rejected.)

   (c) Create an acceptor Turing Machine whose input alphabet $\Sigma = \{\texttt{a}, \texttt{b}, \texttt{c}\}$ and whose language is the set of palindromes. (So `abcba`, `abba`, `c`, and ϵ should be accepted, but `abb`, `baba`, and `abcabc` should be rejected.)

   (d) Create a transducer Turing Machine that will perform the operation of **unary subtraction**. The input tape will have two base-1 numbers present, separated by a 0. If it does not, the machine should reject. The first number should be greater than or equal to the second number. If it is not, the machine should reject. In other cases, the machine should accept and leave the tape with only a base-1 number which is the difference between the two operands.

   For instance, if the tape begins with:

   `1111111011`

   the machine should accept and leave the tape as:

`11111` ✓

If the tape begins with:

`1110111`

the machine should accept and leave the tape as:

□ (all blanks) ✓

If the tape begins with:

`1101111`

or

`11111`

or

`11111011110111`

the machine should reject (and I don't care what's left on the tape).

Turning it in

To submit this homework, you should send me an email message by the deadline with subject line "`CPSC 326 Homework #6 Turnin`". In the body of the email, you should type out your five answers to problem #1. You should also attach *four* plain-text files to the email (double-check that they're actually attached!), the names of which should be `threeas.tm`, `wordhashwordhashword.tm`, `palindrome.tm`, and `unary_subtract.tm`.