CS 321H Homework 5

Lyell Read

Submit to Canvas a pdf file containing verbal explanations and transition graphs for the Turing machines in problems 1 & 2 and the written answers to problems 3 & 4. Also submit JFLAP .jff files (named youronidnameP1a, youronidnameP1b, etc.) for problems 1 & 2.

1. (10 pts) Design single-tape Turing machines that accept the following languages using JFLAP

- a. $L_2 = \{w : n_a(w) = n_b(w) : w \in \{a, b\}^+\}$.

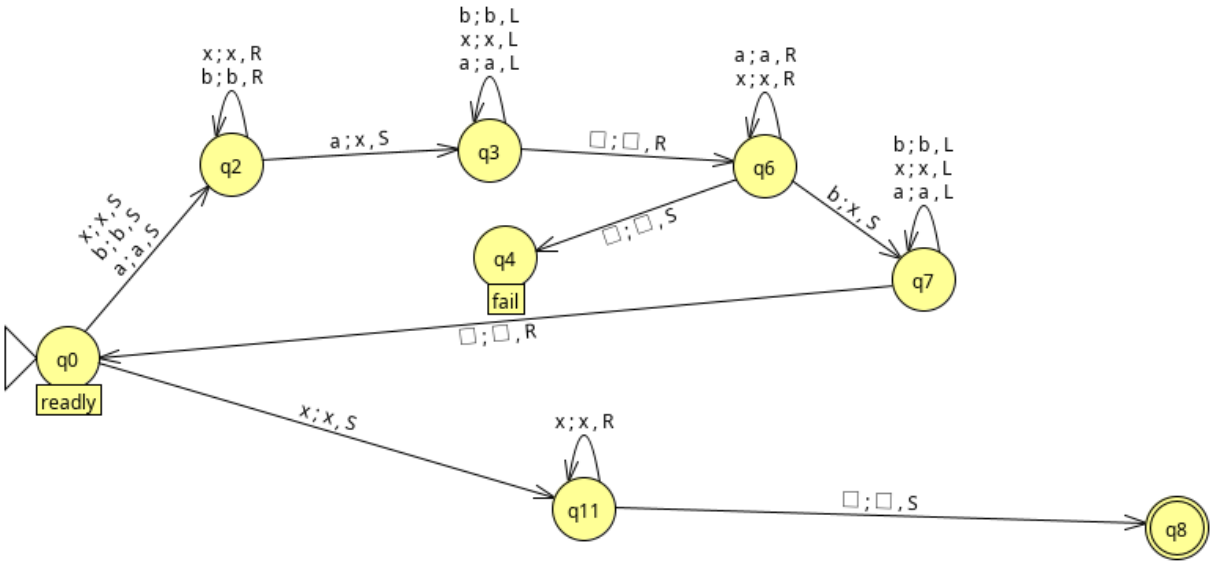

Figure 1: Turing Machine for 1a

- b. $L_3 = \{ww : w \in \{a, b\}^+\}$.

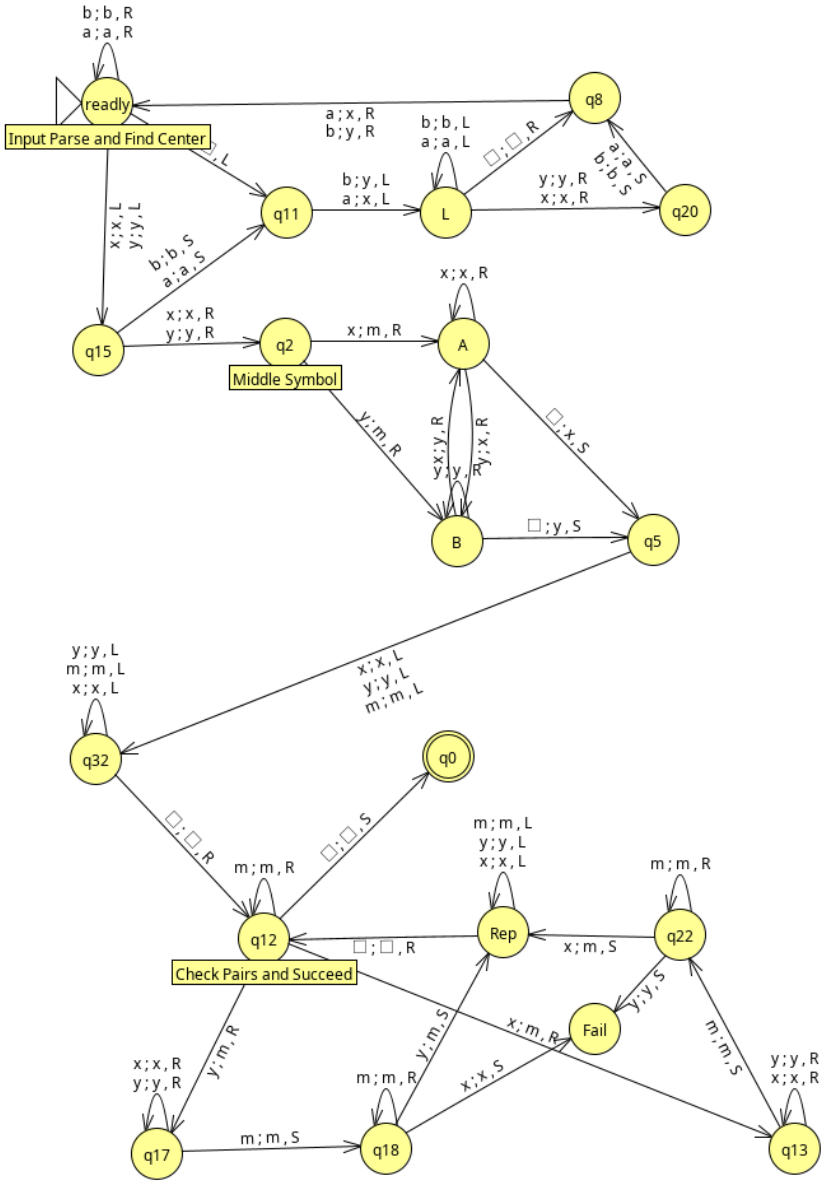

Figure 2: Turing Machine for 1b

2. (10 pts) Design Turing Machines using JFLAP to compute the following functions for x and y positive integers represented in unary. The value f(x) represented in unary should be on the tape surrounded by blanks after the calculation.

- a. $f(x) = \begin{cases} x - y & x > y \\ 0 & otherwise \end{cases}$

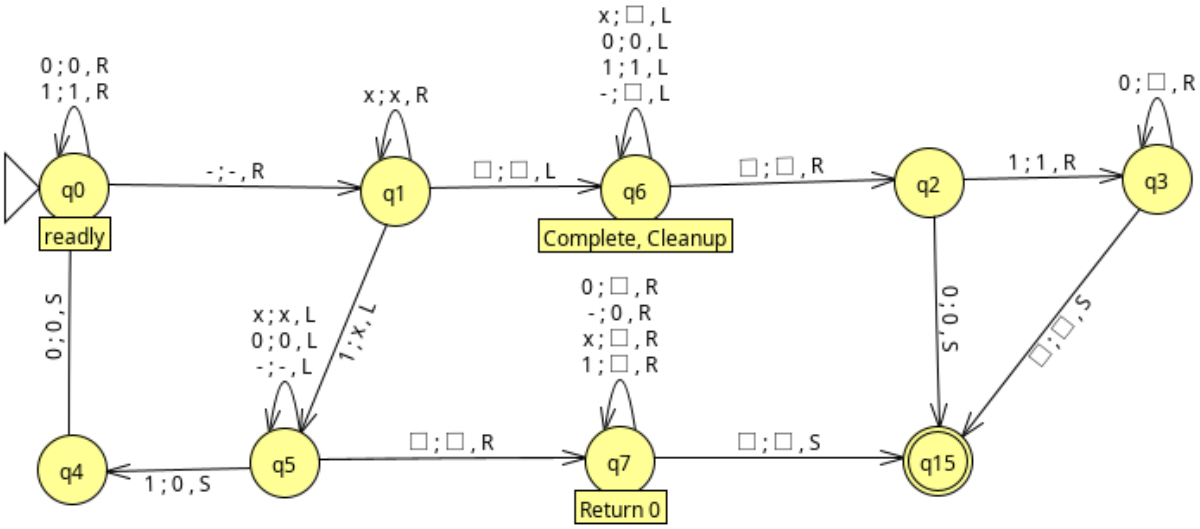

Figure 3: Turing Machine for 2a

- b. $f(x) = x \mod 5$

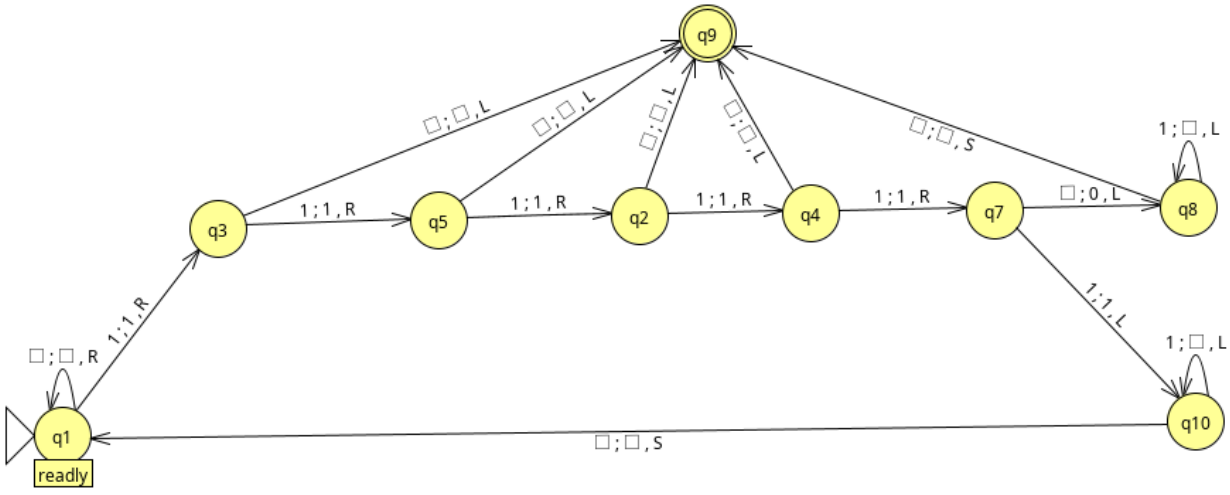

Figure 4: Turing Machine for 2b

3. (5 pts) The nor of two languages is defined below, prove that recursive languages are closed under the nor operation.:

$$nor(L_1, L_2) = \{w : w \notin L_1 \text{ and } w \notin L_2\}.$$

4. (5 pts) Suppose we make the requirement that a Turing machine can only halt in a final state, that is, we require that (q,a) be defined for all pairs (q, a) with $q \notin F$ *and* $a \notin \Gamma$. Does this restrict the power of the Turing machine? Prove your answer.