Middle East Technical University | Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

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Homework 6

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Answer for Q1

1. 1954

2. The Enigma

3. Alan Turing

4. The Chemical Basis of Morphogenesis

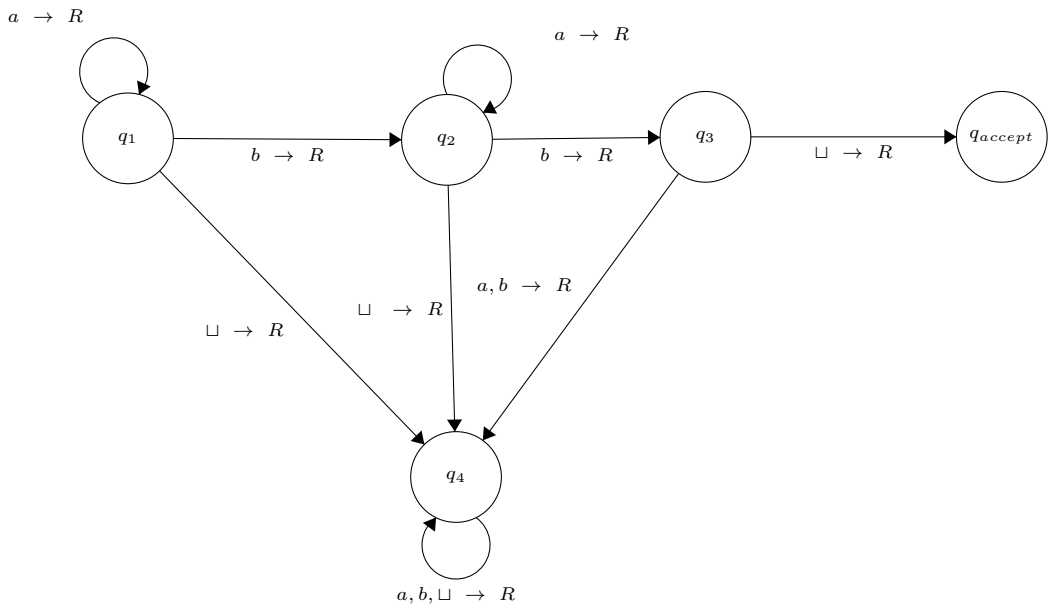
5. Enigma

Answer for Q2

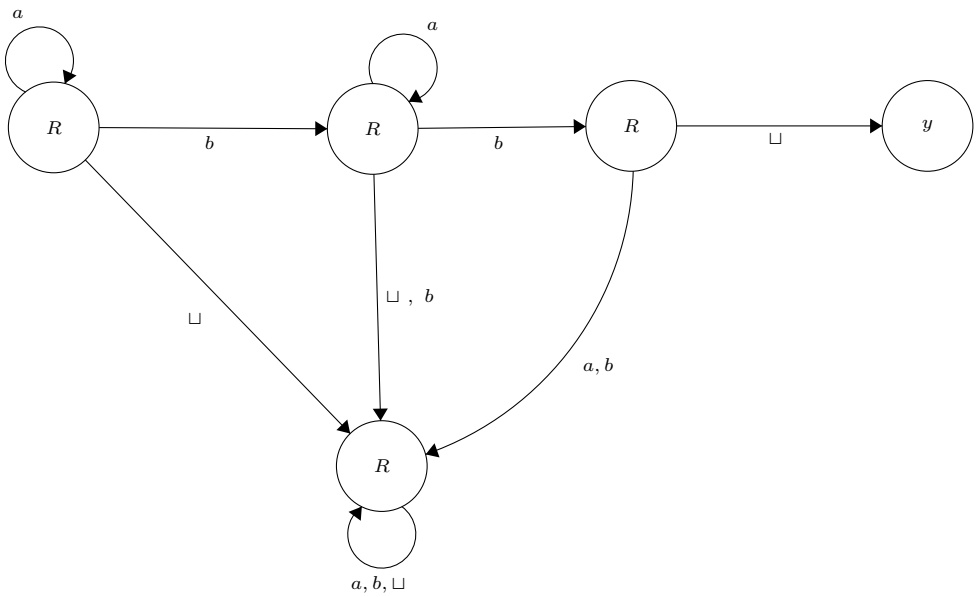
I assumed there is no symbol other than alphabet symbols in the input for both cases.
First let me introduce the machine:
(1) It checks the first b. Number of a's is not important since opearation is Kleene Star, it can be 0 or more. After first b, we shouldn't see a b, because there should be exactly two b's in the string.
(2) It checks the second b. Again number of a's is not important. After second b, we shouldn't see any a's or b's. The rest of tape should be all blank symbols.
(3) Checks for blank symbol and make a transition to halting state, and halts.

If the machine encounters a erroneous symbol, it makes a immediate transiton to q_4, which is trap state, and looping infinitely. It's a must to obtain a semi-decider machine. Because it can only halts when the input is accepted.

a. K = $\{q_1, q_2, q_3, q_4, q_{accept}\}$
$\sum = \{a, b, \sqcup, \triangleright\}$
s = q_1
H = $\{q_{accept}\}$
You can see the transitions below from diagram:



b. I am using the same logic from previous machine. The difference is the machine halts when it reaches y. It's combination of R machines.



Answer for Q3

I asssumed there is a left-end marker in each tape.
We should basically mulitply a by itself b times. So, we need to keep track of number of multiplications, and the result of every multiplication. For this, I will use the second tape for number of multiplications,

which is b, and use the third tape for multiplication results.

(1) First, we need to copy b to the second tape. The machine should go right until the head meets the comma, and go right one more time. Now, the head is pointing to first digit of b. We should copy the b's every digit to the second tape until the blank symbol. After copying, the head should come back to the left-end marker of the first tape for further operations.

(2) To handle the third tape, value in this tape must be initially 1, since we are going to multiply a's. To do that we can use second tape. We can copy a 1 to third tape from second tape and with necessary transitions, it's easy to find a 1. If there isn't any 1 in b, then we can copy a 0 and increment it by 1 with M_+. The machine will halt, since a^0 is 1.

(3) We can start the multiplications. First, we need to check second tape. If it's zero our result is ready. Otherwise we will perform the multiplication with M_x and then write it to third tape. Also we need to decrement second tape with M_- which can be considered as a counter.

(4) After counter hits 0, we can copy the result to desired tape and halt the machine.

Finally, we know that any multi-tape Turing machine can be converted to a standart Turing machine. Therefore if we apply the rules for that we can obtain a standart Turing machine.