

CENG 280

Formal Languages and Abstract Machines

Spring 2022-2023

Homework 6

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Answer for Q1

Alan Turing was born in June 23 1912 and died in June 7 1954.

Turing played a crucial role in breaking the Enigma code during World War II.

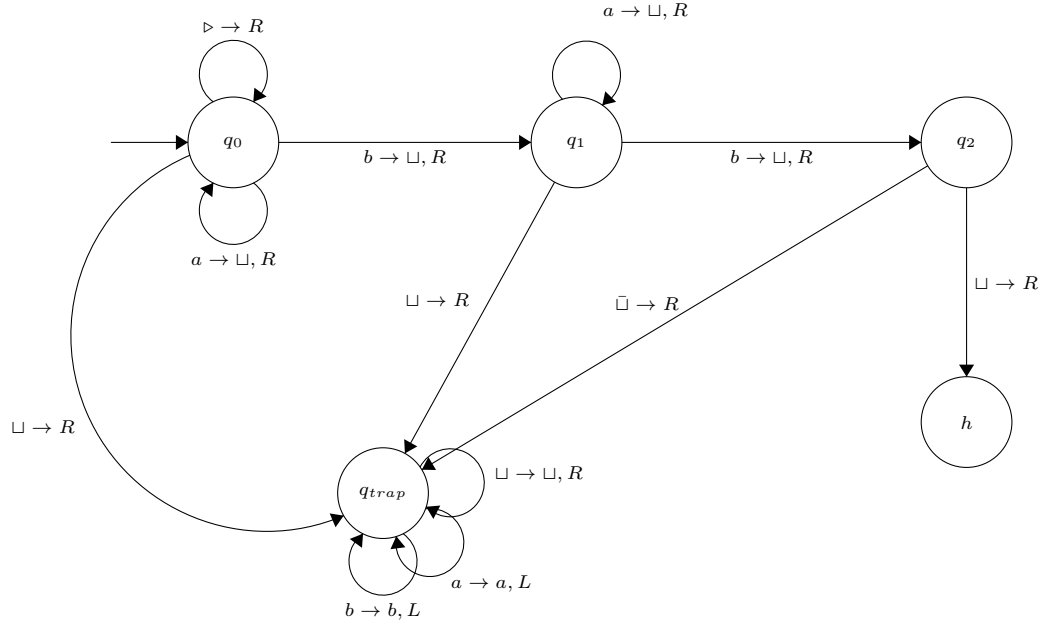
The now-famous Turing test , proposed in his paper Computing Machinery and Intelligence (1950), is an attempt to define a standard for a machine to be called “intelligent”.

One of his most-cited works, titled Theory of Morphogenesis was published in 1952, which proposed a mechanism as to how inhomogeneous patterns in nature arise from symmetric starting states.

The 2014 movie titled The Immitation Game aims to give a biographical portrait of Turing.

Answer for Q2

a. The turing machine we are going to construct is going to read all a's and replaces them with the blank symbol until it finds a b. It will repeat the process once more. When it finds the second b, it will halt if and only if it reaches the end of the string. Otherwise, it will go to a trap state and will enter to an infinite loop. Also, if machine encounters a blank symbol before reaching the second b, the machine will enter the infinite loop. The turing machine that satisfies these conditions is:



$$M = (K, \Sigma, \delta, s, H)$$

$$H = \{h\}$$

$$K = \{q_0, q_1, q_2, q_{trap}, h\}$$

$$\Sigma = \{a, b, \sqcup, \triangleright\}$$

$$s = \{q_0\}$$

$$\delta(q_0, \triangleright) = (q_0, \rightarrow)$$

$$\delta(q_0, a) = (q_0, \rightarrow)$$

$$\delta(q_0, b) = (q_1, \rightarrow)$$

$$\delta(q_0, \sqcup) = (q_{trap}, \rightarrow)$$

$$\delta(q_1, \triangleright) = (q_1, \rightarrow)$$

$$\delta(q_1, a) = (q_1, \rightarrow)$$

$$\delta(q_1, b) = (q_2, \rightarrow)$$

$$\delta(q_1, \sqcup) = (q_{trap}, \rightarrow)$$

$$\delta(q_2, \triangleright) = (q_2, \rightarrow)$$

$$\delta(q_2, a) = (q_{trap}, \rightarrow)$$

$$\delta(q_2, b) = (q_{trap}, \rightarrow)$$

$$\delta(q_2, \sqcup) = (h, \rightarrow)$$

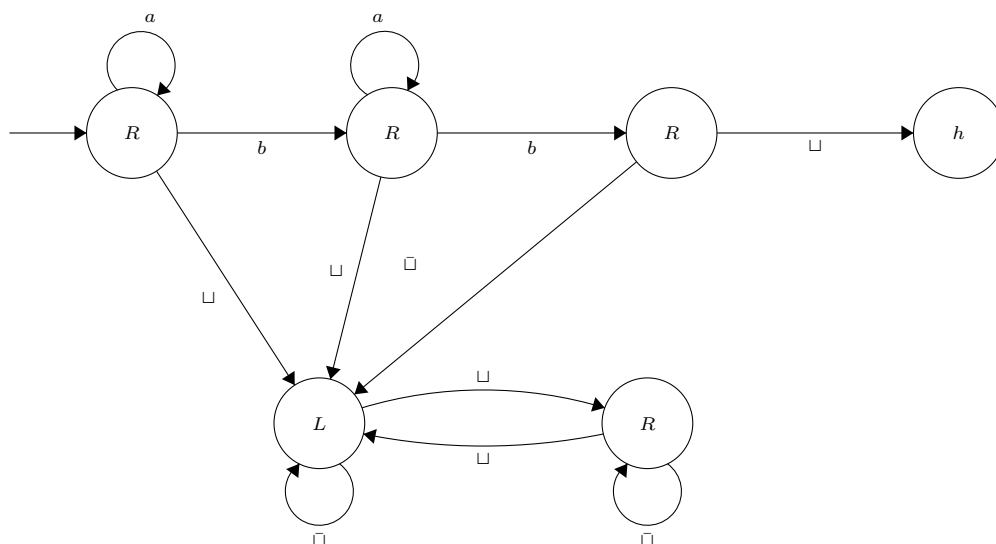
$$\delta(q_{trap}, \triangleright) = (q_{trap}, \rightarrow)$$

$$\delta(q_{trap}, a) = (q_{trap}, \leftarrow)$$

$$\delta(q_{trap}, b) = (q_{trap}, \leftarrow)$$

$$\delta(q_{trap}, \sqcup) = (q_{trap}, \rightarrow)$$

b.



Answer for Q3

– Let's assign each tape with different mission:

Tape 1 → input tape

Tape 2 → calculation tape

Tape 3 → result tape (initial value of this tape will be 1)

– Steps to follow for Integer Exponentiation: (a^b)

1. Read the input from Tape 1, get the values of a and b .

2. While b is greater than 0;

– Use the turing machine M_x to multiply the value on Tape 3 with the value of a on Tape 2. Store the result to Tape 3.

– Subtract 1 from b by using the turing M_- .

3. If b is equal to 0, use M_x to multiply the value on Tape 3 with 1.

4. Write the final value of Tape 3 as the result.

5. Halt