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

i) 1954

ii) Enigma

iii) Turing Test

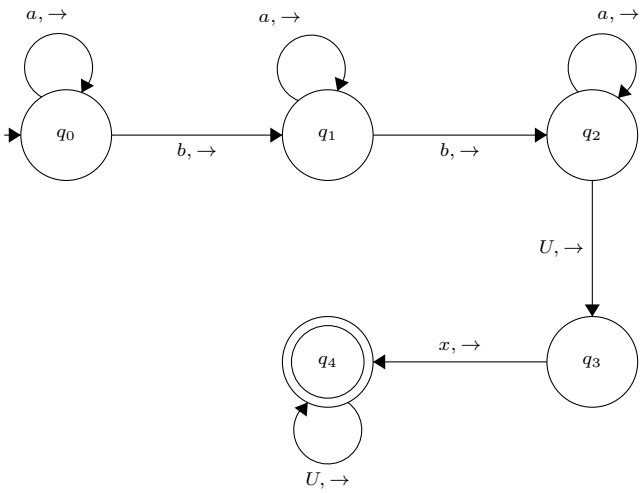
iv) The Chemical Basis of Morphogenesis

v) The Imitation Game

Answer for Q2

a) It is the quintuple $(K, \Sigma, \delta, s, H)$
$K = (q_0, q_1, q_2, q_3, q_4)$
$\Sigma = \{a, b, U, x\}$
$s = (q_0)$
$H = (q_4)$
$\delta =$

q	σ	$\delta(q, \sigma)$
q_0	a	$(q_0, \rightarrow)$
q_0	b	$(q_1, \rightarrow)$
q_1	a	$(q_1, \rightarrow)$
q_1	b	$(q_2, \rightarrow)$
q_2	a	$(q_2, \rightarrow)$
q_2	U	$(q_3, \rightarrow)$
q_3	x	$(q_4, \rightarrow)$
q_4	U	$(q_4, \rightarrow)$



b)

1. Start in the initial state.
2. Repeat:

- Use M_a to scan and move right until a non-'a' symbol is encountered or the end of input is reached.
  - If the current symbol is 'b', move to the next step.
  - If the current symbol is 'a', repeat the previous step.
  - If the current symbol is blank, move to the next step.
  - If any other symbol is encountered, reject the input.
- Use M_b to scan and move right until a non-'b' symbol is encountered or the end of input is reached.
  - If the current symbol is 'a', reject the input.
  - If the current symbol is 'b', move to the next step.
  - If the current symbol is blank, reject the input.
  - If any other symbol is encountered, reject the input.
- Use M_a to scan and move right until a non-'a' symbol is encountered or the end of input is reached.
  - If the current symbol is 'a', repeat the previous step.
  - If the current symbol is 'b', move to the next step.
  - If the current symbol is blank, move to the next step.
  - If any other symbol is encountered, reject the input.
- Use M_b to scan and move right until a non-'b' symbol is encountered or the end of input is reached.
  - If the current symbol is 'a', reject the input.
  - If the current symbol is 'b', accept the input.
  - If the current symbol is blank, reject the input.
  - If any other symbol is encountered, reject the input.

Answer for Q3

Tape 1: Input tape (a, b in binary, separated by a comma)

Tape 2: Computation tape

Tape 3: Auxiliary tape (used for temporary storage)

1. **Step 1: Initialization**
   - Read the input on Tape 1.
   - Move the contents of Tape 1 to Tape 2.
   - Write a blank symbol on Tape 3 as a marker.
2. **Step 2: Base case handling**
   - Check if b equals zero. If it does, move to the Halt state and accept.
   - If b is not zero, continue to the next step.
3. **Step 3: Exponentiation loop**
   - Start a loop that will iterate b times. Use the following steps within the loop:
     - Read the rightmost symbol on Tape 2.
     - Move the read symbol to Tape 3.
     - Move the remaining symbols on Tape 2 one position to the left.
     - Repeat this process until all symbols on Tape 2 have been moved to Tape 3.
4. **Step 4: Exponentiation calculation**
   - Reset Tape 2 to its original position.
   - Start another loop that will iterate b times. Use the following steps within the loop:
     - Move the symbols from Tape 3 back to Tape 2 in the original order.
     - Call the Turing machine M$\times$ to multiply the numbers on Tape 2.
     - Store the result on Tape 2.
5. **Step 5: Finalization**
   - Move the final result from Tape 2 to Tape 1.
   - Halt and accept.