Student Information

Full Name: Berk Ulutaş
Id Number: 2522084

Answer 1

- Alan Turing was born in June 23 1912 and died in June 7 (i) **1954**.
- Turing played a crucial role in breaking the (ii) **Enigma** code during World War II.
- The now-famous (iii) **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 (iv) **"The Chemical Basis 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 (v) **"The Imitation Game"** aims to give a biographical portrait of Turing.

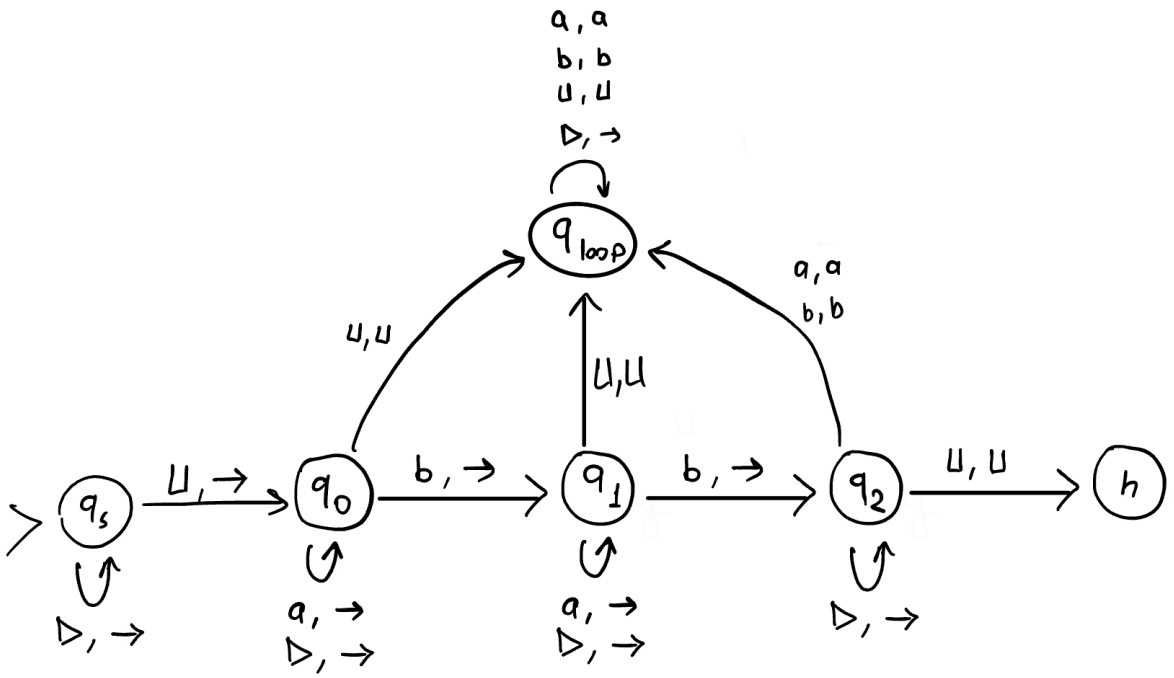
Answer 2

a)

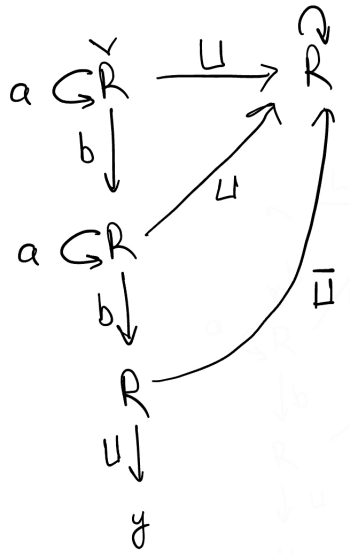
$M = (K, \Sigma, \Delta, q_s, \{h\})$
$K = \{q_s, q_0, q_1, q_2, q_{loop}, h\}$
$\Sigma = \{a, b, \triangleright, \sqcup\}$
q_s is initial state
h is halting state

Assuming initial configuration of M of input w in the form $(q_0, \triangleright \sqcup w)$ and δ is given by following table

q	σ	$\delta(q, \sigma)$
q_s	$\sqcup$	$(q_0, \rightarrow)$
q_s	$\triangleright$	$(q_s, \rightarrow)$
q_0	a	$(q_0, \rightarrow)$
q_0	b	$(q_1, \rightarrow)$
q_0	$\sqcup$	$(q_{loop}, \sqcup)$
q_0	$\triangleright$	$(q_0, \rightarrow)$
q_1	a	$(q_1, \rightarrow)$
q_1	b	$(q_2, \rightarrow)$
q_1	$\sqcup$	$(q_{loop}, \sqcup)$
q_1	$\triangleright$	$(q_1, \rightarrow)$
q_2	a	(q_{loop}, a)
q_2	b	(q_{loop}, b)
q_2	$\sqcup$	$(h, \sqcup)$
q_2	$\triangleright$	$(q_2, \rightarrow)$
q_{loop}	a	(q_{loop}, a)
q_{loop}	b	(q_{loop}, b)
q_{loop}	$\sqcup$	$(q_{loop}, \sqcup)$
q_{loop}	$\triangleright$	$(q_{loop}, \rightarrow)$



b)



Answer 3

- The Turing machine starts by copying the values of a and b onto the second and third tapes, respectively. The machine starts in the state where it reads from the first tape. If it reads a binary digit, it writes that digit on the second tape and moves right. If it reads a comma, it changes to a new state, where it reads a binary digit, writes on the third tape and moves right. This step ensures, a is copied onto tape 2 and b is copied onto tape 3.
- Erase the content on tape 1, and copy tape 2 to tape 1. After this step we need to subtract 1 from b. Use M_- to subtract 1. Update b on tape 3 with the result. (Since we know a and b are positive integers(said in discussion forum), do not need to worry about $b = 0$ case.)
- Enter a loop that will continue until b (on tape 3) becomes zero:
  - Use $M_\times$ to multiply the current result on tape 1 (initially, this is a) with a from tape 2. Write the result back to tape 1.
  - Use M_- to subtract 1 from b on tape 3. Update b on tape 3 with the result.
  - Check if b has become zero (by looking at tape 3). If it has, exit the loop. If it hasn't, repeat the loop.
- When the machine exits the loop (because b has become zero), the computation is done. The first tape now contains the result of a^b, and the machine halts.