

CENG 280

Formal Languages and Abstract Machines

Homework 6 - Sample Solutions

Question 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.

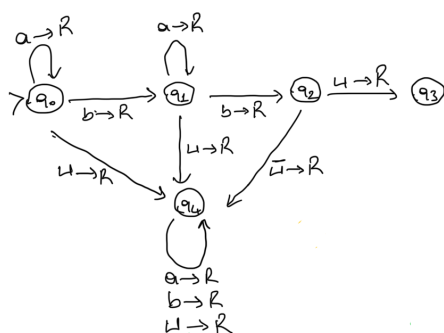
The now-famous (iii) Turing test, proposed in his paper Computing Machinery and Intelligence (1950), is an attempt to define a standard for a machine to be called "intelligent".

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.

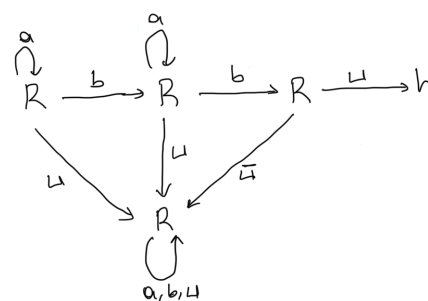
The 2014 movie titled (v) The Imitation Game aims to give a biographical portrait of Turing.

Question 2

Q2.a)



Q2.b)



Question 3

You can go with many different levels of abstraction here, the amount of detail you give is up to you. Here is an example:

1. **Data preparation.** Delete the comma and move number b from the first tape to the second tape. Write 1 to the third tape.
2. **Assumptions.**

- (a) The machine M_{\times} calculates $x \times y$ where x is the number held in the first tape and y is the number held in third tape. It writes its output on the third tape erasing y
 - (b) The machine M_{-} is given a tape as its input. It decreases the value of the number in the tape by 1
3. **Calculation.** While the number in the second tape does not read 0, **repeat** the following.
- (a) Use machine M_{\times}
 - (b) Use M_{-} on the second tape
4. **Termination.** Terminate with the calculated result on the third tape.

You can be meticulous and, for example, go into the details of how to write the answer of the multiplication $x \times y$ on top of y , because it is non-trivial to do so *while* erasing one of the inputs. Since this can be done in other ways, we did not go into the details here.