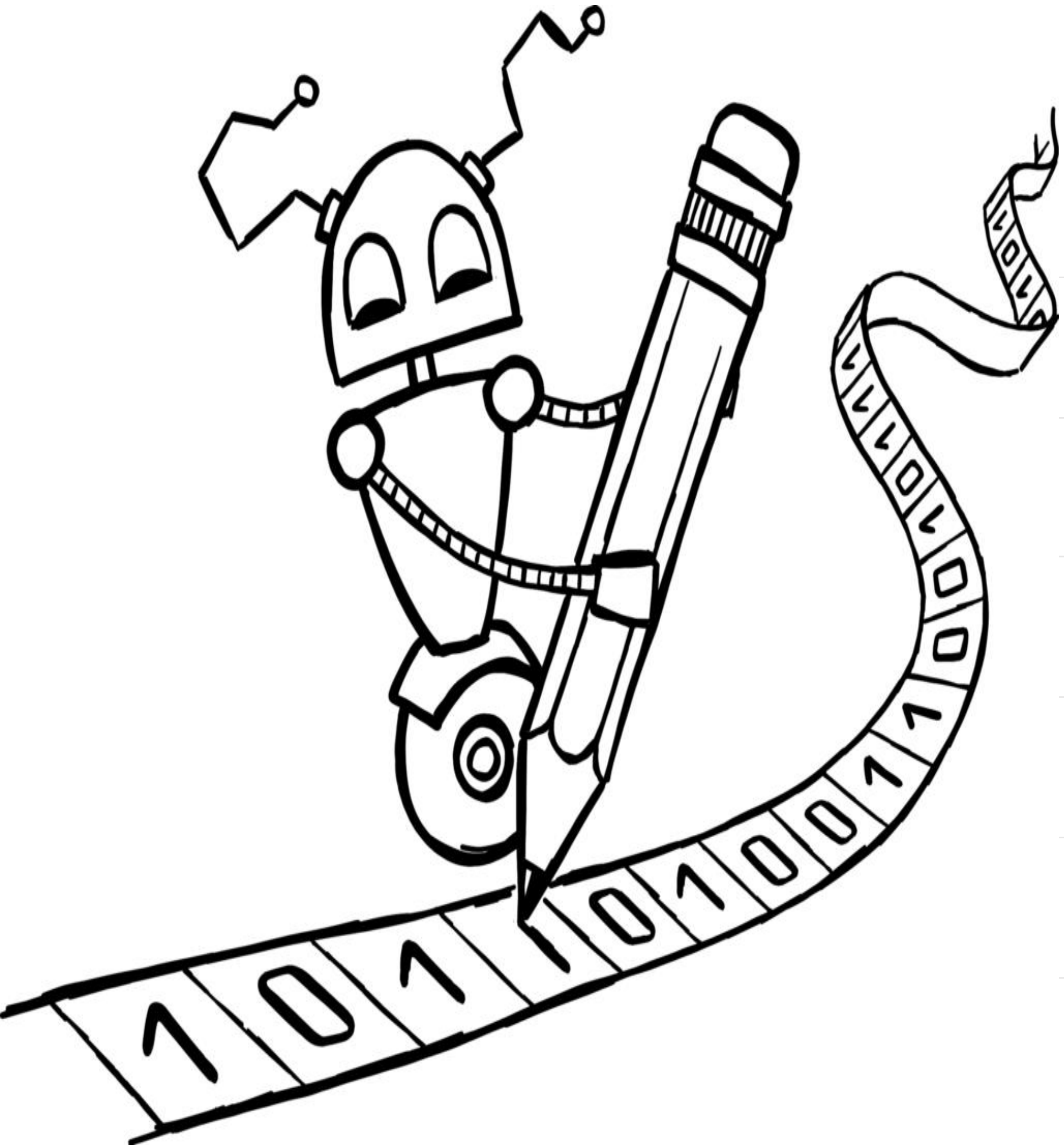
2



Computing

Analiza Algoritmilor

Image: https://soft-eng.sydney.edu.au/

Doing nothing

	$\mathbf{0}$	$\mathbf{1}$	$\square$
$\boldsymbol{q_1}$	$q_1, 0, -$	$q_1, 1, -$	$q_1, \square, -$

Writing 1 forever

	0	**1**	**□**
q_1	$q_1, 1, \rightarrow$	$q_1, 1, \rightarrow$	$q_1, 1, \rightarrow$

Flipping bits forever

	0	**1**	$\square$
$\boldsymbol{q_1}$	$q_1, 1, \rightarrow$	$q_1, 0, \rightarrow$	$q_2, \square, \leftarrow$
$\boldsymbol{q_2}$	$q_2, 1, \leftarrow$	$q_2, 0, \leftarrow$	$q_1, \square, \rightarrow$

Halting on some inputs

	0	**1**	**□**
$\boldsymbol{q_1}$	$H, 0, -$	$q_2, 1, \rightarrow$	$q_2, 1, \rightarrow$
$\boldsymbol{q_2}$	$q_2, 1, \rightarrow$	$q_2, 1, \rightarrow$	$q_2, 1, \rightarrow$

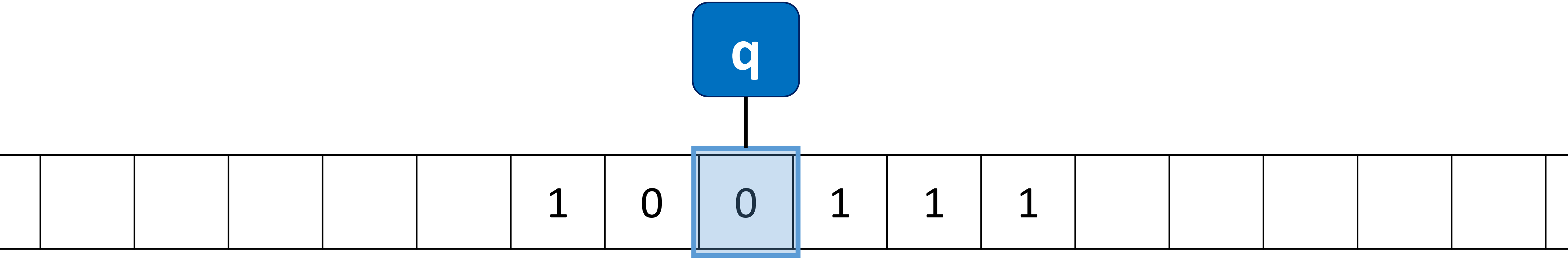
When a machine runs...

- … it can ***halt*** in one of the final states: Y, N, H
- … it can go on forever, ***without halting***

When a machine halts on input w…

- … in final state H, it *computes* a word v (the tape contents)
- … in final state Y, it *accepts* w
- … in final state N, it *rejects* w

Configurations



$$(10, 0111, q)$$

Computation history

$(\varepsilon, 110111, q)$

$(1, 10111, q)$

$(11, 0111, q)$

$(110, 111, q)$

$(1101, 11, q)$

$(11011, 1, q)$

$(110111, \square, q)$

$(11011, 1, p)$

$(1101, 10, p)$

$(110, 100, p)$

$(11, 0000, p)$

$(11, 1000, H)$

Moodle Quiz

Machine Configurations

Solving a problem

For a function problem f**:**

- If a machine M *always halts* with the *correct answer*, then "M **computes** f"

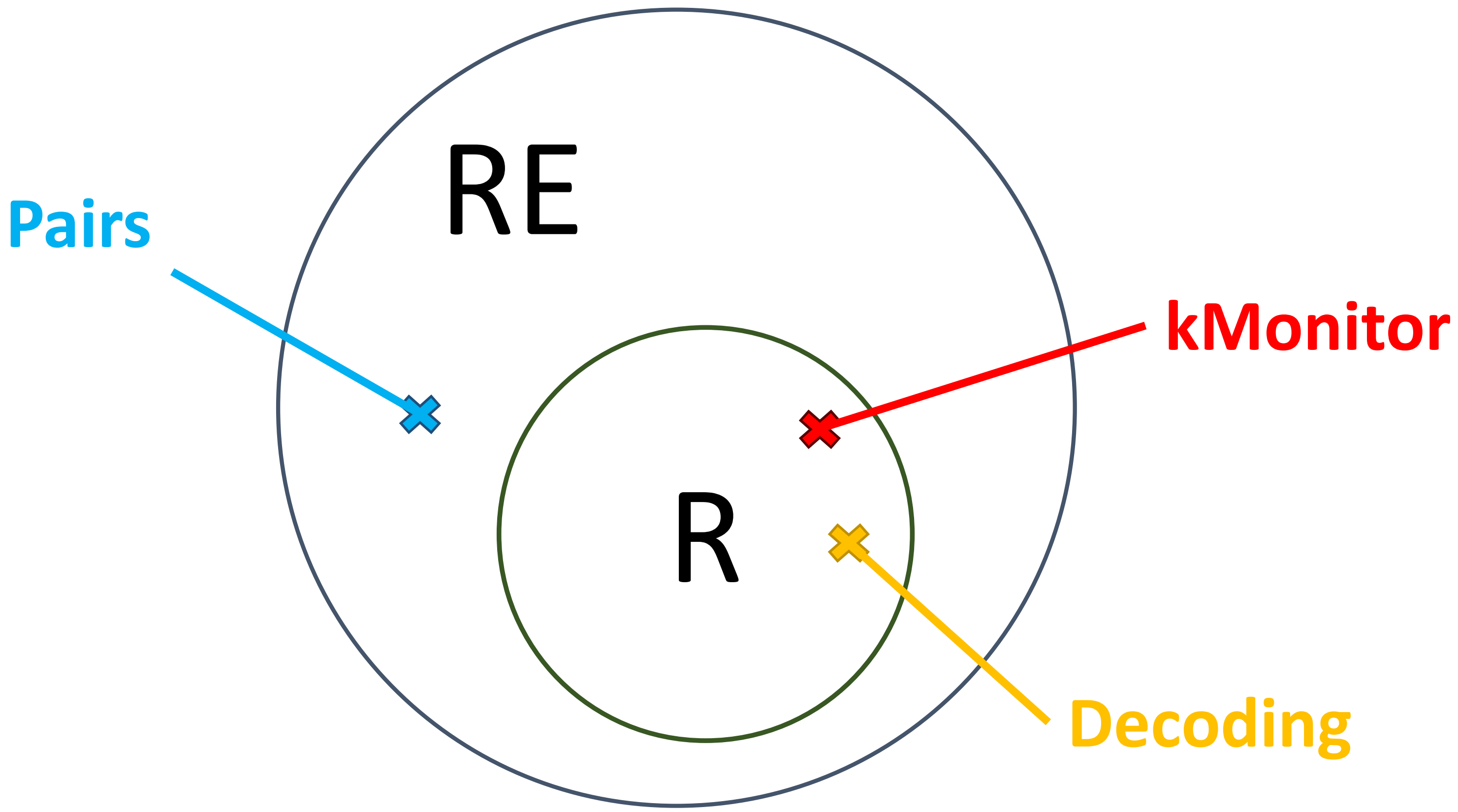
For a decision problem d**:**

- If a machine M *accepts* whenever d is TRUE, then "M **accepts** d"

- If a machine M *always halts* with the *correct answer*, then "M **decides** d"

The sets R, RE

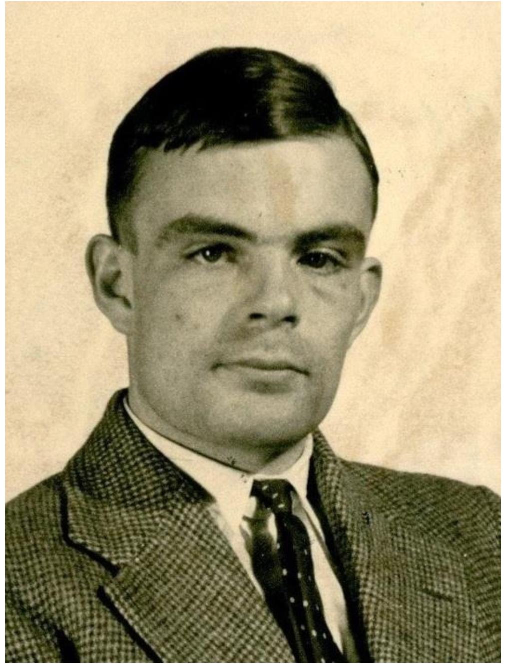
$RE = \{f \mid f \text{ is acceptable}\}$ $R = \{f \mid f \text{ is decidable}\}$



The Church-Turing Thesis

Alonzo Church
(1903 – 1995)

“The problems solvable by algorithms are exactly those computable by Turing machines.”



Alan Turing
(1912 – 1954)

Church: https://en.wikipedia.org/wiki/File:Alonzo_Church.jpg
Turing: https://commons.wikimedia.org/wiki/File:Alan_Turing_(1912-1954)_in_1936_at_Princeton_University_(cropped).jpg

All roads lead to R

Recursive functions

λ-calculus

Turing machines

Markov algorithms

RAM machines

Queue automata

Counter machines

Post canonical system

Wang B-machine

Uniform boolean circuits

Background: https://philippschmitt.com/archive/2018/work/roads-to-rome