# Theory of Formal Languages and Automata

## Lecture 0

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Sharif University of Technology

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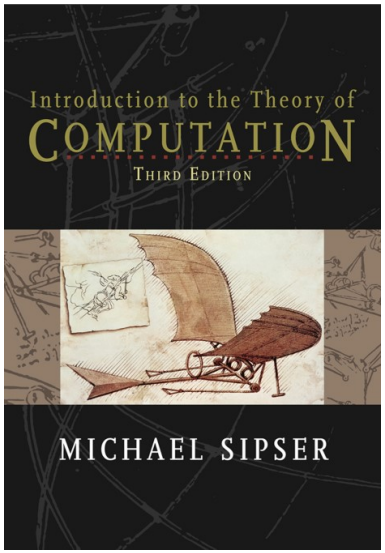
# Course Information

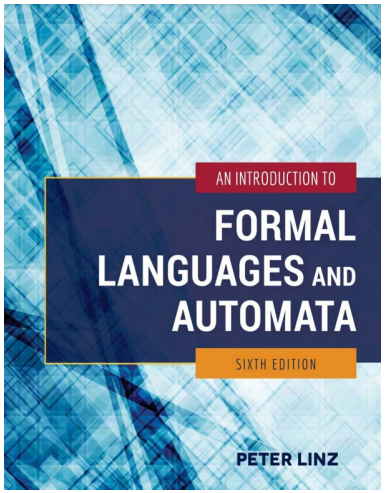
# Welcome!

- Instructor: Mahdi Dolati
- Grading:
  - approx. $1.5$ for 1 Study project
  - approx. $1.5$ for Attendance and participation
  - approx. $5$ for the Midterm exam
  - approx. $7$ for the Final exam
  - approx. $6$ for 5 Assignments

# Course Materials

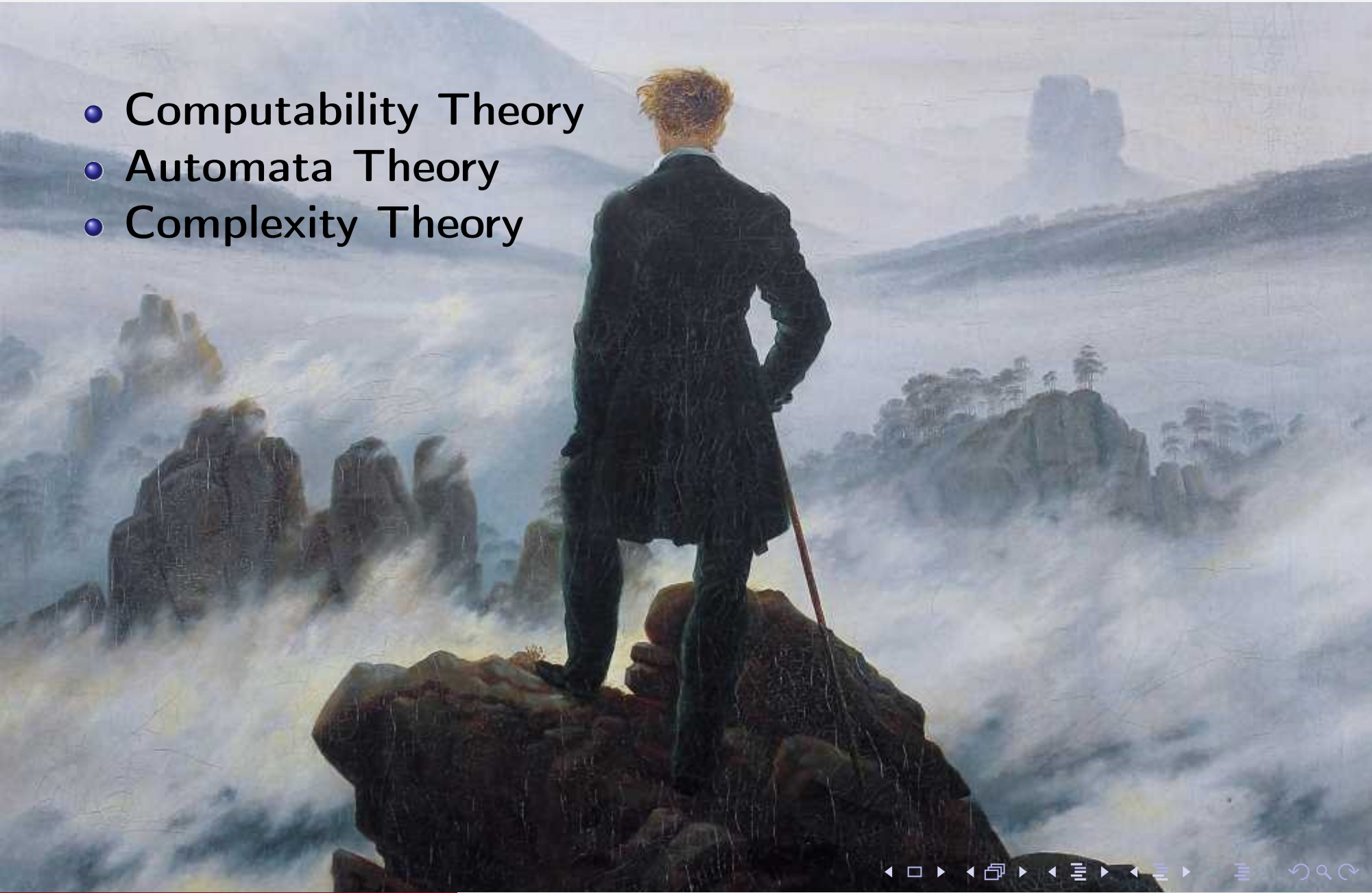



Introduction To The Theory Of Computation,
by: Michael Sipser




An Introduction to Formal Languages and Automata,
by: Peter Linz

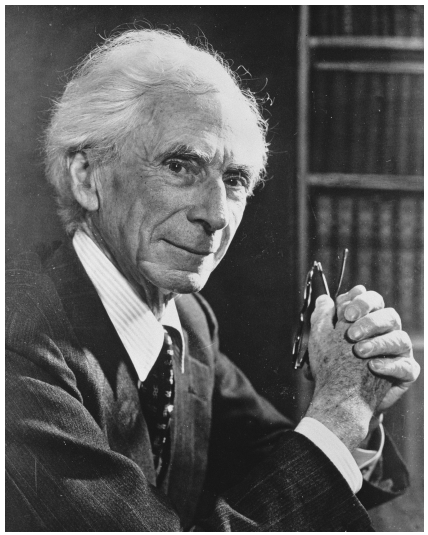
# Theory of Formal Languages and Automata



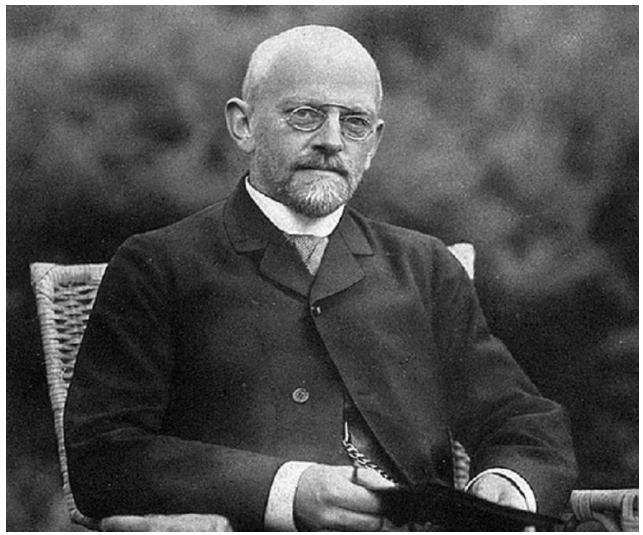
- Computability Theory
- Automata Theory
- Complexity Theory

# Computability Theory

- What is computable?



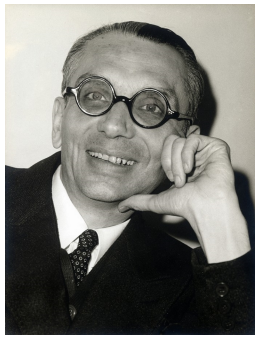
Bertrand Russell



David Hilbert

# Computability Theory

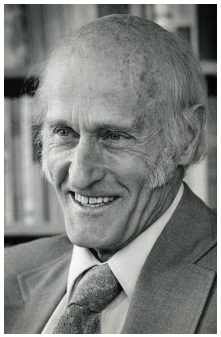
- What is computable?
  - Originated in the 1930s



Kurt Gödel

Alan Turing

Alonzo Church



Stephen Cole Kleene

Rózsa Péter

Emil Leon Post

- What is computable?
  - Examples:
    - Program verification
    - Mathematical truth

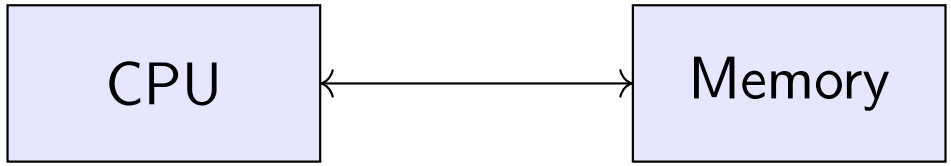
**Example (Unsolved Problem)**

Does the Collatz sequence eventually reach 1 for all positive integer initial values?

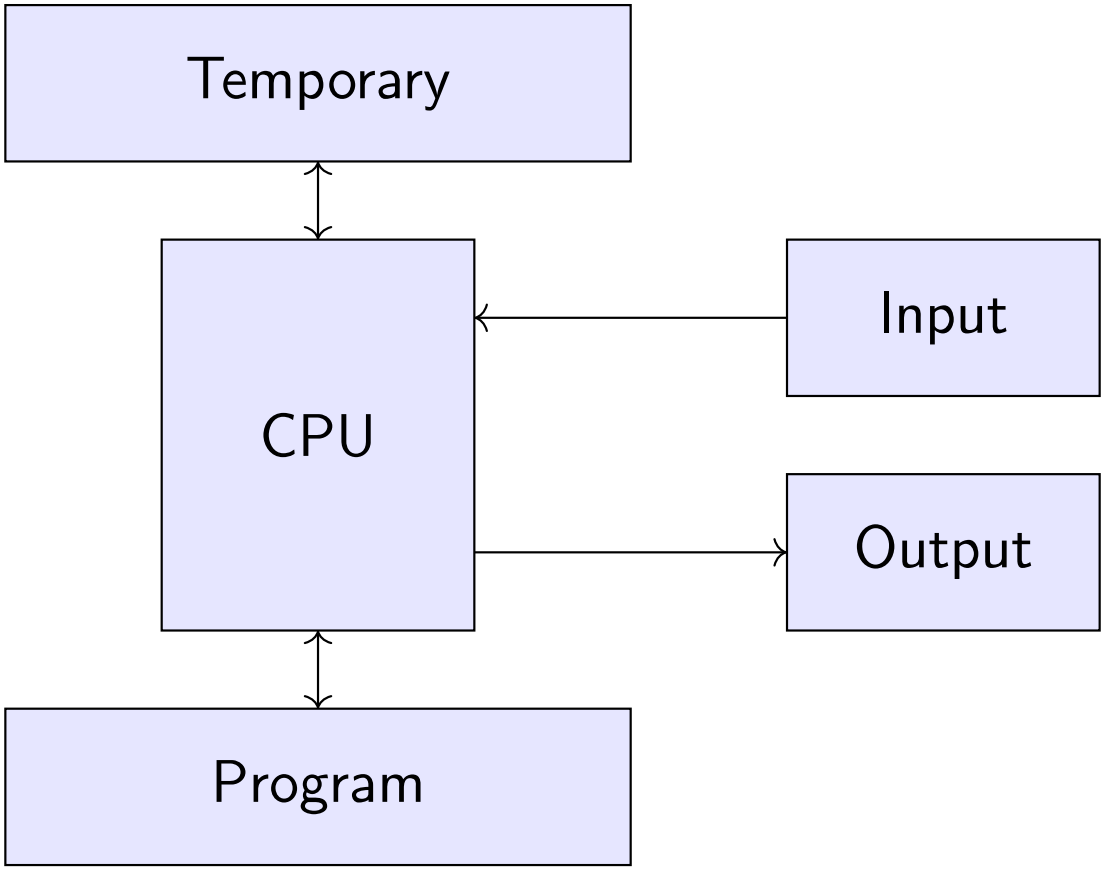
$$a_i = \begin{cases} n & \text{if } i = 0, \\ a_{i-1}/2 & \text{if } a_{i-1} \text{ is even}, \\ 3a_{i-1} + 1 & \text{if } a_{i-1} \text{ is odd}. \end{cases} \tag{1}$$

Requirement: Models of Computation,

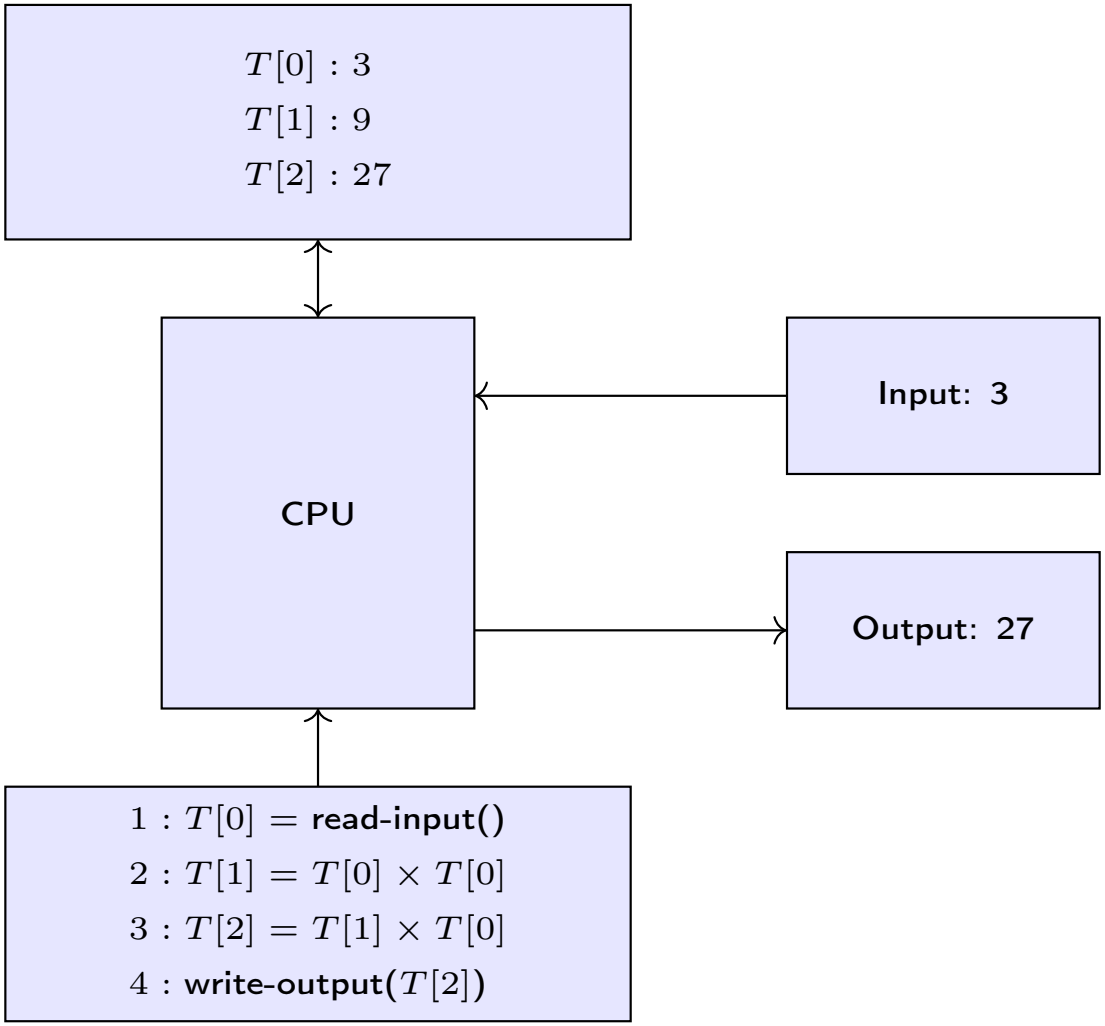
- An abstract device used to perform computation.



Requirement: Models of Computation



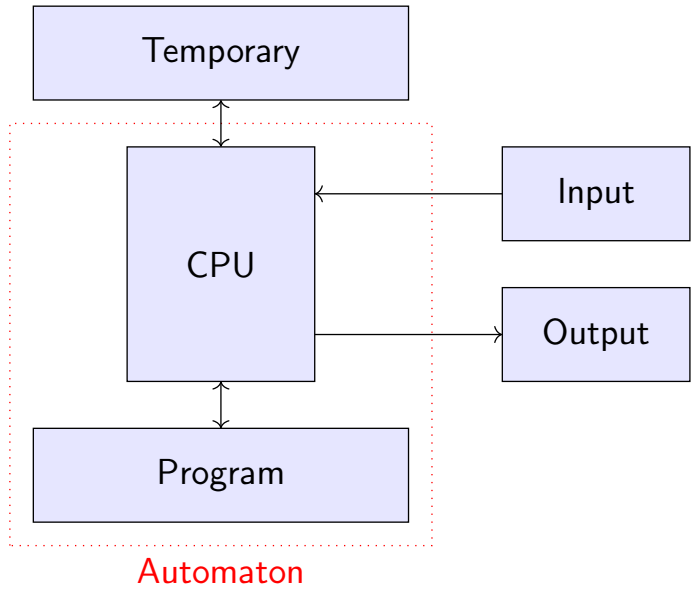
Requirement: Models of Computation
Example: $f(x) = x^3$.



# Automata Theory

Requirement: Models of Computation

- Finite automata
  - No temporary memory
- Pushdown automata
  - Temporary memory is a stack
- Turing machines
  - Temporary memory is a RAM




Power:

- Finite automata $<$ Pushdown automata $<$ Turing machines

# Complexity Theory

What is computable in practice?
Measures of complexity:

- Time
- Space

**Example (Unsolved Problem)**

Can integer factorization be solved in polynomial time on a classical computer?

RSA Factoring Challenge

- RSA Laboratories, March 18, 1991, ended in 2007
- RSA-768 (232 decimal digits) =
  123018668453011775513049495838496272077285356959533479219732245215172640050726365751874520219978646938995647494277406384592519255732630345373154826850791702612214291346167042921431160222124047927473779408066535141959745985690214 3413
  - December 12, 2009