Spring 2021

CS3613: Theory of Automata & Formal Languages

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About the Course & Text Book

Class Schedule

- Monday & Friday (Check your time-table:)

Consult course page on Portal and Network Folder for

- Lecture Notes, Quizzes, Assignments & Term Project

Text Book:

- Michael Sipser, “Introduction to the Theory of Computation”, 3rd Ed., Cengage Learning, 2013

Reference Books:

- John C. Martin, “Introduction to Languages and the Theory of Computation”, 4th Ed., McGraw Hill, 2011
- J.E. Hopcroft, R. Motwani and J.D. Ullman, “Introduction to Automata Theory, Languages and Computation”, 2nd Ed., Addison-Wesley 2001
- Elaine A. Rich “Automata, Computability and Complexity: Theory and Applications”, Prentice Hall, 2013

Assignment Policy

- In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments (by up to 2 days) will be accepted but penalized as per the following formula:

- Less than a day late: 20% penalty
- More than 1 day late but less than 2 days late: 40% penalty
- More than 2 days late: ***not accepted.***

General Topics

- *Abstract machine models* of computation (e.g., DFA, NFA, TM).
- Classes of grammars (e.g., regular grammars, context-free grammars, context sensitive grammars, unrestricted grammars).
- Classes of formal languages (e.g., regular, context-free, context-sensitive, recursive, recursively enumerable).
- Relationships between the languages, grammars and machines.

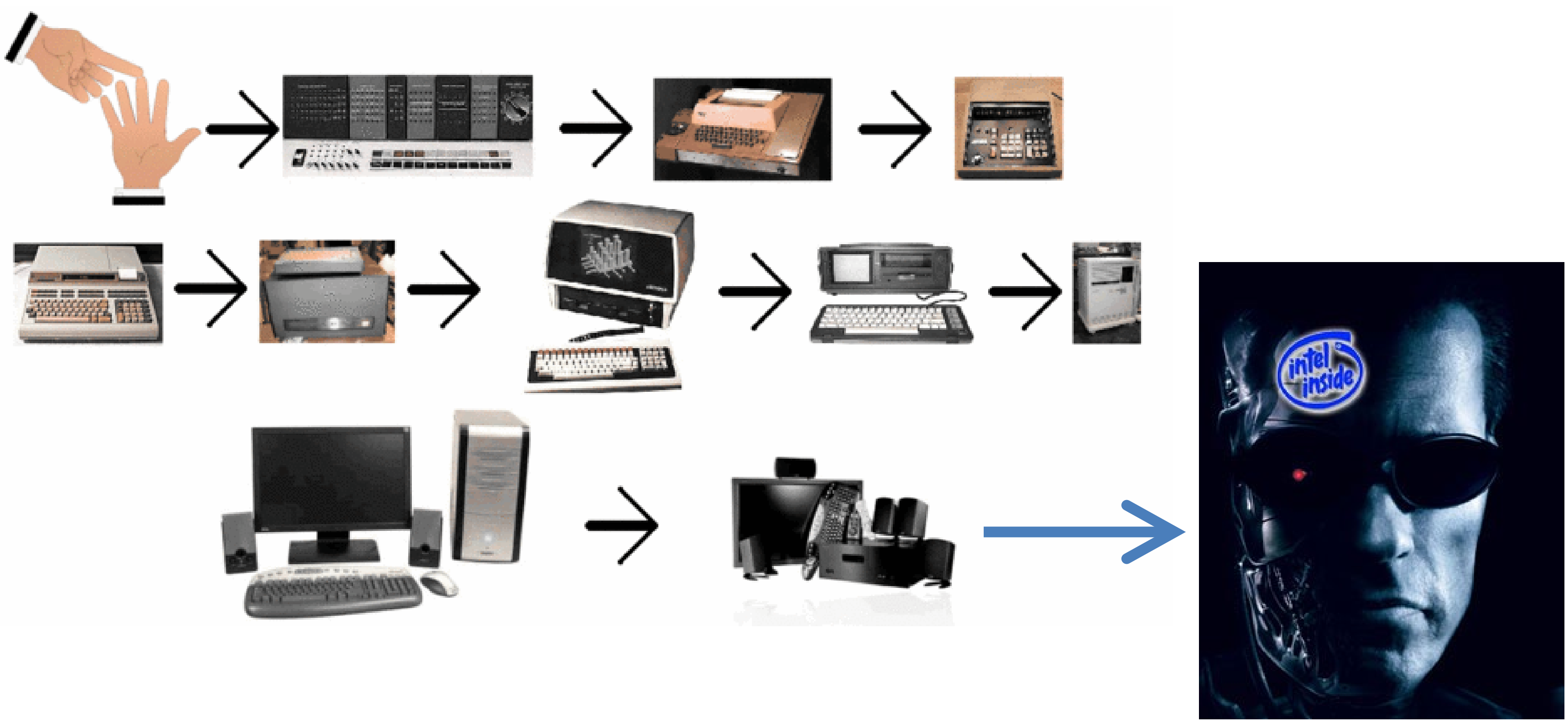
Practical Application/Relevance

- Pattern matching
  - Bioinformatics
  - Lexical analysis
- Design and Verification
  - Hardware & Software
  - Communication Protocols
- Parsing Languages
  - Compiler construction
  - Natural language processing, Machine Translation
- Algorithm design and analysis

Finite Automata

What is a Computer?

- This question, considering hardware, may have different answers in different eras!



Timeless response

A Computer

≡

An idealized Computer

≡

A Computational Model

Note: Like a Mathematical model, a computational model may only be accurate in certain aspects.

Examples of re-programmable machines

- [Jacquard loom]
- [Babbage Difference Engine]
- [Colossus by Turing]
- [DNA Computer]
- [Quantum Computer]
- ……………???

The simplest Computational Model

- The simplest Computational Model is called the ***finite state machine*** or ***finite automaton***.

- *To this simplest computational model, lets define its building blocks !*

Finite Automata

- A finite automaton (FA) is a simple idealized machine used to recognize patterns within input taken from some character set (or alphabet) C.
- The job of an FA is to accept or reject an input depending on whether the pattern defined by the FA occurs in the input.

Alphabets

- We define an ***alphabet*** to be any non-empty finite set, usually denoted by Σ.

Examples:

$\Sigma_1 = \{0, 1\}$

$\Sigma_2 = \{a,b,c\ldots, x,y,z\}$

- Σ_1 and Σ_2 are two alphabets
- 0, 1, a, b, c… are called ***letters***

Strings

- A *word* w is a string of letters from Σ in a linear sequence.
- We are interested only in finite words (bounded length).
- |w| denotes the *length* of word w.
- The *empty string* contains no letters and is written as λ .

Languages

- A *language* L is a set of strings.

- For example, if $\Sigma = \{0,1\}$,

  then $L_1 = \{\varepsilon, 0, 1, 00, 01, 10, 11\}$ is a language

  $L_2=\{0000, 1111\}$ is another language over Σ

A real world example

- The controller of an automatic door is one example of such finite automaton [Sipser07]

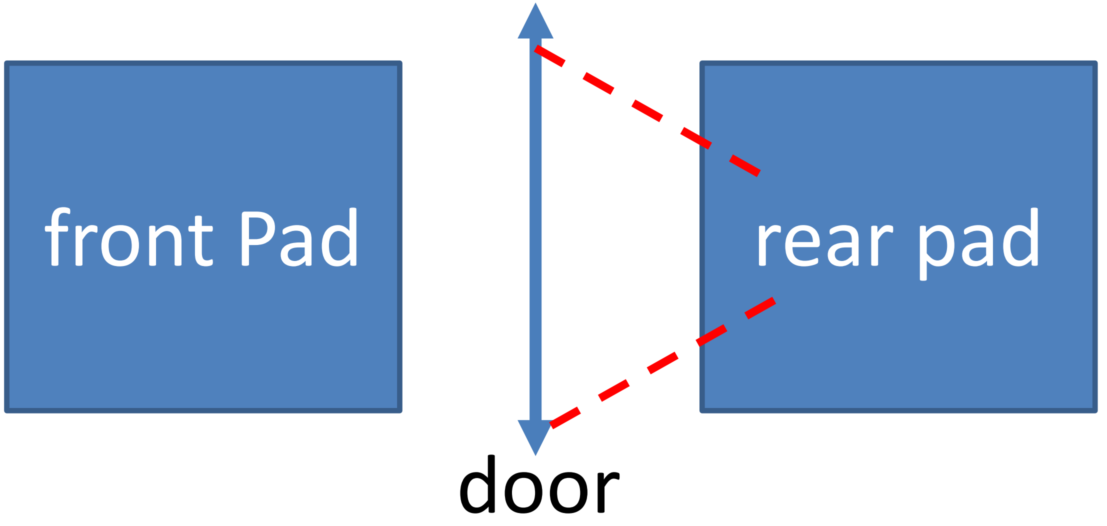


Fig. Top-down view of an automatic door

A real world example

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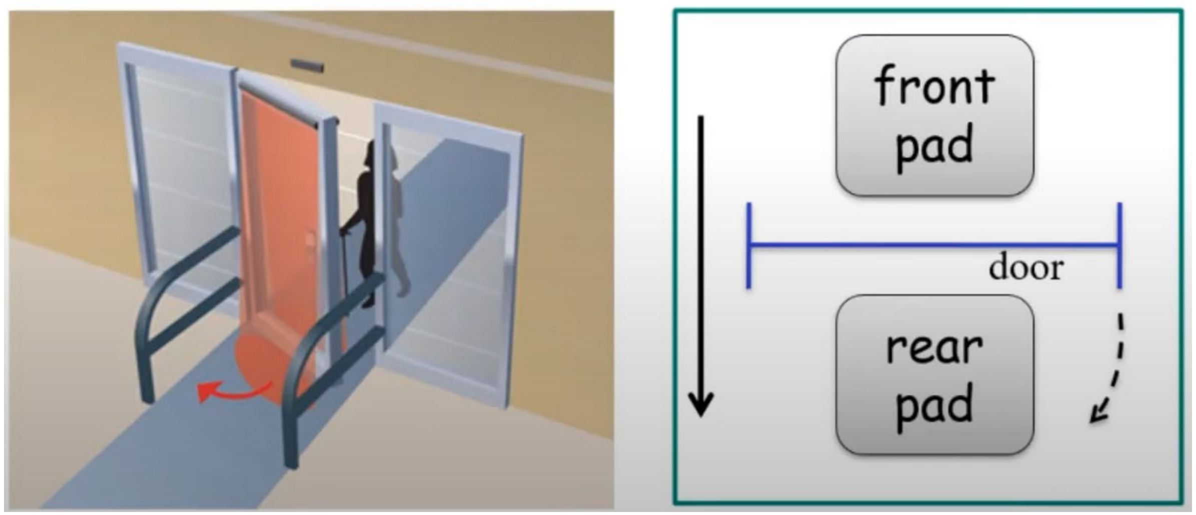
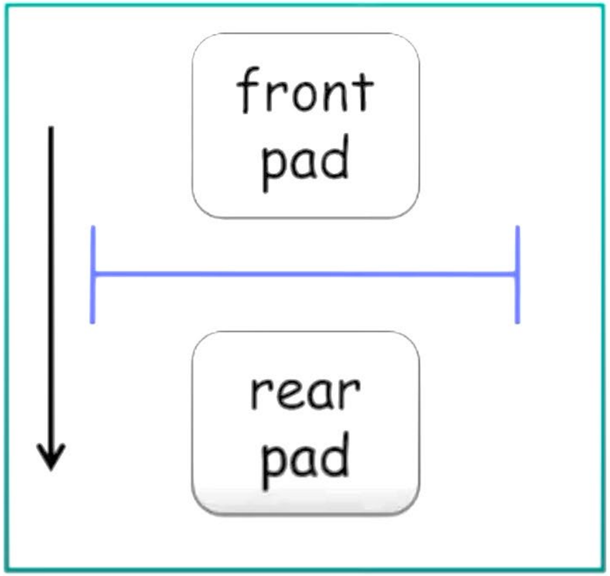


Fig. Top-down view of an automatic door

A real world example

- Front pad detects a person about to walk through.
- Rear pad detects a person standing behind the door.
- Two *states* for the door:
  - Open
  - Close
- Four possible *inputs*:
  - Front
  - Rear
  - Both
  - Neither

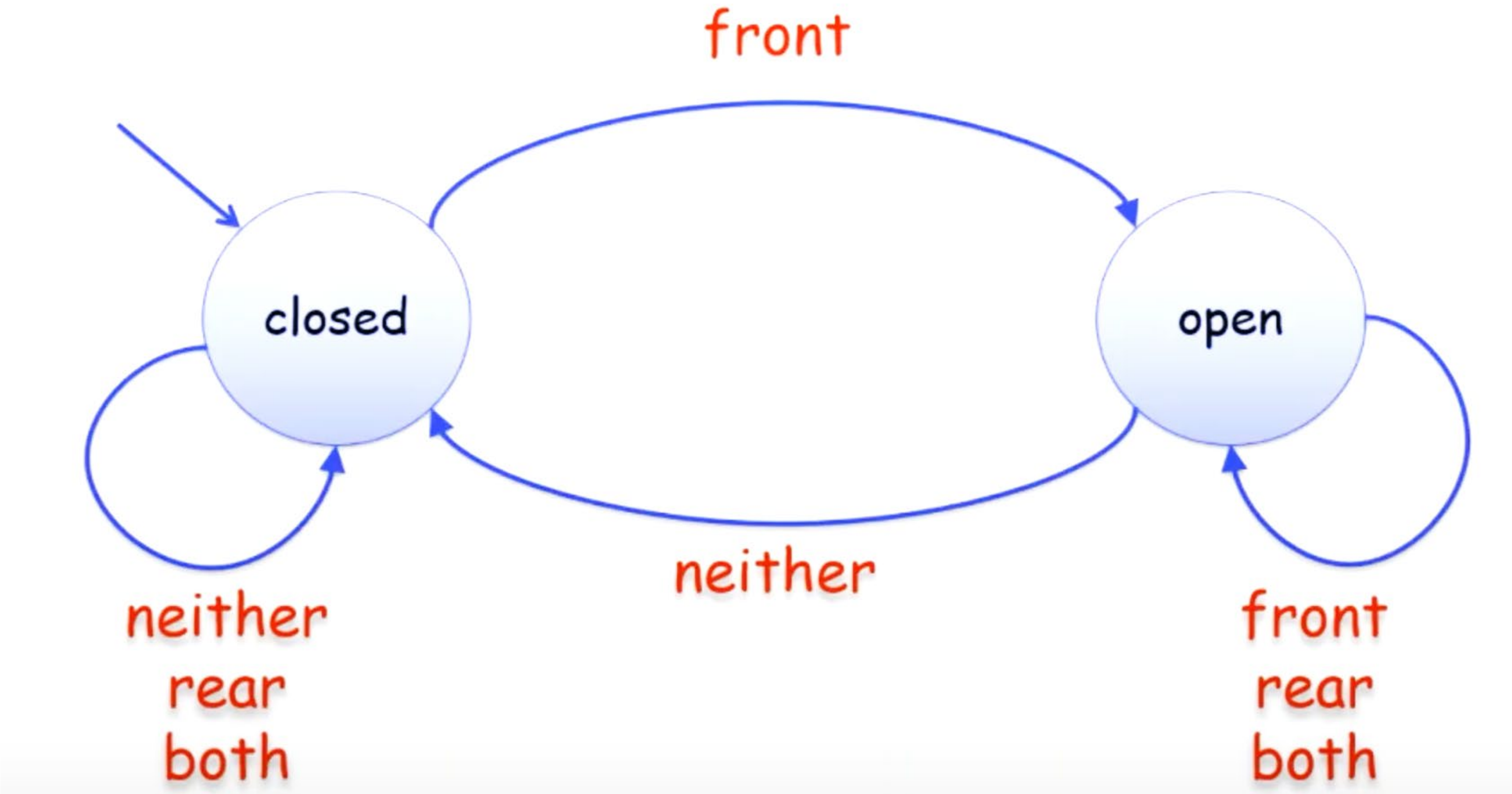


A real world example

Input signal

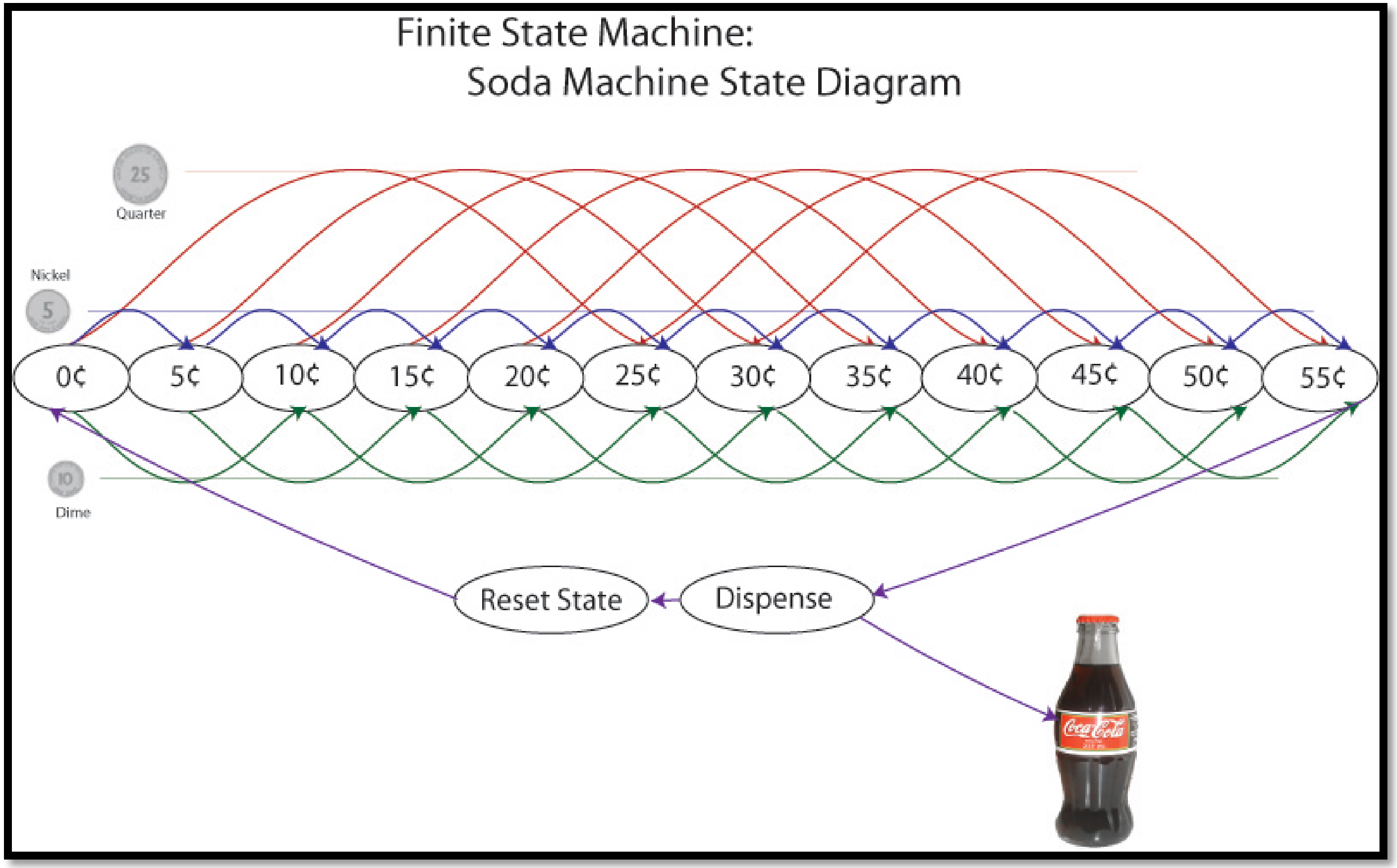
state		Neither	Front	Rear	Both
	Closed	closed	open	closed	closed
	Open	closed	open	open	open

A real world example



Note

- A vending machine is also a good example of finite state automaton



Questions?

Thank You!