CPSC 421: Introduction to Theory of Computing **Winter Term 1 2018-19**

Lecture 2: September 7

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2.1 Finite Automaton (DFA)

Why?

- To study the languages related to F.A.
- 1. As a stepping-stone to richer computational models
  2. Useful background for NLP and compilers
  3. To understand regular expressions

Informal definition: A computational machine for a decision problem on any input string, either:

1. outputs Accept and halts
2. outputs Reject and halts
3. runs forever

In case 1 we say that machine accepts w. The language *accepted by machine* M

$$L = \{w \in \Sigma^* : Macceptsw\}$$

Theme: Understand relationship between:

- classes of machines
- classes of languages $\equiv$ classes of decision problems they can solve
- and their properties

Finiate Automata

What is L or $L(M)$?

Is it:

- $\{w$: either w ends in 1 or # 0s after the last 1 is even$\}$
- $\{w : w$ contains a 1, and after the last 1, has even number of 0s$\}$

Definition 2.1 *A finite automaton is a 5-tuple* $M = (Q, \Sigma, \delta, q_0, F)$ *where*

- Q *is a finite set (set of states)*
- Σ *is a finite set (the alphabet)*
- $\delta : Q \times E \to Q$ *(the transition function)*
- $q_0 \in Q$ *(start state)*
- $F \in Q$ *(the accepting state)*

2.2 "Language Accepted By"

Definition 2.2 *A F.A. M accepts input string* $w \in \Sigma^*$ *if there exists a sequence* $r_0, r_1, r_2, \cdots, r_n \in Q$ *s.t.*

- $r_0 = q_0$
- $r_i = \delta(r_{i-1}, w_i), \forall i = 1, \cdots, n$
- $r_n \in F$

Think of $r_0, \cdots, r_n$ *as the sequence of states visited during the machine's computation.*

$L(M) = \{w \in \Sigma^* : M \text{ accepts } w\}$

- *The language accepted by M*
- *The language decided by M*
- *The language recognized by M*

$L = \{11011, 110011, 1100011, 11000011, \cdots\}$

Implicit Error States: If δ is not fully specified, then we assume an implicit transition to an "error state".

2.3 Regular Language

Definition 2.3 *A regular language is any language accepted by some Finite Automaton. The set of all regular languages is called the the class of regular languages.*