18.404 Recitation 1

Sept 4, 2020
Today’s Topics

- Terminology: Finite Automata
- Example: Finite Automata
  - $\Sigma^*$ (Sigma-star)
  - $\emptyset$ (empty language)
  - $\{\Sigma\}$ (single string)
  - $\{\varepsilon\}$ (empty string)
  - Even number of 0s
- Terminology: Regular language
- Theorem: Every finite language is regular
- Theorem: Regular languages are closed under reversal
Terminology: Finite Automata

- Automata States
  - One start state
  - One or Many accept states
- Automata Transitions
  - Flow follows direction of arrow
  - Every transition consumes one unit from the input. No going back or re-reading input!
- 5-Tuple Definition:
  - $(Q, \Sigma, \delta, q_0, F)$
Terminology: Finite Automata (cont.)

- Automata accepts string
  - Given an input string, is there a path of valid transitions such that:
  - When entire string has been fully consumed, current state is an accept state.
  - “$M_1$ accepts $S$” or $S \in L(M_1)$
- Language
  - Set of all strings accepted by $M_1$
Example: Finite Automata ($\Sigma^*$)

- What is $\Sigma$?
- What does the * do?

What does the language $\Sigma^*$ mean in plain English?

Draw out Finite Automata:
Example: Finite Automata ($\Sigma^*$)

- What is $\Sigma$?
- What does the $*$ do?

What does the language $\Sigma^*$ mean in plain English?

Draw out Finite Automata:
Example: Finite Automata (Ø)

- What is Ø?

What does the language Ø mean in plain English?

Draw out Finite Automata:
Example: Finite Automata (Ø)

- What is Ø?

What does the language Ø mean in plain English?

Draw out Finite Automata:
Example: Finite Automata (\{\Sigma\})

What does the language \{\Sigma\} mean in plain English?

Draw out Finite Automata:
Example: Finite Automata ({$\Sigma$})

What does the language {$\Sigma$} mean in plain English?

Draw out Finite Automata:
Example: Finite Automata ($\{\varepsilon\}$)

What does the language $\{\varepsilon\}$ mean in plain English?

Draw out Finite Automata:
Example: Finite Automata ($\{\varepsilon\}$)

What does the language $\{\varepsilon\}$ mean in plain English?

Draw out Finite Automata:
Example: Finite Automata (Even number of 0s)

Ideas?

Draw out Finite Automata:
Example: Finite Automata (Even number of 0s)

Ideas?

Draw out Finite Automata:
Terminology: Regular Language

Any language for which a valid Finite Automata exists

- Can be a finite language ($|L(M)| = \text{some number}$)
- Can be an infinite language ($|L(M)| = \infty$)

Non-regular languages exists!

- Example in future lecture
Theorem: Every Finite Language is Regular

Direct construction

Closure under union
Theorem: Every Finite Language is Regular

Direct construction

Closure under union
Theorem: Regular Languages Closed Under Reversal

Ideas?

- Objective is to recognize $A^R$ where $A$ is language of $M$
  - Formally: $A^R = \{ w \mid w^R \in A \}$ where for $w=w_0w_1...w_n$ and $w^R=w_n...w_1w_0$
- We have the Finite Automata of $M$
- Need to devise Finite Automata $M_{rev}$
Theorem: Regular Languages Closed Under Reversal (cont.)

Draw simple conceptual example:

![Diagram of a simple conceptual example for the theorem.](image-url)