BRAC UNIVERSITY

Inspiring Excellence

Lecture Plan

CSE331: Automata And Computability

Faculty: Rafiad Sadat Shahir [RSS]

Lecture 1: Theory of Computation

- Computability and Complexity Theory
- Automata Theory
- Preliminaries:
  - Sets and Set Operations
  - Proofs

Lecture 2: Deterministic Finite Automata

- Alphabets, Strings, Languages
- Finite Automata (FA)
- Deterministic Finite Automata (DFA)
  - State Diagram
  - Formal Definition
  - Designing DFA
- Regular Language: A language is called a **Regular Language** if some finite automata recognizes it.

Lecture 3: DFA (Continued)

- Regular Operations
  - Union
  - Concatenation
  - Kleene Star
- Closure of RL Under Union, Intersection, Complement
  - Cross Product of DFA
  - DFA Negation

Lecture 4: Non-deterministic Finite Automata

- Non-deterministic Finite Automata (NFA)
  - State Diagram
  - Formal Definition
  - Designing NFA
- Difference Between DFA and NFA

Lecture 5: Equivalence of NFA and DFA

- Epsilon Closure
- NFA to DFA using the Subset Construction
- Theorem: A language is regular **if and only if** some NFA recognizes it.

Lecture 6: Regular Expressions

- Regular Expressions (RE)
  - Formal Definition
  - Designing RE
- Precedence of Regular Operators
- Union & Concatenation of RE with ε, ∅

Lecture 7: RE to NFA

- Closure of RL Under Concatenation, Kleene Star
- RE to NFA using Thompson's Construction Method
- Lemma: If a language is described by a regular expression, then it is regular.

Lecture 8: FA to RE

- GNFA
- FA to RE using State Elimination Method
  - Steps of the Conversion
- Theorem: A language is regular **if and only if** some regular expression describes it.

Lecture 9: Pumping Lemma

- Pumping Lemma for RL
- Proving Non-regularity using Pumping Lemma
  - Steps of Proof
  - Using Closure Properties of RL
  - Pumping Up and Pumping Down
- Necessary Condition for Regular Languages

Lecture 10: Context-Free Grammar

- Non-regular Languages
- Context-Free Grammar (CFG)
  - Formal Definition
  - Derivation
    - Leftmost and Rightmost Derivation
  - Parse Tree
  - Designing CFG
- Context-Free Languages

Lecture 11: CFG (Continued)

- DFA, NFA to CFG
  - Every Regular Language is Context-Free
- RE to CFG
- Closure of CFL Under Union, Concatenation, Kleene Star
- Ambiguity of CFG

Lecture 12 & 13: Pushdown Automata

- Pushdown Automata (PDA)
  - State Diagram
  - Formal Definition
  - Designing PDA
- PDA for RL
- Additional Topics:
  - Equivalence of CFG and PDA
  - Pumping Lemma for CFL

Lecture 14: Turing Machine

- Turing Machine (TM)
  - Formal Definition
  - State Diagram
  - Designing TM
  - Configuration of TM
- Difference with FA

Lecture 15 & 16: TM (Continued)

- Church-Turing Thesis
- Turing Decidable and Recognizable Languages
- Proving a Language Decidable
  - Notations for Encoding
- Universal Turing Machines
- The Halting Problem
  - Theorem: $HALT_{TM}$ is Undecidable

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