

AUTOMATA and LANGUAGES

- Finite Automata and Regular languages
- Non-Deterministic Finite Automata: NFA \rightarrow DFA
- Regular Expressions: DFA \rightarrow Regular Expression
- Equivalence of Regular Exp with Finite Automata: Reg Exp \rightarrow NFA
- Closure Properties of Regular Languages (\cup , \cap , \cdot , * , $-$)
- Equivalence of DFAs (formula) and Minimizing DFAs
- The Pumping Lemma and Non Regular Languages; Context-Free Grammars and Push Down Automata; Ambiguous and Non-Ambiguous Context-Free Languages
- Chomsky Normal Form; Equivalence of PDAs and CFGs
- The Pumping Lemma and Non-Context-Free Languages

COMPUTABILITY and DECIDABILITY/UNDECIDABILITY

- Turing Machines and variants, including non-deterministic Turing Machines
- Decidability/semi-Decidability (T-Recognizable)/Undecidability; A_{TM} , $HALT_{TM}$, E_{TM}
- Reducibility: Oracle TMs, Turing vs Mapping (many-one) Reducibility
- More Undecidability/non-Turing-Recognizable via Mapping Reducibility: Many examples
- The Recursion Theorem/Rice's Theorem/The Fixed Point Theorem
- Post Correspondence Problem
- Arithmetic Hierarchy

COMPLEXITY THEORY and P vs NP

- Time Complexity and Polynomial Time
- Non Deterministic Turing Machines and the Class NP
- Polynomial Time Reducibility, Examples of poly-time reductions
- NP-Completeness: (Cook-Levin Theorem), 3-SAT, CLIQUE, Vertex-Cover, HamPath, SUBSET SUM, etc
- Space Complexity: Savitch's Theorem (Cor. PSPACE = NPSPACE);
- PSPACE-Completeness: TQBF is PSPACE-Complete, also FORMULA GAME and Generalized Geography
- Randomized Complexity: Schwartz-Zippel; Probabilistic TMs: BPP, RP