

## Summary and Concluding Remarks

Q: What are the fundamental limits and capabilities of computers?

We saw the following topics:

### \* Automata Theory:

- Regular languages : DFA, NFA, Regexp, Closure Properties, Pumping Lemma, Myhill Nerode
- Context-Free languages : CFG, PDA, Chomsky Normal Form, Ambiguity, Pumping Lemma, CYK Algorithm

### \* Computability Theory:

- Turing Machines: Variants like multi-tape, NTM, Church Turing Thesis

- Decidable and Undecidable languages:  
Decidable languages such as A DFA, ANFA, EDFA, ACFA, EQDFA etc. ATM is undecidable. (Countable and uncountable sets)

- Reductions: Undecidable languages such as HALT<sub>TM</sub>, REGULAR<sub>TM</sub>. Rice's theorem. Computation Histories. PCP.

## \* Complexity Theory:

- Time Complexity: P, NP, Verifier model for NP, Polynomial time reductions, NP-completeness, Cook-Levin theorem (SAT is NP-Complete), Other NP-Complete Problems.
- Space Complexity: Basic Model for Space Complexity, Relation between time and space complexity.

Classes  $L$  and  $NL$ ,  $NL$ -Completeness,  
Savitch's theorem, Other results  
( $NL = co-NL$  and  $PSPACE$  - Completeness).

Topics that can be pursued:

- \* Chapter 9 and 10 of Sipser.
- \* Hierarchy Theorems, Relativization, Oracles, Polynomial Hierarchy,
- \* Circuit Complexity
- \* Randomized Computation
- \* Counting Complexity
- \* Interactive Proofs.

(Check out my NPTEL course on  
Computational Complexity)

Finally

- \* let me know any feedback .
- \* Write to me at [SUBBUK@CSE.IITH.AC.IN](mailto:SUBBUK@CSE.IITH.AC.IN)
- \* Hope you enjoyed learning and will continue to be interested in these topics .



THANK YOU!

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