CS 4510 : Automata and Complexity
Introduction to the course

January 11, 2010

- **Instructor :** Subrahmanyam Kalyanasundaram
- **Class times :** MWF 3:05 - 3:55 pm, at Bunger Henry 311.
- **Grading Policy :**
  - 4-5 Homeworks = 25%
  - 2 Mid terms = 40%
  - Final Exam = 35%
- **Text Book :** "Introduction to the Theory of Computation", by Michael Sipser.
- **Resources :**
  - Class website : `www.cc.gatech.edu/~subruk/4510.html`
  - T-Square : I shall put up resources here as well
  - Please check both these places frequently for updates
- **Contact :** Klaus 2116 during office hours. Email me at `subruk@cc.gatech.edu to see me outside office hours.`

As the title suggests, this course is intended to give an introduction to Automata Theory and Computational Complexity. We shall cover chapters 1, 2, 3, 4, 5, 7 and 8 of the textbook in this course. Please read through Chapter 0 of the book to familiarize yourselves with some basics. It's around 25 pages, is a fairly easy read. Please contact me if you have any difficulties reading chapter 0.

Feel free to consult me in case of any questions or suggestions that you may have, or if you need any help with the course. I would appreciate an interactive class, I think this would make the class fun for both the instructor and the students. The detailed topics and syllabus for the course below.

Syllabus :

- **Chapter 0:** Introductory concepts in formal languages and automata theory: languages, operations on languages, and basic machine models.
- **Chapter 1:** Regular languages: Deterministic and nondeterministic finite state automata. Closure under union, intersection, complementation, concatenation, and star operations. Equivalence of Non-deterministic finite state automata and deterministic finite state automata. Regular expressions and equivalence of regular expressions and regular languages. Pumping lemma. Myhill-Nerode theorem.
- **Chapter 2:** Context-free languages: Context-free grammars. Ambiguity. Normal forms such as Chomsky normal form. Closure under union, concatenation, and star operations. Non-closure under intersection and complementation operations. Parse-trees. Pumping lemma. Pushdown automata. Equivalence of pushdown automata and context-free grammars. Cocke-Kasami-Younger algorithm.
- **Chapters 3,4:** Decidability: Turing machines. Decidable and recognizable languages. Equivalence of varieties of models such as multi-tape and non-deterministic Turing machines with the deterministic Turing machines. Diagonalization. Undecidability of the Halting problem.
- **Chapter 5:** Reducibility: Undecidable problems from Language theory. Post Correspondence Problem. Many-one reducibility.
- **Chapter 7:** Complexity Theory: Time Complexity Complexity classes P and NP. Polynomial time reducibility. NP-Completeness. The Cook-Levin theorem. Examples of NP-Complete problems.
- **Chapter 8:** Complexity Theory: Space Complexity Space complexity. Savitch's theorem. PSPACE-Completeness. The classes L and NL. NL-Completeness. NL equals co-NL.