**CS 532: Formal Languages** **Fall 2000**

Lecture 1 — August 28

*Lecturer: Xiang-Yang Li* *Scribe: Xiang-Yang Li*

## 1.1 What is this course about? Why study theory?

This course provides an introduction to the theory of formal languages and machines. We start by defining strings, alphabets, and languages. We then define grammars of different kinds and introduce the Chomsky Hierarchy of languages and corresponding machines. The first half of the course, up through the midterm is centered on regular sets and finite automata. The second half will be spent mostly on context free languages of various types, but we will define Turing machines and introduce the question of decidability at the end.
Particular topics to be covered by this course include but not limited to:

- Finite automata, regular languages, and regular grammars.
- Deterministic and nondeterministic computations on various automata.
- Context free grammars, languages, and pushdown-automata
- Turing machines, Church's thesis, and undecidable problems
- Computational complexity, polynomial-time reductions, NP-completeness, and Cook's theorem.

Other material covered in the process of the course include

- related practical issues from architecture and circuits
- parsing computer and natural languages
- practice with mathematical logic/proofs
- practice with mathematical, precise writing

This course is interested in properties of computation models, e.g.,

1. **countability:** What is the size of set/language?
2. **decidability:** What questions can be answered?
3. **computability:** What languages can be computed?

In addition, this course is interested in relations between models:

- e.g., between machines and languages—- which machines recognize which languages?
- e.g., between machines—- richer control structure and more resources allow accepting larger class of languages; what machines are "universal" – sufficiently powerful to do "anything"
- e.g., between languages—- which languages require more complicated machines?

**Which models?** There are many models of computation exist. Sure, we can't cover them all. We will concentrate on three groups of models: regular grammars; context free grammars; Turing machines.

## 1.2 Class administration

See web page *http://www.cs.iit.edu/∼xli/cs532.html* for more details.

### 1.2.1 Course Information

**Lecturer:** Xiang-Yang Li.

URL: http://www.cs.iit.edu/∼xli;

Email: xli@cs.iit.edu.

Office Hours: 4:00PM-5:00PM MW, or by appointment.

Office: TBA

**TA:** TBA.

Office Hours: TBA or by appointment.

Office: TBA

**Miscellaneous:** Starting Date: 8-28-00; Ending Date: 12-9-00.

ClassTime: 5:00PM-6:15PM (M, W)

Classroom: 220 SB.

The class homepage is http://www.cs.iit.edu/∼xli/cs532.html.

**All handouts and important information will be posted there. Please check it for new information.**

### 1.2.2 Textbook

The official course text is *Introduction to Formal Languages & Automata 2nd 97* ; Peter Linz; Hardcover, 377 pages; Jones and Bartletts, 1997.

One useful text is *Elements of the Theory of Computation - 2nd. ed.*; Harry R. Lewis, Christos H. Papadimitriou; Hardcover, 352 pages; Prentice-Hall, August 1997.

Another useful text, that is also a classic, is *Introduction to Automata Theory, Languages, and Computation*; John E. Hopcroft, Jeffrey D. Ullman; Hardcover, 418 pages; Addison-Wesley, April 1979.

You will also find another text useful later in the course: *Computers and Intractability: A Guide to the Theory of NP-Completeness*; Michael R. Garey, David S. Johnson; Paperback, 338 pages; W. H. Freeman & Co., June 1979.

### 1.2.3 Lecture Notes

The course will be more likely organized as follows.

- Week 1. Introduction.
- Week 2. Finite Automata.
- Week 3. Regular Expressions.
- Week 4. Finite Automata with Output.
- Week 5. Pumping Lemma for Regular Sets.
- week 6. Myhill-Nerode Theorem.
- Week 7. Midterm (date to be announced)
- Week 8. Context-Free Grammars.
- Week 9. Simplification of CFG's.
- Week 10. Chomsky and Greibach Normal Forms.
- Week 11. Push-Down Automata.
- Week 12. Pumping Lemma for CFL's.
- Week 13. Closure Properties and Decision Algorithms.
- Week 14. Turing Machines and Undecidability.
- Week 15. Final Examination.

However, it may have some changes if necessary. I will try to put online lecture notes if possible. For more, see *http://www.cs.iit.edu/cs532/lectures.html*.

**Notice:** To save the time of every students' time, each student will be required to write a scribe notes of one class.

### 1.2.4 Homework

- There will be problem sets roughly every week, usually released on the last lecture of that week, and due by the beginning of the first class of the next week.
- You may take an **automatic extension** by handing in the assignment on the specified extended due date and time (usually the following Wednesday by the end of class)but with 10% deduction on this homework grade.
- **No late assignments handed in after the extended deadline will be accepted.** Requests for an additional extension will almost always be denied.

- In this course you are allowed to discuss the problems with your classmates, and to work together. If you choose to do so, please indicate the name(s) of the people with whom you have worked. Otherwise, it will be treated as cheating! Keep in mind that you may discuss *assignment problems, general proof strategies, or general algorithms* with other students in the course, but you may not collaborate in *the detail development or actual writing* of problem sets. Consulting with students outside of the course, or using past notes or solutions, etc., is expressly forbidden. Refer to the Campus Code regarding academic integrity.
- Please help us by stapling all written pages, labeling them with your name, and clearly labeling each problem. You don't want us to lose part of your assignment or not see your answers, do you?

  See *http://www.cs.iit.edu/∼xli/cs532/homework-guidelines.html* for some guidelines of written homework by Prof. L. Pitt from UIUC.

### 1.2.5 Examinations

There will be one midterm exam, and one final exam. The midterm exam will probably be scheduled for the evening. Details will be announced via the class homepage soon. You will be responsible for all material covered in lectures, homeworks, and assigned readings.

- **The midterm is tentatively scheduled for the evening of ….**
- **The final exam is officially scheduled on ….**

### 1.2.6 Grading Policy

**Tentative** weighting scheme is as follows. However, the instructor reserves the right to make adjustments to these weights based on his a posteriori evaluation of the relative difficulty and fairness of the exams and homeworks.

- Homeworks: 40%,
- Midterm Exam: 30%
- Final Exam: 30%.

Each problem will be graded 80% for correctness and 20% for style and clarity. Good style means giving a sound logical argument and a clear presentation, sufficient to convince someone, who knows the material but not the answer, that your answer is correct. Consider your audience to be a skeptical classmate. Good style also implies that an answer should be reasonably thorough, as well as reasonably concise.

**Note:** In order to pass the class, you must do sufficiently well on **each** of the categories in the table above. In particular, credit will not be given to those who skip many homeworks and rely on stellar exam scores.

**Regrades:** If you feel that a problem was graded incorrectly, please contact the teaching assistant first. Contact the instructor if there is still a disagreement. For best results, please attach a short note stating what you want regraded and why.

**We want everyone happy and satisfied in learning.**

### 1.2.7 How to get the most out of this course?

It is better for you to have taken the prerequisite courses for this course. However, more important than any course is sufficient mathematical maturity to understand the difference between handwaving and proving.

> Handwaving is what I do on the board; proving is what you do on your homeworks–
> L. Pitt, University of Illinois.

Some of the problems will be difficult, and some of the homeworks may require a significant amount of time.

Attend lectures, read the book, and refer to the course notes. If you have trouble solving a homework problem, try doing some easier related problems first. Go over the printed solutions when they become available, and make sure you understand them. Go to the TA or professor to discuss any misunderstandings you may have. If you understand all homeworks and solutions, you will probably do well on the exams.