COMS W3261
Computer Science Theory – Section 001
Lecture 25: December 06, 2017
Final Review

The CS Theory Final

- The final will be held on Monday, December 11, 2017, 1:10-2:25pm, in 428 Pupin.
- The final will have five questions and an extra credit question. The sample problems below are representative of what will be on the final. Answers to almost all of these questions can be found in the textbook or the lecture notes.
- The final will cover the material presented in class in Lectures 12 to 24, Oct 16 to Dec 4. The material on computability theory and complexity theory is covered in Chapter 8, Chapter 9, and Sections 10.1-10.3 of HMU. The material on PAC learning is covered in Lecture 22. The material on the lambda calculus is covered in the course notes for Lectures 23 and 24. The final will be a closed book exam.

Study Hints

- Be sure you know the definitions of the concepts used in Lectures 12 to 24 and the boundary conditions of these definitions.
- Know how to prove a language is recursive, recursively enumerable but not recursive, and not recursively enumerable. Know the important examples of languages of each of these kinds.
- Know the important closure and decision properties of the recursive and recursively enumerable languages.
- Know how to prove a language is in P, is in NP, or is NP-complete. Know the important examples of languages of each of these kinds.
- Know how to reduce a lambda expression into normal form. Know the difference between normal order reduction and applicative order reduction. Know the Church-Rosser theorems and the Y combinator.

Sample Final Problems

1. State what it means for a language to be (i) recursive, (ii) recursively enumerable but not recursive, or (iii) not recursively enumerable. To which of these categories do each of the following languages belong?

   (a) $\overline{L_d}$, (b) SAT, (c) Post's Correspondence Problem, (d) $\overline{L_u}$, (e) $\overline{L_e}$

2. Explain why the recursively enumerable languages are not closed under complement.

3. Is it decidable whether $L(G_1) \cap L(G_2) = \emptyset$ where G_1 and G_2 are two context-free grammars? Prove your answer.

4. Let Y be the lambda expression $\lambda f.\ (\lambda x.\ f(xx))\ (\lambda x.\ f(xx))$ and let E be another lambda expression. Show that $YE = E(YE)$.

5. Does the instance of Post's Correspondence Problem with $A = \{a, b, ca, abc\}$ and $B = \{ab, ca, a, c\}$ have a solution? Explain why or why not.

6. **Extra Credit, 5 points.** Let DOUBLE-SAT $= \{E \mid E$ is a boolean expression with at least two satisfying truth assignments$\}$. Prove that DOUBLE-SAT is NP-complete.