COSC-311 Fall 2018 Final Exam Topics

This is *not* a comprehensive study guide. There may be topics that we have discussed in class or that have come up on homework that are not on this list. You are responsible for all of the course material up to this point, including both in-class material and homework. The exam *is* cumulative, and this study guide only includes topics from the last third of the course. Please refer to the study guides for Midterms 1 and 2 to remind yourself of earlier topics.

1. Network Flow

   (a) Definitions: flow, capacity and conservation constraints, residual graph, forwards and backwards edges, augmenting paths

   (b) Ford-Fulkerson algorithm: what it does, why it works

   (c) Max-flow = min-cut theorem

   (a) Problems we've solved using network flow:

   - Bipartite matching
   - Baseball elimination
   - Blood transfusions (on HW4)

2. Complexity

   (a) Definitions: P, NP, polynomial-time reducibility, efficient verification, NP-hard, NP-complete

   (b) Reductions: what does it mean if $Y \leq_P X$? what does this tell us about the relative hardness of X and Y?

   (c) Reductions we've seen:

   - Independent Set $\leq_P$ Vertex Cover
   - Vertex Cover $\leq_P$ Independent Set
   - 3-SAT $\leq_P$ Independent Set
   - 3-SAT $\leq_P$ Graph Coloring
   - All problems Y in NP $\leq_P$ Circuit-SAT (and ex: Independent Set $\leq_P$ Circuit-SAT)
   - Circuit-SAT $\leq_P$ 3-SAT
   - 3-SAT $\leq_P$ Hamiltonian Cycle
   - Independent Set $\leq_P$ Set Packing (on HW5)
   - Set Packing $\leq_P$ Multiple Interval Scheduling (on HW5)
   - Something about Not-All-Equal-3-SAT and k-Cut (on HW5, part of the assignment involves choosing the correct direction for the reduction)

   (d) What to do if we need a solution to an NP-complete problem

   - Polynomial-time approximation schemes
     - MST-Approx for Traveling Salesman

FAQ

Q: How long will the exam be, relative to the midterms?

A: You had 50 minutes for each of the midterms, and you have 3 hours for the final exam. The final exam will be longer than the midterms, but not three times as long. I expect you will have less time pressure on the final than on the midterms.

Q: What's the level of difficulty of the exam questions, relative to homework?

A: The exam questions will be closer to Mini HW than to HW. You have two weeks to do each homework assignment, and I expect that you're spending lots of time thinking deeply about the problems. You have 3 hours to do the exam, and so the questions that I ask won't be as in-depth as homework questions.

Q: But what will the actual questions look like?

A: Here are some types of questions that I might ask (this is not a comprehensive list):

- Given a new problem, show that it's NP-complete.
- Given a pair of problems Y and X and an input to Y, show what input to X is produced by our reduction from Y to X.
- Discuss the implications of polynomial-time reductions, NP-completeness, etc.

Q: How should I go about studying?

A: The most important recommendation I can give is to study actively. Don't simply read your notes and then conclude that you've mastered the material. Instead, go back and redo previous mini homeworks. Re-derive the solutions to examples we did in class without looking at your notes. Take some of the NP-complete problems we've seen and give reductions that we haven't done in class.

Q: Will the exam be curved?

A: I aim to write my exams so that the median falls somewhere around a B+ (i.e., in the high 80s), and I do not intend to curve the scores. However, I reserve the right to change my mind should I discover after the fact that I've substantially miscalibrated the difficulty of the exam.