

Graphs and Network Flows

IE411

Preliminaries

Dr. Ted Ralphs

Introductory Stuff

- Welcome!
- Class Meeting Time
- Office Hours TR 4–5??

What will this class be about?

- Using graphs and network flows as a modeling abstraction.
- Optimization problems that arise in the study of graphs and network flows.
- The design, analysis, and implementation of algorithms to solve these optimization problems.
- The empirical analysis of these algorithms.

What do I expect you to know?

- Things I expect you to know or pick up “along the way”:
 - Undergraduate mathematics
 - * Logic and proof
 - * Linear algebra
 - Basic optimization theory (linear programming)
 - Basic computer programming (we will use Python)

What are the goals for the course?

After this course, you should be able to:

- Recognize when an optimization problem has an underlying graph or network flow structure and develop an appropriate model.
- Choose appropriately from among available algorithms to solve the problem using algorithm analysis.
- Implement the chosen algorithm and solve the problem.
- Perform appropriate post-processing, such as sensitivity analysis.

Approximate Syllabus

| Week | Topics |
|-------------|----------------------------------|
| 1 | Introduction to Graphs and Flows |
| 2 | Python and Graph Representations |
| 3 | Algorithm Design and Analysis |
| 4 | Graph Search |
| 5 | Minimum Spanning Trees |
| 6–7 | Shortest Path Problem |
| 8 | <i>Mid-term</i> |
| 9–10 | Maximum Flow Problem |
| 11–12 | Minimum Cost Flow Problem |
| 13 | Network Simplex Algorithm |
| 14 | Advanced Topics |
| Date TBD | Final Exam |

Course Requirements

- Attendance
- Participation
- Reading
- Homework
- Exams

Homework and Final Project

- There will be problem sets approximately every 2 weeks.
- Problem sets should be turned in electronically according to the procedure in the syllabus.
- There will also be a comprehensive final project worth 10% of your grade.
- Homework is due at the beginning of class.
- Lateness policy is in the handout.
- I encourage working together, but **you must write up the homework yourself** (unless it is a group assignment).
- **Please reference the work of others.**
- Basic problem types:
 - Modeling
 - Mathematical Proofs
 - Algorithms
 - Programming

Grading

- Your grade will correspond to your learning and understanding of the course material.
- Some areas to keep in mind
 - Good proof technique
 - Level of detail and rigor
 - Accurate self-assessment
 - Class participation
- I will be randomly grading selected problems. Detailed solutions for selected problems will be distributed.
- I encourage you to assess your solutions to **all assigned problems**.
- Approximate weighting
 - 30% Homework
 - 20% Mid-term
 - 20% Final Project
 - 20% Final Exam
 - 10% Class Participation

Class Web Site

- The class Web site will be at

<http://coral.ie.lehigh.edu/~ted/teaching/ie411/>

- I will post lecture slides before class so you can use them to take notes.
- The slides will be in PDF format.
- All handouts for the class will also be available.
- There will also be links to other relevant sites and reference materials.

Textbook

- The primary text is [Sedgewick](#).
- I may also take material out of some other texts.
- There is an abundance of reference material on the Web.
- Check the Web site for links.
- **Please let me know if you want additional supplementary material.**

My Approach to Lectures

- Lectures should be as **interactive** as possible.
- You will get more out of this course if you **ask questions during lecture**.
- The pace and structure of the lectures can be adjusted.
- **I need feedback** from you to adjust appropriately.

Some More Notes

- This course will be quite mathematically rigorous.
- If you are having trouble, let me know.
- Please pay attention to the policy regarding citing the work of others in the syllabus.
- I take this policy **very seriously**.

Questions?