Graphs and Network Flows
IE411

Preliminaries

Dr. Ted Ralphs
Introductory Stuff

- Welcome!
- Class Meeting Time
- Office Hours *TR 3:30–4:30*
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

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to Graphs and Flows</td>
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<td>2</td>
<td>Python and Graph Representations</td>
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<td>3</td>
<td>Algorithm Design and Analysis</td>
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<td>4</td>
<td>Graph Search</td>
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<td>5</td>
<td>Minimum Spanning Trees</td>
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<td>6–7</td>
<td>Shortest Path Problem</td>
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<td>8</td>
<td>Mid-term</td>
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<td>9–10</td>
<td>Maximum Flow Problem</td>
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<td>11–12</td>
<td>Minimum Cost Flow Problem</td>
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<td>13</td>
<td>Network Simplex Algorithm</td>
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<td>14</td>
<td>Advanced Topics</td>
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<td>Date TBD</td>
<td>Final Exam</td>
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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
  - 25% Mid-term
  - 10% Final Project
  - 25% 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.
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?