

## Syllabus

Last updated: 8 January 2018

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**Official course title.** The course catalog lists this course as “Introduction to Mathematical Modeling.” The unofficial title above better captures the spirit of the course.

**Course objectives.** By the end of this course, students will be able to

- (i) identify when a real-world decision-making problem can be modeled as a shortest path problem, deterministic dynamic program, or stochastic dynamic program;
- (ii) formulate such models for real-world decision-making problems;
- (iii) set up these models with data from large-scale real-world sources;
- (iv) solve these models with computational tools and interpret their output.

**Schedule.** Here is a tentative schedule.

Week	Topics
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<b>The shortest path problem</b>	
1	Overview. The OR approach. Graphs and the shortest path problem.
2	The shortest path problem, cont. Longest paths and negative cycles. Introduction to Jupyter Notebook and Python.
3	Solving shortest path problems with <code>networkx</code> . The mileage running problem.
4	Solving the mileage running problem with large-scale real-world data. Review
5	Exam 1
<b>Dynamic programming</b>	
	Introduction to dynamic programming – shortest/longest path representation.
6	Dynamic programming, cont. Solving dynamic programs with <code>networkx</code> .
7	Big DPs and the curse of dimensionality. Drafting a fantasy basketball team.
8	Solving the fantasy basketball draft problem with large-scale real-world data. Machine scheduling.
9	The principle of optimality and formulating DP recursions. Formulating DP recursions, cont.

### The shortest path problem

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|---|---|
| 1 | Overview. The OR approach. Graphs and the shortest path problem.  |
| 2 | The shortest path problem, cont. Longest paths and negative cycles.<br>Introduction to Jupyter Notebook and Python. |
| 3 | Solving shortest path problems with <code>networkx</code> .<br>The mileage running problem.                         |
| 4 | Solving the mileage running problem with large-scale real-world data.<br>Review                                     |
| 5 | Exam 1  |

### Dynamic programming

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|---|---|
|   | Introduction to dynamic programming – shortest/longest path representation.                           |
| 6 | Dynamic programming, cont.<br>Solving dynamic programs with <code>networkx</code> .                   |
| 7 | Big DPs and the curse of dimensionality.<br>Drafting a fantasy basketball team.                       |
| 8 | Solving the fantasy basketball draft problem with large-scale real-world data.<br>Machine scheduling. |
| 9 | The principle of optimality and formulating DP recursions.<br>Formulating DP recursions, cont.        |

Week	Topics
10	Spring Break
11	Review Exam 2
<b>Stochastic dynamic programming</b>	
12	Introduction to stochastic dynamic programming. Stochastic dynamic programming, cont.
13	Solving stochastic dynamic programs with Python. The points-after-touchdown problem.
14	Solving the points-after-touchdown problem with real data.
15	More stochastic dynamic programming models.
16	Review
17	Review