SA367 · Mathematical Models for Decision Making · Spring 2017 · Uhan

Syllabus

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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, dynamic program, or Markov decision process;

  (ii) formulate such models for real-world decision-making problems;

 (iii) collect and set up data for these models from large-scale real-world sources;

 (iv) solve these models with computational tools and interpret their output.

Schedule. Here is a (very) tentative schedule.

Unit	Week	Date	Topics
Shortest paths	1	1/12	Overview. The OR approach. Graphs and the shortest path problem. Equipment replacement.
	2	1/17	Shift scheduling, vacation rentals. Longest paths and negative cycles.
		1/19	Project networks and critical paths. Multinational tax planning. Getting Jupyter up and running.
	3	1/24	Introduction to Jupyter Notebook and Python.
		1/26	Solving shortest path problems with `networkx`. Mileage running.
	4	1/31	Mileage running: setting up shortest path problems with large-scale data.
		2/2	Mileage running: getting data and setting it up.
	5	2/7	Review
		2/9	**Exam 1**
Dynamic programming	6	2/14	The knapsack problem as a shortest path problem. Dynamic programs: stages, states, principle of optimality, cost-to-go. Network representation.
		2/16	Inventory management, resource allocation.
	7	2/21	Resource allocation, cont. Solving dynamic programs with `networkx`.
		2/23	Big DPs: Tetris, Rubik's cube. The curse of dimensionality.
	8	2/28	Drafting a fantasy basketball team: setting up DPs with large-scale data.
		3/2	Drafting a fantasy basketball team: getting data and setting it up.
	9	3/7	Formulating DP recursions: shortest path, inventory management, resource allocation.
		3/9	DP recursions, cont. Non-additive DPs: minimax shortest path.

Unit	Week	Date	Topics
	10		Spring Break
	11	3/21	Review
		3/23	**Exam 2**
Markov decision processes	12	3/28	States, actions, transitions, rewards. Cost-to-go function. Policies. Equipment replacement revisited.
		3/30	Inventory management revisited, car financing.
	13	4/4	Investing over time.
		4/6	Solving MDPs with `pymdptoolbox`.
	14	4/11	Big MDPs: Scrabble, blackjack. The curse of dimensionality (again). Approximate methods.
		4/13	Going for 2 in football.
	15	4/18	Going for 2 in football: setting up MDPs with large-scale data.
		4/20	Going for 2 football: getting data and setting it up.
	16	4/25	Review
		4/27	Review
	17	5/2	Wrap-up