ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

IMRT Measurement and Control Laboratory
Prof. R. D'Andrea
Prof. L. Guzzella

151-0563-00 Dynamic Programming and Optimal Control (Fall 2008)

Class Website

All information concerning the class: announcements, class facts, problem sets, etc. **Please check regularly.**

`www.imrt.ethz.ch/education/lectures/optimal_control`

Description

Contents:
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Deterministic Continuous Time Optimal Control; Hamilton-Jacobi-Bellman Equation; Pontryagin Minimum Principle; Problems with Perfect and Imperfect State Information; Infinite Horizon Problems.

Book:
The lecture, as well as the problem sets, are based on the text book by Dimitri P. Bertsekas: *Dynamic Programming and Optimal Control by Dimitri P. Bertsekas, Vol. I, 3rd edition, 2005, 558 pages, hardcover.*

Requirements:
Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Class Facts

Instructor	Prof. Raffaello D'Andrea, `rdandrea@ethz.ch`
Teaching Assistants	Angela Schöllig, `aschoellig@ethz.ch` Sebastian Trimpe, `strimpe@ethz.ch`
Lecture	Wednesday, 13:00 to 15:00, ML F38
Recitation/Lecture	Wednesday, 15:00 to 16:00, ML F38 If no recitation takes place, the time might be used for the lecture.
Office hours	Monday, 16:00 to 18:00, ML K37.1 (IMRT library) Tuesday, 18:00 to 20:00, ML K37.1 (IMRT library) by teaching assistants
Exams	**Midterm Exam:** November 12, 2.5 hours, in-class, covers everything up to, and including, problem set 3. **Final Exam:** December 17, 2.5 hours, in-class, covers all material.
Grading	*20% problem sets, 30% midterm exam, 50% final exam* if the grade in the midterm is better than the grade in the final exam OR *20% problem sets, 80% final exam* if the grade in the midterm is not better than the grade in the final exam.

Lectures

#	Date	Topic	Reading
1	Sep 24	The Dynamic Programming Algorithm: Introduction, The Basic Problem; Review Probability Theory	1.1, 1.2, Appendix C
2[1]	Sep 30	The Dynamic Programming Algorithm: The Dynamic Programming Algorithm, State Augmentation and Other Reformulations; Mathematical Review	1.3, 1.4, Appendix A
2R[1]	Oct 01	”	”
3	Oct 08	Optimization Theory, Finite-State Markov Chains	Appendices B, D
4	Oct 15	Deterministic Systems and the Shortest Path Problem: Finite-State Systems and Shortest Paths, Some Shortest Path Applications, Shortest Path Algorithms	2.1, 2.2, 2.3
5	Oct 22	Deterministic Continuous-Time Optimal Control: Continuous-Time Optimal Control, The Hamilton-Jacobi-Bellman Equation, The Pontryagin Minimum Principle	3.1, 3.2, 3.3
6	Oct 29	Deterministic Continuous-Time Optimal Control: The Pontryagin Minimum Principle (cont'd), Extensions of the Minimum Principle	3.3, 3.4
7	Nov 05	Problems with Perfect State Information: Linear Systems and Quadratic Cost, Inventory Control	4.1, 4.2
8	Nov 12	**Midterm in-class exam**	
9	Nov 19	Problems with Perfect State Information: Optimal Stopping Problems, Scheduling and the Interchange Argument	4.4, 4.5
10	Nov 26	Problems with Imperfect State Information: Reduction to the Perfect Information Case, Linear Systems and Quadratic Cost	5.1, 5.2
11[1]	Dec 02	Problems with Imperfect State Information: Linear Systems and Quadratic Cost (cont'd), Sufficient Statistics and Finite-State Markov Chains	5.2, 5.4
11R[1]	Dec 03	”	”
12	Dec 10	Bang-Bang Control, Trajectory Generation Paper	*to be announced*
13	Dec 17	**Final in-class exam**	

Problem Sets/Recitation

- The solutions to the problem sets will be covered in the recitation on the day, when the problem set is due. On the dates, when there is no recitation, the time might be used for the lecture.
- Up to three students can work together on the problem set. If they do, they have to hand in one problem set per group and will all receive the same grade. One can also work alone, of course.
- The problem sets will be graded and account for 20% of the final grade.

#	hand out	due	recitation
PS1	Sep 24	Oct 08	Oct 08
PS2	Oct 08	Oct 22	Oct 22
PS3	Oct 22	Nov 05	Nov 05
PS4	Nov 05	Nov 26	Nov 26
PS5	Nov 26	Dec 10	Dec 10

[1]The lecture will be held by Prof. D'Andrea on Tuesday evening (18:30 to 21:30, ML F38). The same lecture is given by one of the Teaching Assistants on Wednesday at the regular place/time.