Syllabus for MAE247
Cooperative Control of Multi-Agent Systems - Spring 2013

Jorge Cortés

May 14, 2013

This course covers modeling, analysis, and design of cooperative control systems. Topics include continuous and discrete-time evolution models, distributed algorithms, distributed linear iterations, proximity graphs, performance measures, invariance principles, and coordination algorithms for aggregation, deployment, flocking, formation of autonomous vehicles, and consensus. The techniques and methodologies presented in the course are introduced through application setups including robotic networks, sensor networks, camera networks, and power networks.

Instructor

Jorge Cortés, `cortes at ucsd.edu`. Office at Engineering Building I, # 1608

Course Objectives

By the end of the course, you would/should have:

1. learned and used various tools for the modeling, analysis and control of multi-agent systems;
2. known and played around with several cool coordination algorithms that achieve a variety of objectives;
3. got a feeling and gained insight into the dynamics of interconnected systems, and emergent behaviors.

Prerequisites

Knowledge of linear algebra, ordinary differential equations, dynamical systems, and analysis is assumed. Familiarity with simulation software of your choice (e.g., Matlab/Mathematica/Maple).

Text

Our main reference will be F. Bullo, J. Cortés, and S. Martínez. *Distributed Control of Robotic Networks*. Applied Mathematics Series. Princeton University Press, 2009. Electronically available at http://coordinationbook.info. At the book website, you can download the chapters individually or the manuscript as a whole.

Additional recommended texts and readings

You will also find great insight in

- M. Mesbahi and M. Egerstedt. *Graph Theoretic Methods in Multiagent Networks*. Applied Mathematics Series. Princeton University Press, 2010
- W. Ren and R. W. Beard. *Distributed Consensus in Multi-vehicle Cooperative Control*. Communications and Control Engineering. Springer, 2008

Course webpage

http://tintoretto.ucsd.edu/jorge/teaching/mae247/

The webpage contains this syllabus and the list of homework due. Please check it periodically for updates and other announcements related to the course.

Calendar

The website contains a list of downloadable PDFs for the lectures. To access them off campus, you will need the username and password provided in class.

Part I

- Introduction: what are multi-agent systems?
- Linear algebra (BCM, Ch 1.2)
- Graph theory (BCM, Ch 1.4)
- Linear iterations and agreement (BCM, Ch 1.6)
- Laplacian consensus, distributed optimization, formation control, distributed estimation (BCM, Ch 1; ME)

Part II

- Distributed algorithms on networks of processors (BCM, Ch 1.5)
- Proximity graphs (BCM, Ch 2)
- Distributed algorithms on robotic networks (BCM, Ch 3)
- Connectivity maintenance and rendezvous (BCM, Ch 4)
- Deployment (BCM, Ch 5)

Exams

The midterm will be on Wednesday, May 8, 2013, in class.

The final will be on Friday, June 14, 2013, in class, from 3:00pm to 6:00pm.

Homework

There will be a set of homework problems per week (mostly from the main text). The homework will be collected on Fridays. *You need to complete all exercises, although only one, randomly selected, will be corrected from each assignment.* Homework assignments are due weekly (specific dates for your reference are included in the webpage). No late homework will be accepted.

Grading policy

Homework: 25%
Midterm: 25%
Final exam: 50%

In exceptional cases, I reserve the right to give extra points for excellent performance on the midterm and final. Please do not count on it as a way to avoid doing the other assignments.

ted

Your grades will be available via ted. Check out http://ted.ucsd.edu for instructions on how to register and log in.

Academic honesty

No form of academic dishonesty will be tolerated. For the definition of academic dishonesty and its (ominous) consequences, refer to the UCSD General Catalogue 2012-2013 at http://ucsd.edu/catalog

Room location and hours

Lectures take place at Applied Physics & Mathematics Building (Map Building #249), room 2301, Mondays, Wednesdays, and Fridays, from 2:00pm to 2:50pm.

Office hours

Instructor: Mondays, from 3:30pm to 4:30pm, at EBU I, room 1603 (conference room). Please, send me email describing the problem before coming to office hours. Be prepared to show attempts at solving the problem.

If you have any questions about the course, please send me email. I will try to respond as quickly as possible. Additionally, I will share questions that are particularly good (and their answers) with the rest of the class by broadcasting my answer to the entire class.