Department of Electrical and Computer Engineering
University of Massachusetts/Amherst

ECE 634: Optimal Control of Dynamic Systems

Fall 2017

Overview: Optimization is ubiquitous in engineering and computer science. A recent application is the defeat of the world Go champion by the artificial intelligence algorithms executed in the Google's AlphaGo system. Other application examples include deep learning network training, large data set clustering, and many engineering design problems. The optimization procedure involved in these applications can be summarized in the topic of optimal control of dynamic systems where the objective function values from the current state to the end plays a critical role and a backpropagation type of computation for the reinforced learning scheme is needed.

Historically optimal control theory and algorithms are developed for various space programs include the Apollo program. The mathematical foundation can be traced back to the famous theory of calculus of variations. We will discuss the technical development of the unique theoretical base and the ever more interesting applications.

Objectives: Students completing this course will gain substantial knowledge about optimization of dynamic systems. The course is designed to help students for their own research projects as well as to prepare them for the future development.

Prerequisites: Linear algebra, ordinary differential equations and a basic knowledge of probability theory. The intent is to present an intuitive understanding of the advanced topics in optimization, from static ones to dynamic ones. We hope to cover some exciting examples.

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Instructor: Weibo Gong
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Lectures: Place: TBD; Time: TThu 2:30-3:45pm

Office Hours: TBD

Textbook: Lecture Notes

References: Handouts

Grading policy: Homework: 20%
Midterm Exam: 30%
Term Paper: 50%

Topics plan to cover:

1. Optimization – an exciting journey from Newton to AlphGo;
2. How to provide incentive to team members – Lagrange multiplier for parametric optimization;
3. Backpropagation – optimization for discrete time dynamic systems;
4. Decoding for convolutional code – Viterbi algorithm and dynamic programming;
5. How to defeat human Go champion - reinforced learning;
6. Flying from New York to Beijing via Alaska – calculus of variations;
7. Landing on the moon – optimal control of space vehicles;
8. Where is the incoming missile – Kalman filter and the Linear Quadratic Gaussian problem;
9. Keep the Internet secure – dynamic game theory;