Engineering Tripos Part IIB, 4F3: An Optimisation Based Approach to Control, 2019-20

Module Leader and lecturer

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Lecturer

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Timing and Structure

Lent term. 14 lectures + 2 examples classes, Assessment: 100% exam

Prerequisites

3F1 and 3F2 useful

Aims

The aims of the course are to:

- introduce methods for feedback system design based on the optimization of an objective, including reinforcement learning and predictive control.
- demonstrate how such control laws can be computed and implemented in practice.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand the derivation and application of optimal control methods.
- appreciate the main ideas, applications and techniques of predictive control and reinforcement learning.

Content

Optimal Control (7L + 1 examples class, Dr F Forni)

- Formulation of convex optimisation problems
- Status of theoretical results and algorithms
- Formulation of optimal control problems. Typical applications
- Optimal control with full information (dynamic programming)
- Control of Linear Systems with a quadratic objective function
- Output feedback: ‘LQG’ control
- Control design with an “H-infinity” criterion

Predictive Control and an Introduction to Reinforcement Learning (7L + 1 examples class, Dr G Vinnicombe)
What is predictive control? Importance of constraints. Flexibility of specifications. Typical applications.
Basic formulation of predictive control problem without constraints and the receding horizon concept.
Comparison with unconstrained Linear Quadratic Regulator.
Including constraints in the problem formulation. Constrained convex optimization.
Terminal conditions for stability.
Emerging applications: advantages and challenges.
Policy and generalized policy iteration; rollout algorithms and predictive control.
Approximate dynamic programming.
Deep neural nets as universal approximators for value and policy.
Simulation based vs state space models - Q learning.

Booklists

Please see the Booklist for Group F Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

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