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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