Engineering Tripos Part IIA Project, SF3: Machine Learning, 2025-26

Leader

Dr C Micou [1]

Timing and Structure

Students work to their own schedule. A staffed "surgery" runs during scheduled lab sessions on Tuesdays and Fridays to give help, advice and feedback.

Prerequisites

Part I computing; Either of 3F3 or 3F8

Aims

The aims of the course are to:

- expose students to machine learning approaches to non-linear regression
- to gain practical experience necessary to use these techniques successfully (e.g the use of training and test sets for evaluation, optimisation etc.)
- to understand the robustness of these approaches to challenging real world phenomena including noise and non-linearities

Content

In this project, students will consider the inverted pendulum system receiving a software simulator of a cart with a pendulum attached written in Python.

The goal will be to learn a controller that balances the pendulum in a data-driven way. The students will initially learn how to operate the simulator and explore the different types of behaviour that the system can exhibit. Next, they will collect training data from the simulator and use this to train non-linear regression models, including linear regression with non-linear basis functions. The trained models will be assessed on test data from the simulator. Once accurate models are learned these will be used to learn controllers that can balance the pendulum in the upright position and keep it there. Finally, the controllers and the models will will be stress tested in various ways to test their robustness.

Students work individually for this project.

Week 1

Explore the cart-pendulum system using the simulator. Understand the state space and the governing differential equations and fit data with simple linear models.

Week 2

Further explore training and test data from the simulator for building models of the system and validating them. Introduce non-linear models and assess their quality compared to simple linear models.

Week 3

Define a function that maps from the system's state to control actions (the "policy"), optimise the policy to keep pendulum upright.

Week 4

Extend the project by investigating robustness to noise and disturbances, or investigate more advanced policies for control.

Coursework

Coursework	Due date	Marks
Interim report	29 May 2026	20
Final report	12 June 2026	60

All reports are submitted via Moodle. The deadline for submission is 4pm on the due date.

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

Last modified: 28/04/2026 16:29

Links
[1] mailto:cm704@cam.ac.uk
[2] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations