

Optimisation & Data Refinement under Uncertainty

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Optimisation under uncertainty is pervasive, as is the standard strategy to deal with it. You first look at a wide range of options in little detail, then progressively narrow your search in increasing detail. In problems where the uncertainties are quantitative and refinable, some systematic work is available: “Stochastic annealing”, Ball RC, Fink TMA, Bowler NE, PHYSICAL REVIEW LETTERS 91 (3): Art. No. 030201 JUL 18 2003.

Guided data refinement (in experiments or simulations) presents a variant on the same general problem: given some limited data points, how do you choose further input values to evaluate so as to optimise your understanding of the system, the fit to a model, or your forecast of future events?

Ensemble Weather Forecasting is a particular case in point. Full simulations such as are used to make 24 hour weather forecasts for the UK are expensive, but are sufficiently sensitive to their inputs that the uncertainty in forecasting arising from the uncertainty in inputs must be considered. It is now established practice to consider of order ten simulations, each with inputs drawn independently from their estimated likelihood distribution.

The objective of this project is to establish a coherent methodology for refining the sample of input data explored, such that the value of the resulting forecast is optimised. We expect to exploit multi-level evaluation, in the manner of optimisation under uncertainty, progressing upwards in cost and accuracy in simulation to guide a reducing sample of input values. There is prospective collaboration with UK MetOffice.

The student will be tasked to:

- appreciate prior separate work on: stochastic annealing, and the principles of ensemble forecasting
- develop a simple two-step methodology where one cheap level of simulation is used to bias (according to value) the sampling of inputs to full forecasting.
- attempt to refine to a more progressive approach in the spirit of Stochastic Annealing.

They will be expected to try these out, on toy models if not on full weather simulation.

This project could run in either miniproject period and could lead into a PhD.