Project proposal

Robust Optimisation over Time

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Background: Many practical optimisation problems are changing over time, e.g. because the customer base changes over time in supply chains, or because the profit predictions change in investment. It thus becomes necessary to adapt the chosen solution to the changing problem.

However, changes are usually small, and rather than re-optimising after a change of the problem, information from the previous optimisation step should be exploited to quickly find the new optimum. Bayesian Optimisation seems particularly suited for this type of problem, because the surrogate model it constructs contains all the collected information that can be exploited. This has been used successfully in [1].

While this work aims to continuously track the moving optimum of a changing problem, in practice adapting a solution is associated with a cost, and thus it is not economical to continuously adapt the solution. Instead, one would be looking for a solution that is robust over time [2], i.e., a solution that has a high probability of being "good enough" for some time, and then change the solution only occasionally, when it promises to pay off long-term. This project would be about developing Bayesian Optimisation algorithms for such problems.

Mini-project: The goal of this project would be to develop a method to predict the robustness of a solution in a changing environment. What is the expected time the solution will remain above the minimum quality threshold? What expected quality will the solution have over the next k iterations? Is there a trend or are fluctuations random?

Deliverable: Working code, paper with some empirical results on artificial benchmark problems (as those are quicker to compute and easier to analyse).

PhD prospect: In the PhD project, the prediction module should be integrated into a Bayesian Optimisation framework, continuously recommending the best (in terms of quality and robustness) solution, to maximise the quality and minimise the changeover cost over time.

Student requirements: Programming skills.

References:

[1] S. Morales-Enciso, J. Branke, Tracking global optima in dynamic environments with efficient global optimization, European Journal of Operational Research, 242(3), 2015, pp.744-755,
[2] H. Fu, B. Sendhoff, K. Tang and X. Yao, Robust Optimization Over Time: Problem Difficulties and Benchmark Problems, IEEE Transactions on Evolutionary Computation, vol. 19, no. 5, pp. 731-745, 2015