Bayesian Optimisation using Neural Networks

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Technical Abstract

Bayesian optimisation is an effective methodology for the global optimisation of functions with expensive evaluations. For instance, while designing robotic gaits, we may want to optimise the function from the parameters of the robot gait to the speed of the robot. Each function evaluation involves running a physical experiment on the robot which could involve a lot of human effort. Bayesian optimisation allows us to decide which experiment to run next, utilising all the information from previous function evaluations.

Bayesian optimisation relies on querying a physical distribution over functions defined by a relatively cheap surrogate model. An accurate model for this distribution over functions is critical to the effectiveness of the approach and is typically fit using Gaussian processes (GPs). However GPs can only model a limited set of functions well, scaling them to deal with higher dimensional functions is also very challenging.

In this project, we explore the use of Bayesian neural networks as an alternative to GPs to model the distribution over functions. Bayesian neural networks define more flexible priors on functions and can potentially be extended to high dimensional problems. It is also possible to use Bayesian neural networks (BNNs) with non-Gaussian priors (such as Cauchy) on its parameters to model non-smooth functions.

We compare the performance of this BNN based model for Bayesian optimisation to one using a GP based model. The BNN based model performs competitively with state-of-the-art GP based approaches.