DATA6811 - Computational Inference for Machine Learning

Assignment 2

Due: Monday 18 April 2022, 23:59AEST

1 General Description

This assignment covers topics 3 and 4 of DATA6811, evaluating knowledge in the topics of Hamiltonian Monte Carlo, Bayesian Optimisation and Variational Inference. It consists of programming and technical exercises which are closely related to the topics covered in the respective tutorials. The expected completion time is 4 hours.

1.1 Deliverables

Submission will be through Microsoft Teams. Please complete the python notebooks / r markdown files for each section and upload them to the Teams assignment environment in the "your work" section.

Marking criteria involves a total of 100 points, with 40 points assigned to HMC, 30 points to Bayesian Optimisation and 30 points to Variational Inference. A penalty of MINUS 5 points per each day after the due date will be applied.

2 Sampling using HMC (40%)

Please follow the instructions and exercises from the file 'DATA6811 - Assignment 2 - HMC.ipynb'. Add this completed file to the repository.

3 Bayesian Optimisation(30%)

Use BO and the code from the tutorial to maximise the following objective function:

$$f(x) = 6x^2 \sin(5\pi x) + \epsilon \ , \tag{1}$$

where $\epsilon \sim \mathcal{N}(0, 0.2^2)$ and $x \in [0, 1]$.

Compare the performance of PI, EI and UCB as acquisition functions, depicting the value of exploration-exploitation parameter (ξ for EI and PI, and κ for UCB). As we did in the tutorial, you can pre-estimate the hyper-parameters of the Gaussian Process.

Performance can be quantified using the regret at iteration i, $R(f, i) = f(x^\star) - f(x^{BO_i})$, where $f(x^{BO_i})$ is the BO-estimated maximum of f at iteration i. Hint: you can plot the regret over time, and also evaluate the cumulative and final regret.

Create a python notebook with this solution and add it to the deliverables.

4 Variational Inference(30%)

Please follow the instructions and exercises from the file 'DATA6811 - Assignment 2 - Variational Inference.ipynb'. Push this completed file to the repository.