DEEP LEARNING FOR THE NONLINEAR FILTERING PROBLEM

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1. Project description

The filtering problem concerns finding the conditional distribution of an unknown state, given noisy observations. In applications such as, e.g., signal processing, forecasting and target tracking, it is often a crucial yet difficult objective to solve. The field of nonlinear filtering is a research field within Bayesian statistics that has a lot of connections to Partial Differential Equations (PDE), Stochastic Differential Equations (SDE), Stochastic Partial Differential Equations (SPDE), and Backward Stochastic Differential Equations (BSDE).

In recent years there have been multiple approaches based on deep learning that have set out to achieve scalable methods suitable for (S)PDEs. One such approach is the Deep BSDE method, [1, 2], which was tested successfully on numerical examples in PDE up to 100 dimensions. The goal of this project is to develop and investigate numerical methods, based on this recent success, for the nonlinear filtering problem.

1.1. **The suitable student.** In this project it is necessary to have studied at least one course in stochastic analysis. Some familiarity with Bayesian statistics is expected and practical experience with deep learning is strongly meriting.

1.2. **Project and supervision.** This project includes a literature study and close collaboration with the supervisors to develop, implement and evaluate suitable algorithms for the problem. We are two supervisors, Adam Andersson from Chalmers and SAAB and Kasper Bågmark at Chalmers. If you are interested or want to know more, feel free to contact any of the supervisors and we will get back to you. You can also visit `https://kadamandersson.github.io` for completed master thesis projects with reports from previous years, including a project on a similar topic from this year A Deep Learning Method for Nonlinear Stochastic Filtering.

References

[1] K. Andersson, A. Andersson, and C. W. Oosterlee. Convergence of a robust deep FBSDE method for stochastic control. *SIAM J. Sci. Comput.*, 45(1):A226–A255, 2023.

[2] W. E, J. Han, and A. Jentzen. Deep learning-based numerical methods for high-dimensional parabolic partial differential equations and backward stochastic differential equations. *Commun. Math. Stat*, 5(4):349–380, Nov. 2017.

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