

Variational approximation for sharp Bayesian neural networks

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1 Background

Bayesian neural networks (BNNs) have been widely applied to solve inverse problems (e.g., deconvolution), offering flexibility between prediction fidelity and uncertainty quantification. However, a downside of BNNs is that they are computationally expensive models, if insisting on using statistical exact methods, such as Markov chain Monte Carlo. In practice, approximate methods are used, by using, for instance, Laplace approximation or variational approaches. In this project, we will focus on a particular subclass of BNNs which aim to preserve the sharpness of data sample. We will further develop an efficient variational Bayes approach for computing the posterior distribution with such a BNN. Details will be given to the student at the initial meeting. You will be jointly supervised by me and Jan Glaubitz (<https://www.janglaubitz.com/>) at the Department of Mathematics.

2 Learning outcomes

You will substantially learn new knowledge in statistical machine learning as well as practical skills:

- Bayesian neural networks.
- Variational Bayes inference.
- JAX/PyTorch, two popular Python libraries for machine learning.

3 Reading list

Chen Li, Matthew Dunlop, Georg Stadler. Bayesian neural network priors for edge-preserving inversion. *Inverse Problems and Imaging*, 2022, 16(5): 1229-1254.

4 Eligibility requirements

- Strong background in statistical machine learning is necessary. Preferably the candidate also has a good hands-on experience of deep learning.
- The student has a research vision, and is willing to summarise and present the results to an international conference.

5 Contact

We implement a *interest-selection-meeting-agreement* procedure. You contact us if you feel interested in this topic, and then we will get back to you for a meeting if we find you potentially suitable. At the meeting, we will give you full details of the project. You will then have a few days to think whether you indeed want to do this project and get back to us with yes/no. If we both agree, we will come up with a concrete plan and project starts.

To apply, please send an email to Zheng Zhao (email: zheng.zhao@liu.se) and Jan Glaubitz (email: jan.glaubitz@liu.se) *with your CV and transcripts enclosed*.