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Assessing the Reliability of Prediction Intervals from Bayesian Neural Networks

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Introduction

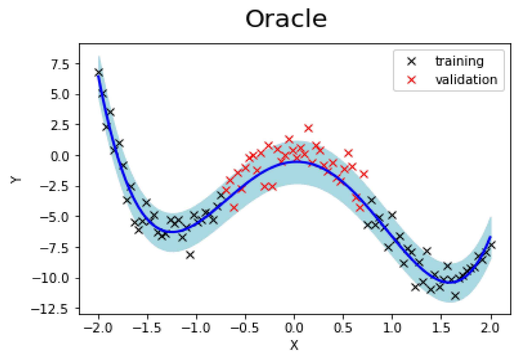
Bayesian neural networks (BNN) are a popular model for prediction because they provide uncertainty quantification (UQ). They are typically trained using variational inference (VI) or Markov Chain Monte Carlo (MCMC). There are questions whether the UQ provided by the trained BNN provides an accurate representation of the true uncertainty given the observed data. There are also questions about how the network architecture affects this accuracy. We perform a simulation study to assess these questions.

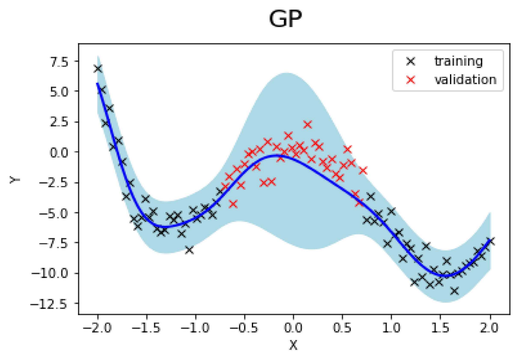
Objectives

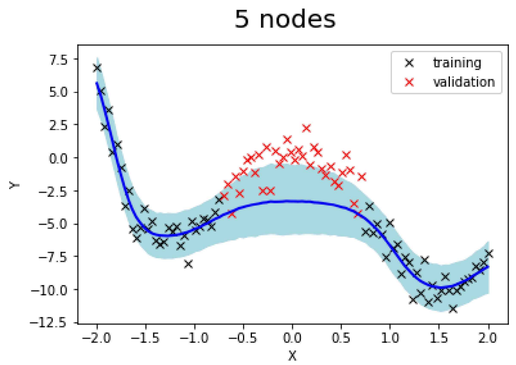
1. Assess quality of UQ for MCMC-fit BNN
2. Assess quality of UQ for VI-fit BNN
3. Illustrate effect of network architecture on UQ

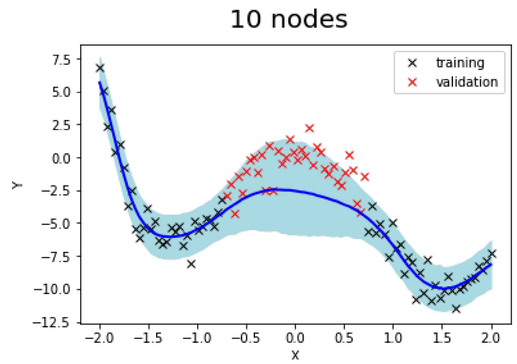
Conclusions

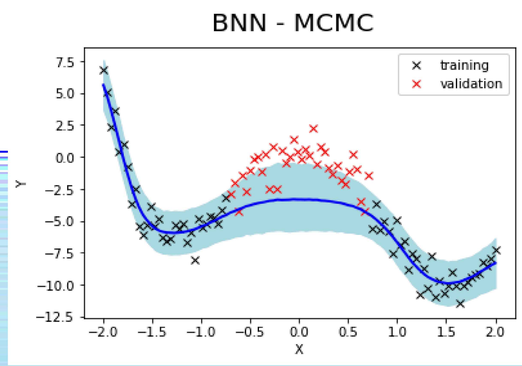
- MCMC-fit BNN behave as expected and appear to give accurate UQ
- VI-fit BNN do not behave as expected and give unstable results
- Further work is needed to validate VI approach for its use in practice
- Network architecture has significant impact on UQ
- Calls for more formal approach to selecting architecture and priors compared to traditional neural network approaches

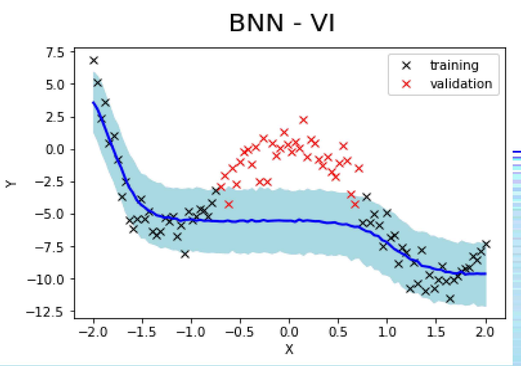


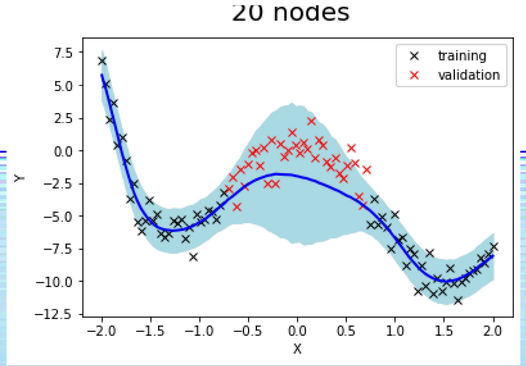


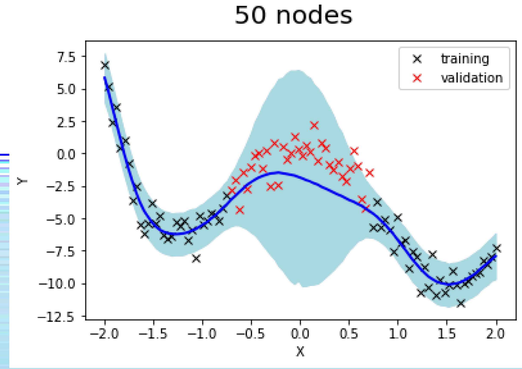












Model	Coverage (0.9)	Width-Train	Width-Val
Oracle	0.83	2.6	2.8
GP	0.94	3.5	8.2
BNN-MCMC	0.93	3.6	4.8
BNN-VI	0.88	4.9	4.8

Model	Coverage (0.9)	Width-Train	Width-Val
MCMC 5 Nodes	0.93	3.6	4.8
MCMC 10 Nodes	0.93	3.5	5.7
MCMC 20 Nodes	0.93	3.5	7.5
MCMC 50 Nodes	0.88	3.4	10.9

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