Khachatur Mirijanyan
Leif-Martin Sæther Sunde
Håkon Olav Torvik

Project Proposal

Main Theme

- Our group wants to examine and explore the efficacy and capabilities of Bayesian Neural Networks relative to other architectures.
- Firstly we would like to compare classical NN's to BNN's with naive gaussian priors on regression tasks. And perhaps include uncertainty estimates from our BNN.
- Then if we can, we would like to look at how BCNNs compare standard CNNs for image classification, or alternatively on time series or object segmentation or regression.
- Study the variation of the weights and their representations, perhaps doing PCA-analysis of the weights.
- Improve computational efficiency using methods for parameter pruning proposed in Shridhar, et al.

Background

Classical neural networks use point-weights in their layers. This negates the possibility of determining a probability estimate on the weights themselves. Bayesian neural networks fix this by introducing priors on the weights. Then Bayes rule is used to find posteriors from the prior and new data.
Choosing a gaussian as the priors lets us represent the weights by the mean and variance. BNNs can be extended to CNN, as BCNN, where in place of a single convolution, two are performed, one on the mean and one on the variance.
Earlier work on the subject has shown that it is possible to achieve similar results with BCNNs compared to non-BCNNs.

We want to test the capabilities and features of such networks, such as the representations they form in top layers, variation of the weights, and how resilient they are to e.g. adversarial attacks. BNNs are more computationally heavy then comparable non-BNNs, so parameter pruning can be a vital part to increase time-efficiency, with minimal decrease in complexity. We further have a hypothesis that imposing physical/geometric constraints on the representations formed in image classification can further improve accuracy.

Goals

- Compare and contrast BCNNs vs CNNs on image classification tasks
- Create method for determining priors for BCNNs

- Use priors to increase model accuracy while maintaining computationally efficiency.

Reference Papers

- Binary Time Series Classification with Bayesian Convolutional Neural Network When Monitoring for Marine Gas Discharges, https://www.mdpi.com/1999-4893/13/6/145
- A Comprehensive guide to Bayesian Convolutional Neural Network with Variational Inference, https://arxiv.org/abs/1901.02731
- Understanding Priors in Bayesian Neural Networks at the Unit Level, https://arxiv.org/abs/1810.05193