

Master Thesis: Active Learning via Uncertainty Estimation for Deep Learning Tasks with Costly Data Acquisition

We are pleased to invite applications for an exciting master thesis opportunity in the field of active learning and deep learning, with a focus on Bayesian neural networks and object detection.

Research Overview: This thesis addresses a critical challenge in domains like medical imaging (MRI, PET scans) and specialized sensing (SAR imagery), where data labeling is expensive and time-consuming. Traditional active learning approaches use heuristic methods to estimate model uncertainty, but these lack principled foundations for measuring epistemic uncertainty, the uncertainty that can be reduced with more training data.

Key Research Questions:

- How can Bayesian neural networks provide better uncertainty estimates for active learning in object detection?
- What is the comparative performance of Bayesian versus heuristic-based active learning approaches?

Research Objectives: You will design, implement, and evaluate a Bayesian active learning framework that integrates Bayesian layers into modern architectures (ResNet-18, ViT, Faster R-CNN) and uses approximate inference methods like variational inference or Laplace approximation. The work includes developing acquisition strategies that prioritize regions with high epistemic uncertainty and comparing against state-of-the-art methods using uncertainty calibration metrics.

What You'll Gain:

- Deep expertise in Bayesian machine learning and uncertainty quantification
- Hands-on experience with modern object detection architectures (Faster R-CNN, ResNet-18, ViT)
- Skills in approximate inference methods (variational inference, Laplace approximation)
- Experience with specialized datasets (SAR imagery, MRI data) and domain-specific acquisition parameters
- Opportunity to contribute to cutting-edge research in efficient machine learning with real-world applications

Ideal Candidate: We are looking for motivated students with:

- Strong background in machine learning and deep learning
- Programming experience (Python, PyTorch/TensorFlow)

- Interest in Bayesian methods and uncertainty quantification
- Experience with computer vision tasks
- Interest in medical imaging or remote sensing applications (beneficial)

Next Steps: If you are interested in this research opportunity, please contact us with:

- Your CV and transcript
- A brief statement of interest explaining your motivation for this topic
- Any relevant project work or research experience

Best regards,

Prof. Dr. Nadja Klein, Moussa Kassem Sbeyti, and Clara Hoffmann

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