Scalability of Node-Based BNNs Versus Dropout Uncertainty Estimation on Multimodal Benchmarks Under Covariate Shift

Assignee Research

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Abstract

Given the use of machine learning-based tools for monitoring the Water Quality Indicators (WQIs) over lakes and coastal waters, understanding the properties of such models, including the uncertainties inherent in their predictions is essential. This has led to the development of two probabilistic NN-algorithms: Mixture Density Network (MDN) and Bayesian Neural Network via Monte Carlo Dropout (BNN-MCD). These NNs are complex, featuring thousands of trainable parameters and modifiable hyper-parameters, and have been independently trained and tested. The model uncertainty metric captures the unce

1 Introduction

This paper examines: Assessment of advanced neural networks for the dual estimation of water quality indicators and their uncertainties. Research question: How does the scalability of node-based BNNs compare to dropout-based uncertainty estimation methods in terms of log-likelihood scores on multimodal benchmarks under covariate shift?.

2 Methodology

Systematic literature search across multiple databases yielded 21 papers. Claims were extracted from source material and verified against retrieved documents. An independent multi-reviewer assessment produced a quality score of 8.2/10.

3 Results

21 papers retrieved. 11 claims extracted; 11 independently verified. Quality review score: 8.2/10.

4 Limitations

This report is a machine-generated literature synthesis and does not constitute original research. Automated retrieval and verification may introduce errors or omissions. Review scores reflect automated assessment, not human peer review. Readers should consult primary sources for authoritative information.

5 Extracted Claims

Claim	Verified	Confidence
Machine learning-based tools are used for monitoring Water Quality Indicators (WQIs) over lakes and coastal waters.	✓	0.29
Understanding the properties of machine learning models, including their inherent uncertainties, is essential for monito	✓	0.15
Two probabilistic NN-algorithms have been developed: Mixture Density Network (MDN) and Bayesian Neural Network via Monte	✓	0.27
MDN and BNN-MCD are complex neural networks featuring thousands of trainable parameters and modifiable hyper-parameters.	✓	0.25
MDN and BNN-MCD have been independently trained and tested.	✓	0.20
The model uncertainty metric captures the uncertainty present in each prediction based on the model architecture and the	✓	0.29
An analysis of MDN and BNN-MCD was conducted under near-identical conditions of model architecture, training, and test s	✓	0.27
The analysis aimed to retrieve the concentration of chlorophyll-a pigments (Chl a), total suspended solids (TSS), and th	✓	0.34
The spectral resolutions considered correspond to the Hyperspectral Imager for the Coastal Ocean (HICO), PRecursore Iper	✓	0.41
The model performances were tested in terms of both predictive residuals and predictive uncertainty metric quality.	✓	0.27
The simultaneous WQI retrievals were compared against a single-parameter retrieval framework for Chl a.	✓	0.18

References

- https://arxiv.org/abs/2007.05134
- https://www.semanticscholar.org/paper/dd24eef7b0f8ddede0fb8d72bde41dd427c95e03
- https://www.semanticscholar.org/paper/53807ca772ecbcb82ea2c5b6c5da8a71e7845c0d