Mechanical Engineering
Faculty of Engineering

Term 4 Progress Report

Instructions

- The progress report should be brief and clear. The maximum number of pages is 5 (including the Gantt chart).
- The supervisor **does not** need to approve the report prior to submission. After submission, discuss the progress report with your supervisor; your supervisor will provide feedback on your progress **after** the report has been submitted.

Information

Title	Bayesian deep learning based semantic segmentation for marine environments
Student name	Zehao Ye
Supervisor	Dr Yuanchang Liu
Programme	PSE
Student Number	23119333

Project Progress

Project Summary and Status:

Semantic segmentation of marine environments enables the classification of different regions within oceanic images, aiding in the navigation of unmanned surface vessels. However, achieving high-precision semantic segmentation is challenging due to the complexity and diversity of marine image data. The primary goal of this project is to utilize Bayesian deep learning methods for semantic segmentation of marine environments. Bayesian deep learning combines the strengths of Bayesian statistics and deep learning, introducing uncertainty estimation in model parameters, which enhances generalization on small datasets and provides better confidence measurements in predictions.

Currently, the dataset for marine environment segmentation was selected. A small-scale linear dataset was tested using Monte Carlo Markov Chain (MCMC) in Bayesian deep learning. The performance of the model on epistemic uncertainty and aleatoric uncertainty has also been evaluated. Additionally, an initial Bayesian CNN model is being constructed to test its capabilities in image semantic segmentation.

Achievements since last reporting:

The Bayesian deep learning algorithm based on SegNet is currently being used in conjunction with the MaSTr1325 dataset. Initial image segmentation tasks based on Non-Bayesian SegNet and Bayesian SegNet have already been completed.

Problems that have arisen:

The epistemic uncertainty and aleatoric uncertainty would be difficult to classify. Meanwhile, the model may have series of problems, including overfitting, weight-space symmetry and scaling symmetry. Afterwards, there are some unclear aspects regarding the principles, and corresponding optimizations are also needed.

Have objectives and targets been met?

A preliminary result has been successfully conducted using Non-Bayesian SegNet and Bayesian SegNet.

Work that lies ahead:

None.

Project Anticipated Risks and Mitigation Measures (risk register):

Firstly, inadequate computational resources may prolong model training times or restrict experimentation, which can be mitigated by utilizing cloud computing services or simplifying Bayesian Neural Networks with Bayesian inference on the (N-) last layer(s) only. Secondly, the project may face challenges in meeting milestones within the anticipated timeline, but timely reporting and communication can ensure that the project stays on track according to the plan.

Project Ethics

Does your project involve human participants or data derived from living human participants?

No.

If yes, have you submitted a request for ethics approval?

No.

Safety and Risk Assessment

Does your project require risk assessment?

The project is software-based only, which do not need risk assessment.

If yes, have you completed riskNET?

No.

Sustainability

Please explain if and how your project contributes to sustainability and which UN Sustainable Development Goals your project relates to:

This project is designed to assist in the operation of USVs and promote their intelligence. Regarding Goal 9 - Industry, Innovation, and Infrastructure, it contributes to advancements in autonomous navigation facilities within the marine environment. Simultaneously, by monitoring the water surface, it can also contribute to Goal 14 - life below water to some extent, assisting in the conservation of marine animals.

Diversity and Inclusion

Does your project take Diversity and Inclusion (D&I) perspectives into account (e.g. ensures unbiased image recognition or AI software, diverse consumer sample needs assesses for the product...)? Please explain:

This project is primarily designed for USVs. Given that most semantic segmentation datasets for the marine environment do not include recognition of humans, there is no need to consider a Diversity and Inclusion (D&I) perspective.

Project Log

Have you attended/reviewed all the lectures from the lecture series?

Yes

How many meetings with supervisors have you had?

In Term 2: 2

In Term 3: 4

I have discussed with the supervisor their availability over the summer (e.g., potential holiday periods etc.)

No

Gantt Chart: