Machine Learning (XAI501) Term Project Proposal

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Bayesian Uncertainty Estimation for Ultrasound Medical Image Segmentation

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**Introduction**

* Statement
  + Sonography is a diagnostic medical procedure to produce visual images of organs, tissues or blood flow, nerves inside the body. Different structures in the body reflect ultrasound waves differently. With this characteristic, it is highly utilized as a diagnostic aid. However, Sonographer requires a lot of proficiency to distinguish different organs in the visual image of ultrasound. Also the accuracy of the test is affected by the condition of the Sonographer.
* Motivation
  + In particular, the nerves are very difficult to recover once they are damaged, so more attention is required during the medical procedure. Therefore, accurate detection is necessary to reduce the chance of side effects and failures during anesthesia or medical procedures.

**Goal**

We want to make a detector that segments nerves in an ultrasound image as a tool to assist the proficiency of Sonographer. Furthermore, using bayesian properties learned in class, we aim to inform the uncertainty of the segmentation map that the sonographer can help in making a decision. Therefore our goal is to acquire epistemic uncertainty matrix which can be used to evaluate bayesian model for semantic segmentation

**Dataset**

* Source and organization of data
  + Total 5635 ultrasound images of the neck
  + 47 subjects with about 120 images for each subject
  + Further details of the data description is shown on the below link
    - https://www.kaggle.com/c/ultrasound-nerve-segmentation/data
* Data pre-processing
  + Missing data
  + Normalization

**Method**

* We will combine a DeepLabV3+ and U-Net structure concepts in our architecture
  + To derive a sharper segmentation outcome, we apply to a concept of skip-connection method which can be utilized appearance information extracted by an encoder network
  + We utilize an atrous or dilated convolution in our network which is a way to widen the field of view over the input feature maps without increasing the number of parameters or using pooling layers

**Role of Members**

* Sangjin : Baseline (U-net, DeepLab) experiments and data pre-processing
* Jinhyo : Merge and model (skip-connection, DeepLabV3+) performance improvement
* Sunwoo : Bayesian architecture design and implementation
* Kwanseok : Method analysis how to make an uncertainty map (MC dropout, variational inference)

**Milestones**

1. Data preprocessing and understanding (~1 week, 04 Nov)

2. Proposed architecture design and implementation (~1 week, 11 Nov)

3. Experiments conducting (~2.5 weeks, 29 Nov)

4. Analysis (~0.5 week, 02 Dec)

5. Final documentation and presentation preparation (~1.5 week, 13 Dec)