Ultrasound Nerve Segmentation

Machine Learning CS582 Project Proposal

# Dataset

The dataset for this project is taken from a Kaggle competition “Ultrasound Nerve Segmentation”. It consists of ultrasound images of the neck, from which nerve structures can be identified to improve the placement of the catheter.

# Project Idea

Surgery oftentimes involves post-surgical pain. Managing pain involves the use of narcotics which have several unwanted side effects; under or overdosing respiratory side effects and sedation.

One way to manage pain with less dependency on narcotics is through the use of indwelling catheters that deliver anesthetic. Pain management catheters block or mitigate the pain at the source. These catheters are inserted in the area around the nerves that carries sensation from the surgical site. It is therefore imperative to accurately identify nerve structures in order to effectively insert the catheters.

# Software to Write

The goal of this project is to identify a collection of nerve structures called the Brachial Plexus (BP). Given an ultrasound image, highlight or annotate the area in the image where the BP is located.

We will apply deep learning in computer vision to recognize the BPs in ultrasound images. In doing so, the following tasks will be involved:

1. Design a deep neural network
2. Train the neural network from a dataset of ultrasound images
3. Create a script that accepts images as input, and outputs the same images with highlighted/annotated Brachial Plexus, if present.

# Papers to Read

Y. LeCun et al. “Gradient-based Learning Applied to Document Recognition.” Proc. Of the IEEE, <<http://yann.lecun.com/exdb/publis/pdf/lecun-98.pdf>> (1998)

C. Farabet et al. “Learning Hierarchical Features for Scene Labeling.” <<http://yann.lecun.com/exdb/publis/pdf/farabet-pami-13.pdf>> (2013)

C. Szegedy et al. “Going deeper with convolutions.” arXiv preprint arXiv:1409.4842v1 (2014)

C. Szegedy et al. “Rethinking the Inception Architecture for Computer Vision.” arXiv preprint arXiv:1512.00567v3 (2015)

D. Kingma, J. Ba. “Adam: A Method for Stochastic Optimization.” arXiv preprint arXiv:1412.6980v8 (2015)

D. Eigen, R. Fergus. “Predicting Depth, Surface Normals and Semantic Labels with a Common Multi-Scale Convolutional Architecture.” arXiv preprint arXiv:1411.4734v4 (2015)

O. Ronneberger, P. Fischer, T. Brox. “U-Net: Convolutional Network for Biomedical Image Segmentation.” arXiv preprint arXiv:1505.04597v1 (2015)

# Team

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# Deliverables

At the end of the project, we are expected to have:

1. Deep neural network architecture
2. A trained model
3. A paper describing the preprocessing of data, training results, and visualizations of results

If time permits:

1. A simple server application where the trained model will be embedded, and returns annotated ultrasound images given raw images
2. iOS application that simulates an ultrasound device that automatically annotates Brachial Plexus nerve endings.