EE 456 Final Project Proposal

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Design and Implementation of a Convolutional NN for Detection of Pneumonia Characteristics

Overview

The Final Project for EE456 will include a working Convolutional Neural Network, that involves backpropagation and binary classification to identify Pneumonia from X-Ray Image inputs. There is a large dataset of X-Ray Images for training and validation present, that is stored for the neural network to form a prediction from (for a sample example image).

The key idea is that the X-Ray image of a pneumonia ridden patient is vastly different than that of a non-pneumonia ridden patient. There are discernable differences around the thoracic cavity (lungs area) of the patient, near the ribs and in the color gradation near that region as well. Through a Convolutional Neural Network (CNN) (the best network architecture for image analysis for feature extraction and classification, exactly what is being done right now), we aim to identify pneumonia as a disease. This disease is chosen as it has a tested and vast existing dataset and is simpler to a fair degree to detect with a sophisticated (within certain bounds) Neural net, unlike COVID-19 or more complex imaging tasks as far as diseases go.

Basic Idea of Architecture

The typical architecture of a CNN will be followed, with an 80%-20% or 90%-10% training to validation splitting, of the data. The data is in png files, and are mainly grayscale, to provide for easy data vector computations/weight updating. There will be nonlinear activation functions of a radial nature, that provide for sharper contrast determination within the context of boundary setting to identify the features that contribute to the pneumonia label of extraction (another label being normal).

If time permits, we may design a deep version of the CNN (DCN, or deep convolutional network), which involves the typical CNN architecture but with fuller (associative) connections between all the hidden layers, with a general increase in said parameter count. This can be trained on the same data with the same settings of activation, splitting of the dataset and so on. The classification as per the problem statement shall be the same in this case.

The *helping libraries* used will be that of TensorFlow for simplifying matrix computations, sklearn (and skimage) and seaborn for data preprocessing and data mapping (and plotting), pandas for data objectification, NumPy for other mathematical calculations, cv2 for image file reads, and random for random seed generation.

Expectations + Results

Ideally, we hope to see a considerable accuracy in detection of Pneumonia solely from a large data set and X-Ray images, with verification from existing data that it is the case. It will also be interesting to compete the performances of the CNN and DCN, with intuitive senses suggesting the DCN outperforming the CNN, but depending on the solution and data, that may not be the case (example overfitting situations).

The performances will be computed by the typical metrics of MSE, or that of accuracy in MLP vectors by weight error corrections, (in training and testing), and the learning rate will be annealed linearly at a small rate of decease to ensure optimal error surface functional energy minimization (for the given local minima for the dataset).

Interesting aspects include ideal identification of complex sets of visible characteristics and a clear margin of are mapping pertaining to a real-world medical problem (illness) and its remedy. Using the same principles of PCA, classification, decision boundaries, backpropagation, activations and layers, and MLP type aspects of hidden layers and connectivity, along with other methods relating to feed forward algorithms, algorithms that involve weigh updates and learning rate updates, and minimizing error energy functions, as well as concepts involving computing error/loss across epochs will all be useful here.

Workload distribution:

The work will be evenly split with one member handling training, one member handling validation and initialization, and the member handling the training will also handle the plot generation. Since the code will be implemented in python, with existing python open-source global libraries, there won't be logistical issues of support. Additionally, if there is time for a DCN implementation, the workload will be split up the same way, though each team-mate will work on different tasks, if need be, within these categories.

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