Machine Learning Engineer Nanodegree Capstone Proposal

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Domain Background

Image-based Deep Learning has been a vital diagnostic tool for the screening of various diseases in patients. In this project, chest X-ray images from the public will be used for the detection of pneumonia using convolutional neural network (CNN) and transfer learning frameworks of the machine-learning (ML) domain. Pneumonia is an inflammation of small air sacs in the lungs known as alveoli. The severity of the disease can range from mild to life-threatening. Chest X-ray is one of the tools to help confirm the diagnosis [1]. Recently, machine learning algorithms have been crucial in extracting valuable information about various diseases from medical images. Using ML in the medical diagnosis process has automated the task, providing instant feedback about the disease in real-time which would otherwise require extensive human effort. Therefore, the project has wide application in the field of medical science.

Problem Statement

In this project, we aim to develop a machine learning model that can instantly detect pneumonia in human chest X-rays. CNN and transfer learning has proven crucial in solving such problem of image classification. Therefore, one of the relevant solutions will be to apply CNN and transfer learning to solve the prosed problem.

Datasets and Inputs

The datasets for building a model will be taken from Kaggle's Chest X-Ray Images (Pneumonia) [2]. The dataset comprises chest X-ray images each with pixel size 736 by 1048 and 3 color channels. The images are broadly classified into two main labels: 'PNEUMONIA' and 'NORMAL'. Each label has images separated into 'train', 'test', and 'val' directories for training, testing, and validation purpose. These images will be used in training the CNN models.

Solution Statement

The solution to the proposed problem in the project is to develop a highly accurate machine learning model based on CNN and transfer learning. Using the transfer learning technique of the previously trained model can be applied in solving other similar problems of medical diagnosis by instantly tuning the model relevant to the problem. Thus, the proposed solution is quantifiable, measurable, and replicable.

Benchmark Model

A convolutional neural network (CNN) will be the benchmark model for the problem. The performance of the transfer learning model based on previously trained models will be compared and evaluated against the base CNN model.

Evaluation Metric

Model 'accuracy' will be the evaluation metric for the problem which is appropriate given the context of the project.

Project Design

The project will be accomplished in the following sections:

i. **Exploratory data analysis**: The image dataset provided by Kaggle is already separated into the ones with and without the disease, and into the train, test, and validation sets. Therefore, exploratory data analysis is going to be image visualizations and rescaling [3].

ii. **Define model:** The base CNN model based on Keras sequential architecture will be defined to solve a binary classification problem. The model's accuracy will be the evaluation metric.

iii. **Train and optimize the base model:** The base model will be trained to achieve maximum accuracy. During the process, the model architecture and hyperparameters (learning rates, optimizers, etc.) will be optimized to improve the metric.

iv. **Model evaluation and predictions:** The model's performance will be evaluated by the model's predictions against the test images that are not used during the training.

v. **Transfer learning model:** The top-performing pre-trained model for image recognition known as VGG19 will be used to build a transfer learning model. The weights of the pre-trained model will be used which will be customized with few outer layers [4].

vi. **Comparisons:** The performance of the transfer learning model will be compared against the CNN base model.

References:

1. Kermany, Daniel S., et al. "Identifying medical diagnoses and treatable diseases by image-based deep learning." *Cell* 172.5 (2018): 1122-1131.
2. https://www.kaggle.com/paultimothymooney/chest-xray-pneumonia.
3. https://keras.io/api/preprocessing/image/
4. https://keras.io/api/applications/vgg/