Introduction

Chest computed tomography (CT) scans are used by radiologists to detect and classify Interstitial Lung Disease (ILD), however the use of computer-aided diagnostic (CAD) systems can reduce the time taken for these decisions with less intervention from radiologists. We explore the performance of both traditional image processing and convolutional neural networks (CNN) techniques in classifying ILD. Traditional image processing has long been successful at recognizing and classifying images into defined groups, but some may consider the technology outdated. On the other hand, CNN’s possess very powerful computing capabilities but require large image sets to train and evaluate. We hope to bypass this issue using “transfer learning”, where input images are trained and tested on pre-existing model weights.

Data Sets

- ImageNet Dataset (used to pre-train the CNN)
  - 14 Million Images
  - 1000/10000 Categories
  - Sample Images
- Talisman Test Suite Data Set
  - 19521 Images from 96 Patients
  - 28 categories (square type)
  - Sample Images

Talismen Tool Suite Data Set

- 19521 Images from 96 Patients
- 28 categories (square type)
- Sample Images

Image Count per Disease

Multi-Class Comparison

CNNS were then tested in a multi-class classifier to see how their performance would be affected. This new classifier defines an image as healthy, fibrotic, emphysema, nodules, glass, oil, microvascular. Since the models appear to perform much worse here, we applied transfer learning to improve scores. We measured 2 scores for each model: the score from using Transfer Learning on the last layer; and the score from using Transfer Learning on the optimal layer.

Performance of Traditional Image Processing and Convolutional Neural Network Techniques in Classifying Interstitial Lung Disease

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Methodology

- HU to RGB
  - Each pixel of a CT scan holds a Hounsfield unit (HU) value, representing the density of material at the pixel. However, the methods we’re using expect color channel values. RGB images consist of 5 color channels that have pixel values between 0 and 255.
  - We linearly mapped
    - HU range (>2000) into the Red Channel
    - HU range (-601, -200) into the Green Channel
    - HU range (-1000, -600) into the Blue Channel
  - Each HU range looks for different anatomical features in CT scans, such as air, blood vessels, bone, etc. Values outside of the HU ranges of each channel were mapped to either 0 or 255.

ImageNet Dataset

- At the last feature layer (pictured in “Transfer Learning”) the network takes RGB images in its input layer. We first pull features from the last feature layer in the network to find an optimal layer (G) which produces the highest F1 Score. With a smaller number of layers, the time spent traversing them will reduce drastically, and the features extracted will be simpler constructs.

Evaluation Measures

- Confusion Matrix: contingency table showing the actual class versus the predicted class for all images. These values can be normalized to obtain a rate for each value.

transfer learning is a useful tool to customize a CNN model for ILD classification.

Future work involves “fine-tuning” later layers of the network to add an optimal layer (D) which produces the highest F1 Score. With a smaller number of layers, the time spent traversing them will reduce drastically, and the features extracted will be simpler constructs.

Experimental Set-Up & Results

- CNN’s are more feasible than traditional image processing techniques for classifying ILD.
- Transfer learning is a useful tool to customize a CNN model for ILD classification.
- Performing “Data Augmentation” for emphysema images or using a more established database of images may yield higher scores.
- Future work involves “fine-tuning” later layers in networks, based on the observed optimal transfer layers in each network.

Work done in collaboration with the Koret Scholar Foundation. Data provided by Adrian Deppeersingh.