Alexandria University
Faculty of Engineering
Computer and Systems Engineering
Department

CS 4E3 Computer Vision
Assigned: Saturday, April 4, 2020
Due: Thursday, April 23, 2020

Assignment # 3
MRNET for Knee Diagnosis

1 MRNET Dataset

The MRNet dataset consists of 1,370 knee MRI exams performed at Stanford University Medical Center. The dataset contains 1,104 (80.6%) abnormal exams, with 319 (23.3%) ACL tears and 508 (37.1%) meniscal tears; labels were obtained through manual extraction from clinical reports. Each exam has three views and every view is a volume of multiple scans [not a single image per case].

The exams have been split into a training set (1,130 exams, 1,088 patients), a validation set (called tuning set in the paper) (120 exams, 111 patients), and a hidden test set (called validation set in the paper) (120 exams, 113 patients). To form the validation and tuning sets, stratified random sampling was used to ensure that at least 50 positive examples of each label (abnormal, ACL tear, and meniscal tear) were present in each set. All exams from each patient were put in the same split.

Dataset Link: https://stanfordmlgroup.github.io/competitions/mrnet/

2 Building Well-Known Networks

You will start with building the following well-known networks from scratch using Keras:

- Visual Geometry Group (VGG)
- Residual neural network (ResNet)
- MobileNet
- Inception V3

Divide the training split of the dataset into training part (90%) and validation part (10%). For training, assume each scan in an exam is an individual image (data point). Use the original validation dataset for testing, where the final classification of a test exam is the majority voting of its scans. Report the accuracy produced by each model.

3 Transfer Learning

Instead of training the models staring from random state, we can use transfer learning to start with a better set of networks' weights trained on famous datasets. Here, you will use ImageNet

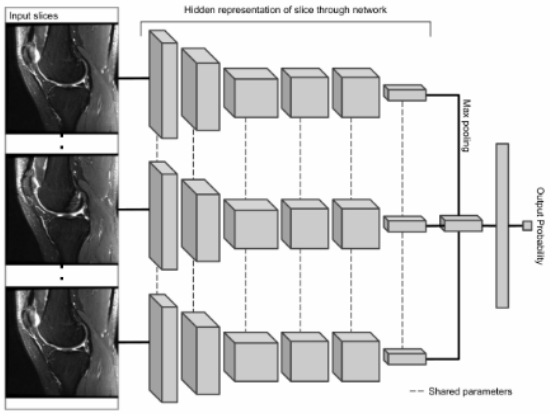
weights to enhance the training of well-known networks. Choose the best performed network from the previous part and apply transfer learning with ImageNet weights. In this part use the networks models built-in keras. Report the new performance of the network.

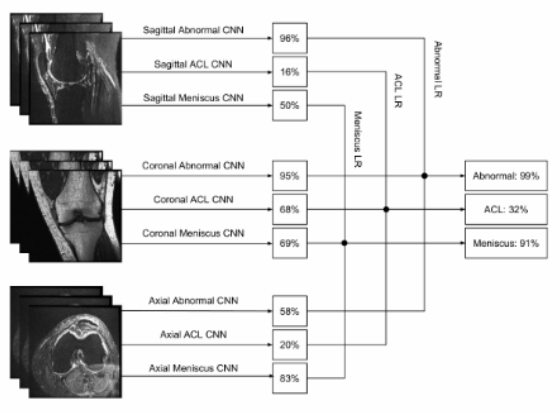
4 MRNET Model

In this part, you are required to rebuild the MRNet model. Report and compare the obtained results to the reported results in the paper (https://stanfordmlgroup.github.io/projects/mrnet/)

The primary building block of MRNet is a convolutional neural network (CNN) mapping a 3-dimensional MRI series to a probability. The input to MRNet has dimensions $s \times 3 \times 256 \times 256$, where s is the number of images in the MRI series (3 is the number of color channels). First, each 2-dimensional MRI image slice is passed through a feature extractor to obtain a $s \times 256 \times 7 \times 7$ tensor containing features for each slice. A global average pooling layer is then applied to reduce these features to $s \times 256$. We then applied max pooling across slices to obtain a 256-dimensional vector, which is passed to a fully connected layer to obtain a prediction probability.

Because MRNet generates a prediction for each of the sagittal T2, coronal T1, and axial PD series, a logistic regression is trained to weight the predictions from the 3 series and generate a single output for each exam.





5 Contribution

Invent some new solution that takes the multiple scans of the exams in the dataset, and produces the classification. You may refer to the work done in the following papers:

- Deep Learning for Musculoskeletal Image Analysis
- Using Deep Learning Algorithms to Automatically Identify the Brain MRI Contrast: Implications for Managing Large Databases

6 Notes

- You are required to deliver your well-commented code, and a report containing all the used networks and models, with their obtained results.
- You can work in groups of 2 or 3.