Early Alzheimer's detection through Deep Convolutional Neural Networks

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Purpose: To create a system capable of detecting and diagnosis cases of Alzheimer's disease and MCI using fMRI data.

Materials and Methods: We will use fMRI data from the ADNI and NMorphCH databases with the Caffe Deep Learning framework.

Temporary goal: To be able to differentiate between Alzheimer's and Normal patient fMRI with a high degree of accuracy

Final goal: To develop a complete diagnostic system capable of diagnosis early stage Alzheimer’s disease and MCI for clinical use

Study design

1. Collect reference（Sample）data（Normal, MCI, Alzheimer: 50 each）from ADNI database（3T data only）.
2. Preprocessing stage （using FSL software: e.g., Brain extraction, Image registration, Normalize）, Pipeline processing are desired.
3. Other subject's data collection（e.g. MMSE scores, Age, as nuisance covariance?）
4. Generate machine learning algorithm.
5. Analyzing stage（Training stage using sample data and machine learning technique）.
6. To evaluate the results of analyzing stage （e.g. accuracy, specificity）
7. Clinical usage testing.

Key words

Functional MRI

Deep Learning

Convolutional Neural Network

Machine Learning

FSL, Pipeline

Classify Normal, MCI, or Alzheimer

Previous Work

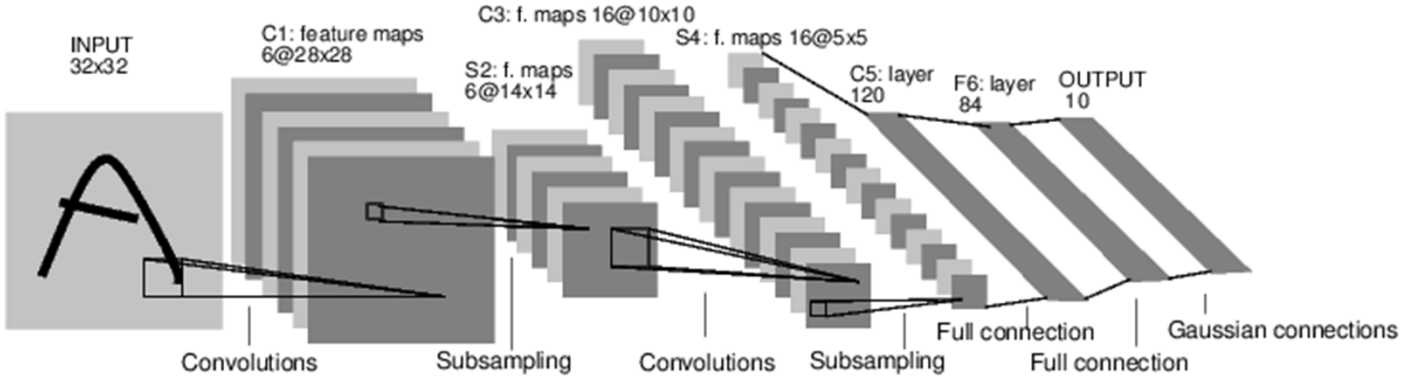
Classification of alzheimer's disease using fmri data and deep learning convolutional neural networks:
S Sarraf, G Tofighi - arXiv preprint arXiv:1603.08631, 2016

・They classified functional MRI data of Alzheimer’s subjects(n=28) from normal controls(n=15) where the accuracy of test data on trained data reached 96.85%.
・They are using convolutional Neural Network and the famous architecture LeNet-5.

Neural Network Model

We use a standard convolutional neural network model based off of the LeNet-5 convolutional network (LeCun et al., 1989) but using 6 convolution and 6 subsampling layers instead of 2 each.

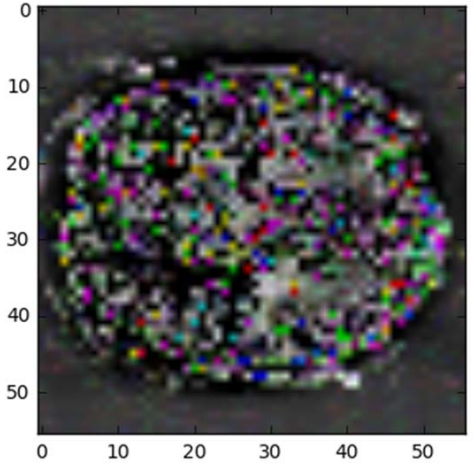
We further modified the parameters of the network to accommodate lower resolution fMRI data



Neural Network Input

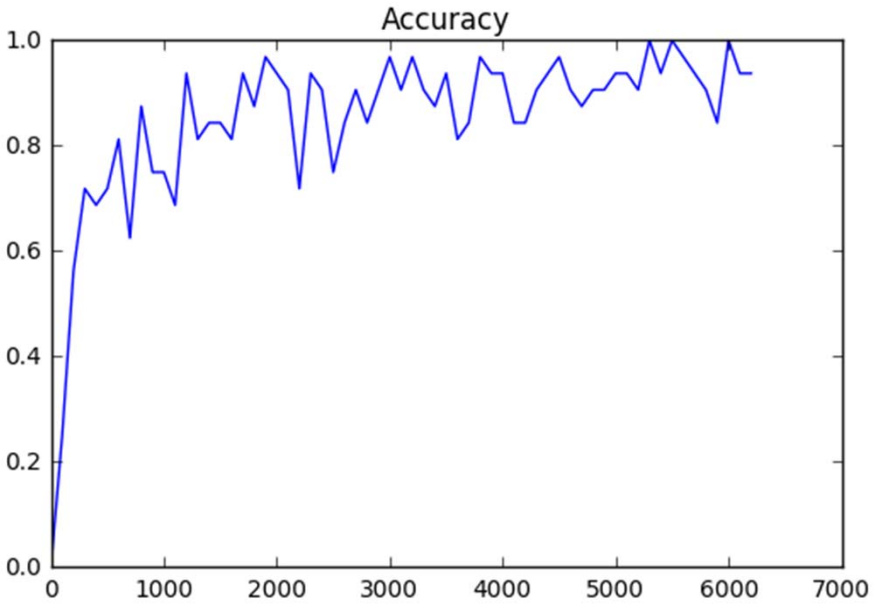
We processed the fMRI images (Pretrain Normal n=138, Normal n=24, AD n=22) and took only 3 axial slices (4cm thick) from the region around the Hippocampus

The fMRI time sequence data was sampled at 3 evenly distributed time points which was transformed into 3 individual color channels (RGB) and merged together to create a single “time-voxel”



Results

We were able to achieve an accurate classification of 87.3% over training and a separate test set



Our originality

1. Machine learning algorithm generated from a large number of subject's datasets.
2. The algorithm classify the subjects into three groups(evaluate as possibly normal, possibly MCI, or possibly Alzheimer).
3. By classifying like this way, we try to diagnose those subjects with neurodegenerative disease at very early stage with high accuracy.
4. Simplify the preprocessing process using our original pipeline (Pipeline is not necessary?).
5. Pre-training step allows much greater accuracy with lower amount of patient data
6. Aim to establish more cheaper, less invasive compared with conventional method (like PET or Blood flow scintigraphy).
7. Try to establish one-stop-shopping workflow of memory disturbed patient using 3T MRI for clinical usage (including T1w,T2w,FLAIR, and fMRI within 15 minutes).