Dementia Diagnosis with Deep Convolutional Neural Networks

Ethan Liu, Raymond Liu
Crescent Valley High School

Methodology

• Our methodology:
  • Deep convolutional neural network (CNN) followed by support vector machine (SVM).

• Deep CNNs consist of many layers.
  • Each layer consists of many neurons
  • Neurons implement a mathematical function
  • Each neuron consists of “weights” which are learned (adjusted) by a process called backpropagation

• An linear SVM model is trained to combine results of all 2D slices
  • Activations of penultimate layers from CNN are concatenated to form training samples for SVM classifier
  • This increases the overall accuracy of our method
  • ~55% -> 65.3% accuracy

• ADNI cross-sectional dataset
  • All 3D MRI scans
  • Filtered by age >= 65
  • Over 2000 scans

• Example 2D slices created from 3D scans:

Challenges

• A lack of sufficient data leaves the network prone to overfitting or inaccuracy

• Solution: Split 3D scans into many (176) 2D slices. Afterwards, combine the classification results via SVM.
  • Each slice still contains unique visual cues
  • Allows us to train a very powerful, accurate, and deep 2D CNN with a limited amount of data
# Background
- About **15%** (48 million) of America’s population is aged over 65 years
- Approximately **47.5 million people** worldwide with dementia
- It is estimated that **7.7 million new cases** of dementia are discovered every year
- Stages of dementia: Clinical Dementia Rating (CDR)
  - 0 = healthy
  - 0.5 = at risk
  - 1 = mild dementia
  - 2 = moderate dementia
  - 3 = severe dementia
- **Diagnosis:** performed by radiologists
  - Often time-consuming, complicated, and puts lots of stress on patients

# Goals
What if an accurate diagnosis could be performed using only a patient’s MRI scans?

- **The goal of this project** is to develop a **fast and accurate** method for dementia diagnosis using 3D MRI scans

# Results
- Results of the system:
  - Final accuracy = 65.3%
  - Random guess = 20%
  - Radiologist = 69 ± 10%

# Conclusions
- Model can make accurate diagnoses on par with modern radiologists
- Currently, development of the network is bottlenecked by the amount of data available
- With more data, our method will become more accurate as it processes increasing amounts of information

# Future Work
- Final accuracy of 65.3% on a held out test set of 3D slices.
- The ultimate goal of this project is to give doctors the ability to **make an early diagnosis or estimate the probability** that a person will develop dementia years before they actually start showing symptoms