Dementia Diagnosis with Deep Convolutional Neural Networks

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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:
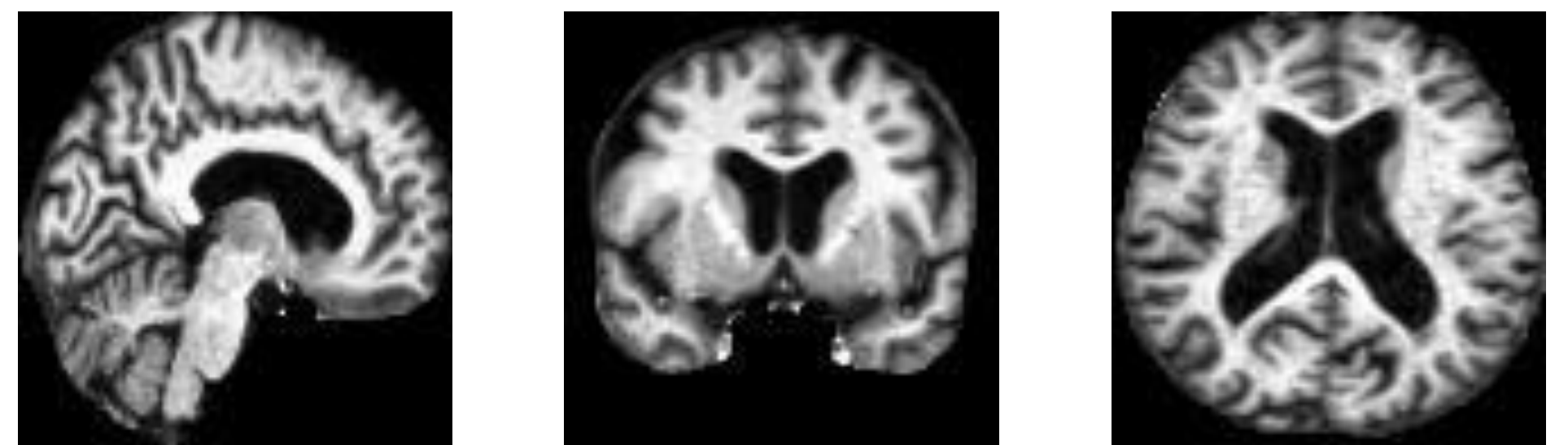
Challenges

- 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

Conv-BN-ReLU building block

Average pooling and softmax output
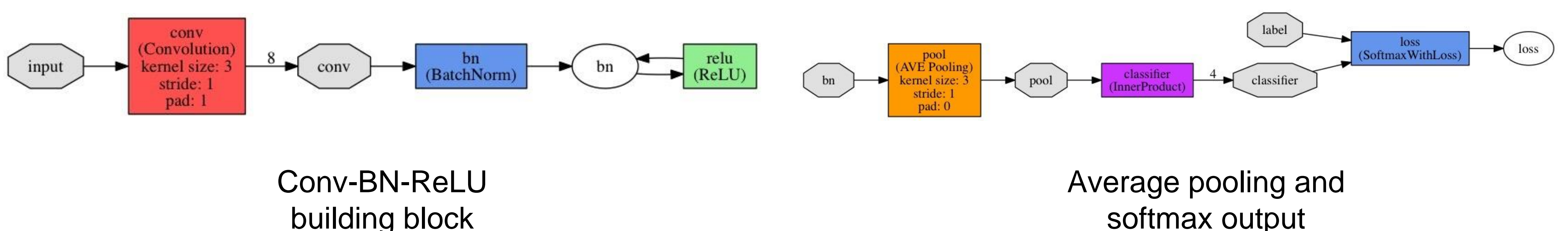
Background

- 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**