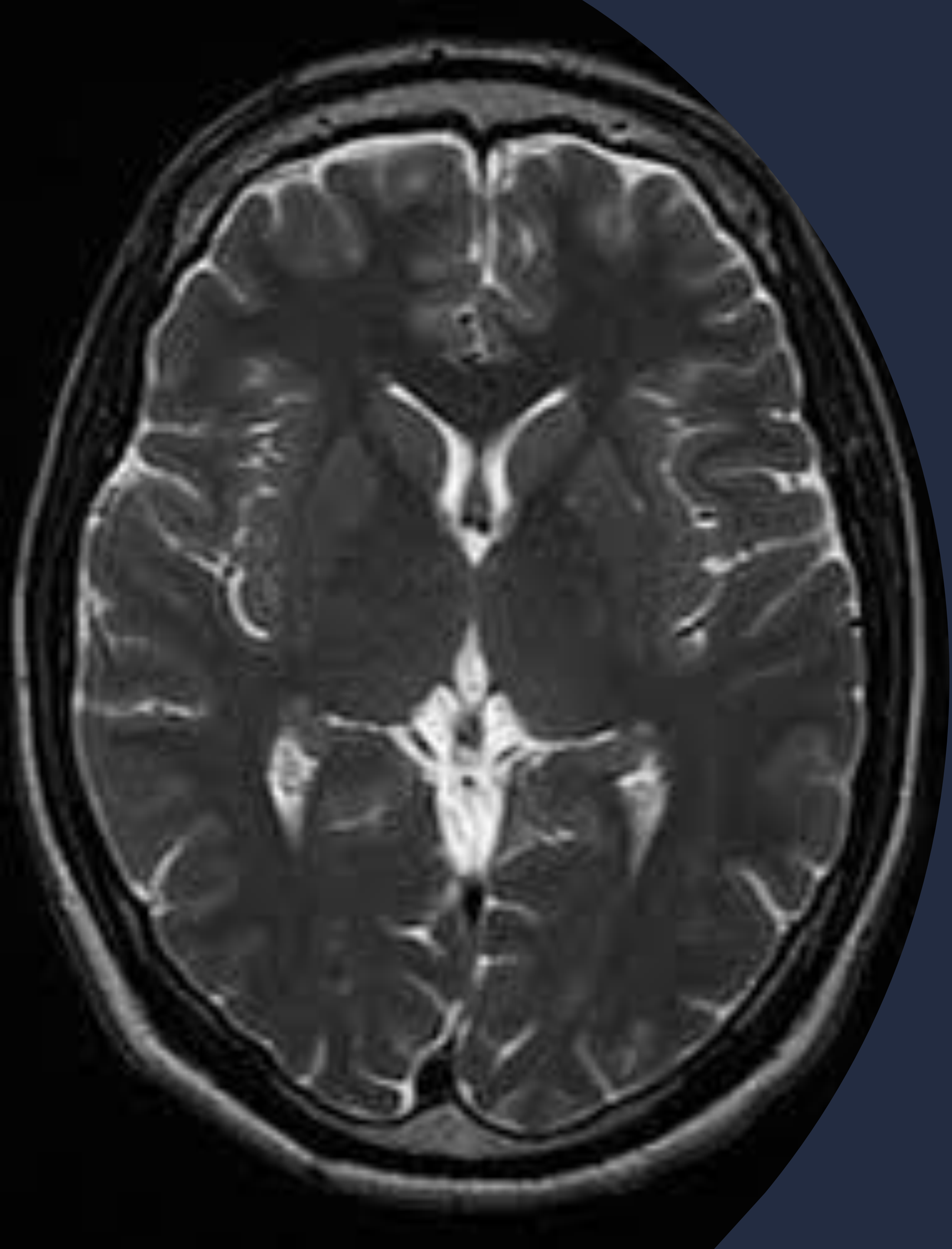

49275 Neural Networks and Fuzzy Logic

L10. DEMENTED AND NONDEMENTED BRAIN MRI IMAGES CLASSIFICATION

Seminar 1

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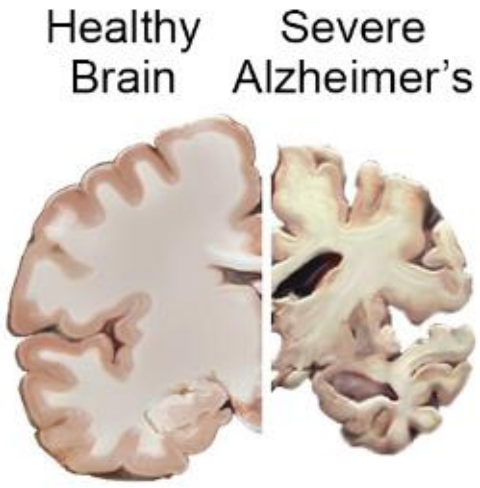
13886357 Robert Makepeace

13797093 Sannjit Saha

Agenda

- Aim / Background
- Data Source
- Literature Review
- Software
- Method
- Functional Block Diagram
- Feasibility
- Conclusion



(National Institute on Aging, 2021)

Motivations

- Most common form of dementia
- No immunity or cure for the disease
- According to WHO, more than 55 million people live with dementia globally.
- "In 2019, the estimated total global societal cost of dementia was US$ 1.3 trillion, and these costs are expected to surpass US$ 2.8 trillion by 2030 as both the number of people living with dementia and care costs increase" (World Health Organisation, 2021)

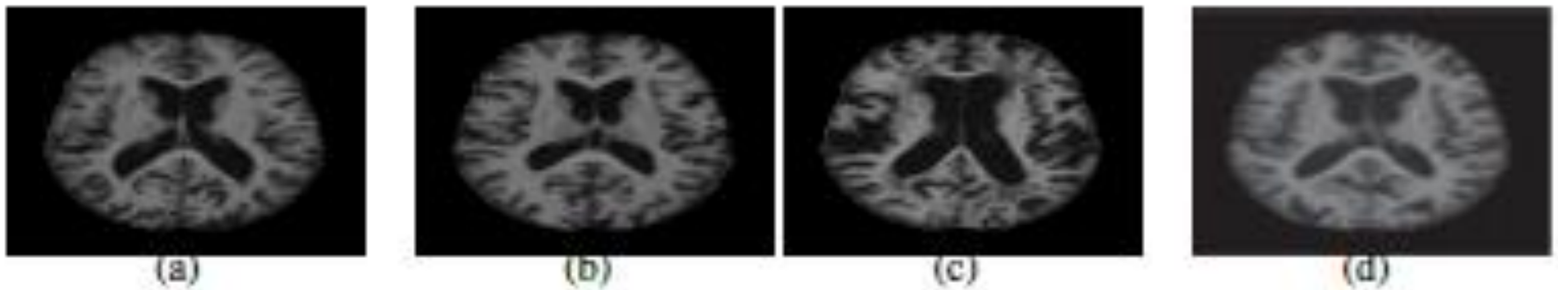


Figure 1: Example of different brain MRI images presenting different AD stage. (a) Nondemented; (b) very mild dementia ; (c) mild dementia; (d) moderate dementia.

Awate et al., 2018 figure 1.1

Aim / Objectives

- Aim: Classification and prediction of demented and nondemented brain MRI using neural networks
- Ideal outcome: High accuracy (>90%) performing model, low variance and not overfitting.
- Objectives:

Pre-processing data to select most relevant features.

Create neural network capable of predicting patients likely to develop Alzheimer's disease.

Verify constantly model is not overfitting

SCIENTIFIC REPORTS

OPEN

Predicting Alzheimer's disease progression using multi-modal deep learning approach

ceived: 10 September 2018
cepted: 12 December 2018

Garam Lee[1,2], Kwangsik Nho[3,4], Byungkon Kang[1], Kyung-Ah Sohn[1], Dokyoon Kim[2,5] & for Alzheimer's Disease Neuroimaging Initiative*

An Ensemble of Deep Convolutional Neural Networks for Alzheimer's Disease Detection and Classification

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Detection of Alzheimer's Disease from MRI using Convolutional Neural Network with Tensorflow

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FEATURED ARTICLE

THE JOURNAL OF THE ALZHEIMER'S ASSOCIATION

Predicting sporadic Alzheimer's disease progression via inherited Alzheimer's disease-informed machine-learning

Nicolai Franzmeier[1] | Nikolaos Koutsouleris[2] | Tammie Benzinger[3,4] | Alison Goate[5,6] | Celeste M. Karch[4,7,8] | Anne M. Fagan[4,7,9] | Eric McDade[4,9] | Marco Duering[1] | Martin Dichgans[1,10,11] | Johannes Levin[10,11,12] | Brian A. Gordon[4,13,14] | Yen Ying Lim[15] | Colin L. Masters[15] | Martin Rossor[16] | Nick C. Fox[16] | Antoinette O'Connor[16] | Jasmeer Chhatwal[17] | Stephen Salloway[18] | Adrian Danek[12] | Jason Hassenstab[4,9,14] | Peter R. Schofield[19,20] | John C. Morris[4,8,9] | Randall J. Bateman[4,9] | the Alzheimer's disease neuroimaging initiative (ADNI)[21] | the Dominantly Inherited Alzheimer Network (DIAN)[22] | Michael Ewers[1]

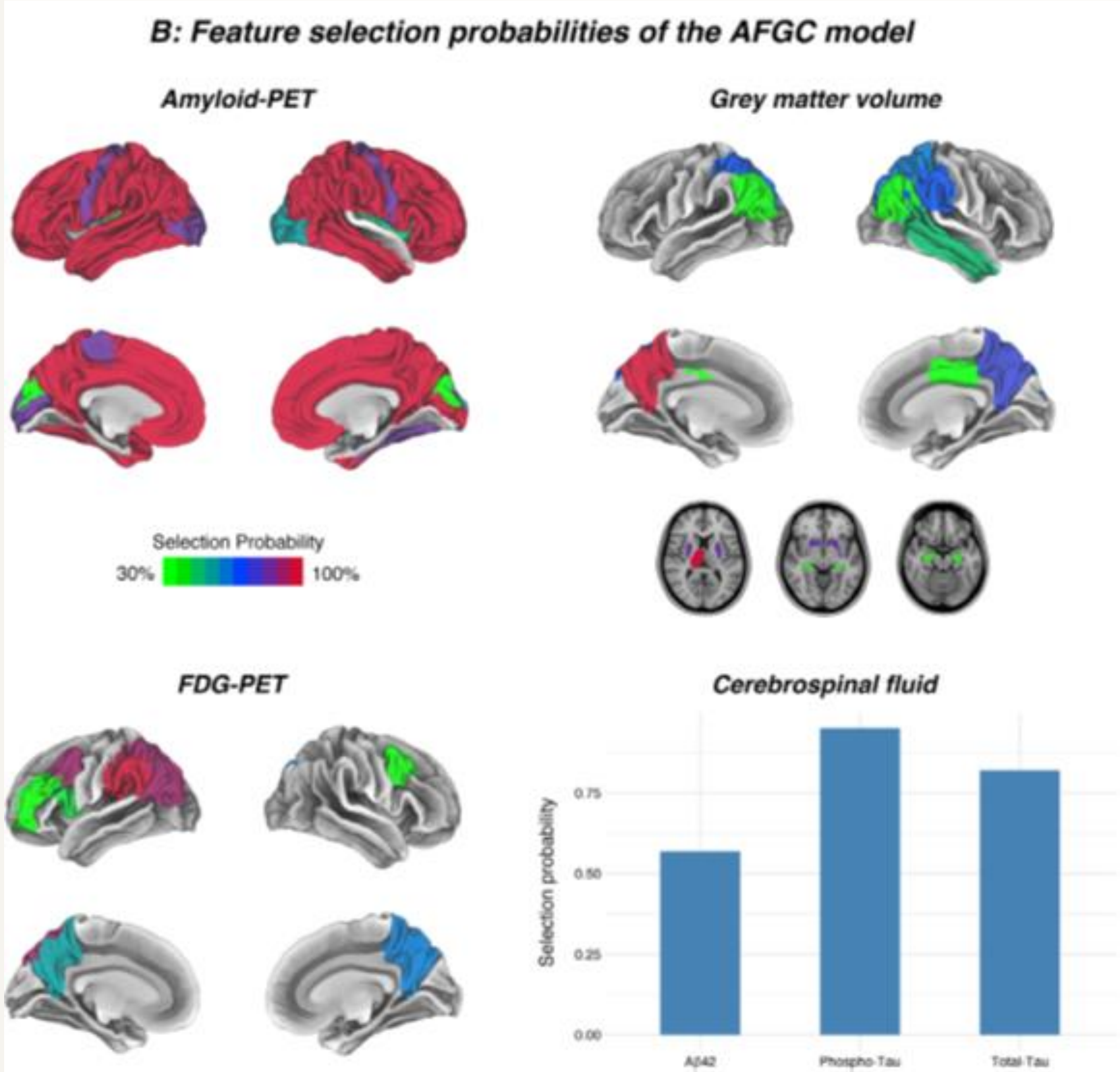
Literature Review / Market Review

- Alzheimer's disease is classified into 3 stages
  - ❑ Pre-clinical – Normal cognitive function
  - ❑ Prodromal – Mild cognitive impairment (MCI)
  - ❑ Dementia – Functional impairment

(Scharre D. W., 2019)

Literature Review /Market Review

Author(s)	Data source	Model	Modality(s)	Accuracy (r^2)
Detection of Alzheimer's disease from MRI using convolutional neural network with Tensorflow	OASIS	Convolutional neural network (CNN)	MRI images	99%
An Ensemble of Deep Convolutional Neural Networks for Alzheimer's Disease Detection and Classification	OASIS	Ensemble of 3 Dense net (a type of CNN)	MRI images	93.18%
Predicting Alzheimer's disease progression using multi-modal deep learning approach	ADNI	Multimodal recurrent neural network	Demographic information Longitudinal CSD biomarkers Longitudinal cognitive performance	81%
Predicting sporadic Alzheimer's disease progression via inherited Alzheimer's disease-informed machine-learning	DIAN & ADNI	Multi-modal support vector regression to predict future symptom manifestation between 1 – 4 years.	MRI images Cerebral spinal fluid (CSF) Amyloid-PET Fluorodeoxyglucose (FDG-PET) Grey matter volume (GM)	N/a ($R^2 = 0.53$)

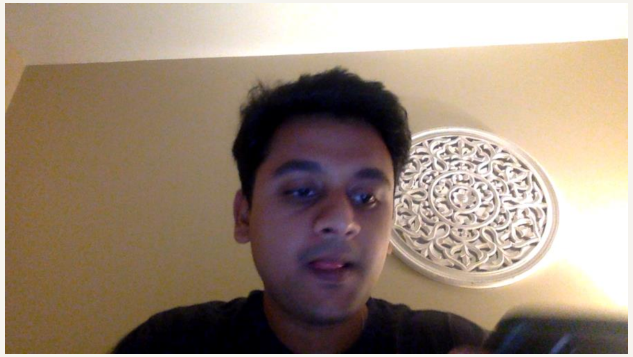


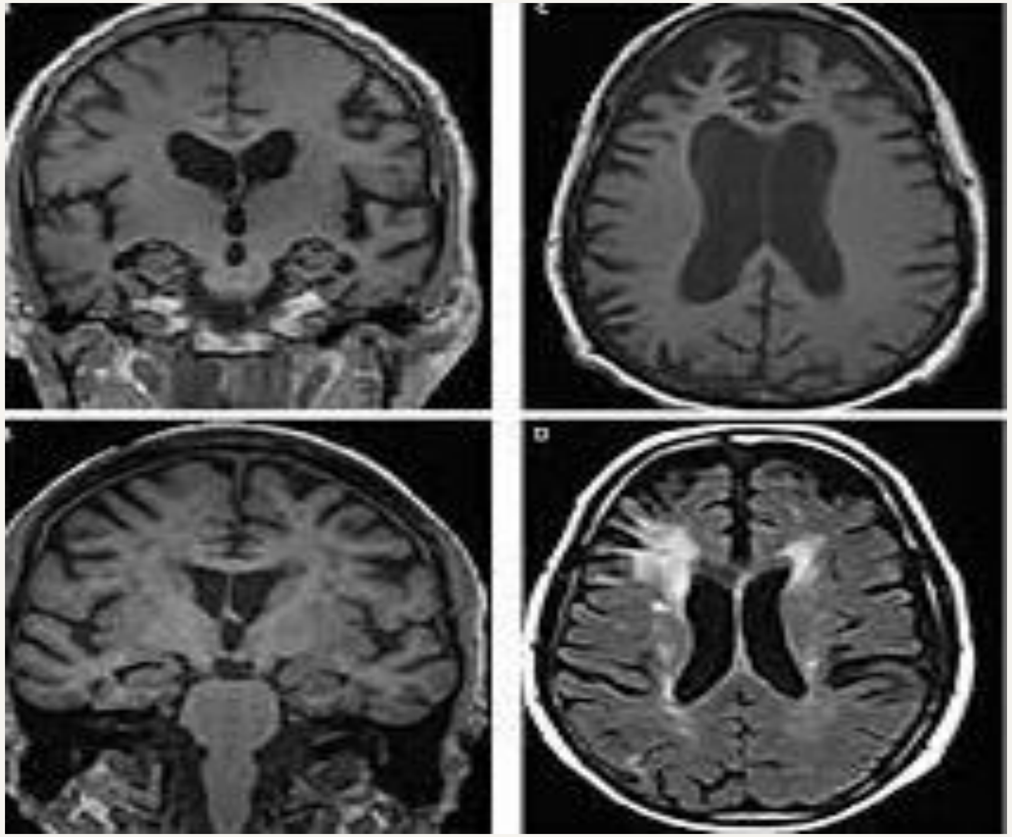
(Franzmeier et al., 2020) Figure 2 B.

Method

- We use various methods to find out about the demented and non-demented MRI Brain classification.
- Some of them are the Medulla Oblongata and other various parts of the human brain.
- In case of any injury to the skull or the brain, we need to do a few MRI scans in order to get the photographs of the brain in case there is any abnormality.
- The various methods are by using an MRI scanner which helps to record images of the human brain in case there is any abnormality.
- Demented and Non-Demented Brain MRI classification depends on various biological platforms and other various Central Nervous System and Neural Studies.
- These can be classified on the basis of Neural Network and Fuzzy Logic Theory.

Functional Block Diagram





Various Demented and Non- Demented Brain MRI classification images.

Feasibility

- Nowadays Brain MRI scanning has become very convenient with added technology.
- New Radio Waves and Magnetic scanners at a reasonable price are available in the market.
- These help to record and scan Magnetic Resonance Imaging of various parts of the Demented and Non-Demented Human Brain.
- This is the feasibility with added technology how we can record and scan various MRI images of the human brain with scanners and computer systems that show the images processed.
- These kind of Scanners are available in Hospitals and Diagnostic Centers.

Data Source

- www.oasis-brains.org.
- Open access series of imaging studies (OASIS)
- OASIS-2: Longitudinal MRI Data in Nondemented and Demented Older Adults
- 150 subjects with 373 MRI sessions

    64 demented

    51 mild to moderate dementia

    14 developed later

    Rest undemented

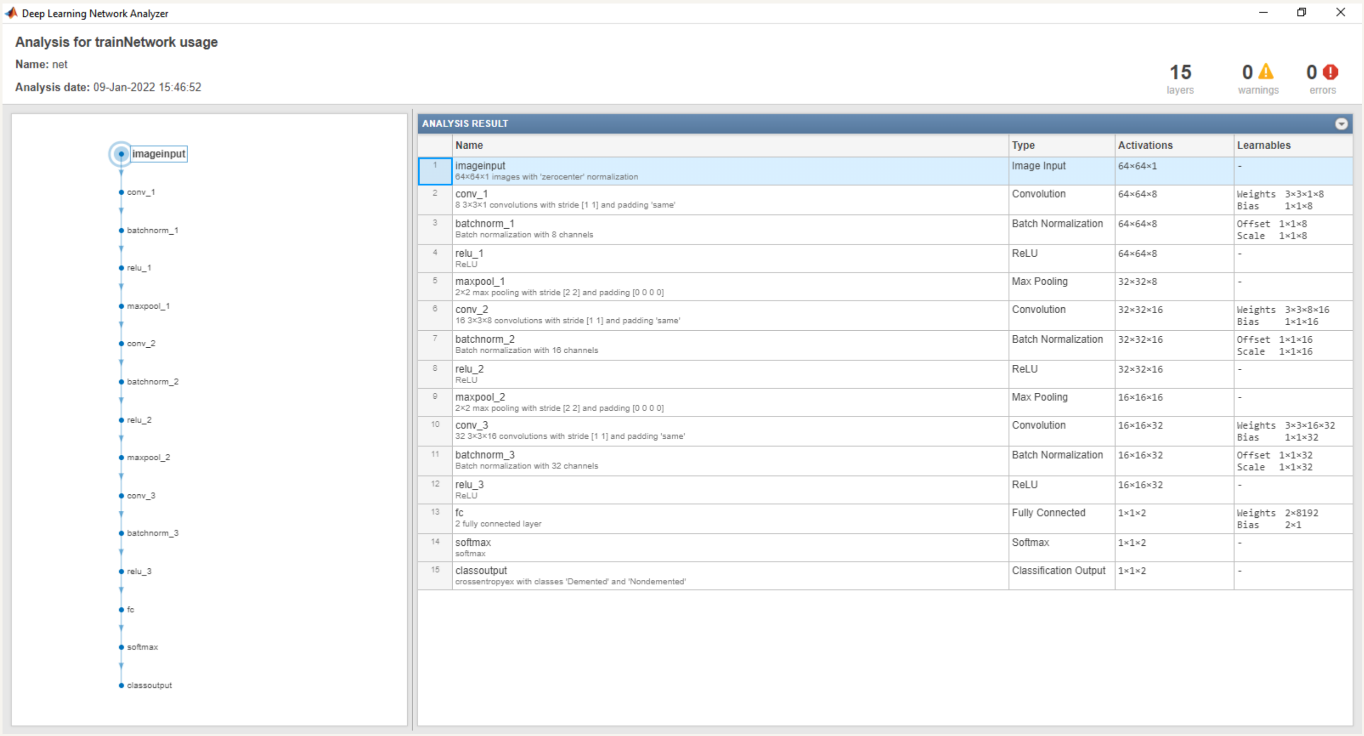
Source:

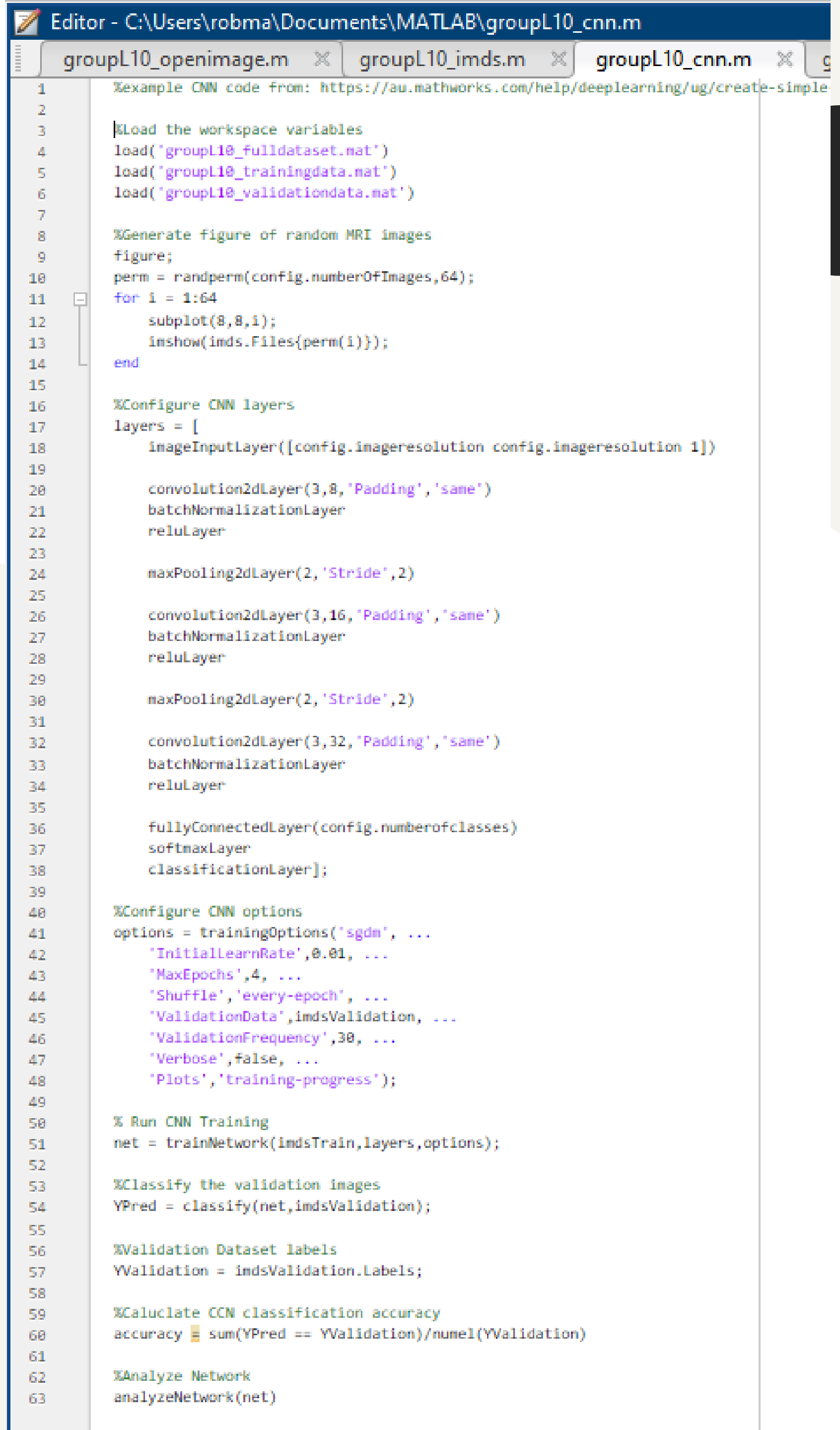
Open Access Series of Imaging Studies (OASIS): Longitudinal MRI Data in Nondemented and Demented Older Adults

Marcus, DS, Fotenos, AF, Csernansky, JG, Morris, JC, Buckner, RL, 2010. Journal of Cognitive Neuroscience, 22, 2677-2684. doi: 10.1162/jocn.2009.21407

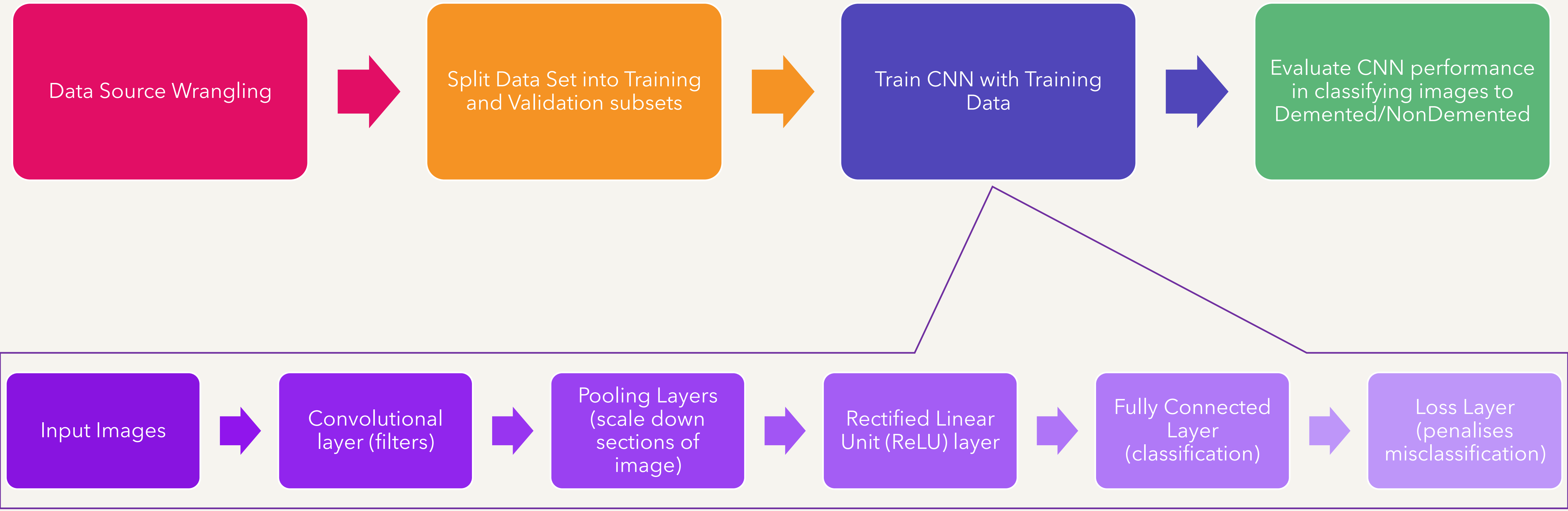
Software

- Matlab
- Deep Learning Toolbox
- Built In CNN functions, graphs and visualisations

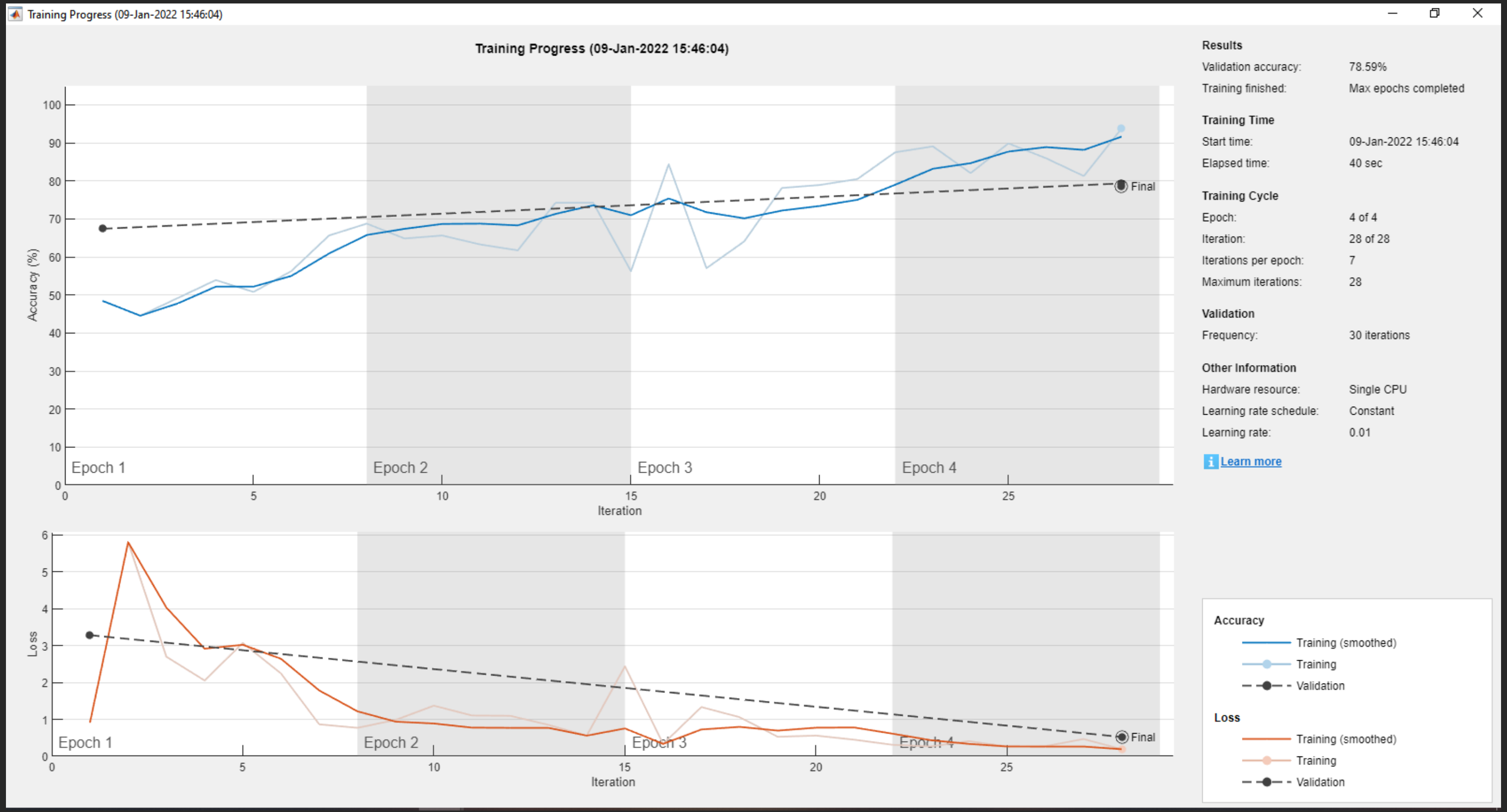




Functional Block Diagram



What we have achieved so far?



- Data Wrangling

  Matlab Scripts to convert MRI files to 64 x 64 pixel images

  Import images into Matlab image datastore structure

  Labelling images with classification (Demented / Nondemented)

  Splitting data into training (70%) and validation (30%) subsets

- Ran through Matlab example Convolutional Neural Network script

  Baseline accuracy: 79%

  Show feasibility of method

  Room for improvement with CNN structure and training

Individual Project Contributions:

Yuk Leong	Robert Makepeace	Sannjit Saha
• Literature Review • Motivations / Objectives	• Data wrangling of data source • Functional Block Diagram • Setup of example CNN Matlab script	• Method • Feasibility

Conclusion

- Automated classification of Alzehmier's from MRI images is a powerful tool to assist medical professionals
- Our projects aims to develop a Convolutional Neural Network to accurately and automatically classify patients as demented / nondemented
- So far we have completed our literature review, data wrangling and have preliminary results with our Convolutional Neural Network.

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