

EX00



Ashapriya Sebastian
Israt Jahan
Khalid N. Ismail
Birmingham City University

Bahadar Bhatia
Sandwell and West Birmingham
Hospitals NHS Trust, Birmingham





Using Machine
learning for building
a demonstrative
model to counter
the under-
diagnosis of
dementia

Agenda : Table of contents

01

INTRODUCTION
AND DETAILS
OF THE
PROJECT

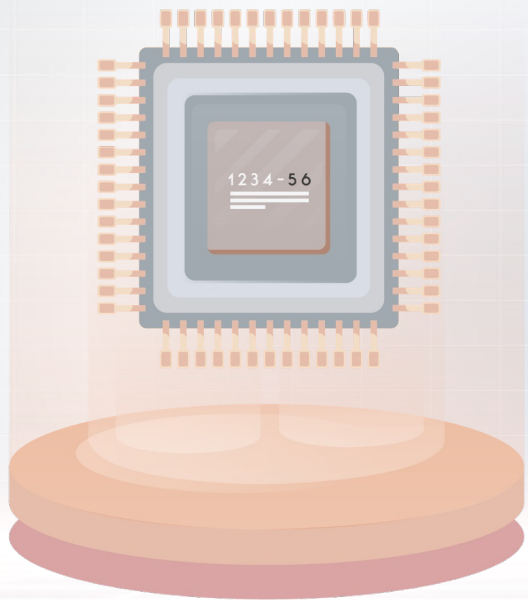
02

RESEARCH
WORK

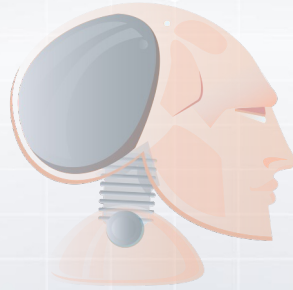
03

RESULTS AND
FUTURE
SCOPE





01 Introduction



Dementia!

Dementia refers to a group of neurodegenerative disorders characterised by decline in cognitive abilities, including memory, language, and thinking skills, that interfere with daily functioning (Alzheimer's Association, 2022).

Dementia type and facts

- **Types**

Alzheimer's

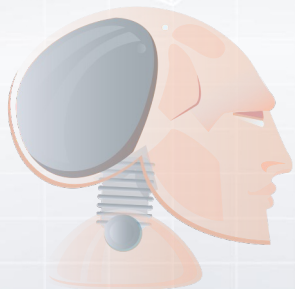
Vascular

Lewy body

Frontotemporal dementia



- Dementia cost the global economy over \$1 trillion in 2019 and is the 7th leading cause of death worldwide (World Health Organization, 2023).



Problem Statement!

Current diagnostic criteria cannot identify specific dementia diseases early enough to enable effective treatment, so new techniques using deep learning on brain imaging are needed to detect subtle cognitive changes that predict future dementia.

Project aim and objectives



Aim:

- ❑ Utilise deep neural networks for the early detection of dementia.

Objectives:

- ❑ Develop and implement a novel deep learning architecture tailored for biomedical image segmentation.
- ❑ Evaluate the performance of the developed model on biomedical datasets.
- ❑ Compare the performance of the developed model with existing state-of-the-art methods.
- ❑ Provide recommendations and insights for biomedical image segmentation in real-world applications.

02 Research work





Detection methods and studies using:

- ☐ Speech acoustic and language features
- ☐ Amyloid PET imaging
- ☐ MRI
- ☐ CT



Brain MRI dataset

3929 MRI Images for 110 patients with about 2,555 images false case and 1,374 true cases

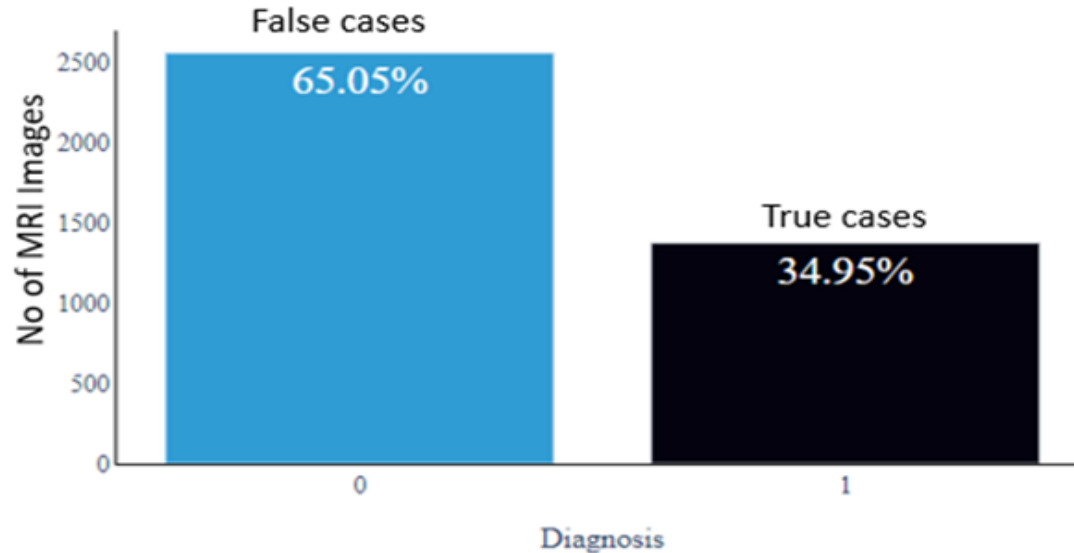


Figure 1: Brain MRI Dataset Distribution (own creation)





MRI Segmentation

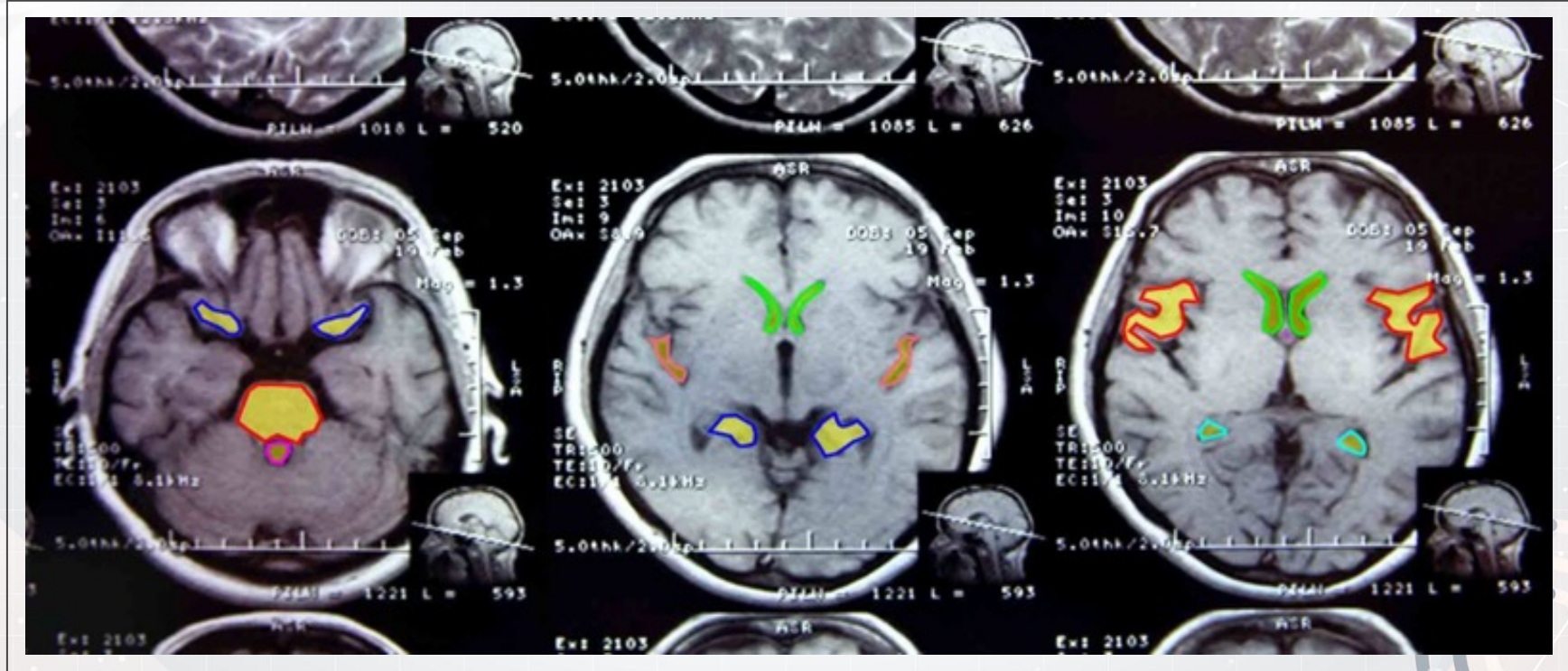


Figure 2: MRI Segmentation for dementia detection (MRI Segmentation, 2023)

MRI Segmentation

- ☐ Convolutional Neural Networks
- ☐ Ensemble System of Deep Convolutional Neural Networks
- ☐ Deep Recurrent Neural Networks
- ☐ DEMNET
- ☐ Graph Neural Networks
- ☒ Deep Neural Network-Based Method for Prediction of Dementia Using Big Data
- ☐ Ensemble Deep Neural Networks using FDG-PET Scans
- ☐ SegNet
- ☐ U-Net
- ☐ Attention U-Net



SegNet – Architecture

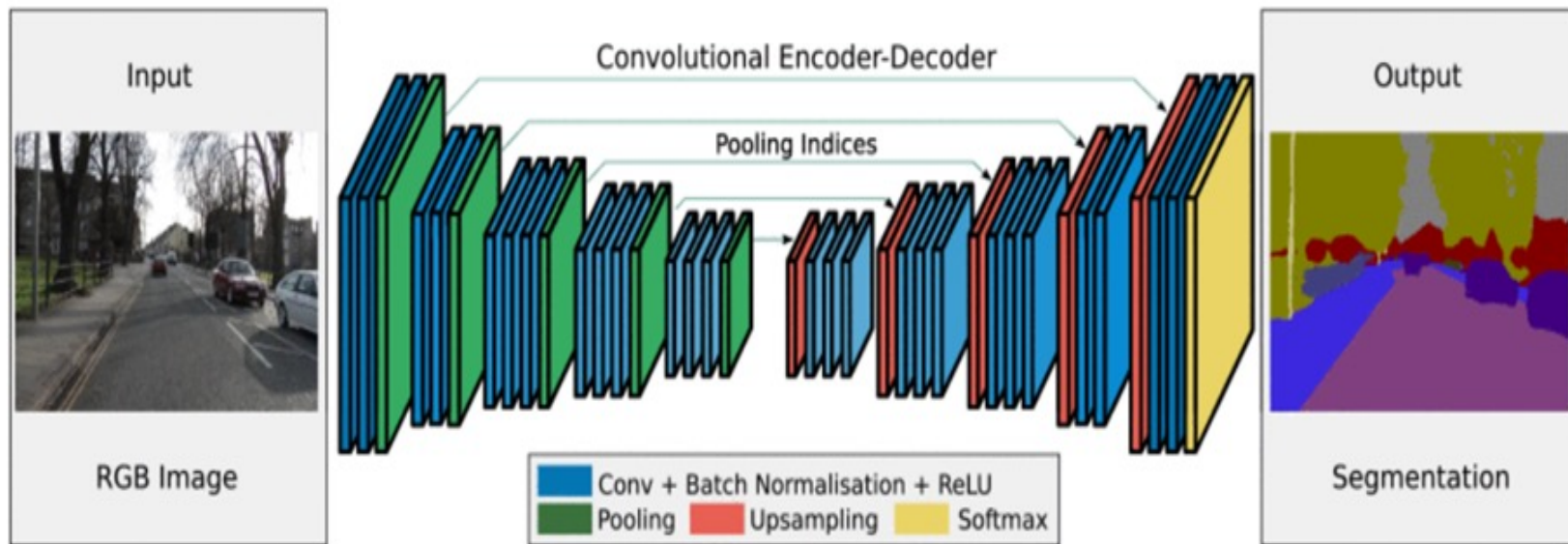


Figure 3: An illustration of the SegNet architecture [Badrinarayanan, Kendall and Cipolla, 2017]



U-Net – Architecture

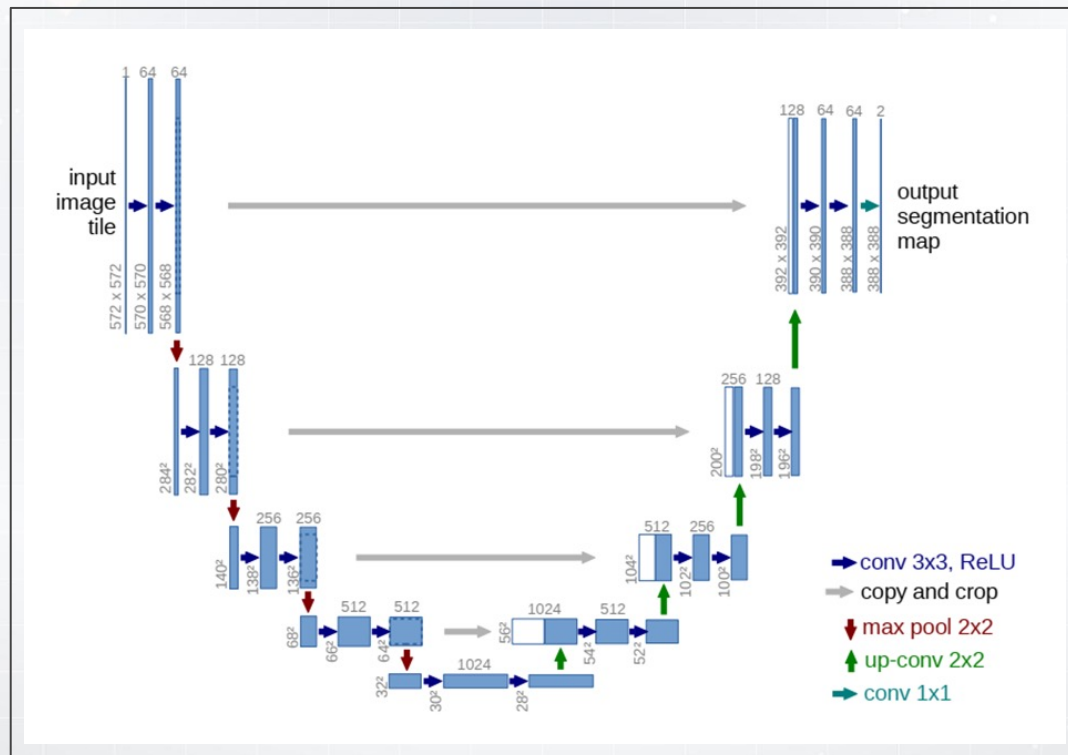


Figure 4: U-net architecture (Ronneberger, Fischer and Brox, 2015)



Attention U-Net – Architecture

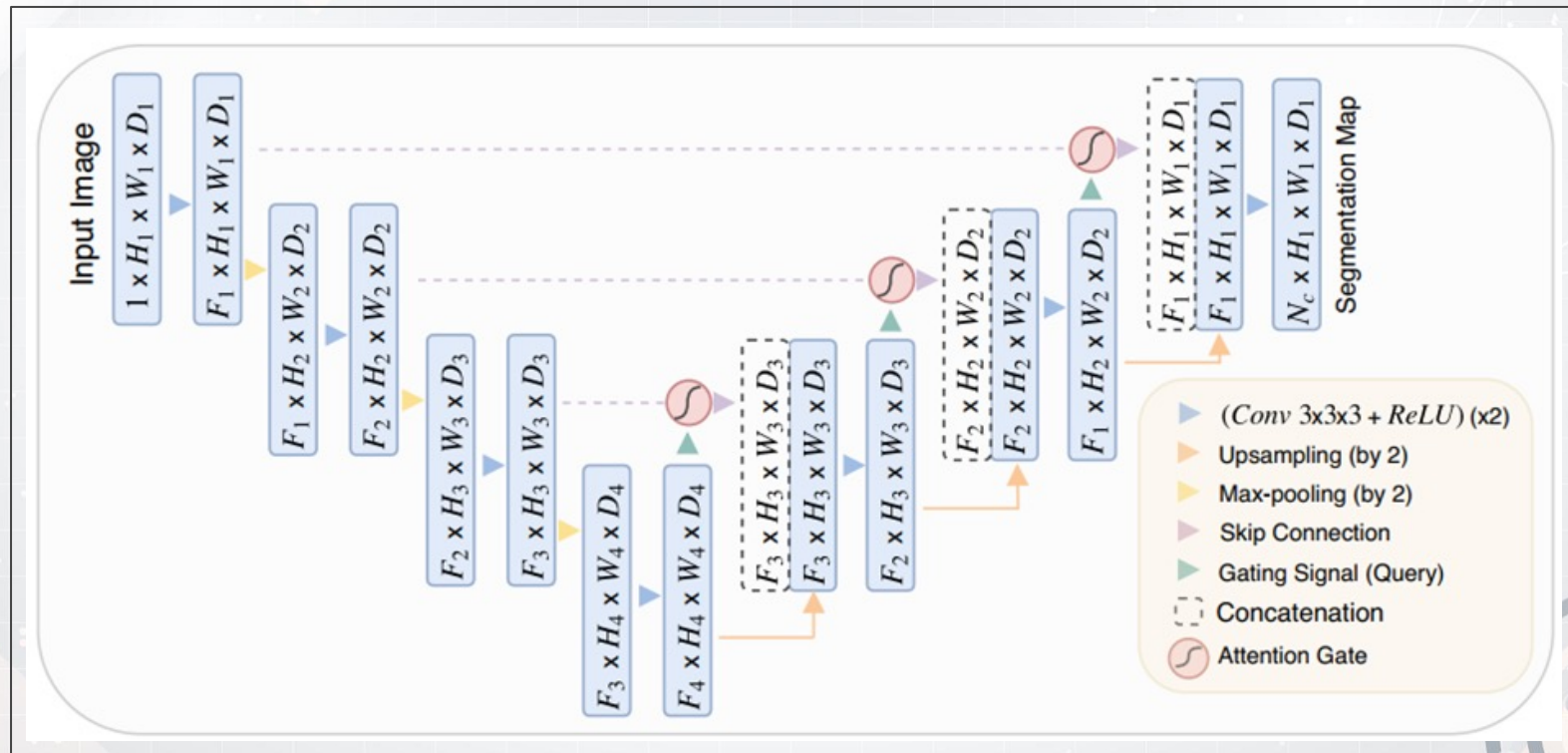
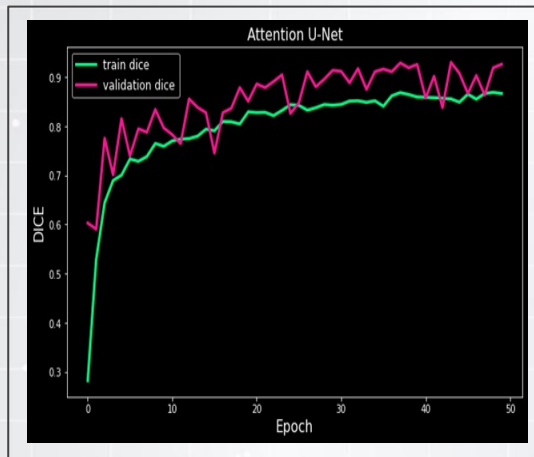


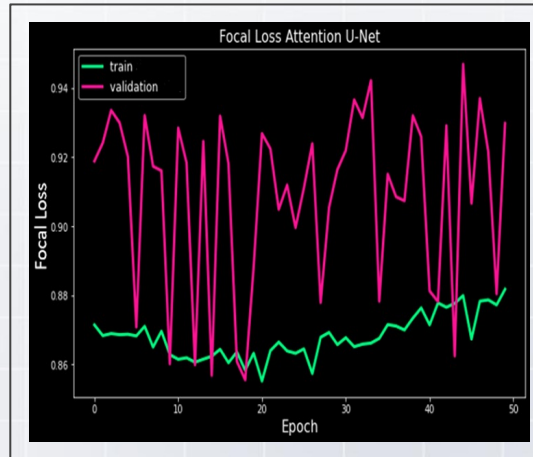
Figure 5: A block diagram of the Attention U-Net segmentation model (Oktay et al., 2018)

Diff Loss functions



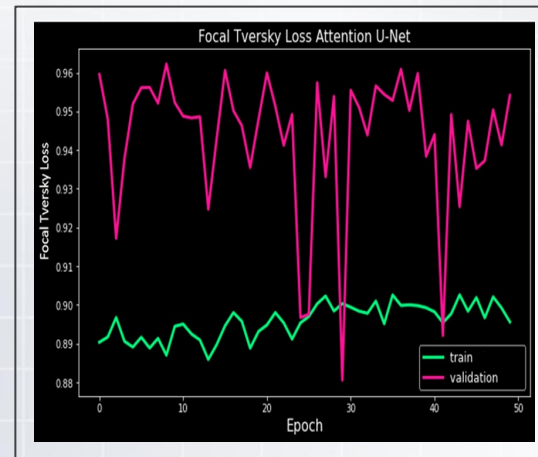
Dice Loss

Measure of overlap widely used to assess segmentation performance when a gold standard or ground truth is available (Sudre et al., 2017)



Focal Loss

Specialised loss function for one-stage object detection tasks with severe class imbalance (Lin et al., 2017)

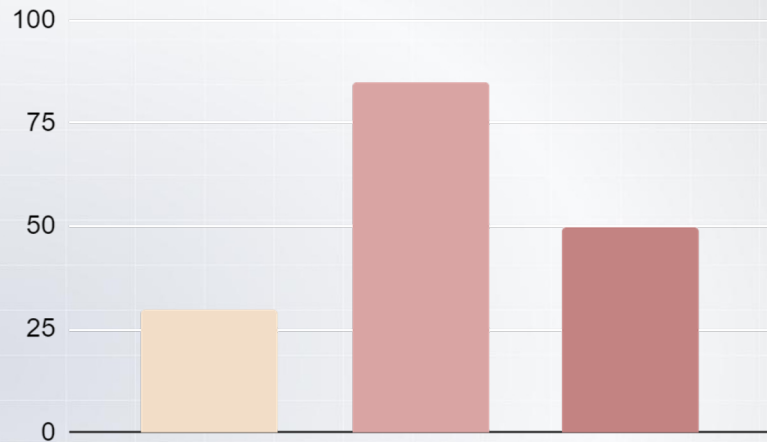


Focal Tversky Loss

Specialised loss function designed for medical image segmentation, particularly in scenarios where class imbalance is prevalent (Abraham and Khan, 2018)

03

Results and future scope





Output

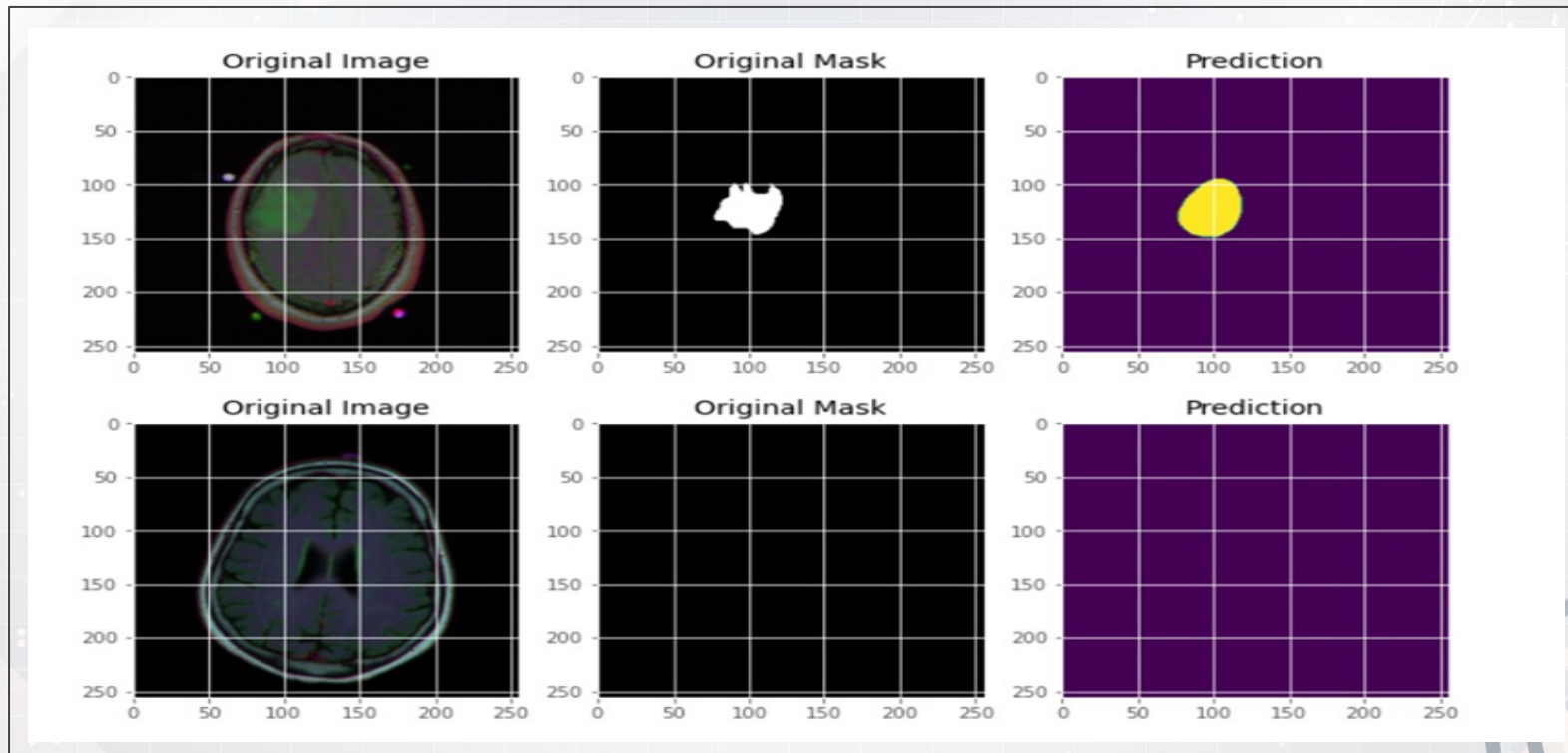


Figure 6: Original image, Original mask and Predicted output (Own creation)

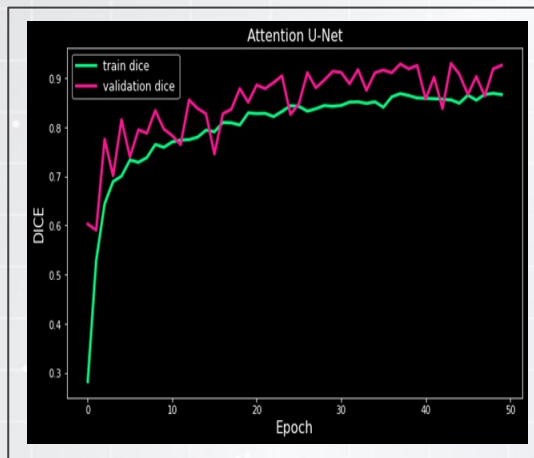
Result analysis



	Model	Time	Dice Coefficient	IoU
0	DeepLab V1	2730.870146	0.526110	0.312561
1	U-Net	2069.442503	0.743251	0.579358
2	DeepLab V3+	1430.632357	0.830617	0.608129
3	DeepLab V2	1287.892191	0.843672	0.751113
4	DeepLab V3	1250.195640	0.846639	0.765788
5	SegNet	4750.87	0.7616603	0.6293079
6	Attention U-Net	3257.4	0.926174	0.88

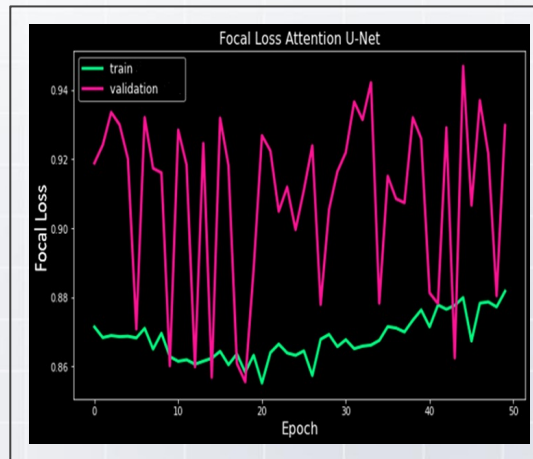
Table 1: Comparison of different models with time, dice coefficient and IoU (own creation)

Diff loss functions



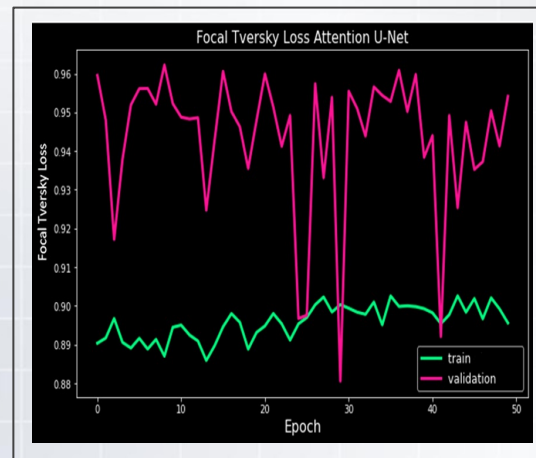
Dice loss

0.9262



Focal loss

0.9297



Focal tversky loss

0.9627

FUTURE SCOPE

- ☐ Future of early stage detection of dementia
- ☐ Challenges remain around model optimization
- ☐ Reducing bias
- ☐ Clinical validation before real-world deployment



REFERENCES

- Abraham, N., & Khan, N. M. (2018). A Novel Focal Tversky loss function with improved Attention U-Net for lesion segmentation. Proceedings - International Symposium on Biomedical Imaging, 2019-April, 683-687. <https://doi.org/10.1109/ISBI.2019.8759329>
- Badrinarayanan, V., Kendall, A., & Cipolla, R. (2017). SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(12), 2481-2495. <https://doi.org/10.1109/TPAMI.2016.2644615>
- Lin, T. Y., Goyal, P., Girshick, R., He, K., & Dollar, P. (2017). Focal Loss for Dense Object Detection. IEEE Transactions on Pattern Analysis and Machine Intelligence, 42(2), 318-327. <https://doi.org/10.1109/TPAMI.2018.2858826>
- MRI Segmentation. (n.d.). Retrieved June 23, 2023, from <https://bitrefine.group/industries/healthcare/91-industries/health/health-solutions/193-mri-image-segmentation>
- Oktay, O., Schlemper, J., Folgoc, L. Le, Lee, M., Heinrich, M., Misawa, K., Mori, K., McDonagh, S., Hammerla, N. Y., Kainz, B., Glocker, B., & Rueckert, D. (2018). Attention U-Net: Learning Where to Look for the Pancreas. <https://arxiv.org/abs/1804.03999v3>
- Ronneberger, O., Fischer, P., & Brox, T. (2015). U-Net: Convolutional Networks for Biomedical Image Segmentation. IEEE Access, 9, 16591-16603. <https://doi.org/10.1109/ACCESS.2021.3053408>
- Sudre, C. H., Li, W., Vercauteren, T., Ourselin, S., & Cardoso, M. J. (2017). Generalised Dice overlap as a deep learning loss function for highly unbalanced segmentations. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 10553 LNCS, 240-248. https://doi.org/10.1007/978-3-319-67558-9_28
- World Health Organization. (2023, March 15). Dementia. <https://www.who.int/news-room/fact-sheets/detail/dementia>

THANK YOU

Any Questions?

Contact:

Ashapriya Sebastian

ashapriyasebastian11@gmail.com