National College of Ireland

Configuration Manual

MSc Research Project
Masters in Artificial Intelligence

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MSc Project Submission Sheet

School of Computing

Student Name: Shravani Ravindra Waghmare

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Programme: MSc in Artificial Intelligence **Year:** 2025

Module: Msc (Research) Practicum

Lecturer: Prof. Sheresh Zahoor

Submission Due Date: 1st September 2025

Project Title: Enhancing Brain Tumour Segmentation in MRI Scans Using AI: A Comparative Study of U-Net and Transformer-Based Architectures

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I hereby certify that the information contained in this (my submission) is information pertaining to research I conducted for this project. All information other than my own contribution will be fully referenced and listed in the relevant bibliography section at the rear of the project.
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Signature: Shravani Ravindra Waghmare

Date: 30th August 2025

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1 System Requirements

Hardware

Device: Apple MacBook Pro equipped with an M4 chip

Processor: M2 Chip, 8-Core CPU

Memory: 16 GB Unified RAM

Storage: 512 GB SSD

GPU: Integrated Apple M2 GPU

Software

Operating System: macOS Sonoma 14.x

Python Version: 3.11.9 (managed with pyenv)

Integrated Development Environment (IDE): Visual Studio Code (latest version)

Libraries & Frameworks

TensorFlow / Keras, NumPy, Pandas, Matplotlib, Seaborn, OpenCV, Scikit-learn, pyenv + virtualenv, Jupyter / Colab (for experiments)

Dataset Source

Name: Brain Tumor Segmentation Dataset
Source: Kaggle: Brain MRI with Masks (Figshare) 3,000 image-mask pairs (binary segmentation)

2 Installation & Environment Setup

All steps were executed on macOS Sonoma via Terminal and VS Code.

1. **I installed Homebrew, a macOS package manager, to facilitate the installation of Python and the other dependencies.** /bin/bash -c "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/HEAD/install.sh)"

2. **I installed pyenv to manage multiple Python versions and subsequently installed Python 3.11.9.**

brew install pyenv
pyenv install 3.11.9
pyenv global 3.11.9

3. **A virtual environment was created and activated to ensure the isolation of project dependencies.**

python3 -m venv venv
source venv/bin/activate

4. **All necessary Python libraries pertinent to deep learning, fairness evaluation, and explainability were installed.**

pip install tensorflow keras numpy pandas matplotlib seaborn opencv-python shap lime scikit-learn

5. **Dataset**: Extracted into archive_1/images/ and archive_1/masks/ folders.

3 Execution Instructions

The following Python scripts were used to build and evaluate the project:

1. **preprocessing.py**

Prepares the input MRI images and segmentation masks.
Converts to grayscale, resizes to 128x128, normalizes pixel values.

Output:
X.npy and y.npy → preprocessed data arrays.

2. **unet_train.py**

Implements and trains a U-Net architecture for segmentation.
Model is trained on ~2,500 images with 500 used for validation.
Metrics: Accuracy, Dice Score, Intersection-over-Union (IoU).

Output:
unet_model.keras → Trained U-Net model
Training summary, model architecture
Final validation results

3. **explain_gradcam.py**

Applies Grad-CAM on the trained U-Net model to visualize focused regions.
Used final convolutional layer (e.g., conv2d_13) for heatmap generation.

Output:
gradcam_overlay.png
Heatmaps superimposed on original MRI inputs
Highlights tumor focus zone

4. **transformer_train.py** ***(Optional – for model comparison)***

Under development: Implements Swin-UNet or Vision Transformer (ViT).

Expected to follow the same evaluation pipeline as U-Net.

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