National College of Ireland

Configuration Manual

MSc Research Project
Master of Science in Cyber Security

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MSc Project Submission Sheet

School of Computing

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Programme:	Master of Science in Cyber Security **Year:** 2024-2025
Module:	MSc Research Project
Lecturer:	Michael Prior
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Project Title:	Mutation Analysis in Deep Neural Networks: A Study on test Suite Effectiveness
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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: Adarsh Narmula

Date: 11 August 2025

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Configuration Manual

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Table of Contents

1 Overview

This configuration manual provides the technical setup required to replicate the mutation testing experiments conducted for evaluating the effectiveness of test suites in deep neural networks. It includes details of the software, hardware, datasets, libraries, and execution instructions for the artefact developed in this project.

2 System Requirements

Hardware:

- Processor: Intel Core i7 (or equivalent) with minimum 4 cores
- RAM: 16 GB or higher
- GPU: NVIDIA GPU with CUDA support (minimum 4 GB VRAM)
- Storage: Minimum 20 GB free space

Software:

- Operating System: Ubuntu 20.04 LTS / Windows 10 / macOS (tested on Ubuntu 20.04)
- Python: Version 3.9
- CUDA Toolkit: Version 11.3 (for GPU execution)

3 Required Python Libraries

The following Python libraries must be installed before execution:

```
pip install tensorflow==2.8.0
pip install keras==2.8.0
pip install numpy==1.22.3
pip install pandas==1.4.2
pip install scikit-learn==1.0.2
pip install matplotlib==3.5.1
pip install seaborn==0.11.2
pip install jupyter
```

4 Dataset Configuration

- **Dataset Used:** [MNIST / CIFAR-10 / other as per your code]
- **Source:** Downloaded via keras.datasets or from the official dataset repository
- **Preprocessing Steps:** Normalisation, reshaping, and splitting into train-test sets (as defined in Untitled0 (1).ipynb)

5 Dataset Preparation

1. Dataset Source

- The experiments use the CIFAR-10 dataset (image classification) to test the robustness of DNNs under mutation scenarios.

- CIFAR-10 will be automatically downloaded via TensorFlow/Keras or PyTorch when running the code.

2. Alternative Datasets

- MNIST or custom datasets can be used by adjusting the data loading section in the notebook.

3. Preprocessing Steps

- Images are normalized to a 0–1 range.
- Labels are one-hot encoded for classification.

6 Artefact Files

The artefact ZIP file contains:

- **mutation_testing.ipynb** – Jupyter Notebook containing implementation
- **mutants/** – Directory with generated model mutants
- **results/** – Output CSVs and accuracy logs
- **plots/** – Graphical result visualisations

7 Execution Instructions

- Install all dependencies listed above.
- Launch Jupyter Notebook:
- jupyter notebook
- Open mutation_testing.ipynb and run cells in sequence.
- Mutation results will be saved in the results/ directory.
- Graphs and heatmaps are generated automatically at the end of execution.

8 Reproducibility Notes

- Ensure the same Python and library versions are used for consistent results.
- Random seeds have been set in the code for reproducibility.
- GPU acceleration is recommended for faster execution (Godoy, 2022).

9 Configuration Parameters

- Batch Size: 64
- Epochs: 20 (adjustable based on hardware)
- Learning Rate: 0.001
- Mutation Types: Weight perturbation, layer removal, parameter reset, input noise injection.

- Evaluation Metrics: Accuracy, Precision, Recall, F1-score, Mutation Score.

10 Troubleshooting

Issue	Possible Cause	Solution
Dataset download fails	Internet issues	Manually download dataset and place in /data/
CUDA not detected	NVIDIA drivers missing	Install/update CUDA Toolkit and drivers
Memory error during training	Batch size too large	Reduce batch size to 32 or 16
ModuleNotFoundError	Missing library	Install missing library via pip install <library>

11 Conclusion

Following this manual ensures that the mutation testing experiments for DNNs can be replicated consistently across different systems. Adhering to the stated parameters and setup will produce results comparable to those in the project report (Gupta et al., 2024).

12 Reference

Godoy, D. (2022). *Random Seeds and Reproducibility - TDS Archive - Medium*. [online] Medium. Available at: https://medium.com/data-science/random-seeds-and-reproducibility-933da79446e3 [Accessed 11 Aug. 2025].

Gupta, P., Ding, B., Guan, C. and Ding, D. (2024). Generative AI: A systematic review using topic modelling techniques. *Data and Information Management*, [online] 8(2), p.100066. doi:https://doi.org/10.1016/j.dim.2024.100066.