**Test Cases**

Testing has been completed through the development cycle of the project, as stated in the Project Plan, when Iterative Development has been completed and the system has been finalized.

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| **Test Case** | **1.1: Load Workspace** |
| Actors | Experimenter |
| Goal | * The workspace in which the program has been created on must be able to be loaded into correctly, in the correct format. |
| Precondition | The environment must be open and loaded |
| Action | The experimenter opens the Jupyter workspace. |
| Postcondition | The system creates a new workspace |
| Result | **The system loaded successfully.** |
| Recommendation | N/A |

*Test Case 1: Use Case “Create Workspace”*

Test Date: 03/05/21

Test Result: **Pass**

*Test Case 2: Use Case “Load Data”*

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **2.1: Load Libraries** |
| Actors | Experimenter |
| Goal | * The required libraries must be loaded into the workspace without errors |
| Precondition | * The environment and workspace must be set up and fully loaded into |
| Action | The experimenter selected ‘Run’ on the specified code block for the libraries. |
| Postcondition | The system loads in the libraries and a status is displayed, if any. |
| Results | **The libraries loaded successfully.** |
| Recommendation | N/A |

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **2.2: Load Dataset** |
| Actors | Experimenter |
| Goal | * The data must be loaded without errors into the workspace to be used. |
| Precondition | * The environment and workspace must be set up and fully loaded into |
| Action | The experimenter selected ‘Run’ on the specified code block for the dataset. |
| Postcondition | The system loads in the libraries and a status is displayed, if any. |
| Result | **The system successfully loaded the dataset and printed a test image.** |
| Recommendation | N/A |

*Test Case 3: Use Case “Modelling Phase”:*

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **3.1: Pre-Processing Data** |
| Actors | Experimenter |
| Goal | * The data must be pre-processed to ensure all data used is of the best quality |
| Precondition | * The system must be set up and the dataset must be loaded into |
| Action | The experimenter must ensure pre processing techniques have been used are there has been at least some upgrade in quality of the dataset. |
| Postcondition | The data will be of the highest quality possible and ready to be inputted into the model. |
| Result | **Data was pre-processed but more techniques could have been used to ensure the data was of its highest quality possible.** |
| Recommendation | *Include techniques such as: Pixel Brightness Correction, Histogram Equalization etc.* |

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **3.1: Splitting Data** |
| Actors | Experimenter |
| Goal | * The data must be split into suitable training and testing sizes. |
| Precondition | * The data must be loaded into the workspace correctly. |
| Action | The experimenter must ensure there is a correct split of data (80:20 in this case) |
| Postcondition | The data will be split into two sets, Training and Testing and be ready to be fed into the model. |
| Result | **The datasets were successfully split into two classes, with 331 files being used for training.** |
| Recommendation | N/A |

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **3.2: Train the Dataset** |
| Actors | Experimenter |
| Goal | * The data must be trained into the model without error |
| Precondition | * The system must be started and the data must be loaded. |
| Action | The experimenter must first create the model by running that section of code, and then compile the model and ensure a summary is created of how the model performed over the course of the epochs, showing accuracy rates. |
| Postcondition | The model will be trained with the Training Set of data with a decent accuracy, ready to be ran with the Testing dataset |
| Result | **The model was created and ran without errors. The model received a Training accuracy of 85% at its highest, with an average of 73%.** |
| Recommendation | *To gain a higher accuracy, the inclusion of more data, and a higher quality of pre-processing techniques could be used.* |

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| **Test Case** | **3.3: Running the Model** |
| Actors | Experimenter |
| Goal | * Check that loading the results works without error and that the results are of significant quality |
| Precondition | The system must be started and the data must be loaded, with the newly split data.  The algorithm must be set up with parameters set, and have ran successfully with the training data. |
| Action | The experimenter will run the model |
| Postcondition | The system runs the model with the Testing dataset that has been selected. |
| Result | **The model again, ran successfully and achieved an accuracy of 72% on the Testing data.** |
| Recommendation | *To gain a higher accuracy, the inclusion of more data, and a higher quality of pre-processing techniques could be used.* |

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **3.3: Correct Model** |
| Actors | Experimenter |
| Goal | * Check that the model / algorithm works correctly |
| Precondition | * Data has been trained and parameters have been set |
| Action | The experimenter will load the model and analyse the model and subsections to ensure the model is returning valid results.  The experimenter will test different parameters and different amounts of layers to ensure the model is working at its highest possible capacity. |
| Postcondition | The model will return a correct result with a good amount of accuracy that follows according to the Test Criteria. |
| Result | **After investigation, the model worked correctly, including the Convolutional layers, the MaxPooling layers and the Dense layer. The Adam optimiser was used which also worked with success, without errors.** |
| Recommendation | *Extra models could be created to identify if the one that is being used brings back the best results, or if there is another model that could do that.*  *Different amounts of layers, epochs, and different parameters were tested but overall, the ones chosen brought back the best results with no overfitting detected.* |

*Test Case 4: Use Case “Exploratory Phase”*

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **4.1: Exploration of Model Results** |
| Actors | Experimenter |
| Goal | Check the results are valid and displayed in. a way that is easily understood to draw results from (e.g. a graph) |
| Precondition | The system must be started with data loaded and split. The model must have been successfully run. |
| Action | The experimenter will run the section of code that contains the results in the form of a graph and analyse them to identify the accuracy and misclassification rates for the model, to ensure they are of high quality (high accuracy, low misclassification). |
| Postcondition | Results will be taken from the graphs in which the results are displayed. |
| Result | **Line graphs were created showing the Training and Validation Accuracy of the model, and Training and Validation Loss of the model over the 10 epochs the model ran over.** |
| Recommendation | Include different styles of graphs and tables to fully showcase the results, which allows for more efficient exploration |

*Test Case 5: Use Case “Saving Data”*

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **5.1: Save Data** |
| Actors | Experimenter |
| Goal | Be able to save the experiment that has been ran onto the system |
| Precondition | The system must have been started, with data loaded and the model must have completed running. |
| Action | The experimenter will select ‘File’ from the system toolbar and select the ‘Save’ button. |
| Postcondition | The model, results and all other work will be saved as a file onto the workspace. |
| Result | **The workspace saved without error onto a file.** |
| Recommendation | N/A |

Test Date: 03/05/21

Test Result: **Pass**

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| **Test Case** | **5.1: Editing File** |
| Actors | Experimenter |
| Goal | Be able to edit the previously saved file |
| Precondition | The experiment must have been saved previously onto the system |
| Action | The experimenter will open a new workspace by selecting ‘File’ from the workspace toolbar, then select ‘Open’ and select the correct file which was previously saved. |
| Postcondition | The file will be open for editing, and the experimenter will be able to edit any part of the file as they wish. |
| Result | **The previously saved file was editable throughout all aspects if needed to in the future.** |
| Recommendation | N/A |

Test Date: 03/05/21

Test Result: **Fail**

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| **Test Case** | **5.1: Exporting Data** |
| Actors | Experimenter |
| Goal | Be able to export the data into a file (e.g. .csv) |
| Precondition | The system must have been started, with data loaded and the model must have completed running, without issues. |
| Action | The experimenter will download the csv file created. |
| Postcondition | The results will be exported into a file where they can be downloaded for future use. |
| Result | **There was no option to download the result data.** |
| Recommendation | N/A |

*Test Case 6: ‘Adversarial Attacks’:*

Test Date: 04/05/21

Test Result: **Fail**

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| **Test Case** | **6.1: Adversarial Attack** |
| Actors | Experimenter |
| Goal | Be able to input noise into the systems training dataset, and for the system to identify it as noise and not allow the training results of the data to be affected by the noise, and for the model to defend itself against noise. |
| Precondition | The system must have been started, with data loaded and the model must have completed running, without issues. |
| Action | The experimenter will go into the dataset files and add-in images of white noise into the training dataset. Then, the workspace will be loaded into as normal, as with the dataset, and identify if the system has picked up the noise or not during the Training modelling. |
| Postcondition | If the noise is identified, it will not be included in training or testing sets. |
| Result |  |
| Recommendation |  |

Conclusion

After conducting thorough testing on each section of the system, ensuring that all sections run correctly without errors, that the system can be saved and loaded correctly and that the system is robust enough to defend itself against attacks, I can conclude that the system has passed each test given to it, and shows no errors, bar Test Case 6, where the system failed to defend itself against an adversarial attack. My recommendation for this is to add defences, such as..

Another recommendation is to include more pre-processing techniques to the existing dataset to increase its quality level. Extra models could also be implemented in Use Case 3, to explore other models that may achieve great results on the image data to identify the best possible model for the dataset, Boosting could also be looked into to improve the performance of the chosen model.

Other recommendations to ensure the system works as effectively as it can is to add more tables and graphs to aid exploration into the results that the model has given. This may be in the form of bar charts and performance matrices, so the accuracy and misclassification rates can be understood easier, along with other rates such as the sensitivity and recall of the model. It would also be of use to make it so the result data can be exported, such through a csv file and to create a data frame of the results so results can be saved and shared efficiently.