

Iteration 3 Report  
EECE 2560: Fundamentals of Engineering  
Algorithms  
Handwritten Digit Recognition

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**Important:** Each student must submit individually, even though the project is completed as a team. Prepare this report in **Overleaf** and export it as a **PDF** for submission.

**GitHub Link:** <https://github.com/emescher/DigitRecognition>

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# 1 Summary of Team Progress and Development Updates

This iteration 3 serves as a status update for our handwritten digit recognition project. Details about the development update and the progress of the team are covered above along with the description of the core features implemented, challenges faced and how they were addressed, and the general timeline/plan. The code can be viewed in our Github repository.

During this iteration, we worked on Github repository, which was created and shared to serve as the central workspace for code collaboration. This setup ensured that all the google colab notebooks and files were efficiently managed and synchronized across team members. Each team member was granted collaborator access and a standardized branching and commit protocol was agreed upon during the group meeting, to maintain proper project organization. For now, all the files and google colab notebooks are in the main branch, but another branch has been created and all the data will be moved to the new branch. During this session, the team linked the main google colab notebook to the github repository. This meeting established the foundation for the model development and data processing tasks planned for upcoming days. A team leader (Sean Costello) was assigned during this meeting to ensure task distribution and to maintain team communication.

## 2 Implemented Core Features

### Feature 1: MNIST dataset

- **Purpose:** To load, preprocess, and visualise the MNIST dataset for digit recognition.
- **Implementation:** The dataset was loaded using TensorFlow and its structure was verified using NumPy and matplotlib.pyplot for visualisation. OS was imported, which is used to check if the file exists, numpy was imported, which is used for array operations. Cv2 was imported since that is used for reading and manipulating images. matplotlib.pyplot(plt) was imported since that is used for displaying images. Tensorflow (tf) was imported since that is used for loading and running the trained neural network. The commented out part loads the MNIST dataset and normalizes pixel values to range [0,1], which is required for neural network input. This part was commented out because the model was already trained and was saved. MNIST digits are white on black, so the images might be black on white, so inversion ensures consistency.
- **Validation:** Sample digit images were displayed using matplotlib.pyplot, ensuring that the dataset was correctly loaded and formatted.

### Feature 2: Model training

- **Purpose:** To develop and train the model for the project.
- **Implementation:** A three-layer neural network was implemented and trained using TensorFlow. It was trained for 6 epochs, which means that the model will go through the entire training dataset six times during training. Then the accuracy was evaluated on the test dataset using the `model.fit()` command, and validation data.
- **Validation:** The training metrics of the model were recorded and the graphs were plotted. The notebook was then pushed to github. The model was trained for 6 epochs, resulting in a final training accuracy of 99 percent and a validation accuracy of 97.99 percent. The validation loss decreased, which explains that the model effectively learned to distinguish between digits. This established a reliable baseline model, which will then be later compared with KNN and SVM algorithms. The graph can be seen in our Github repository inside the data branch.

### Feature 3: GUI design (still in progress)

- **Purpose:** To design a graphical user interface that allows user to draw digits and test the trained model's predictions.
- **Implementation:** The GUI was developed in Spyder and there were components like a drawing canvas for the user to draw the digit on, buttons like "clear" and "save".
- **Validation:** Implementation is planned for the next iteration. The GUI was tested but the images were manually uploaded images. To do this, we sent the drawings from one laptop to another through outlook and then uploaded them to the MNIST dataset. This allowed us to test the MNIST dataset as well as the model that we used for this project.

## 3 Challenges and Resolutions

- **Challenge 1:** Difficulty collaborating on GitHub without overwriting each other's work.  
**Resolution:** Held a brief meeting and learned how to create separate branches and got more familiar with Github by committing changes frequently. This setup ensured that all the google colab notebooks and files were efficiently managed and synchronized across team members.
- **Challenge 2:** Understanding and integrating the MNIST dataset into the project.  
**Resolution:** Discussed how to preprocess it and use it to test the model. Through research and group discussions, we were able to connect the dataset to the trained model and verify its functionality.

- **Challenge 3:** Designing the graphical user interface (GUI) layout.  
**Resolution:** Held a group meeting to discuss the GUI structure and divided tasks among members. By collaborating and testing different layout ideas, we were able to design a functional interface, that will later be connected to the trained model.

## 4 Leadership Rotation and Team Contributions

### Leadership Summary

Week/Span	Leader	Responsibilities	Key Outcomes
Week 1	Sean Costello	Managed team communication and project setup, led the kick-off meeting and verified MNIST dataset along with the model	Integrated MNIST dataset and successfully initialized the model.

### Individual Contributions

Team Member	Contributions (Technical / Documentation)	Hours
Sean Costello	Served as project manager; handled communication, scheduling, and MNIST dataset setup; verified data consistency.	5 hrs
Eva Mescher	Designed the GUI layout, participated in system testing and group meetings and organised Github repo	5 hrs
Sara Sethi	Trained the model and evaluated its accuracy, wrote down the meeting notes and organised Github repo	5 hrs

### Statement by the Individual Submitter

I, **Sara Sethi**, confirm that the above table accurately reflects my personal contributions during Iteration 3.