# ECS174 Final Project
# Fruit Classification

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Video Presentation: https://youtu.be/dBJcwC0Y7sQ
Github Link: https://github.com/Wahad10/ECS174FinalProject

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# Final Project Report

## Introduction:

We aim to use computer vision techniques to achieve a goal to detect fruits in pictures with various picture backgrounds. The dataset can be used for model validation, performance evaluation, and model classification training. The main task here is image classification and we are solving the problem of identifying different kinds of fruits.

This project is significant because it's valuable for learning and scientific purposes, and because it can help people recognize fruits that they don't know and maybe classify other images. Our motivation was that it provides valuable learning opportunities, assists in classifying and recognizing fruits, and can extend to other similar image categorization tasks.

## Contributions:

Here is how we split the work between our group of three:

- **Stephen Donecker:** Wrote the code for Convolutional Neural Network (CNN) and the imported "rexnet_150" model. Cleaned the data before training. Created and presented video recording.

- **Chenyi Zhou:** Researched image classification problems and found the dataset. Verified the cnn code. Wrote the report. Helped in the presentation video.

- **Wahad Latif:** Analyzed output graphs, experimental results, and compared the two models to each other and to a baseline. Wrote the report and formatted it with sections and references. Hosted the code on Github and the video on Youtube.

## Background:

The dataset contains 100 types of fruit images, each type of fruit contains 400 pictures. One thing regarding the data quality is that the test data is compromised, all the category columns are -1. Therefore, we chose to use the val dataset as a test dataset to gather testing/validation results. This dataset was pulled from Kaggle and has been used before in image classification tasks, so we chose to compare our method with other models as well.

Based on our research and literature review, we found various strategies have been implemented before to solve the fruit image classification problem. We studied and built on these techniques to improve our own methods, specifically the Rexnet_150 model.

## Experiment Method:

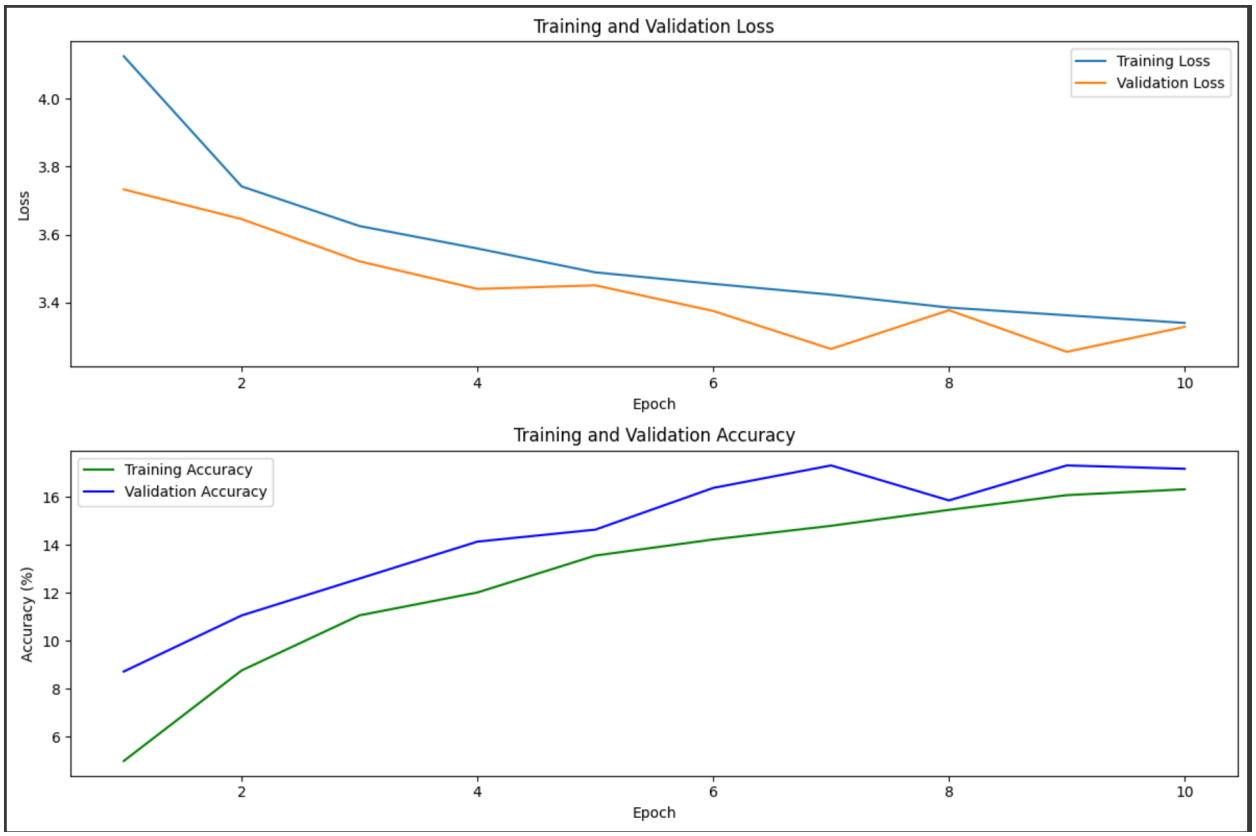
Since we are using a very complex dataset, we must do a lot of preprocessing and data cleaning. We encoded input images into np_arrays with encoded labels. We also used data augmentation techniques to further introduce randomness. This also helped us make the images a consistent size for training.

We first tried to use CNN method with 2 convolutional layers and 3 linear layers. We used cross_entropy_loss and SGD optimizer to assist in the training.
Then we tried a more complex model called “rexnet_150”. The data preprocessing and encoding is the same. We used cross_entropy_loss and Adam optimizer to finetune the training.

## Experiment Results and Analysis:

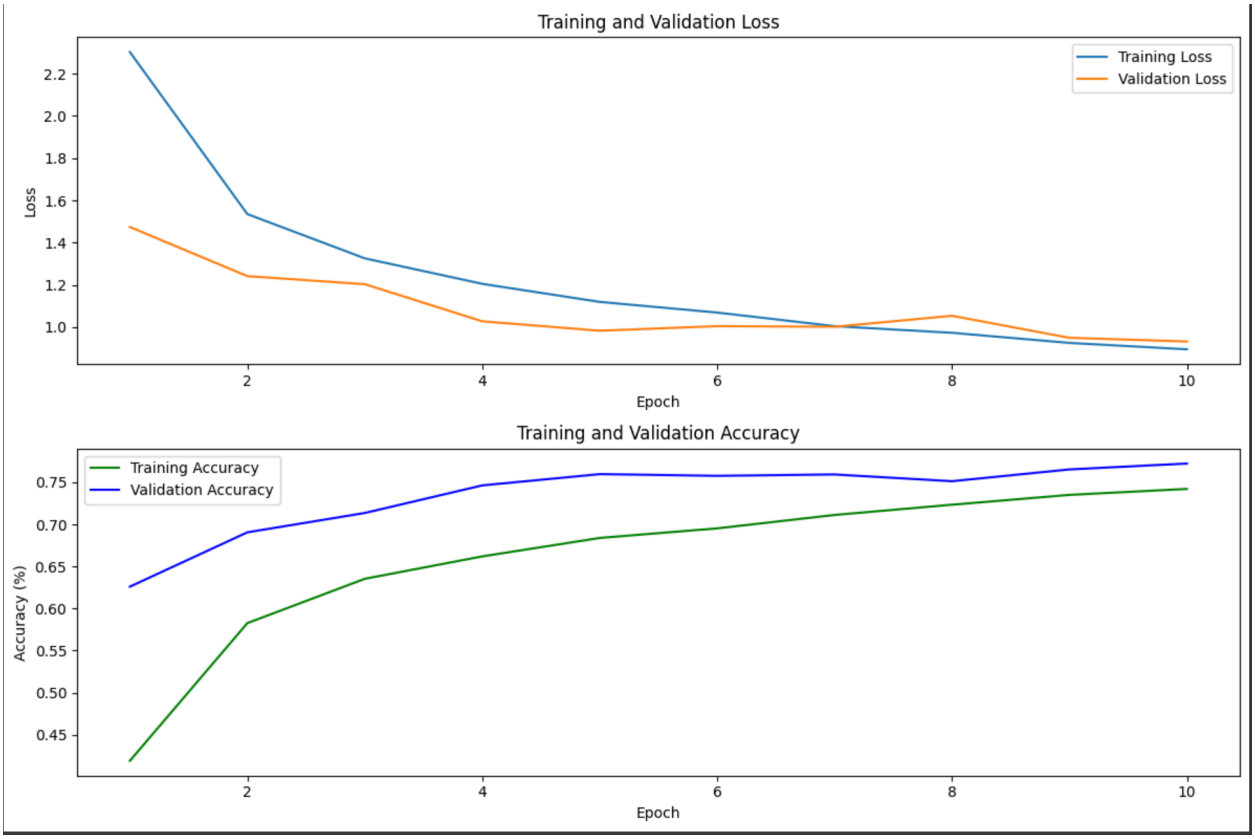
First we trained our own neural network model from scratch using a convolutional neural network. From Figure 1, we can see the accuracy is going up and loss is going down which shows the model is correct, but the data is too complex, and the model is not deep enough. Therefore, we only got a result of about 17% accuracy after training for 10 epochs and both loss and accuracy converge. It takes about 4.5 hours to complete the 10 epochs process.  With more training and a deeper network, we may be able to get better results.

### Figure 1:  Loss and Accuracy - CNN Method



To improve performance and results, we utilized a more complex model. This method uses a pre-trained Rexnet_150 model and was inspired by Olimov's approach on Kaggle. We imported the model, adjusted it for our specific data, and trained it for 10 epochs and got 70% percent accuracy. Both loss and accuracy converge after the 10 epochs and it only takes about 1.5 hours to finish the process. The model performs much better because it has multiple residual layers which capture the complex data patterns, it has pre-trained on a large dataset, it uses a more advanced optimizer, and it is more computationally efficient.  All of this leads to faster convergence, better generalization on unseen data, and higher accuracy.

Figure 2:  Loss and Accuracy - Rexnet_150 Method




## Conclusion:

A baseline method of solving this problem could be randomly guessing instead of classifying. Since we have 100 classes, the accuracy would be 1% based on probability rules. As we can see, our CNN model with an accuracy of 10% and our Rexnet_150 model with an accuracy of 70% both performed better than the baseline.

Although our CNN model performed better than the baseline, the Rexnet_150 model was much better because of its depth, complexity, pre-training, advanced optimization, and efficient design. Overall, the project successfully demonstrated the application of computer vision and neural networks to classify fruit images accurately.

# References

Marquis03. “Fruits 100.” Kaggle, 27 Oct. 2023, www.kaggle.com/datasets/marquis03/fruits-100/data

Olimov, Bekhzod [killa92]. “Fruits Classification Using Pytorch: ACC 90%.” Kaggle, 20 Dec. 2023, www.kaggle.com/code/killa92/fruits-classification-using-pytorch-acc-90.