Rice Grain Identification Using Deep Neural Networks

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Abstract

This study attempts to develop deep-learning neural networks to accurately identify and classify specific types of rice grains. This simple problem is a representation of a much larger field of image classification using machine learning algorithms including facial recognition and automated driving software to name a few. For this project we used five different types of rice; Jasmine, Basmati, Karacadag, Ipsala, and Arborio. We collected one thousand images of each grain totaling five thousand total images to use for our classification model. We were able to successfully create a model with 98.30% accuracy, allowing us to very accurately classify different types of rice even though variations in physical characteristics were minimal. The success in the creation and accuracy of this model proves meaningful for further development and implementation of deep-learning neural networks.

Keywords : Computer Vision, Image Recognition, Classification Models, CNN Models, Deep Learning, Data Science

1. Introduction

Deep learning and neural networks have become a large focus in the scientific and computer science communities. The ability to predict and classify trends and images has always been a desired yet hard task. Through deep learning models, we decided to see if we could accurately classify different types of grains of rice with very small differences.

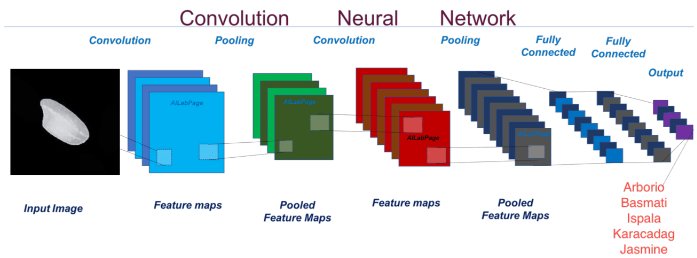
We gathered our data from Kaggle's online data set library. It consisted of five different folders with thousands of images in each of five different types of rice. These types were Arborio, Basmati, Ipsala, Jasmine, and Karacadag.

Although identifying classifications of rice doesn't have many applications in the real world, it serves as a proof-of-concept for Deep Neural Networks to show that these models can classify minute details with high accuracy. As we move towards a world of self-driving cars and things of the like, the accuracy of image detection models is becoming increasingly important, so proof-of-concept projects like this one are necessary to show that these models can be accurate if used correctly.

2. Related work

- `https://dl.acm.org/doi/abs/10.1145/2986035.2986039`
- `https://dl.acm.org/doi/abs/10.1145/2986035.2986042`
- `https://www.sciencedirect.com/science/article/pii/S0924224403002711?casa_token=VWIkeOh4X-gAAAAA:tv_kvUQK3c1_x1jNcoCvI5Qy4d7sp_J0GbS7RJLUIa4_LVcWeMpkIdLoPNkryvKd_POcWXTPWg`

3. Modelling approach



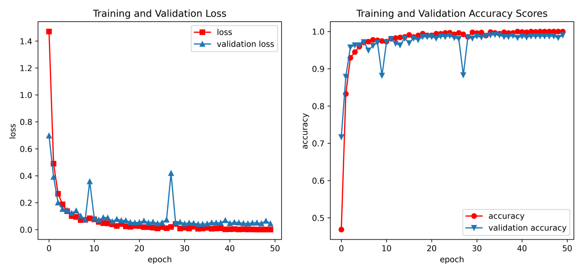
https://becominghuman.ai/beginners-guide-cnn-image-classifier-part-1-140c8a1f3c12

In order to create our rice classification model we needed to use a type of deep learning called a Convolution Neural Network or CNN. This model sets up digital neurons and uses them to see the image, almost like humans would. As you can see from the image above the model first starts by inputting a image into the neural network. After that the model will use convolution layers to develop multiple feature maps of the image. Then it takes these maps and pools them. it does this by breaking them down into only there essential features. This will allow the model to use less computing power while still maintaining its accuracy. Then these convolution layers and pooling layers are connected to a dense layer through the neural network. The model will then output five nodes for each classification of rice.

4. Data exploration and input preparation

We used 5070 different images of rice. All images were in color. We had 3,549 images in our training data and then 1,521 images in our test data. We then trained and split our data using a train-test-split model. We came to the conclusion that 20 epochs were best because as you can from the figure below the validation accuracy barely changed after 20.

Arborio, Basmati, Ispala, Karacadag, Jasmine



Validation Loss and Accuracy Charts

5. Experimental results

Model one used 32 filters, single convolution layer, and 20 neurons single dense layer CNN Model. Model 2 used 32-16 filters, two convolution layers, and 20-10 neurons two dense layers CNN Model. Model 3 used 32-16-8 filters, three convolution layers, and 20-10 neurons two dense layers CNN Model. After testing epochs we found that 20 epochs was good enough for us to test our models. After training and hyper parameter tuning we found that our best model was Model 1 using the Adam optimizer with a .001 learning rate. This model produced a 98.3 percent accuracy rate.

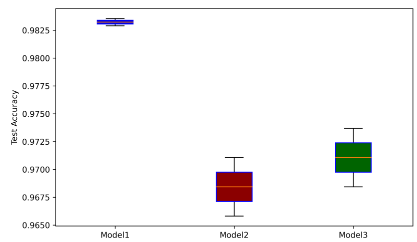
Table 1: **Best Hyperparameters for each Model**

Model	Parameters
Model 1	Conv Layers(32), Dense Layers(20), Optimizer=Adam, Learning Rate(.001)
Model 2	Conv Layers(32,16), Dense Layers(20,10), Optimizer=Adagrad, Learning Rate(.01)
Model 3	Conv Layers(32,16,8), Dense Layers(20,10,) Optimizer=Adam, Learning Rate(.001)

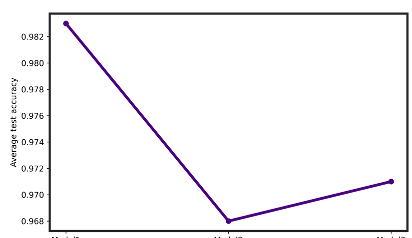
Table 2: **Average Accuracy for Each Model**

CNN Model	Accuracy
Model 1	98.30%
Model 2	96.80%
Model 3	97.10%

Distribution of Each Model



Average Accuracy of Each Model



Remarks: You can see that model 1 had the best average accuracy score. Not only that but you can see it was the most consistent.

6. Conclusion

We found that we were able to classify rice grains with a high level of accuracy and very few incorrect identifications. Our best model was Model 1 with an accuracy of 98.30%. This software could be further adapted to scan grain harvest samples for quality, looking for imperfections, disease, or pests to prevent ecological damage and help create better agricultural products. It could also be used to identify infestations of unwanted species of grain by classifying a sample of harvests. The use of this technology is limitless and this model is a proof of concept for the applications of this technology.

7. Ethics and implications

There are minimal ethical implications for this work. This study has very limited use in the real world and was used to show that deep neural networks can perform with extreme accuracy. There are very serious ethical implications of the extension of this technology, most notably in the use of facial recognition software by law enforcement.

8. Acknowledgment

Roger Williams University. The Math and Computer Science Department. Murat KOKLU for his rice image Data set on Kaggle.

9. References

https://www.kaggle.com/code/ahmederaky/rice-classification-with-cnn-99-acc

https://www.kaggle.com/code/sumon9300/99-75-rice-image-dataset

`https://becominghuman.ai/beginners-guide-cnn-image-classifier-part-1-140c8a1f3c12`