CS2: Selected Topics in Computer Science

(COVER SHEET)

Project Name: Multi-class image classification using CNN on Fruits and Vegetables Dataset

Team ID: 25

Team Information:

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Project Description Document:

Paper Description

Citation:

Alzubaidi, L., Al-Shamma, O., Fadhel, M.A., Arkah, Z.M., Awad, F.H. (2021). A Deep Convolutional Neural Network Model for Multi-class Fruits Classification. In: Abraham, A., Siarry, P., Ma, K., Kaklauskas, A. (eds) Intelligent Systems Design and Applications. ISDA 2019. Advances in Intelligent Systems and Computing, vol 1181. Springer, Cham. https://doi.org/10.1007/978-3-030-49342-4_9

Dataset Used:

Fruits 360

https://www.kaggle.com/datasets/moltean/fruits

Implementation Details:

The model proposed in the paper has an architecture of **two traditional CNN layers**, followed by **four blocks of parallel CNN layers; each block has four layers**, and finally **one average pooling, two dropout**, and **three fully connected layers**. Each CNN layer is followed by **rectified linear unit and batch normalization**.

Model Results:

The model achieved an accuracy of **100% on a divided set from the training set** and achieved an accuracy of **99.6% on the testing set.**

Dataset Description

Name: Fruits and Vegetables Image Recognition Dataset

https://www.kaggle.com/datasets/kritikseth/fruit-and-vegetable-image-recognition

Brief: Fruit and Vegetable Images for Object Recognition

Description:

This dataset contains images of the following food items:

- **fruits**- banana, apple, pear, grapes, orange, kiwi, watermelon, pomegranate, pineapple, mango.
- **vegetables**- cucumber, carrot, capsicum, onion, potato, lemon, tomato, raddish, beetroot, cabbage, lettuce, spinach, soy bean, cauliflower, bell pepper, chilli pepper, turnip, corn, sweetcorn, sweet potato, paprika, jalepeño, ginger, garlic, peas, eggplant.

Total of 36 classes, labeled:

0 : apple 1 : banana 2 : beetroot 3 : bell pepper 4 : cabbage

5 : capsicum 6 : carrot 7 : cauliflower 8 : chilli pepper 9 : corn

10 : cucumber 11 : eggplant 12 : garlic 13 : ginger 14 : grapes

15 : jalepeno 16 : kiwi 17 : lemon 18 : lettuce 19 : mango 20 : onion

21 : orange 22 : paprika 23 : pear 24 : peas 25 : pineapple

26 : pomegranate 27 : potato 28 : raddish 29 : soy beans 30 : spinach

31 : sweetcorn 32 : sweetpotato 33 : tomato 34 : turnip 35 : watermelon

This dataset contains three folders:

- **train** (100 images each label)

- **test** (10 images each label)
- **validation** (10 images each label)

each of the above folders contains subfolders for different fruits and vegetables wherein the images for respective food items are present

Implementation & Results

CNN MODEL

Dataset Details

Image Width = 100

Image Height = 100

Samples for Training: 3115

Samples for Validation: 351

Samples for Testing: 359

Parameters:

Total params: 6,621,660

Trainable params: 6,618,748

Non-trainable params: 2,912

Total Numbers of Network Layers: 74

Hyperparameters used:

Number of Convolutional Layers: 18

Number of RelU Layers: 18

Number of Dense Layers: 4

Number of units in Dense Layers: 300, 200, 36, and 36 respectively.

Pooling Size: (2,2) for Max Pooling and (7,7) for Average Pooling

Filters in each Convolutional Layer: 16, 32, and 64

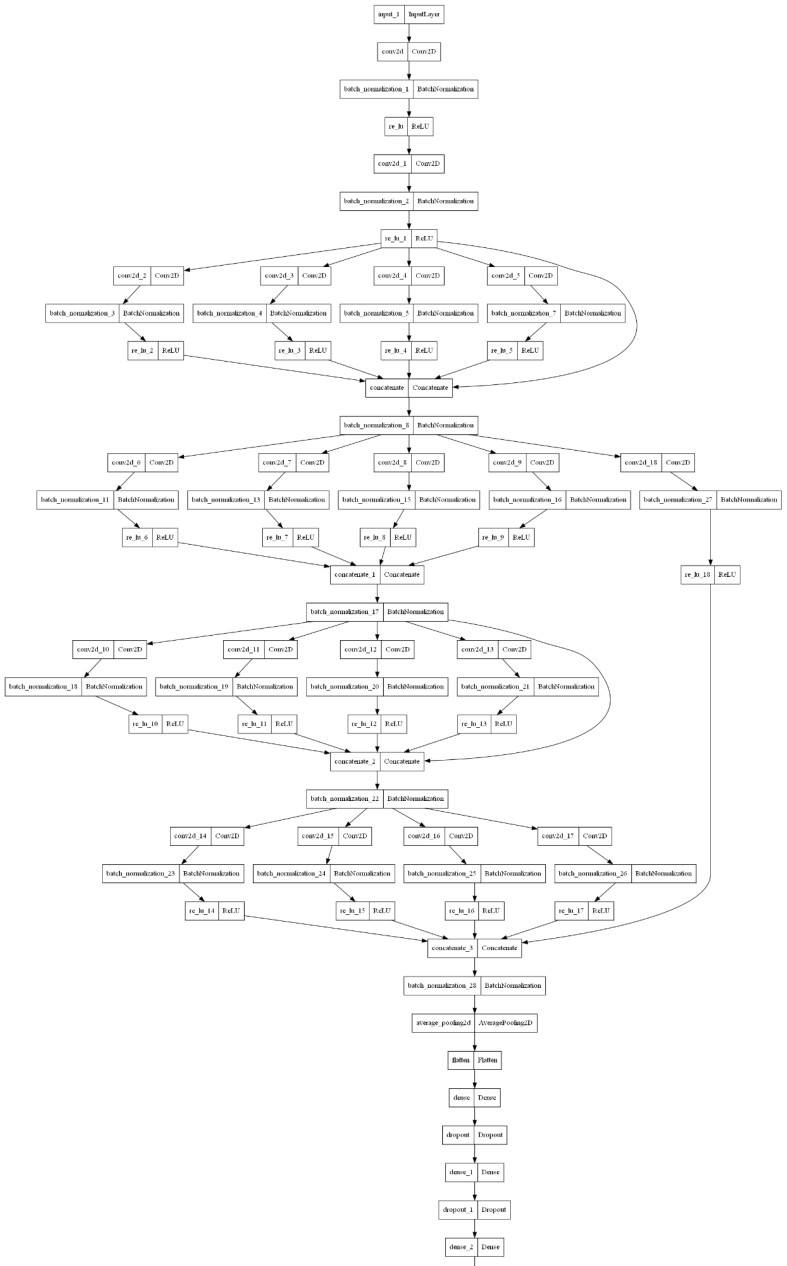
Kernel Size of Convolutional Layers: (3,3) , (5,5) , (7,7) an (11,11)

Batch Size = 32

Dropout: Two Layers, 0.5

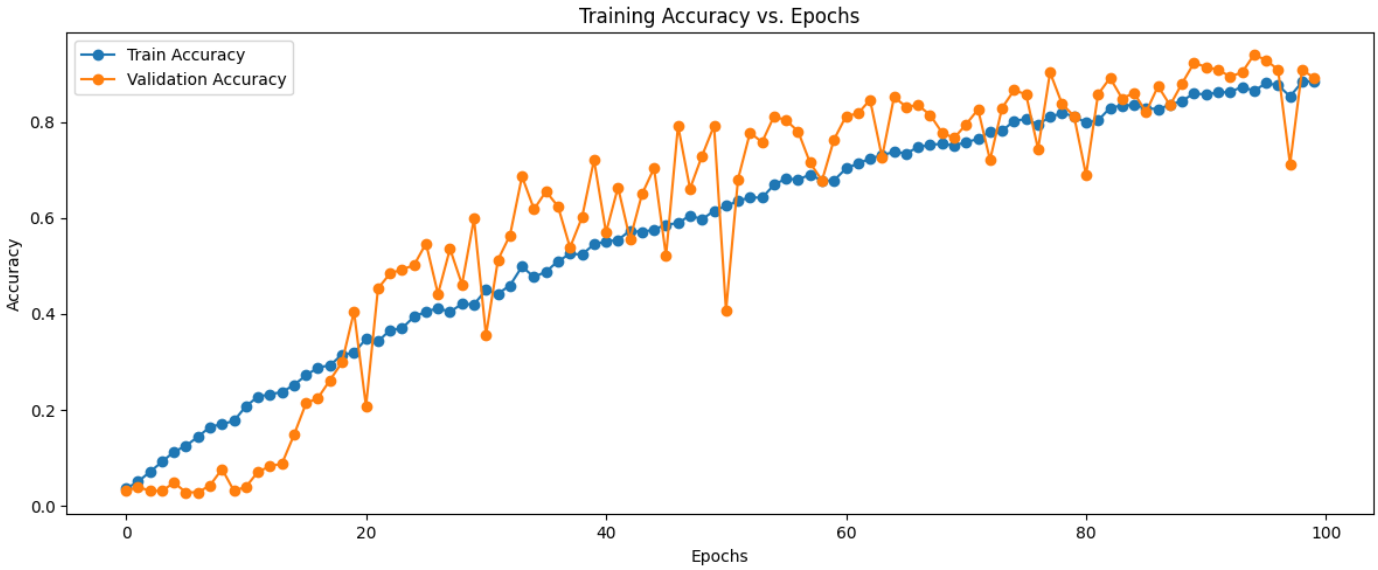
Learning Rate: 0.001

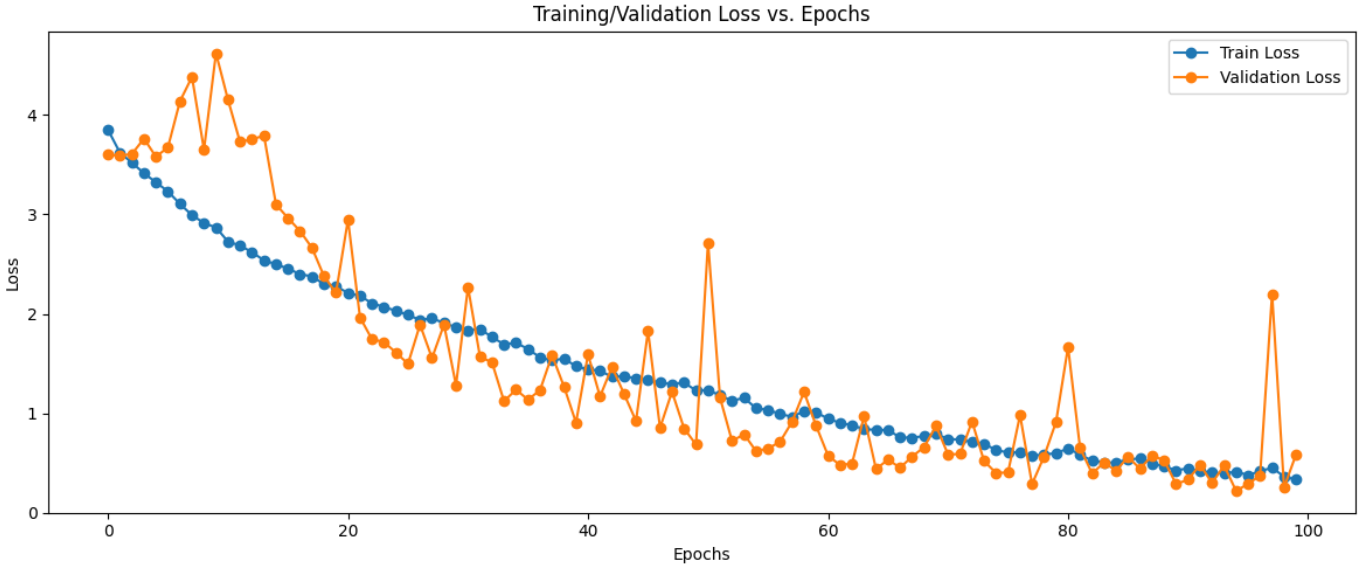
A Block Diagram of the Model network and Algorithms used:



Results:

Training and Validation Accuracy:



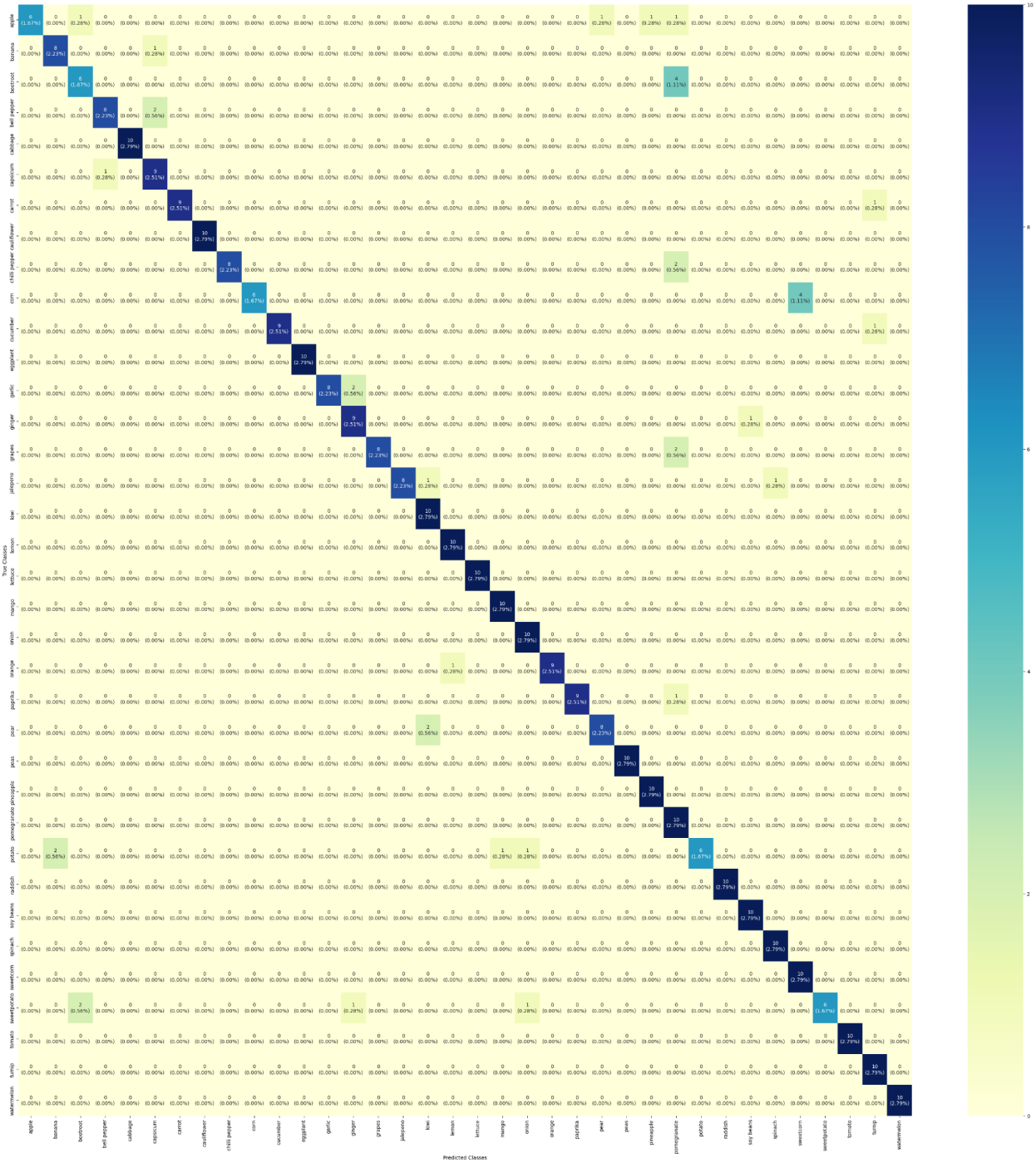


Testing Accuracy:

```
test_loss, test_accuracy = cnn.evaluate(test_generator, batch_size=BATCH_SIZE)
```

```
3/3 [==============================] - 10s 3s/step - loss: 0.6865 - accuracy: 0.8914
```

Confusion Matrix:



Classification Report:

	precision	recall	f1-score	support
apple	1.00	0.60	0.75	10
banana	0.80	0.89	0.84	9
beetroot	0.67	0.60	0.63	10
bell pepper	0.89	0.80	0.84	10
cabbage	1.00	1.00	1.00	10
capsicum	0.75	0.90	0.82	10
carrot	1.00	0.90	0.95	10
cauliflower	1.00	1.00	1.00	10
chilli pepper	1.00	0.80	0.89	10
corn	1.00	0.60	0.75	10
cucumber	1.00	0.90	0.95	10
eggplant	1.00	1.00	1.00	10
garlic	1.00	0.80	0.89	10
ginger	0.75	0.90	0.82	10
grapes	1.00	0.80	0.89	10
jalepeno	1.00	0.80	0.89	10
kiwi	0.77	1.00	0.87	10
lemon	0.91	1.00	0.95	10
lettuce	1.00	1.00	1.00	10
mango	0.91	1.00	0.95	10
onion	0.83	1.00	0.91	10
orange	1.00	0.90	0.95	10
paprika	1.00	0.90	0.95	10
pear	0.89	0.80	0.84	10
peas	1.00	1.00	1.00	10
pineapple	0.91	1.00	0.95	10
pomegranate	0.50	1.00	0.67	10
potato	1.00	0.60	0.75	10
raddish	1.00	1.00	1.00	10
soy beans	0.91	1.00	0.95	10
spinach	0.91	1.00	0.95	10
sweetcorn	0.71	1.00	0.83	10
sweetpotato	1.00	0.60	0.75	10
tomato	1.00	1.00	1.00	10
turnip	0.83	1.00	0.91	10
watermelon	1.00	1.00	1.00	10
accuracy			0.89	359
macro avg	0.92	0.89	0.89	359
weighted avg	0.92	0.89	0.89	359