Project Deep Learning

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This machine learning project aims to automatically classify images by assigning them a class according to the fruit represented on the image.

For this PyTorch will be used. It's a Python machine learning package based on Torch, which is an open-source machine learning package.

The objective of this project is to find optimal parameters in order to have the higgest recognition score on the fruits. To do this, we have two datasets:

- Training dataset with **42798** images
- Testing dataset with **14369** images

The idea is to train first, a convolutional neural network to recognize each fruits (so there will be N class for N fruits) and then, test if the network assign the right label to each fruit from a random subset of the training dataset.

After multiple test, for a CNN with **two** layers, the best found parameters are:

- batch size = 100
- number of epochs = 5
- learning rate = 0.001

With a good GPU (using CUDA), the program train the classifier and test the accuracy of the model in less than 30 secondes. The accuracy (calculated on images of the datasets) is 96.57%.

The batch size is the number of samples that will be propagated through the network. For example on the training set, there is 42798 images, so with a batch size of 100, there will be 428 steps (the last one containing only 98 samples).

We can take a batch size equal to the total number of images, but it will require a lot memory and will not be efficient. In my tests 100 seems to be a good compromise.

The number of epochs here is the number of iterations/pass of the full set. Each epoch goes through each batch. This parameter in our dataset don't seems to have the biggest impact on the accuracy. With only one or two epochs the accuracy remains close to 96%. By setting the number of epochs at 5 we sometimes achieve an accuracy of 97% at the cost of running time.

The learning rate affects how quickly this model can converge to a local minima (reach the best accuracy). Getting a good learning rate means lesser time to train the model (and less epochs needed).

In the article "Understanding Learning Rates and How It Improves Performance in Deep Learning" by *Hafidz Zulkifli*[1], the author explain how a good learning rate can be estimated. There is multiple scenarios, a too high learning rate can lead to high loss and a too small learning rate can cause the algorytm to take too much time to converge (especially in plateau regions). A learning rate of 0.001, was the best in my tests.

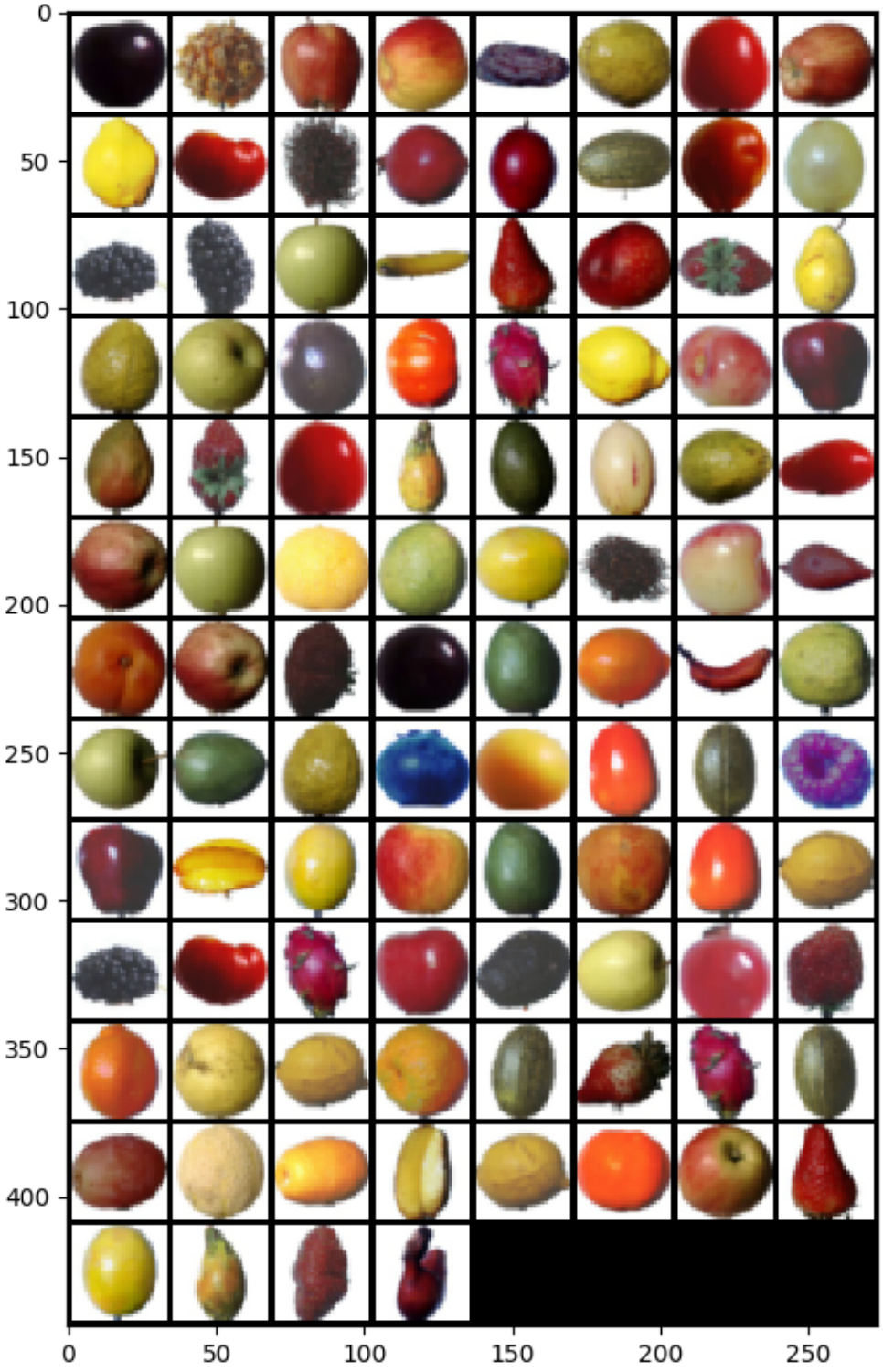

Figure 1: 100 fruit from the testing dataset

Cherry Wax Black	Pineapple Mini	Apple Red 1	Apple Red Yellow	Dates	Guava	Tomato 4	Apple Red 1
Quince	Tomato 3	Rambutan	Pomegranate	Tamarillo	Melon Piel de Sapo	Tomato 1	Grape White
Mulberry	Mulberry	Apple Granny Smith	Banana	Strawberry	Nectarine	Strawberry Wedge	Pear Monster
Guava	Apple Golden 3	Passion Fruit	Clementine	Pitahaya Red	Quince	Cherry Rainier	Apple Red Delicious
Papaya	Strawberry Wedge	Tomato 4	Cactus fruit	Avocado	Pepino	Guava	Tomato 2
Apple Red 3	Apple Granny Smith	Cantaloupe 1	Limes	Maracuja	Rambutan	Cherry Rainier	Salak
Apricot	Apple Red 3	Strawberry Wedge	Cherry Wax Black	Mango	Tangelo	Banana Red	Limes
Apple Granny Smith	Mango	Guava	Huckleberry	Cherry Wax Yellow	Kaki	Melon Piel de Sapo	Raspberry
Apple Red Delicious	Carambula	Maracuja	Apple Red Yellow	Mango	Peach	Kaki	Lemon
Mulberry	Tomato 3	Pitahaya Red	Cherry 2	Avocado ripe	Apple Golden 2	Redcurrant	Strawberry Wedge
Tangelo	Apple Golden 1	Lemon	Mandarine	Melon Piel de Sapo	Strawberry	Pitahaya Red	Melon Piel de Sapo
Grape Pink	Cantaloupe 2	Kumquats	Carambula	Lemon	Clementine	Apple Red 2	Strawberry
Maracuja	Cactus fruit	Strawberry Wedge	Banana Red				

Figure 2: Corresponding detected classes from the fruit on the figure 1. The detected classes and the images of fruits are corresponding

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I didn't success to ajust parameter in order to have an accuracy higher than 97% in some tests, but with these parameters, and with dataset shuffling, the accuracy stay at 96% which is correct.

References

[1] Hafidz Zulkifli. Understanding Learning Rates and How It Improves Performance in Deep Learning. 21/01/2018. Last time accessed: 12/02/2019. Website: `https://towardsdatascience.com`