Searching Best Model in Neural Architecture Search Space

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***Abstract*—We have given a Neural Architecture Search (NAS) space. We have to find a searching technique that can search in a Neural Architecture Search space for the best performing Convolution Neural Network (CNN) Architecture on the fashion-mnist dataset. Best here means having a high accuracy with less number of parameters.**

I. Introduction

We have fashion-mnist dataset which you can download using tensorflow.keras.datasets.fashion-mnist. Alternatively, you can also download this dataset from Kaggle. This is a dataset of Zalando's article images. It consists of 60,000 training examples and 10,000 testing examples. Each example is a 28x28 grayscale image, associated with a label from 10 classes. Those 10 classes are T-shirt/top, Trouser, Pullover, Dress, Coat, Sandal, Shirt, Sneaker, Bag, Ankle boot.[1]

II. Load Fashion-MNIST Dataset

As mentioned earlier we have loaded our dataset using fashion-mnist.loaddata() and then we have stored the training and testing data in their corresponding variables.

Fig. 1. Some of the training images

III. CNN Architecture

The CNN model we have used consists of three layers.

1) First layer is a Normal layer (NL) which consist of parameters stride = 1, padding=same, kernel size=3x3, input-shape=(28,28,1), randomly chooses the filter-size from 32,64,128, activation-function is also randomly chosen from list of activation functions viz relu, gelu, swish, sigmoid, tanh.
2) Second layer is a reduction layer (RC) which have stride=2, kernel-size=3x3, padding=valid, filter size chosen from 32, 64, 128, similarly, activation function chosen from a list of activations as stated in first point.
3) Third layer is also a reduction layer (RL) which have stride=2, kernel-size=3x3, padding=valid, filter size chosen from 32, 64, 128, similarly, activation function chosen from a list of activations as stated in first point.
4) Then comes our Final layer (FL) which are used for classification purpose.[2][4]

IV. Search Strategy

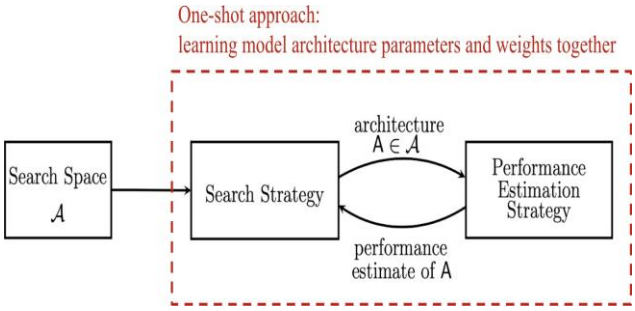

Fig. 2. Neural Architecture search

Here we have used the A* algorithm for finding the best model from the dataset. A* is an informed search algorithm. It starts from a specific starting node of a graph and aims to find a path to the goal node having the least cost. It is done by maintaining a tree of paths starting from the start node and extending it one edge at a time till termination. At each iteration, A* needs to determine which path to extend further.

It does so based on the cost of the path and an estimate of the cost required to extend the path all the way to the goal.

In this project, we have followed a similar approach. Initially we have randomly chosen an index. We will keep the track of the indexes traversed and also maintain a list of visited index. We will define the goal accuracy as 0.75 since our aim is to find a model with accuracy above 75%. We have used a getHeuristic() function which stores the accuracy of the training model so that next time again the model don't have to compute it. It takes the arguments as genome string and its index. If the initial accuracy is less than the goal accuracy then we call the getHeuristic() function to get the accuracy and parameters for the randomly chosen index.

Now we will consider previous and next value for the indexes and compute their accuracy and parameters. From the parameters value of current and previous model, compute the cost. Repeat this for the next index. We will then choose the direction with respect to maximum cost as our objective is to maximize the cost. After applying the search technique,we get our best model from the dataset.

V. Results

After applying the A* search technique, we get the best model and its corresponding parameters as shown in Fig. 3

```
[3, 4, 5]
Iterations Req 2
Best Model Found: RC 10 3 tanh;NC 20 3 relu;RC 10 3 swish;FL swish; with Accuracy 0.7602666616439819
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Fig. 3. Result of the best model

The parameters of the best model after applying the search technique are:

genome string: RC 10 3 tanh;NC 20 3 relu;RC 10 3 swish;FL swish;

Accuracy: 76.02%

Then we have plotted the graphs between parameters and model index, accuracy and model index, accuracy and parameters.

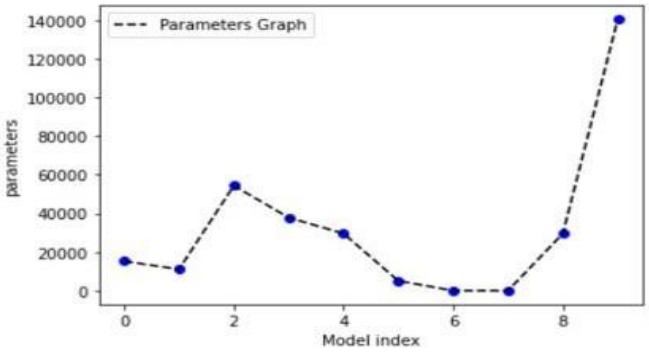

Fig. 4. Parameters vs model index

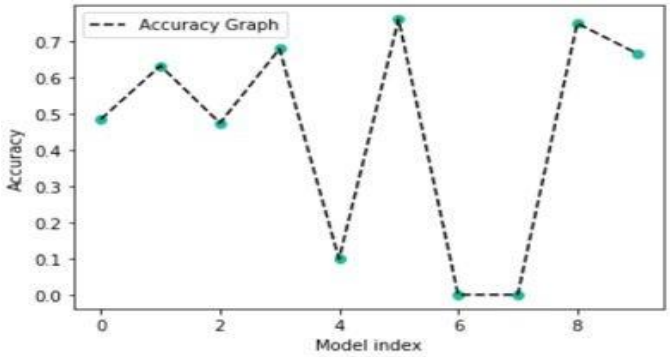

Fig. 5. Accuracy vs model index

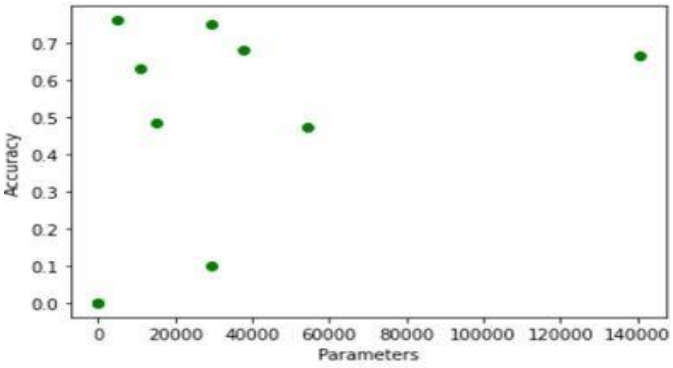

Fig. 6. Accuracy vs Parameters

References

[1] https://www.kaggle.com/zalando-research/fashionmnist

[2] Poletaev, Konstantin Pervunin, and M. Tokarev. "Artificial neural network for bubbles pattern recognition on the images". In: Journal of Physics Conference Series 754 (Oct. 2016), (072002)–13. doi: 10.1088/1742-6596/754/7/072002.

[3] M. S. Tanveer, M. U. Karim Khan and C. -M. Kyung, "Fine-Tuning DARTS for Image Classification," 2020 25th International Conference on Pattern Recognition (ICPR), 2021, pp. 4789-4796, doi: 10.1109/ICPR48806.2021.9412221.

[4] https://machinelearningmastery.com/how-to-develop-a-cnn-from-scratch-for-fashion-mnist-clothing-classification/