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SysEng 6213 Deep Learning Homework 1

Build your deep learning platform that you will be using this semester and run the file Homework 1.ipynb on googlecolab and comment on the results obtained. Modify the file to answer the below questions and create a new *.ipynb file so as your answer for each question. You can provide text in each file using # to explain what you did in each cell that you modified or added.

1. Change the random number seed number used in the code run it for four new seeds and comment on the results. Did the accuracy change? If it did, what is the reason of change?

The accuracy results change because the weight initialization, regularization, layers, optimization, and model fitting are stochastic processes involving randomness. So, if different random seeds are used then the results will vary as shown in Table 1.

Table 1. Effect of changing random seed on validation and test accuracies

Random Seed	Validation Accuracy	Test Accuracy
0	0.9245	0.9220
42	0.9236	0.9221
32768	0.9239	0.9217
1234	0.9232	0.9219

2. Change the activation function softmax to another activation function and comment on the results? Did the performance change?

For this, the ‘relu’ activation function was used instead of the ‘softmax’ function. All other hyperparameters were unchanged. Accordingly, the model accuracies are significantly worse with the validation and test accuracies being 0.0995 and 0.0980 respectively. This is because for the MNIST dataset we are trying to predict the handwritten digits based on probabilities. Since ‘relu’ generates values in the $[0, \infty)$ interval, hence, using it as the output layer will fail to produce accurate results. Therefore, the ‘softmax’ function which generates values in the $(0, 1)$ interval must be used as the output layer of our model.

3. It is possible to add multiple hidden layers to the model given in Homework 1.ipynb file by adding a new layer like “name='dense_layer_2 …….. “ etc. Add two more hidden layers with relu activation function and run the model again and comment on results.

Yes, it is possible to add a new layer. For this, two hidden layers with ‘relu’ as activation function was added along with the final layer with ‘softmax’ as activation function. The number of units for each layer was unchanged and set to 10 as before. This a significant effect on the model

accuracies. For example, when 10 units each are used, the validation and test accuracies are 0.9429 and 0.9403 respectively, whereas when 64, 64, and 10 units are used in each layer, these accuracies are 0.9703 and 0.9734 respectively.

4. You will be using a large data set for this course project. There is not enough time to generate new data. We need to depend on data sets that are publically available to use. Here is the link for large data sets that you can pick for your semester project https://towardsdatascience.com/top-sources-for-machine-learning-datasets-bb6d0dc3378b Review the data sources and select three of them that is of interest to you for a semester project.

The following datasets will be used in my project:

(a) MOD16: https://lpdaac.usgs.gov/products/mod16a2v006/
(b) GRACE: https://grace.jpl.nasa.gov/data-analysis-tool/
(c) USDA-NASS: https://nassgeodata.gmu.edu/CropScape/
(d) PRISM: http://www.prism.oregonstate.edu/
(e) Kansas Groundwater Database: http://hercules.kgs.ku.edu/geohydro/wimas/
(f) Arizona Groundwater and other data: https://infoshare.azwater.gov/docushare/dsweb/View/Collection-72

The first two datasets cover the entire world and must be pre-processed to fit the Kansas and Arizona regions having different climatic conditions. Also, datasets 3 and 4 are for the continental US and need to be pre-processed. Essentially, my research involves using ML/DL methods to predict and forecast groundwater extraction which is aimed towards helping water managers in addressing water security issues. The entire spatio-temporal data consisting of these six datasets span from 2002-2019.

N.B:
The following files have been submitted on Canvas:
(a) HW1_P1: Problem 1
(b) HW1_P2: Problem 2
(c) HW1_P3_1: Problem 3 with 64, 64, 10 units
(d) HW1_P3_2: Problem 3 with 10, 10, 10 units