Assignment 4 – Modified-MNIST Challenge Write-up

Team name: Deeply Convoluted Team

Team members: Ahmad Ghawanmeh, Feng Xia, Tahseen Bin Taj

1. Implementation:

In this assignment, our goal is to identify the largest digit in an image given a set of images of handwritten digits. We achieve this through training a CNN model by exploiting mainly Tensorflow and its interface, Keras. In addition, we leverage scikit-learn, pandas, numpy and h5py libraries for data manipulation and model storage, and rely on matplotlib for visualization. We were inspired by a CNN based solution we found online and used it as the basis for our implementation. Check the references to have a look at their implementation of the idea.

Our approach is as follows:

1) Data Retrieval and Preprocessing: We originally plan to remove the background noise in each image with gaussian filtering in skimage. However, this renders an overfitted model with high variance. We surprisingly get a better result without filtering, thus commenting out this part of code. In terms of labels, we convert the integers into a binary class matrix.

2) Data Augmentation: We utilize the image preprocessing tool "ImageDataGenerator" from Keras, performing some rotation, weight/height shifting and zooming, to generate varied images from one.

3) Model Training: We train our CNN model using around 20 layers, performing a "Dropout" as our regularization method after each 3 convoluted layers. We also add "BatchNormalization" to stabilize the learning process, which allows for reduced number of epochs.

4) Accuracy Calculation

5) Result Storage

2. Results:

Our model reaches an accuracy of 97.90% with batch=400 and epochs=40.
We notice that these parameters perform the best among many tests we performed by changing the number of batches, epochs and the amount of shifting in data augmentation. As mentioned above, we also try to clean the background of our images with gaussian filtering but that leads to a decrease in accuracy on the test set.

We hence choose this model in the Kaggle competition.

3. Challenges:

Determining the number of layers to use is very hard, and we do much research online to see how other CNN models are implemented.

The work in testing for the best-performing parameters (hyperparameters tuning) is also tedious, as there are infinitely many choices on each. Changing one parameter by a little could affect the result by a considerable amount.

4. Conclusion: We deepen our understanding in Deep Learning, specifically in CNN. We see that difference choices on hyperparameters can place a great effect on results. Furthermore, we get to apply the regularization idea learnt in lecture to model training, for example, data augmentation to increase data size.

5. Individual Contribution:

- Ahmad Ghawanmeh: Research on how to run the code without running out of RAM, at some point I was working on setting up an AWS EC2 server to solve that. The team decided to scrap that idea after figuring out how to train the model on colab. I also worked on tweaking the model itself, through many test runs.

- Tahseen Bin Taj: Setting up google colab and researching various models to decide the perfect one for our challenge. I had a look at various MNIST solutions online and realized the most effective solutions used CNN. Using that idea, I searched for similar projects as our challenge which used CNN. I landed on another modified MNIST write-up, which I used as the base of our code to solve the problem. Some challenges included managing to keep the data within the RAM's limits.

- Feng Xia: Data-preprocessing and augmentation: I played around with skimage, and ImageDataGenerator in Keras. Next, I worked on hyperparameters tuning by changing the number of batches and epochs, and observed their performances during various test runs. I also handled the writing of the write-up.

6. References:

https://www.kaggle.com/sid321axn/regularization-techniques-in-deep-learning

https://machinelearningmastery.com/batch-normalization-for-training-of-deep-neural-networks/

https://github.com/nikhilpodila/Modified-MNIST