CMPE 597 Sp. Tp. Deep Learning
Spring 2021 Project II
Due: June 20 by 11.59pm

In this project, you are going to implement a VAE, where the encoder is an LSTM network and the decoder is a convolutional network. You will use MNIST dataset. MNIST is an image dataset, however you can treat each image as a sequence of rows. For instance, MNIST dataset has 28×28 images, which can be treated as a 28 dimensional multivariate sequence of length 28. You can load the MNIST dataset via the deep learning library of your choice. Modify your implementation in Project 2. For instance, in `model.py`, implement your VAE architecture instead of the CNN you implemented in Project2. Keep your implementation in `main.py` but you may of course make necessary changes in terms of the optimizer, number of epochs, and learning rate, etc. Please implement the following steps and report your results.

Network

You should implement the following in `model.py`.

- (20 pts) Implement a single layer LSTM as the encoder of the VAE. You may use the LSTM functions provided by the deep learning library. You will determine the dimensionality of the hidden states.
- (20 pts) Implement a convolutional decoder with transpose convolutional layers. This decoder should take a random vector sampled from the distribution that was outputted by the encoder and decodes it to an 28×28 grayscale image. Since you will go to an image from a random vector, you will need transpose convolution. You will decide the number of layers, kernel size, number of filters and the stride value. You are free to add dropout or batch normalization if they are necessary.
- (20 pts) Implement the reconstruction loss with binary cross-entropy and the regularization term with KL-divergence. You may check the closed form of KL divergence between two univariate Gaussians (you may come across implementations using the closed form on the internet) or you may use a built-in function.

Training

You should implement the following in `main.py`.

- (15 pts) Train your model and plot the values of the loss function and the regularization term during training. Comment on their behaviors.
- (5 pts) Save the trained model and include it in your submission folder. If you don't provide the saved model, 5 points will be deducted.

Generation

You should implement the following in `generator.py`.

- (15 pts) Load the trained decoder and generate 100 images from 100 random vectors. Visualize the generated samples. Comment on your performance.
- (5 pts) Provide a README file including the information about how to train your VAE and how to generate samples. If you don't provide a README, 5 points will be deducted.

Submission

You need to submit a zip file with the name `NameSurname_Project3.zip` containing the files below.

- A pdf report including your name, your student number, your answers to questions, and references.
- `model.py`
- `main.py`
- `generator.py`
- `model.pk`
- `README.txt`

IMPORTANT NOTE: Do not forget to cite your references and resources.