Deep Learning (Homework 2)

Due date : 2020/5/22

- High-level API are forbidden in this homework, such as Keras, slim, TFLearn, etc. You should implement the forward computation by yourself.
- Homework submission – Please zip each of your source code and report into a single compressed file and name the file using this format: HW2_StudentID_StudentName.zip (rar, 7z, tar.gz, ... etc are *not* acceptable)
- If you have any problem about implementation, DON'T directly upload your code on the E3 discussion

1 Recurrent Neural Network for Classification

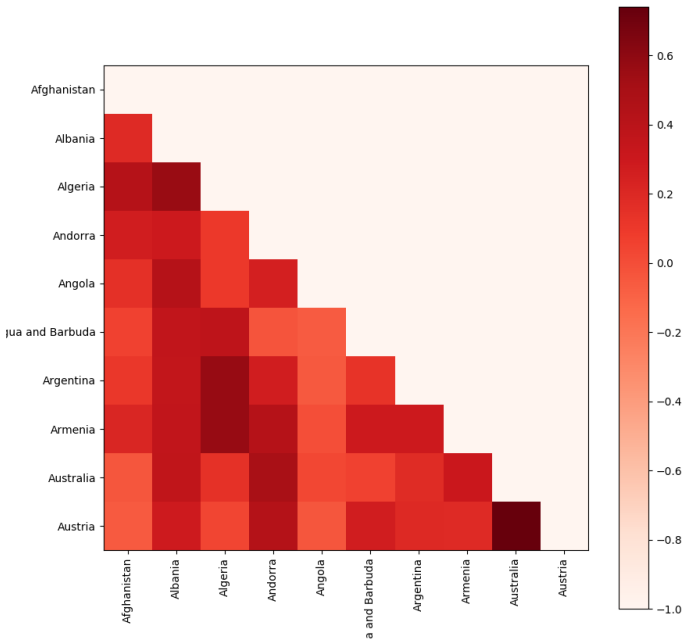
In this problem, you are given a csv file that contains the number of confirmed people with COVID-19 in a period of time in different countries. You are required to implement a recurrent neural network to classify if the number of confirmed people will increase in the next day. The following figure shows some samples in the dataset. The dataset can be downloaded here.

	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	1/28/20	1/29/20	1/30/20	1/31/20	#######	#######	#######
	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum	sum
Country/Region															
Afghanista	33	65	0	0	0	0	0	0	0	0	0	0	0	0	0
Albania	41.1533	20.1683	0	0	0	0	0	0	0	0	0	0	0	0	0
Algeria	28.0339	1.6596	0	0	0	0	0	0	0	0	0	0	0	0	0
Andorra	42.5063	1.5218	0	0	0	0	0	0	0	0	0	0	0	0	0
Angola	-11.2027	17.8739	0	0	0	0	0	0	0	0	0	0	0	0	0
Antigua ar	17.0608	-61.7964	0	0	0	0	0	0	0	0	0	0	0	0	0
Argentina	-38.4161	-63.6167	0	0	0	0	0	0	0	0	0	0	0	0	0
Armenia	40.0691	45.0382	0	0	0	0	0	0	0	0	0	0	0	0	0
Australia	-255.97	1129.86	0	0	0	0	4	5	5	6	9	9	12	12	12
Austria	47.5162	14.5501	0	0	0	0	0	0	0	0	0	0	0	0	0
Azerbaijan	40.1431	47.5769	0	0	0	0	0	0	0	0	0	0	0	0	0
Bahamas	25.0343	-77.3963	0	0	0	0	0	0	0	0	0	0	0	0	0

i Please compute the correlation coefficient between two countries. The correlation coefficient function is expressed by

$$\text{Correlation}(X, Y) = \frac{\text{Cov}(X, Y)}{\sqrt{\text{Var}(X)}\sqrt{\text{Var}(Y)}}.$$

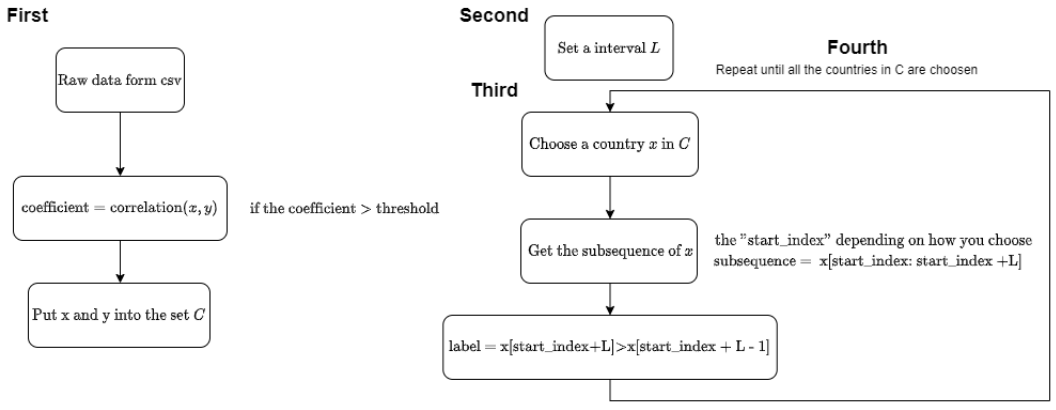
You should plot these coefficients in all the pairs of two countries like the following figure.



ii To process on you data,

- first, collecting the pairs of the country with high correlation with the other country. Here, you therefore collect a lot of countries in a set denoted as C.
- second, setting an interval (sequence length) L.
- third, using the sequence x of the country in C to generate the subsequence with the length equal to L in x, And based on the next day of the last day in the subsequence, you can give it a label to specify if it is increasing or not.
- fourth, repeating third step until all the countries in C are used to generate the data.

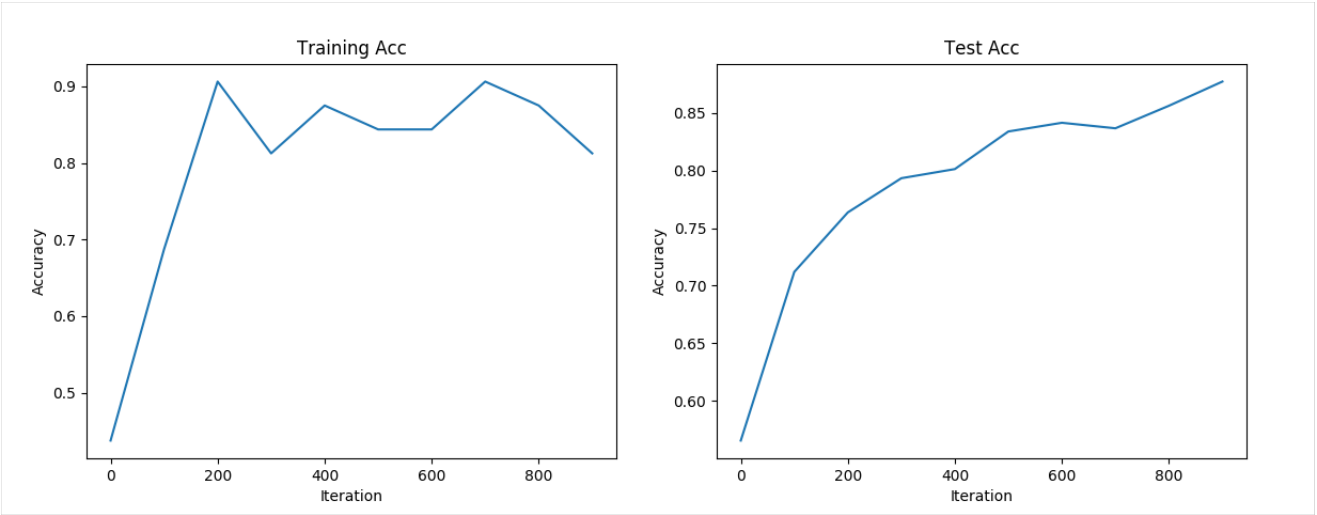
To help you understand the above process, the following is the simple example graph to show how to generate the data.



Note

Remember in the above process, the sequence of a country is a difference sequence
For example, when you can a list from csv like [1, 3, 4, 1, 0] and [2, 1, -3, -1] is the difference sequence.
Because you are predicting if the number is increasing or not, you should use the difference sequence as your input instead of the original sequence.

iii Build a recurrent neural network to predict the label based on the given sequence. And show the accuracy of training and test.



iv Please implement different recurrent neural network like **LSTM** and **GRU** and change the value of interval L to analyze its effect on the result

v Compute the probability for each country and plot on a world map by using "pygal" package in python as below example.

vi Do some discussion based on your result.

2 Variational Autoencoder for Image Generation

In this exercise, you will construct a Variational Autoencoder (VAE) for image reconstruction by the animation faces dataset here.

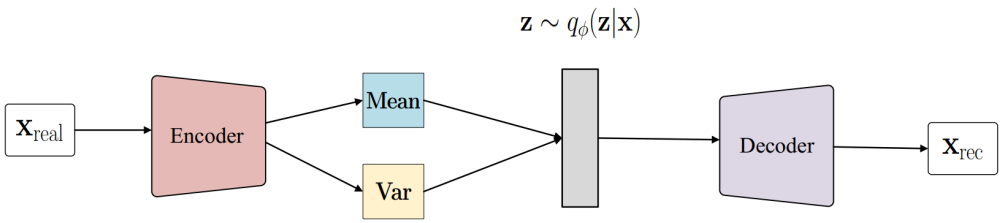


Figure 1: Structure of VAE

VAE paper can be downloaded here. You should preprocess the images such as resizing or cropping by yourself before implementation.

i Describe in details how to preprocess images (such as resizing or cropping) and design the network architecture.

ii Plot the learning curve of the negative evidence lower bound (ELBO) of log likelihood of training images.

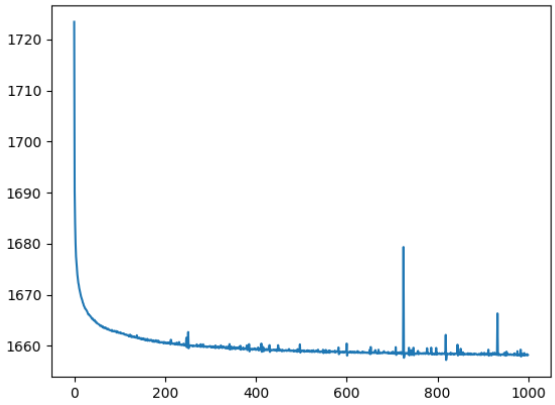


Figure 2: Learning curve of negative ELBO using VAE

iii Show some examples reconstructed by your model.

Figure 3: Real samples in dataset

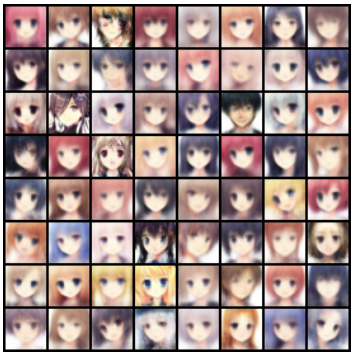


Figure 4: Reconstruction samples using VAE

iv Sample the prior $p(\mathbf{z})$ and use the latent codes $\mathbf{z}$ to synthesize some examples when your model is well-trained.

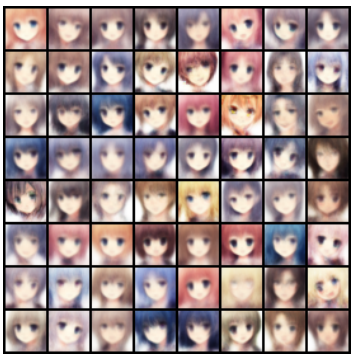


Figure 5: Synthesized samples drawn from VAE

v Show the synthesized images based on the interpolation of two latent codes $\mathbf{z}$ between two real samples.

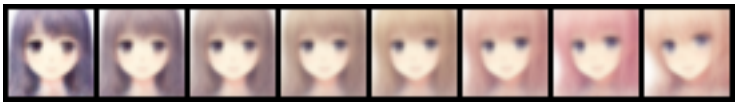


Figure 6: Generated images based on interpolation of latent codes from two real images.

Hint: you need to interpolate two latent variables encoded form two real images. Several new latent variables in two images should be drawn. Finally, decode those new latent variables into images.

vi Multiply the Kullback-Leibler (KL) term in ELBO by 100 in your loss and repeat ii $\sim$ v.

vii Multiply the KL term by 0 in ELBO and repeat ii $\sim$ v.

viii Do some discussion on the effect of KL term based on your result.

3 References

– The dataset in first problem is collected from https://github.com/CSSEGISandData/COVID-19

– The dataset in second problem is collected from https://www.kaggle.com/soumikrakshit/anime-faces