Question 1

[15 points] Use Python programming with Numpy and Scipy libraries to compute the 2D convolution of

$$Z = x * K,$$

and without using zero padding and stride of 1, where x and the kernel K are defined by:

30	30	80	100	0	30
0	0	100	80	10	0
30	100	20	90	80	0
100	0	80	20	20	80
20	70	0	95	100	30
20	0	0	100	0	0

x

$*$

0	0	1/3
0	1/3	0
1/3	0	0

K

$=$ Z

Question 2

[10 points] Explain the effects of convolving the kernel K with the input matrix x as shown in Question 1.

Question 3

[20 points] Use Python programming and Pytorch library with Fashion MNIST dataset [2] (images of size 28×28 pixels):

- Compare the train and test accuracies of two different ConvNet models (kernel width 5, and number of filters is 32) at stride of 1 and 2.
- Calculate the total number of parameters for each case.

Question 4

[15 points] From the previous question, plot sample successful and failure cases, and explain the effect of changing the stride size on the results.

Question 5

[10 points] List four types of loss functions that are commonly used in the field of deep learning. Then compare them in terms of :

- Formula that computes the error/similarity between true and predicted labels
- Advantages / Disadvantages (if exist)
- Can it act as a surrogate loss function?
- Example ML/DL task(s)

Question 6

[30 points] Use Python programming, PyTorch Library and Fashion MNIST dataset [2] (images of size 28×28 pixels) do the following:

- Build your model as: one layer ConvNet with kernel of width 5, and number of filters 32, followed by one ReLU layer, and one fully connected layer to predict the input class label out of 10 possible classes. Then, specify the loss function as cross entropy loss.
- Compare SGD and RMSProp Optimizers in terms of plotting the accuracy and loss on the training and validation sets for epochs 1 to 10, when the batch size is 32.
- Repeat the last step for batch size of 1000 and 10,000.
- Explain the effect of increasing the batch size on the speed, accuracy and loss values of the training process.

Notes: Please upload your answers in one PDF file to your Moodle account by the announced due date above, and refer to your Colab URLs for your answers on the programming questions, where you need to grant access to Eng. Aly Mohamed Abdelmageed (alymohamed@nu.edu.eg) on Colab notebooks to evaluate your answers. Recommended to use Overleaf assignment template[1] or another Latex template. Please remember that this is an individual work assignment.

References

[1] Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner, "Gradient-based learning applied to document recognition," *Proceedings of the IEEE*, vol. 86, no. 11, pp. 2278–2324, 1998.

[2] H. Xiao, K. Rasul, and R. Vollgraf, "Fashion-mnist: a novel image dataset for benchmarking machine learning algorithms," *arXiv preprint arXiv:1708.07747*, 2017.

[1] https://www.overleaf.com/latex/templates/assignment-template/hwddqynqfrhn