THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY
Department of Computer Science and Engineering
COMP4211: Introduction to Machine Learning
Spring 2022: Assignment 2
Due time and date: 11:59pm, Mar 28 (Mon), 2022.

IMPORTANT NOTES

- **Your grade will be based on the correctness and clarity.**

- **Late submission: 25 marks will be deducted for every 24 hours after the deadline.**

- **If you have questions, please contact the TA Yimin Zheng at** yzhengbs@cse.ust.hk.

In this assignment, you are provided with partial code assignment2.ipynb.

Q1. In this question, you will use a convolutional neural network (CNN) for CIFAR-10 (color) image classification. Some sample images are shown below.
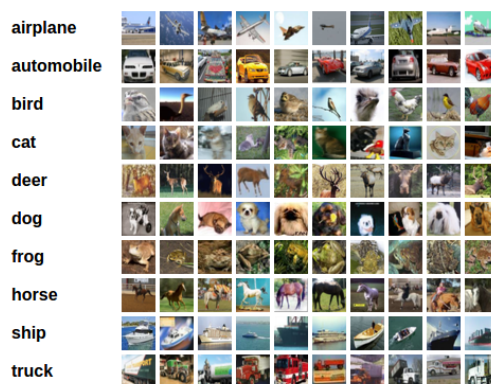
(a) Fill in the provided Net() class, and build a CNN with the following structure:
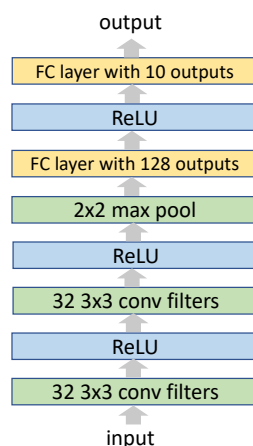
- For convolution layers, use (i) zero-padding (to ensure that the dimensions of input and output representations at each layer remain the same); (ii) a bias term; (iii) ReLU activation; and (iv) stride = 1.

- For the max-pooling layer, use (i) NO zero-padding; and (ii) stride = 2.

- For the other parameters, use the default PyTorch setting.

(b) Fill in the provided train() and test() functions for training and testing the CNN.

(c) Plot the training accuracy (in the y-axis) with the number of training epochs (in the x-axis) when the following four optimizers are used to train the network:

  (a) SGD with learning rate 0.001;

  (b) SGD with learning rate 0.005;

  (c) Adam optimizer with learning rate 0.001;

  (d) Adam optimizer with learning rate 0.005.

Q2. In this question, we consider the following 1-dimensional "image" of size 6.

1	3	9	8	4	2

We use a convolutional neural network with the following architecture:

1. One convolutional filter of size 3 with ReLU activation, no zero-padding and the following filter weights:

1	0	-1

2. This is then followed by a max-pooling layer covering each 1×2 area with stride of 2;

3. Finally, one output unit with sigmoid activation and the following weights:

0.5	0.5

In assignment2.ipynb, show the outputs of the (i) convolutional filter; (ii) pooling layer, and (iii) output.

Q3. You are given a two-dimensional data set of two circles (variable X in assignment2.ipynb).

(a) Using sklearn's API, perform K-means clustering (with $K = 2$) and store the cluster labels in the variable y1.

(b) You should see that the clustering result in part (a) is not good. Now, transform each 2-dimensional data point (u, v) to the scalar $u^2 + v^2$. Again using sklearn's API, perform K-means clustering (with $K = 2$) on the transformed data and store the cluster labels in y2.

Submission Guidelines

Please submit a completed Python notebook file (based on the assignment2.ipynb file) to show your work. Name the .ipynb file in the format **YourStudentID_assignment2.ipynb** (e.g., 12345678_assignment2.ipynb) and upload it to Canvas. Required results should be shown clearly. **Plagiarism will lead to zero point on this assignment**.