COMP3032 – Machine Learning

Assignment Two (25marks)

Due date: EOD Week 16 Sunday

Main objective

We will build a manifold learning or sometimes called dimensionality reduction model on CIFAR-10 images so that we can visualise images in low dimensional space, say in 2D plane. In this assignment, we use image data CIFAR-10. The CIFAR-10 dataset is a collection of images that are commonly used to train machine learning and computer vision algorithms. It is one of the most widely used datasets for machine learning research. The CIFAR-10 dataset contains 60,000 32x32 color images in 10 different classes. The 10 different classes represent airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, and trucks. There are 6,000 images of each class. See https://www.cs.toronto.edu/~kriz/cifar.html for details.

As we use images, you **need to use convolutional neural networks instead of simple MLP**. You are free to choose the structure of the CNN, for example, the number of layers, activation functions etc. In terms of the dimensionality of the manifold, we fix it to be 2, meaning the middle layer (bottle neck layer) of your autoencoder should have only 2 units. The output of this bottleneck layer is usually called *the representation* of the input. Refer to tutorial materials for learning module 10 and 12 for autoencoder.

Tasks

You need to accomplish the following tasks for this assignments.

1 (3 marks): *Randomly* select 3 classes with 100 images per class for this assignment;
2 (15 marks): Build the autoencoder model using CNN with functioning training code (*if not CNN based, 60% reduction of marks will incur for this task*);
3 (5 marks): Plot the learnt images 2D coordinates (normally called *embeddings* in machine learning) of all images in training with each class denoted by a symbol, for example, circles for dogs, triangles for cats and so on;
4 (2 marks): *Randomly* select 5 images that are not in the training set and obtain their 2D representations, add them to the plot produced in task 3 and describe what do you think about them in terms of their locations in relations to others.

Your code should produce the plot similar to Fig. 1.

Bonus task (10 marks)

Build a **supervised** manifold learning model on CIFAR-10 images. The main idea is to incorporate labels information in the manifold learning process. It is very similar to LDA (linear discriminant analysis) in terms of functionality. However, instead of a linear function, we use neural networks autoencoder as the backbone for manifold learning. Therefore, The model is a combination of autoencoder and classification, i.e. incorporating supervision information in the modelling process, for example, adding classification cost function into original autoencoder cost function. Do task 1-4 (see above) but replace the autoencoder by this supervised one.

NOTE: This is extra 10 marks contributing towards your final scores if you can do it.

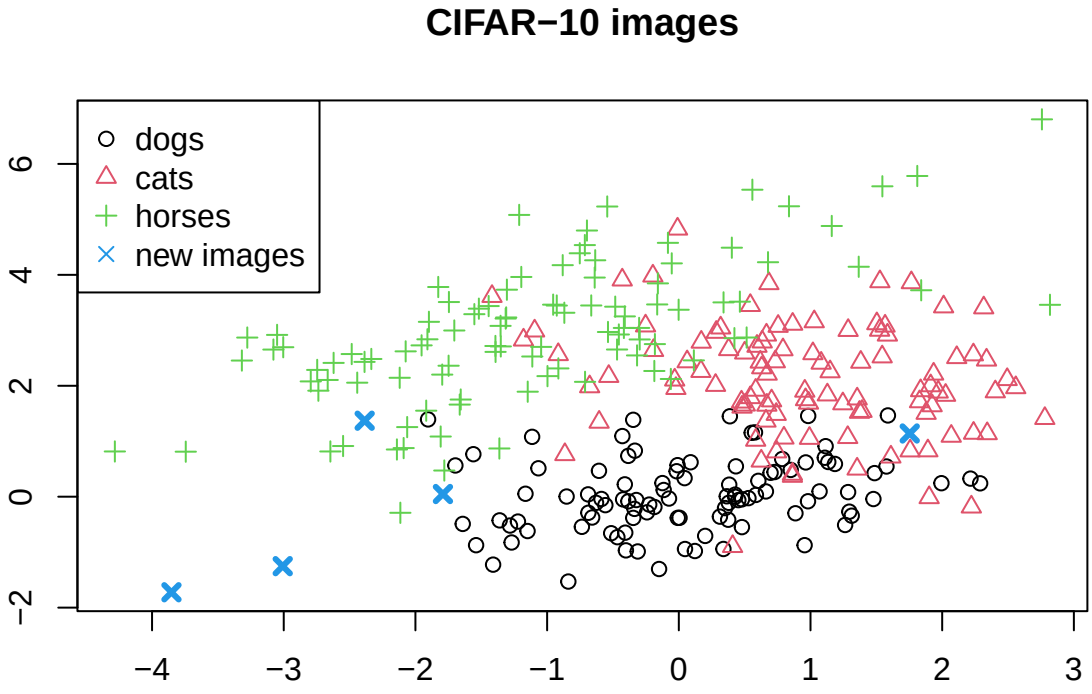

Figure 1: 2D representations of images in CIFAR-10.

Documentation

1. You should write a readme file (in plain text) which contains:

(a) Your name and student ID
(b) How to compile and run your code
(c) Description about any (hyper)parameters if you have
(d) Description about your findings in task 4
(e) Your design for bonus task (only if you have solution for it)

NOTE: All output should be generated by your code. No screenshots and PDFs.

2. Your code should contain necessary comments to explain what the code is doing.

Submission

All related files (such as the readme, python program, trained models if you want to but not the data) should be zipped into a single file `StudentID_Assignment2.zip` and submitted via vUWS. You are required to provide a stand alone python program so that it can run . Please note that you must ensure the following:

1. submit before deadline;
2. your program runs with no error;
3. keep a copy of your own submission;
4. no email submissions accepted.