CSE5ML: Machine Learning – Assignment Part 1

Semester 1, 2020

Overview

- This assignment contributes **20%** of your final mark in the subject. Please read this sheet carefully before doing your assignment.
- The assignment aims to consolidate your knowledge and practical skills to build **neural networks** (NNs) for **supervised learning**. The task is formulated as **multi-class classification problem** for hand-written images, and the goal is to model the relationship between an image's content and label.

Policies

- You need to provide a working code and a written report of 750 words on the method and results.
- Plagiarism is the submission of somebody else's work in a manner that gives the impression that the work is your own. The Department of Computer Science and Information Technology at La Trobe University treats plagiarism very seriously. When it is detected, **penalties are strictly imposed**.

Submission

- The assignment is due at 10:00 am, 17th of May 2020 (Monday).
- The submitted assignment consists 1) a report (in PDF format) with no less than 750 words and 2) all codes for modelling, training and testing the NN with TensorFlow in Python.
- The assignment is to be submitted by email to the lecturer; Each person needs to make only **ONE** submission.
- A penalty of 5% per day will be imposed on all late assignments up to 5 days. An assignment submitted more than five working days after the due date **will NOT be accepted and zero mark will be assigned**.
- Assignment without the signed declaration of authorship attached **will NOT be accepted and zero mark will be assigned**.
- As the assignment contributes over 15% of your final mark, you need to apply for **Special Consideration** to the University if requiring an extension. Please refer to the link below for more details.
  https://www.latrobe.edu.au/students/admin/forms/special-consideration

Problem Description

The **MNIST** database of handwritten digits (from 0 to 9) has a training set of 55,000 examples, and a test set of 10,000 examples. The digits have been size-normalized and centered in a fixed-size image (28x28 pixels) with values from 0 to 1. You can use the following code with TensorFlow in Python to download the data.

```
from keras.datasets import mnist
(x_train, y_train), (x_test, y_test) = mnist.load_data()
```

Every MNIST data point has two parts: an image of a handwritten digit and a corresponding label. We will call the images x and the labels y. Both the training set and test set contain x and y.

Each image is 28 pixels by 28 pixels and can be flattened into a vector of 28x28 = 784 numbers.

As mentioned, the corresponding labels in the MNIST are numbers between 0 and 9, describing which digit a given image is of. In this assignment, we regard the labels as **one-hot vectors**, i.e. 0 in most dimensions, and 1 in a single dimension. In this case, the n-th digit will be represented as a vector which is 1 in the n dimensions. For example, 3 would be [0,0,0,1,0,0,0,0,0,0].

The assignment aims to build NNs for classifying handwritten digits in the MNIST database, train it on the training set and test it on the test set.

Please read the following comments and requirements very carefully before starting the assignment:

1. The assignment is based on the content of **Labs**.
2. In Lecture 1, we talked about the use of **training set**, **validation set** and **test set** in machine learning. In the assignment, you are asked to train the NN on the training set and test the NN on the test set, instead of doing the two steps on the same data set as what was done in Lab 5. You do **NOT** need the validation set in the assignment.
3. In the assignment, the performance of a NN is measured by the its prediction accuracy in classifying images from the **test set**, i.e. number of the correctly predicted images / number of the images in the test set.
4. You are asked to model **THREE** NNs by changing the architecture. For example, you may change the number of layers, use different type of layers, and try various activation layers.
5. You are encouraged to repeatedly train and test your NNs with different parameter setting, e.g. learning rate.
6. Your report **MUST** at least contain the following content
    a. Your names and student number;

b. Architectures of the NNs, with figures;
c. Experiments and performances, with parameter setting;
d. Discussion on the improvement / deterioration of the NN's performance after changing the architecture and parameter setting;
e. The best performance of the NNs;
f. The declaration of authorship signed by all group members on the last page.

Marking Criteria

Criterion	Contribution
The report includes your details	10
The report includes a detailed description on the architectures of three NNs, illustrated by figures.	30
The report includes a detailed description on the experiments and the performances of three NNs, with detailed parameter settings.	15
The report includes an in-depth discussion on the improvement / deteriorations of the NN's performance after changes.	20
The ranking of NN's best performance among the class.	10
The codes are in good style and in accordance with the reported details.	15
Total	**100**