**Date handed out:** **03 June 2022**
**Date submission due:** **17June 2022 23:55**

# Image Classification

**Objectives:** The purpose of this assignment is to familiarize yourselves with the fundamental deep learning solutions to computer vision problems and framework on classification problem. The assignment aims to give insights about the deep learning-based computer vision research and their evaluation methods.

**Description:** In this project you are required to implement a classification system based on deep learning methods, and to evaluate it with the provided dataset. The text continues with detailed explanations of the methods and requirements.

**1. Image Classification:** The main purpose of the image classification is to determine the class label of a query image. The classification is done by evaluating semantic contents of the query image. However, there is a difficulty in revealing the semantics of images due to the semantic gap. In order to overcome this difficulty, images are described as feature vectors which are higher level representations than collection of numbers. With these feature vectors, image classification can be formulated as a learning problem to match an image representation with the class label. Hence, in this assignment you are required to construct a fully-connected network with nonlinearity function between layers and train it with optimizer using the extracted feature vectors. While training the network you are required to use SoftMax (cross-entropy loss) function to minimize the difference between actual class label and the estimated one.

**2.Database and feature extraction:** Database contains 3 classes (cloudy, shine and sunrise) and consists of 908 images. A query is simply the name of an image whose content will be used for classification. For these queries, the ground truth results (class labels) are the names of the images. This allows you to evaluate your implementation and do experiments. For features you should simply use image pixels as a feature. You should form your training, validation and testing sets.

**3.Classification:** You are required to implement the aforementioned image classification using fully connected neural networks with four different number of hidden layers (1,2,3). After implementation, you should evaluate your solution with these configurations before using the test set. Finally, you will decide on the most successful configuration based on your experiments and then evaluate the error rate with the testing set.

An important hint about the implementation is saving model at intermediate epochs. While training the network, dataset is usually divided into mini-batches. After computing the loss for each batch, parameters of the network are updated. One pass of whole training set is called an epoch. In order to get a good fit to data, the number of epochs that the network will be trained should be determined. This can be done with the help of loss history plots that shows the loss computed using training and validation sets for each epoch. After examining the plot, one can decide on the number of epochs. In order not to retrain the network, you can save model and optimizer parameters at some epochs (i.e. at each 5 epochs). Another important hint is setting a seed for random number generators. This allows the experiments to be repeatable since whenever it is run, it starts from the same random parameters.

Along with the implementation of image classification, you are required explain rationale behind your choices and results of the experiments. It should include at least the following items;

• Discussion on the effects of the number of layers.

• Rationale behind your choices of hyper-parameters like number of layers, number of epochs, layer sizes etc.

**Submission Requirements:**

- You can only submit one file with all functions defined inside it.
- I will put your code inside the "Database" folder which is given to you and run the code. Hence, you must implement your code to work properly accordingly.
- Uncompiling codes will be graded as zero.
- Using grid and histogram-based feature extraction will be graded as zero.
- Late submissions will not be accepted.

**Grading Policy:**

| Grading Item | Mark (out of 100) |
|---|---|
| Acquisition (reading data from database, forming datasets) | 20 |
| Feature Extraction | 10 |
| Training and validating with 3 different configuration (layers) | 35 |
| Evaluation of testing with the best configuration | 15 |
| Explanation (reasons) of used techniques for every stage | 5 |
| Answers of questions | 10 |
| Submission requirements followed | 5 |