Assignment

In this individual assignment, you will perform image processing and implement Machine Learning (ML) and Deep Learning (DL) models to solve a classification problem in Computer Vision (CV). You will then tune each model accordingly to improve the performance of your models. Having acquired the fundamental understanding of these models, you will then explore powerful AI services provided by Google Cloud Vision API and propose an application to solve any problem relating to CV. This assignment carries a total of 50 marks and constitutes 35% of the module grade.

Schedule

- In week 16, your tutor will conduct a progress check
- In week 17, you will demo Part 1, 2 and 3 to your tutor
- Upload a zip file of your 4 Jupyter notebooks and 1 Word document to Brightspace by end of week 17, Sun 14 Aug 2022, 2359h

Assignment Brief

Part 1 – Input Dataset

The original CIFAR-10 dataset consists of 60,000 32x32 color images in 10 classes, with 6,000 images per class. There are 50,000 training images and 10,000 test images.

You will use black and white images converted from CIFAR-10 as your input dataset. Document your work and results in a Jupyter notebook:

(1) Download the black and white source files here
(2) Perform Exploratory Data Analysis (EDA) and discuss the input data
(3) Perform data normalization
(4) Derive the black and white images from the original color images
    - Download CIFAR-10 python version (color)
    - Understand the data structure
    - Convert the first 50 color training images to black and white using the Python Imaging Library
    - Verify the black and white values are identical to (1)

Part 2 – Machine Learning

Build the following Machine Learning models to classify the input datasets, calculate the performance metrics and document your work and results in a Jupyter notebook:

(1) Logistic Regression
(2) Random Forest

For the better model, use the Grid Search CV to determine the optimum set of hyperparameters.

Part 3 – Deep Learning

Build a Convolution Neural Network (CNN) to classify the input dataset, calculate the performance metrics and document your work and results in a Jupyter notebook:

(1) Build the following CNN model:
   i. Convolutional layer
      Feature Maps: 32; Receptive field: 3 by 3; Activation: Relu
   ii. Max pooling layer
      Pool size: 2 by 2
   iii. Convolutional layer
      Feature Maps: 64; Receptive field: 3 by 3; Activation: Relu
   iv. Max pooling layer
      Pool size: 2 by 2
   v. Convolutional layer
      Feature Maps: 64; Receptive field: 3 by 3; Activation: Relu
   vi. Max pooling layer
      Pool size: 2 by 2
   vii. Flatten layer
   viii. Fully connected (Dense) layer
      Units: 64; Activation: Relu
   ix. Fully connected (Dense) output layer
      Activation: Softmax
(2) Implement relevant techniques (covered in the lecture) to optimize your model. Possible options include:
   - Exploring data augmentation
   - Tuning the hyperparameters (e.g. the number of layers) in your CNN
   - Tuning the hyperparameters in Neural Networks
(3) Conclude the performance of the final model
(4) Analyse the effect of input data on performance
   - Create a new model based on your final model in (3) and tweak it to accept inputs of color images (3 channels)
   - Train it using the original CIFAR-10 color training images
   - Calculate the performance using CIFAR-10 color test images
   - Explain why this model is better/worse than (3)

Part 4 – AI Services

Google Cloud Vision API provides a set of services for analyzing images. Here are some examples:

- Label Detection
- Text Detection
- Document Text Detection
- Facial Detection
- Landmark Detection
- Logo Detection
- Image Properties

Propose an application that uses one, two or three services to solve a problem relating to CV:

- You do not need to build a working prototype
- For each service you use, show your workings of the API (e.g. issuing request and processing response) in a Jupyter notebook
- Describe any background research, challenges and assumptions in a Microsoft Word document

Rubrics

Criteria	F (0-4)	C-D (5-6)	B (7-8)	A (9-10)
Input Dataset [8 Marks]				
Exploratory Data Analysis	• Poor understanding of input data, data cleaning and relationship between variables • Poor statistical analysis	• Moderate understanding of input data, data cleaning and relationship between variables • Moderate statistical analysis	• Good understanding of input data, data cleaning and relationship between variables • Good statistical analysis	• Excellent understanding of input data, data cleaning and relationship between variables • Excellent statistical analysis
Input Processing	• No/Poor derivation • Poor understanding of conversion process	• Partial derivation • Moderate understanding of conversion process	• Good derivation • Good understanding of conversion process	• Full derivation • Excellent understanding of conversion process
Machine Learning [8 Marks]				
Models Creation and Analysis	• Models do not work • Poor understanding of performance metrics	• Models partially work • Moderate understanding of performance metrics	• Models mostly work • Good understanding of performance metrics	• Models fully work • Excellent understanding of performance metrics
Hyperparameters Tuning using Grid Search	• Poor knowledge of Grid Search • Poor understanding of tuning hyperparameters	• Moderate knowledge of Grid Search • Moderate understanding of tuning hyperparameters	• Good knowledge of Grid Search • Good understanding of tuning hyperparameters	• Excellent knowledge of Grid Search • Excellent understanding of tuning hyperparameters

Deep Learning [15 Marks]				
Models Creation and Performance	• Model is not constructed according to specifications	• Model is partially constructed according to specifications	• Model is mostly constructed according to specifications	• Model is fully constructed according to specifications
Hyperparameters Tuning	• Poor knowledge in tuning hyperparameters and implementation of optimization techniques	• Moderate knowledge in tuning hyperparameters and implementation of optimization techniques	• Good knowledge in tuning hyperparameters and implementation of optimization techniques	• Excellent knowledge in tuning hyperparameters and implementation of optimization techniques
Processing Color Images	• Model does not work • Poor understanding of DL concepts	• Model partially works • Moderate understanding of DL concepts	• Model mostly works • Good understanding of DL concepts	• Model fully works • Excellent understanding of DL concepts
AI Services [10 Marks]				
Innovation and Feasibility	• Application has no real benefits or positive impact • Application has no feasible elements	• Application has minimal benefits or positive impact • Application has a few feasible elements	• Application has moderate benefits or positive impact • Application has some feasible elements	• Application has huge benefits or positive impact • Application has many feasible elements
Application of APIs	• Little understanding on the APIs used • Unable to interface to the APIs	• Partial understanding on the APIs used • Able to interface to some of the APIs	• Good understanding on the APIs used • Able to interface to most of the APIs	• Thorough understanding on the APIs used • Able to interface to all the APIs
Report Structure and Content	• Content is poorly organized and lacking a logical flow of ideas	• Content is partially organized with a logical flow of ideas and some ideas are conveyed	• Content is mostly organized with a logical flow of ideas and most ideas are conveyed	• Content is well organized with a clear and logical flow of ideas and all ideas are clearly conveyed

	• Poor use of language with many grammar and spelling mistakes	• Partial use of language with some grammar and spelling mistakes	• Good use of language with no grammar and spelling mistakes	• Excellent use of language with no grammar and spelling mistakes
Source Codes & Demo [9 Marks]				
Notebooks Structure and Content	• Content is poorly organized • Poor use of Markdown to explain processes • Poor use of comments in codes	• Content is moderately organized • Moderate use of Markdown to explain processes • Moderate use of comments in codes	• Content is mostly organized • Good use of Markdown to explain processes • Good use of comments in codes	• Content is well organized • Excellent use of Markdown to explain processes • Excellent use of comments in codes
Demo	• Content meets less than 50% of the objectives • Poor subject knowledge and understanding of codes	• Content meets 50% to 74% of the objectives • Moderate subject knowledge and understanding of codes	• Content meets 75% to 89% of the objectives • Good subject knowledge and understanding of codes	• Content meets 90% or more of the objectives • Excellent subject knowledge and understanding of codes