ADTA 5550: Deep Learning

Final Project

1. PART I: Use TensorFlow Directly in Coding

* **Question 1.1**: Is the student required to use TensorFlow directly in coding (build, train, and test CNN) in this homework assignment?
* **Question 1.2**: Should the student use Keras in coding (build, train, and test CNN) in this homework assignment?

# PART II: A Dataset of Images or Audio Files (10 Points)

## TO-DO

--) Search on the Internet, using Google search or any other approach, to find a dataset in the public domain, i.e., available for use without restrictions.

--) This dataset may contain either images or audio files.

--) This data of the dataset has already been appropriately labeled and ready for use in deep learning research.

--) The dataset should **not** be one of the datasets that are used in classwork: MNIST, CIFAR-10 (or CIFAR-100).

## SUBMISSION REQUIREMENT #2:

--) Write a report on the dataset that includes (but not limited to) all the critical information of the dataset, e.g., name, official website, links to download, the data (how many items), the data structure of the data contained in the dataset, and so on.

## IMPORTANT NOTES:

*--) Some suggestions for websites to start:*

* *Dataset Search (Google):* [*https://toolbox.google.com/datasetsearch*](https://toolbox.google.com/datasetsearch)
* *Kaggle:* [*https://www.kaggle.com/datasets*](https://www.kaggle.com/datasets)
* *Awesome public datasets:* <https://github.com/awesomedata/awesome-public-datasets>

*--) The student should* ***avoid*** *well-known public datasets like the* ***Image-net*** *(image-net.org) or* ***Fashion- MNIST*** *because they are already so popular.*

# PART III: Obtain CIFAR-10 Dataset (5 Points)

The CIFAR-10 dataset consists of 60000 32x32 color images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

The dataset is divided into five training sub-datasets and one test sub-dataset, each with 10000 images. The test sub-dataset contains exactly 1000 randomly-selected images from each class. The training sub- datasets contain the remaining images in random order, but some training sub-datasets may contain more images from one class than another. Between them, the training datasets contain exactly 5000 images from each class.

The classes are entirely mutually exclusive. There is no overlap between automobiles and trucks. "Automobile" includes sedans, SUVs, things of that sort. "Truck" includes only big trucks. Neither includes pickup trucks.

## TO-DO

--) Access the Canvas module: …/DATA\_SETS

--) Download all the dataset files available there (7 files)

* NOTES: These data files belong to the CIFAR-10 dataset

--) Transfer all the data files of the dataset to the remote virtual machine

* Access the remote virtual machine in GCP using SSH:
* Open the sub-folder **JP\_NTBK** in the remote VM
* Create a new sub-folder under ~/**JP\_NTBK** and name it as “**CIFAR\_10\_DATA**”
* Upload all the data files of the aforementioned dataset, CIFAR-10, from the student’s local computer to the newly-created sub-folder in the remote instance.

## SUBMISSION REQUIREMENTS #3:

--) The report about downloading the data set from Canvas and uploading them to the remote server.

## IMPORTANT NOTES:

*--) The student needs to download the data set from the Canvas module: …/DATA\_SETS, and then upload it to the remote deep learning server*

*--) The steps of how to upload the data file to the remote server are discussed in the document:*

***HOWTO\_upload\_files\_to\_remote\_server\_using\_GCP\_SSH****.pdf (Canvas module: …/SW\_DOCS)*

# PART IV: Build, Train, and Test CNN on CIFAR-10 Dataset (30 Points)

To provide help to students while working on the final project, **the instructor has created a Jupyter Notebook document and provided code to re-arrange the dataset**, **making it similar (**but **not** exactly the same**)** to the MNIST dataset and ready for use in the project**.**

## IMPORTANT NOTES:

*--) The Jupyter Notebook document,* ***DL\_TF\_cnn\_cifar\_10\_final\_project.ipynb****, that the student downloads from Canvas has already contained TensorFlow and Python code.*

*--) The existing code is used to load the data into the project, reshape, and re-arrange it so that the data is ready for use.*

*--) It is recommended that the student should use the provided Jupyter Notebook to start working on the project. However, he/she is* ***welcome to rewrite the existing code*** *as he/she wants.*

## IMPORTANT NOTES:

*--) The Jupyter Notebook document,* ***DL\_TF\_cnn\_cifar\_10\_final\_project.ipynb****, should be* ***uploaded***

*into the folder ~/****JP\_NTBK*** *in the remote server.*

## IMPORTANT NOTES:

*--) The code that is used to build, train, and test the CNN model using the CIFAR-10 dataset should be very similar to that for the MNIST dataset* ***except for*** *only one step: Original input data can be fed directly into the 1st convolution layer, i.e.,* ***no need to reshape*** *it. All other steps should be the same.*

## TO-DO

--) **Design the convolution neural network** used for the project

--) **Build, train,** and **test** the **convolutional neural network** on the **CIFAR-10 dataset using the TensorFlow AI framework** and Python:

* **Train** the network with 5000 (five thousand) steps
* **Test** the network after every 100 steps of training
  + **NOTES*:*** *each time of testing, one data point of the accuracy level can be collected.*

--) After building, training, and testing the model, copy the results of the tests into a section of the project report (**ADTA5550\_final\_project.docx**).

--) Write a report on the results of testing the model (in the same project report file)

## IMPORTANT NOTES:

*--) In the final project, the student is required to use TensorFlow* ***1.xx****,* ***not*** *Keras in building the model.*

## SUBMISSION REQUIREMENTS #4:

The student is required to submit the following work items:

--) The design of the model, including the diagram of the network architecture and the list of the critical information of each layer (in the above project report file)

--) The results of testing the model (in the above project report file).

--) The report on the results of the test (in the above project report file)

--) The Jupyter Notebook document that contains all the code of building, training, and testing the model.

# PART V: Compare Convolutional Neural Network Performance (10 Points)

## TO-DO

In HW 4, when the student runs the code (in a Jupyter Notebook document) to train and test the CNN on the data set MNIST, the accuracy level is printed 50 times (one test for every 100 steps of training).

--) Collect the data (50 data points) of accuracy levels produced by the CNN with the MNIST dataset that the student worked on in HW 4. Let’s name the collected dataset as “ACC\_cnn\_mnist.”

--) Collect the data (50 data points) of accuracy levels produced by the CNN with the CIFAR-10 dataset. Let’s name the collected dataset as “ACC\_cnn\_cifar\_10.”

--) Compare the performance of the two CNN’s that have been used on the datasets – MNIST and CIFAR-10

--) Using critical thinking, write a report on the results of comparing their performance, i.e., the accuracy levels, in which the student is expected to **provide possible reasons** to **explain** the **gap** in the **performance** of the two CNN’s used on these two datasets if such a gap exists.

## SUBMISSION REQUIREMENTS #5:

The student is required to submit a report that includes the following work items:

--) The dataset (50 data points) of accuracy levels produced by the CNN with the MNIST dataset that the student worked on in HW 4.

--) The dataset (50 data points) of accuracy levels produced by the CNN with the CIFAR-10 dataset.

--) The results of comparing these two datasets

--) The explanation of the gap in the performance of the two CNN’s used on these two datasets, if such a gap exists.

# PART VI: Improve Convolutional Neural Network Performance (20 Points)

## TO-DO

--) It is assumed that there is a gap in the performance of the two CNN’s.

--) Based on the student’s observations while working on PART IV, he/she is asked to think of some ways to improve the performance of the CNN that has worse performance.

--) Using critical thinking and the experiences of working with the MNIST dataset, the student proposes some changes to the network or the network training process with which the network performance may be improved.

--) Write a proposal to make changes to improve the CNN performance (in the above project report file)

--) **Make the changes to** the network or the network training process as proposed in coding

--) **Build, train, and test** the **updated convolutional neural network** on the **CIFAR-10** dataset using the TensorFlow AI framework and Python with the proposed changes implemented in **another** Jupyter Notebook document.

--) Write a report on the results of testing the model (in the above project report file)

## IMPORTANT NOTES:

*--) The student’s proposal to make changes to the network or the network training process* ***may*** *or* ***may not*** *result in real improvements in the network performance.*

*--) It is* ***OK*** *if the changes do* ***not*** *improve the performance because this is an experiment – part of the project.*

*--) The most important achievement should be that the student has used what he/she has learned and critical thinking to come up with some reasonable proposals to make changes.*

## SUBMISSION REQUIREMENTS #6:

The student is required to submit the following work items:

--) The proposal to make the changes to improve the CNN performance (in the above project report file)

--) The results of testing the model (in the above project report file)

--) The report on the results of the test (in the above project report file)

--) The updated Jupyter Notebook document that contains all the code of building, training, and testing the updated model, if necessary.

# PART VII: Project Report (20 Points)

## TO-DO

--) Complete the project report (**ADTA5550\_final\_project.docx**)

## SUBMISSION REQUIREMENTS #7:

The student is required to submit the following additional sections to the report:

* (1) Write an introduction section to introduce the project
* (2) Describe what the student has done in the project (in all three parts: IV, V, and VI)
* (3) List all the conclusions that he/she has learned from the results of testing the CNN models in three parts of the projects (PART IV, V, and VI of the Final Project)
* (4) Write a conclusion section to conclude the project report.