# EEL6935 – SPRING 2019 – DEEP LEARNING
# Homework Assignment 3
# Convolutional Neural Networks

**In this assignment, you will learn how to train a convolutional neural network for an image classification problem on a moderate, popular dataset, titled CIFAR-10.**

**Preparation:** We will use the popular CIFAR-10 dataset for this assignment. This dataset consists of 60000 32x32 colored images representing 10 different image classes. The training and testing sets are fixed: there are 50000 training images and 10000 test images with corresponding labels. To prepare for this assignment: first you will need to download the CIFAR-10 dataset which is not included with this homework assignment. The official website for dataset is given below:

http://www.cs.toronto.edu/~kriz/cifar.html

Please use above website to download the original dataset. The code you will prepare should assume that dataset files are located in a sub folder named as "cifar-10-batches-py". Do not change the

**Objective:** We want to classify the test images by training a convolutional neural network using training images and labels.

**Network Definition: The dataset is already normalized and shuffled so no further processing or modification is required.** You need to build a convolutional neural network with the following properties:

- Please notice that the input images are colored which means you will have three channels for the first (input) layer.
- Your network will have 4 hidden layers.
- 1st layer and 2nd layer will be the convolutional layers with 64 filters in each layer using a kernel size of 5x5.
- Activation functions should be chosen as Rectified Linear Units (except the output layer, see below).
- Use max-pooling with a filter size of 2x2 and stride of 2.
- 3rd and 4th layers of your network should be fully connected with 384 and 192 neurons respectively.
- The last layer (output) should consist of 10 neurons for the 10 classes and use softmax activation functions for classification.

If you need a refresher on what these parameters were and how to define them, please refer to our lecture. The recording can be found here:

https://ondemand.usf.edu/Panopto/Pages/Viewer.aspx?id=5eab97e0-d57b-4702-a742-72e871b7b6b0 **(Lecture portion)**

https://ondemand.usf.edu/Panopto/Pages/Viewer.aspx?id=8beeca2e-6bb8-4299-9f4e-90e4e3c63ba8 **(Python demo portion)**

**Goals:**

1 **Print classification accuracy** on the **test set** after your training is done. (Python help: print("Classification accuracy on the test set:"+str(test_accuracy)) )

2 **Plot cross-entropy error curves** on your **training** and **testing** set as a **function of epochs** on the **same figure**. How does the error change on the training set with increasing number of epochs? How does it change on the testing set?

3 **Show** the **coefficients of the first 5 filters** in the **1st** and **2nd convolutional layers** as **images** after training is done, on **a single figure** as **subplots**.

4 **Comment** on **your results** for goals **1**,**2**, and **3**, a few sentences each, in a Markdown cell **at the end of your Jupyter notebook** as the **final cell**. See Figure 1. for how to do that. *Contact TA if you have questions on this.*

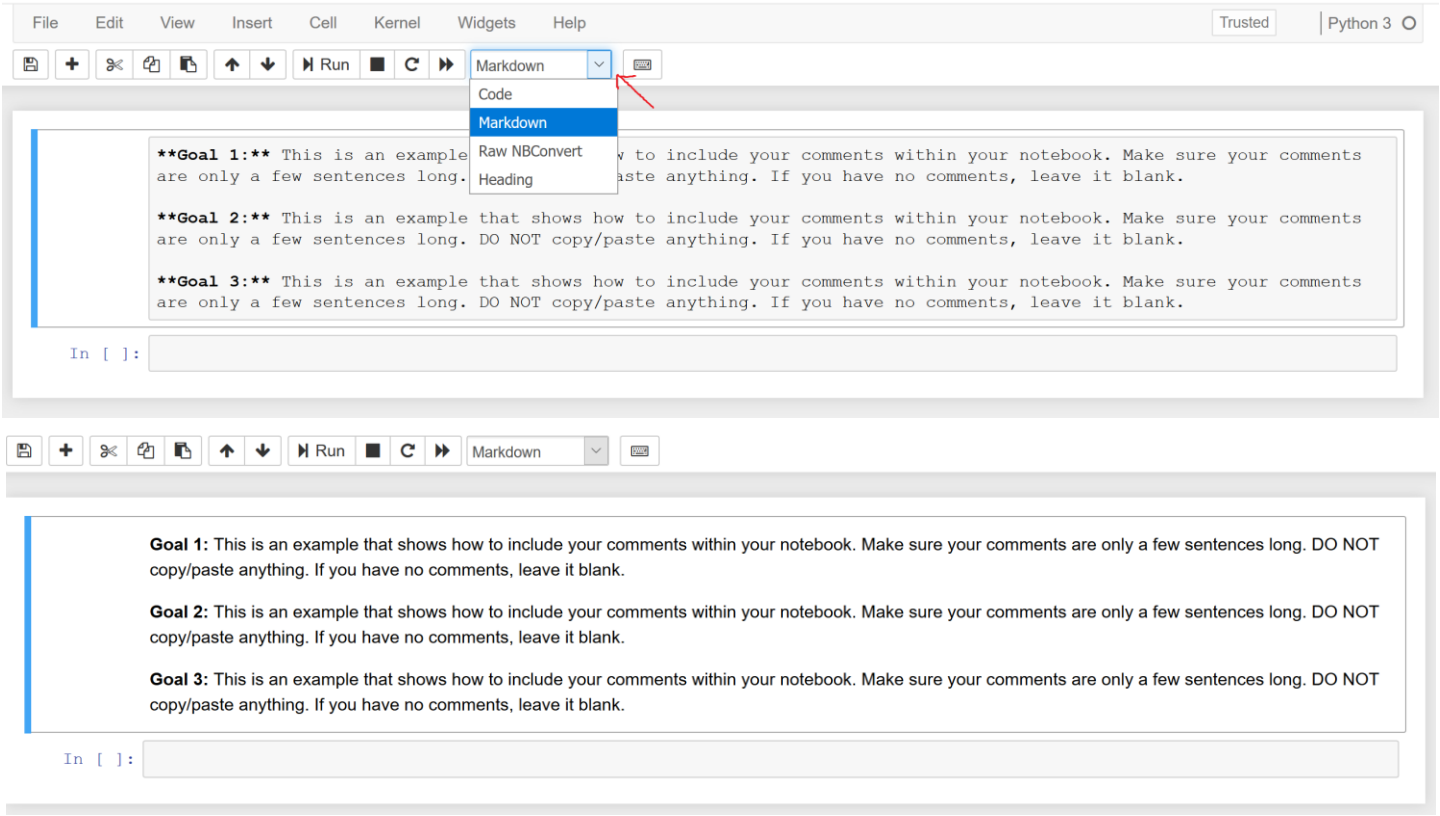


*Figure 1: How to convert a cell to a Markdown cell. (TOP): Before running. (BOTTOM): After running.*

**Deliverables:** This assignment has one deliverable:

1) Your Jupyter notebook which includes all the results, comments, and scripts. Make sure **all your results and comments are clearly visible** and **avoid printing or displaying anything that was not requested in the homework**.

**IMPORTANT INFORMATION:**

Remember what we discussed in class about the HW assignments:

- ⇨ **EXTREMELY IMPORTANT:** You are to submit a **single** Jupyter notebook file, which must include all the results, comments, and scripts. **All your results and comments must be clearly visible and legible.**
- ⇨ Your code should run without modification and produce all the necessary results.
- ⇨ Your code should read dataset files with proper, relative path. That means code and files can only be run if the folder structure is exactly as defined in preparation section: assume that dataset files are located in a sub folder named as **"cifar-10-batches-py".**
- ⇨ Your code and assignment should be saved as follows: last_name_first_initial_hwX.ipynb
    - o **For example, for me it would be: uysal_i_hw4.ipynb**