Final Assessment Report (40 points)

Submission Guidelines:

- The deadline to submit your report is May 31, 2020. The report should be submitted via Google Classroom. You should solve all questions yourself (collaboration is not allowed).
- You must submit two files: 1) pdf file including your writeup. 2) a python code file. Your submissions will be checked using Turnitin.
- Please use your own words when answering the questions. Copy-and-paste is not permitted.
- Please cite all external references using a proper citation method. Failing to do so will affect your grade.
- Please use a word processor such as Word or Latex to prepare your report. Handwriting will not be accepted.
- You should attempt **ALL** questions. Questions should be answered at least partially. Failing to do so will result in an incomplete submission penalty of 25%.

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In all the following questions, you need to cite your references in a proper way

1) (10 points) Object detection is one of the fundamental problems in computer vision. Several neural network architectures have been proposed to enable a fast and accurate detection. These architectures vary in their design, operation, and performance. Write a survey comparing the following three models:
   - FasterR-CNN.
   - YOLO.
   - Single Shot Detector (SSD).

   For each model, discuss:

   - Basic operation.
   - Model architecture highlighting basic building blocks.
   - Model training precedure.
   - Design considerations.
   - Performance on benchmark datasets (if available).
   - Advantages and disadvantages.
2) (7 points) Sequence to sequence models have been applied used successfully in several machine learning tasks such as machine translation, text summarization and video captioning. Illustrate the following concepts in sequence to sequence models highlighting their use and applications
   - Attention mechanisms
   - Transforms
3) (4 points) A useful property in neural networks is that first layers in networks trained for a particular task /dataset can be transferred to another task/dataset. Discuss the concept of transfer learning in neural networks highlighting its benefits and design considerations. (you need to mention your references).
4) (5 points) Discuss the operation of the following optimization algorithms highlighting their advantages and disadvantages (if any)
   a. AdaGrad
   b. RMSProp with Nestrov

c. Adam
d. L-BFGS

5) (14 points) Write a python code to construct a generative adversarial network (GAN) that generate samples similar to the MNIST dataset. Consider the following architectures for the generator and discriminator networks (you may use your own design as well):
   a. A generator network that generates contains
      i. Fully connected hidden layer of 200 neurons with ReLU activation, followed by batch normalization.
      ii. Fully connected hidden layer of 400 neurons with ReLU activation, followed by batch normalization.
      iii. Output layer (linear activation).
   b. A discriminator network that contains
      i. Fully connected hidden layer of 400 neurons, followed by batch normalization.
      ii. Fully connected hidden layer of 200 neurons, followed by batch normalization.
      iii. Output layer (sigmoid activation)

Train the network using a discriminator cross-entropy cost function as below (check lecture slides)

$$J^{(D)}\left(\theta^{(D)},\theta^{(G)}\right) = -\frac{1}{2}\mathbb{E}_{x\sim p_{data}}\log D(x) - \frac{1}{2}\mathbb{E}_{z}\log(1-D(G(z)))$$

a) Using a generator cost function $J^{(G)} = -J^{(D)}$, plot the discriminator loss, generator loss and generated samples. Comment on the results.
b) Using a generator cost function $J^{(G)} = -\frac{1}{2}\mathbb{E}_{z}\log(D(G(z)))$, plot the discriminator loss, generator loss and generated samples. Comment on the results.