ECS767P Emerging Topics in Machine Learning and Computer Vision, 2018

Course Work 2:
Unsupervised Learning by Generative Adversarial Network

1. **What is the difference between supervised learning & unsupervised learning in image classification task? (10% of CW2)**

   In a supervised learning classification task the labels of the training and test images are present, meaning that there is a clear evaluation criteria for the model. An example of this type of machine learning algorithms are logistic regression classifiers for example.
   In an unsupervised learning the labels are not present and this means that an evaluation criteria is less obvious, clustering algorithms for example are an example of unsupervised learning so are generative adverserial networks.

2. **What is the difference between an auto-encoder and a generative adversarial network considering (1) model structure; (2) optimized objective function; (3) training procedure on different components. (10% of CW2)**

   an autoencoder is evaluated and trained on the fidelity of the decoding of the compressed representation of the input space. The measure for optimisation for an autoencoder is some kind of comparative performance metric akin to PSNR or better a perceptual metric of difference between the input images of training set and the decoding of the encoding of the image.. this measures how accurately the lower dimensional feature space compresses the information by measuring how accurately it is decoded.

   For a GAN pits the process is different because a generator network is formulated as a MiniMax game between a generator

and against a discriminator network. The loss of the discriminator network is log proportional to how good the probability of detecting that an original image is drawn (P(x)) and that a fake image is also detected as fake (-log(1-log(Pg(x))). the generator network on the other hand is trained on how well it can fool the discriminator network and hence adjusts its weight using standard backpropagation to optimise a loss function related to log(Pg(x)). the stages between generator and discriminator alternate until the discriminator is ideally unable to discriminate between real input and fake generated images. Some care is taken in the sizes of the batches of images at each stage to ensure convergence.

3. **How is the distribution $p_g(x)$ learned by the generator compared to the real data distribution $p(x)$ when the discriminator cannot tell the difference between these two distributions? (15% of CW2)**

In an infinite capacity network, convergence is guarantedd, the discriminator cannot discriminate between G(x) and X Pd = ½ and p(x) = pg(x)

4. **Show the generated images at 10 epochs, 20 epochs,50 epochs,100 epochs by using the architecture required in Guidance. (15% of CW2)**