ECE523: Engineering Applications of Machine Learning and Data Analytics

I acknowledge that this exam is solely my effort. I have done this work by myself. I have not consulted with others about this exam in any way. I have not received outside aid (outside of my own brain) on this exam. I understand that violation of these rules contradicts the class policy on academic integrity.

Name: _____

Signature: _____

Date: _____

Instructions: There are four problems. You have 50 minutes to complete the exam. Partial credit is given for answers that are partially correct. No credit is given for answers that are wrong or illegible. Write neatly.

Problem 1: _____

Problem 2: _____

Problem 3: _____

Problem 4: _____

Problem 5: _____

Total: _____

Problem #1 – Backpropagation (10 Points)

In class, we discussed the backpropagation algorithm and derived a methodology to be able to update the weights of an artificial neural network. Describe the backpropagation algorithm in some detail. Do not just write the update equation! You should begin by starting out with the objective you're trying to optimize and why we needed to exploit rules from calculus I be able to find these updates.

Problem #1 – Backpropagation (cnt'd)

Problem #2 – Generative Adversarial Networks (10 Points)

Describe what a generative adversarial network is and how they can be used.

Problem #3 – Random Short Answer (10 Points)

(SA:1) Describe the process of learning and testing a random forest on a data set with n samples and p features.

(SA:2) What is an appropriate way to train a deep neural network? The key word in that sentence is "appropriate".

(SA:3) Explain the differences between an adversarial bandit and stochastic bandit. Also, describe the concept of regret.

(SA:4) Explain the difference between backpropagation and backpropagation through time.

Problem #4 – True/False: A Gamblers Ruin (10 Points)

[True/False] (1 point): An ensemble can reduce the variance of the estimated error.

[True/False] (1 point): Passive-aggressive online learning updates a linear model at each time step t regardless if a mistake was made or not.

[True/False] (1 point): The multi-armed bandit addresses problems that require exploration of new arms and exploitation of the ones we know perform well.

[True/False] (1 point): Adversarial bandits are used in stochastic settings where the reward distribution is fixed.

[True/False] (1 point): One of the disadvantages of deep learning with auto-encoders is that we need a large volume of labeled data to train each layer.

[True/False] (1 point): In the context of an adversarial MAB, the term $\gamma \in [0, 1]$ controls the trade-off between the estimated reward of the arm and pure exploration.

$$\widehat{p}_i(t) = (1 - \gamma)\frac{w_i(t)}{\sum_j w_j(t)} + \gamma\frac{1}{K}$$

where K is the number of arms and $w_i(t)$ is the weight of the ith arm at time t.

[True/False] (1 point): A neural network will (likely) find a local minimum for its optimization problem and the same is true for a support vector machine.

[True/False] (1 point): Using a sigmoid activation function in a neural network trained with backpropagation is one way to avoid the vanishing gradient problem.

[True/False] (1 point): A discriminator network, D, after enough training in a GAN will always be able to identify if a sample came from the data set or the generator network, G.

[True/False] (1 point): In backpropagation, the only difference between updating a hidden node versus an output node is how the local gradient is calculated.

Scratch Paper (not graded)