CSE 493 G1/ 599 G1
Deep Learning
Winter 2024 Quiz 1

Jan 19, 2024

Full Name: ____

UW Net ID: ____

Question		Score
True/False	(4 pts)	
Multiple Choice	(8 pts)	
Short Answer	(8 pts)	
Total	(20 pts)	

Welcome to the CSE 493 G1 Quiz 1!

- The exam is 20 min and is **double-sided**.
- No electronic devices are allowed.

I understand and agree to uphold the University of Washington Honor Code during this exam.

Signature: ______________________________ Date: __________________

Good luck!

This page is left blank for scratch work only. DO NOT write your answers here.

1 True / False (4 points) - Recommended 4 Minutes

Fill in the circle next to True or False, or fill in neither. Fill it in completely like this: ●. No explanations are required.

Scoring: Correct answer is worth 1 points.

1.1 KNN parameters only gets updated after the test phase.

◯ True

◯ False

1.2 In a typical train-test-validation split, the training set is used to train the model, the validation set is used for hyperparameter tuning, and the test set is reserved for evaluating the model's performance on unseen data.

◯ True

◯ False

1.3 The softmax function is not differentiable, and we need some adjustments to make it suitable for gradient-based optimization algorithms.

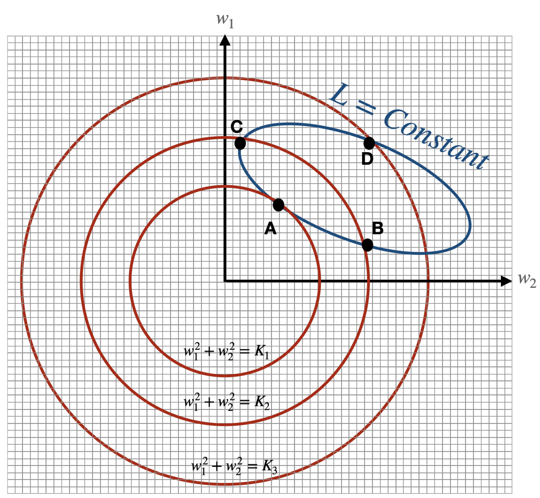
◯ True

◯ False

1.4 Let's consider the Error function as follows: $\mathbf{E} = \mathbf{L} + \mathcal{R}(w)$, where $\mathcal{R}(w)$ represents the L2 regularization term, $\mathbf{L} = \sum_i^N \mathbf{L}_i$ is the data loss, and w is a 2D vector $[w_1, w_2]$. In the provided figure, L is a constant value across the ellipse (We know $\mathbf{L}$ is a function of w). Point D exhibits the lowest Error ($\mathbf{E}$) compared to points A, B, and C.

◯ True

◯ False



2 Multiple Choices (8 points) - Recommended 8 Minutes

Fill in the circle next to the letter(s) of your choice (like this: ●). No explanations are required. **Choose ALL options that apply.**

Each question is worth 4 points and the answer may contain one or more options. Selecting all of the correct options and none of the incorrect options will get full credits. For questions with multiple correct options, each incorrect or missing selection gets a 4-point deduction (up to 4 points).

2.1 Mark the correct statement(s) about loss functions.

$$SVM\ (Hinge)\ loss = \frac{1}{N}\sum_{i}^{N}\sum_{j\neq y_i}\max\left(0, score_j - score_{y_i} + 1\right)$$

$$Cross\ Entropy\ (Softmax)\ loss = -\frac{1}{N}\sum_{i}^{N}\log\left(\frac{e^{score_{y_i}}}{\sum_j e^{score_j}}\right),$$

$$[z_1, z_2, ..., z_d] \rightarrow softmax \rightarrow [\frac{e^{z_1}}{\sum_{j=1}^{d} e^{z_j}}, \frac{e^{z_2}}{\sum_{j=1}^{d} e^{z_j}}, ..., \frac{e^{z_d}}{\sum_{j=1}^{d} e^{z_j}}]$$

- ◯ A: Softmax loss is an extension of hinge loss for handling multiple classes.
- ◯ B: if we add a fixed constant value to all softmax inputs, the softmax outputs or the probabilities do not change.
- ◯ C: Cross-entropy loss is suitable for 2 and more classes classification problems.
- ◯ D: We add regularization term to the loss functions to improve the performance on the train and test data.
- ◯ E: Let assume the output scores for sample i is $[20, -10, -10, -20]$ and the index of its ground truth label is 0. Both the softmax loss and hinge loss for this sample is 0.

2.2 Mark the true statement(s) about optimization.

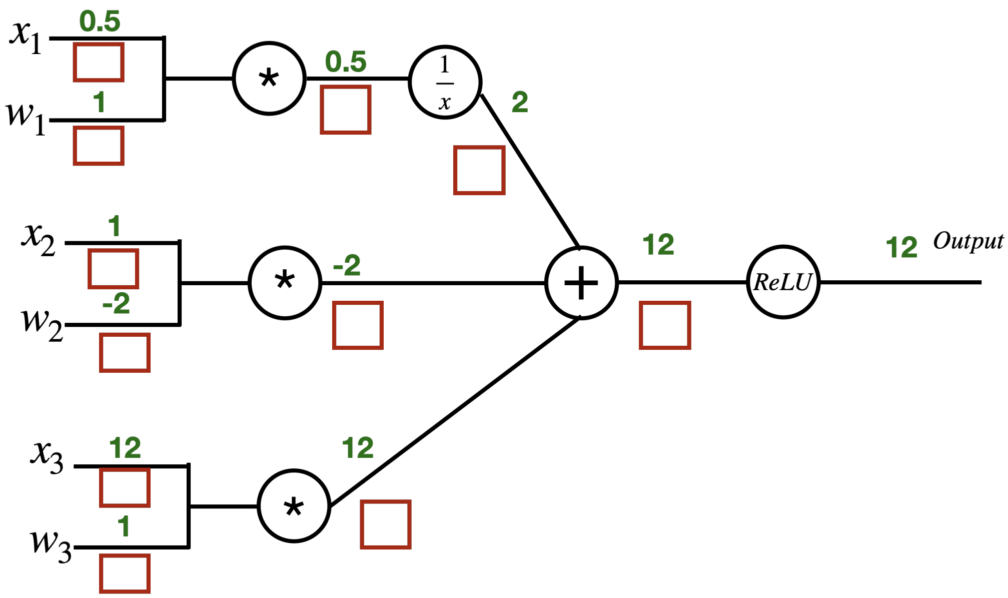
- ◯ A: Given the loss function $L(w) = w^2$ (w is 1D), and initializing w with $w = 1$, and step size of 1, the optimization process will converge, bringing w to the global minimum of the function.
- ◯ B: Given the loss function $L(w) = w^2$ (w is 1D), and initializing w with $w = 100$, and step size of 0.9, the optimization process will converge, bringing w to the global minimum of the function
- ◯ C: Gradient descent is always better than stochastic gradient descent.
- ◯ D: Gradient descent only works when neural networks have non-linear layers.

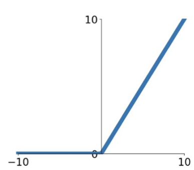
3 Short Answers (8 points) - Recommended 8 Minutes

Please make sure to write your answer only in the provided space.

3.1 Back Propagation (8 points)

1. (4 points) In the following computational graph, the activations for the forward pass have been filled out (numbers above the connections). Please fill out the gradients up to inputs (x_is) and weights (w_is).





ReLU

2. (4 points) After computing gradients in 3.1, use them to update w_1, w_2, w_3 with step size (learning rate) of 0.1. Then with the new weights, do the forward pass again and calculate the *output*. (** DONT change x_1, x_2, x_3)

   (a) $w1 =$

   (b) $w2 =$

   (c) $w3 =$

   (d) $output =$