ECE 421 Programming Assignment Question
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Part 1B Questions

1. Parameter tol is the stopping criterion, if it is not none, it will stop training iterations when (loss > previous_loss – tol) to prevent overfitting.

2. Setting max_iter = 5000 and tol = 1e-3 does not guarantee the algorithm will pass over the training data 5000 times since whenever tol exceeds 1e-3, training iteration will stop. We could set n_iter_no_change = 5000 to ensure that the algorithm will pass over the training data 5000 times since this is the number of iterations with zero improvement.

3. We could use the class_weight parameter to set the weights of the model to certain value.

4. NumPy Implementation Confusion Matrix

		Predicted	
Label		-1	+1
	-1	9	2
	+1	0	9

$$NumPy\ Accuracy = \frac{9+9}{9+9+2} = 90\%$$

Scikit-learn Library Confusion Matrix.

		Predicted	
Label		-1	+1
	-1	9	0
	+1	0	11

$$Scikit - Learn\ Accuracy = \frac{9+11}{9+11} = 100\%$$

Scikit-learn library resulted in 100% accuracy, while our Numpy implementation only resulted in 90% accuracy, which is also very good.

Part 2A Questions

1. The matrix input from function subtestFn() is,

$$X_{train} = \begin{bmatrix} 1 & 2 \\ 2 & 4 \\ 3 & 6 \\ 4 & 8 \end{bmatrix}$$

Its transpose is,

$$X_{train}{}^{T} = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \end{bmatrix}$$

The matrix multiplication of X_train with its own transpose is,

$$X_{train} * X_{train}{}^{T} = \begin{bmatrix} 1 & 2 \\ 2 & 4 \\ 3 & 6 \\ 4 & 8 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \end{bmatrix} = \begin{bmatrix} 11 & 14 & 17 & 20 \\ 22 & 28 & 34 & 40 \\ 33 & 42 & 51 & 60 \\ 44 & 56 & 68 & 80 \end{bmatrix}$$

If this square matrix has determinant of zero, then it is a singular matrix,

$$det \begin{bmatrix} 11 & 14 & 17 & 20 \\ 22 & 28 & 34 & 40 \\ 33 & 42 & 51 & 60 \\ 44 & 56 & 68 & 80 \end{bmatrix} = 0$$

Thus, indeed the input to the function linalg.inv is a singular matrix according to its defination.

2. The function subtestFn() printed “ERROR” in the terminal.

3. Linalg.inv compute the multiplicative inverse of a matrix and it is computed by finding another matrix (avin) that satisfy the following equation.

$$dot(a, ainv) = dot(ainv, a) = eye(a.shape[0])$$

Linalg.pinv compute the Moore-Penrose pseudo-inverse of a matrix and it is computed using singular value decomposition (SVD) and including all large singular values.

The model’s weight is the following,

$$w = [-6.661 \times 10^{-16} \quad 2 \times 10^{-1} \quad 4 \times 10^{-1}]$$