Introduction to Machine Learning (Spring 2019)

Homework #2 (40 Pts, April 29)

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Instruction: We provide all codes and datasets in Python. Please write your code to complete the softmax classifier. Compress 'models/SoftmaxClassifier.py' and submit with the filename 'HW2_STUDENT_ID.zip'.

(1) [20 pts] Implement five functions in 'models/SoftmaxClassifier.py'. ('train', 'eval', 'softmax_loss', 'compute_grad' and '_softmax' respectively). Copy 'optim/Optimizer.py' from the previous assignment if you have implemented.

```
<func train>
        for i in np.arange(0, num_data, batch_size):
            batch_x = x[i:i + batch_size]
            batch_y = y[i:i + batch_size]
            score = batch_x.dot(self.W)
            prob = self._softmax(score)
            batch_losses.append(self.softmax_loss(prob, batch_y))
            grad = self.compute_grad(batch_x, self.W, prob, batch_y)
            self.W = optimizer.update(self.W, grad, lr)

<func eval>
        score = x.dot(self.W)
        pred = np.argmax(score , 1)

<func softmax_loss>
        N = prob.shape[0]
        softmax_loss = -np.log(prob[range(N), label])
       softmax_loss = np.sum(softmax_loss)/N

<func compute_grad>
        dprob = prob
        N = x.shape[0]
        dprob[range(N), label] -= 1
        grad_weight = np.dot(x.T, dprob) / N

<func _softmax>
        ex = np.exp(x - x.max(1, keepdims=True))
        softmax = ex /np.reshape(np.sum(ex, axis=1), (-1, 1))
```

(2) [20 pts] Writre your experimental results.

(a) For 'Iris' and 'Digit' dataset, adjust the number of training epochs and learning rate to maximize accuracy. Report your best results for each optimizer.
(Batch size = 10 for Iris & 256 for Digit, epsilon = 0.01, gamma = 0.9)

Dataset	Optimizer	# of epochs	Learning rate	Acc.
Iris	SGD	500	0.05	1
	Momentum	500	0.05	1
	RMSprop	500	0.05	1
Digit	SGD	50	0.00001	0.92
	Momentum	50	0.00001	0.90
	RMSprop	50	0.00001	0.92

(b) For ‘Digit’ dataset, execute the softmax classifier with a given parameter setting. Using the code provided in ‘main.py’, show 10 sample images for true labels and corresponding predicted labels. (Set the variable ‘show_plot’ as ‘True’ to show sample images.).

Parameter Settings	
Batch size	256
Learning rate	0.00001
Optimizer	RMSProp
Epsilon	0.01
Gamma	0.9
# of Epochs	50