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Problem Sheet 3

Important for applications: Please note that in the first two problems we use image pixels as features. This is for simplicity, for getting familiar with the concepts, for getting in contact with larger problem sizes, but not for getting best classification results (as you will hopefully see.) We note that kNN and linear classifiers get better classification performance when choosing more suitable features (as done in the third problem).

Problem 1 (First week)
k nearest neighbor classifier. To test your implementation download the CIFAR 10 dataset from `https://www.cs.toronto.edu/~kriz/cifar.html`.

a) Implement the k nearest neigbor classifier.

b) Use cross-validation for the hyperparameter k on the CIFAR 10 dataset.

c) Run your model on the test part of the CIFAR 10 dataset and report the accuracy.

(*Hint.* If computation times are too long for development, reduce the problem sizes.)

Problem 2
Softmax classifier. We again use the image pixels as features in this problem. (Don't forget to preprocess your data by subtracting the mean image. Convince yourself that you may only use the training data to compute the mean image. Then subtract this mean image from all data.)

a) Implement the softmax classifier. For training, use batch gradient descent (together with basic backpropagation.)

b) Train the model on the CIFAR 10 data set. (Don't forget to preprocess your data.) Report loss values during backpropagation. (As a hint, use logarithmic scales for the learning rates such as 10^{-7}, 10^{-6}, $10^{-5}, \ldots$ and regularization strengths of $10^5, 10^4, 10^3, \ldots$ when tuning your hyperparameters.)

c) Run your model on the test part of the CIFAR 10 dataset and report the accuracy.

Problem 3

Classifiers on pre-selected features. Instead of using image pixels as features we here use the histogram of oriented gradients (HOG) as well as a color histogram using the hue channel in HSV color space. The feature vector consists of concatenating the HOG and color histogram feature vectors.

a) Implement the feature computation (For computing the HOG and the color histogram you may use libraries).

b) Train a k nearest neighbor classifier on the features using the CIFAR 10 dataset. (Don't forget to preprocess your data.)

c) Train a softmax classifier on the features using the CIFAR 10 dataset. (Don't forget to preprocess your data.)

d) Run your models on the test part of the CIFAR 10 dataset and report the accuracy.