1 K-Nearest neighbors classifier

1.1 The implementation of KNN

• First, calculate the euclidean distance between each test data and each of the other training data

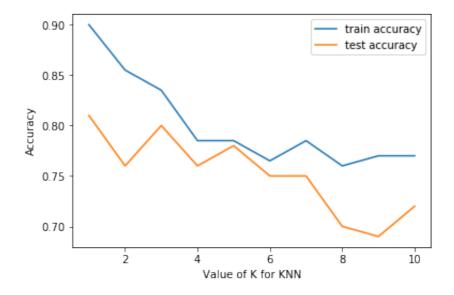
```
def compute_distances(self, X):
num_test = X.shape[0]
num_train = self.X_train.shape[0]
x2 = np.sum(X ** 2, axis=1).reshape((num_test, 1))
y2 = np.sum(self.X_train ** 2, axis=1).reshape((1, num_train))
xy = -2 * np.matmul(X, self.X_train.T)
dists = np.sqrt(x2 + xy + y2)
# print(dists)
return dists
```

• Second, enter the distance matrix of the test data and the training data to predict the category of each test data.

```
def predict_labels(self, dists, k=1):
num_test = dists.shape[0]
y_pred = np.zeros(num_test, dtype=int)
for i in range(num_test):
    closest_x = np.argsort(dists[i])[:k]
    closest_y = [self.y_train[val] for val in closest_x]
    labels, counts = np.unique(closest_y, return_counts=True)
    y_pred[i] = labels[np.argmax(counts)]
return y_pred
```

1.2 Explanation of results

Try different K values to predict the data, the results are as follows:



It can be seen from the above picture that as the value of K increases, the accuracy decreases. When K=1, the accuracy is the highest; when K=10, the accuracy is the smallest.

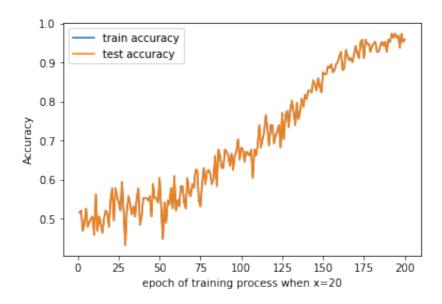
2 Convolutional neural network classifier

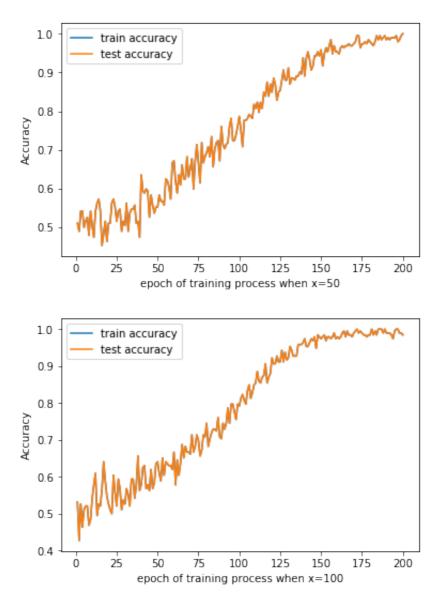
TensorFlow is used here to implement the LeNet network, with different hidden layers size (20, 50, 100) in the fully connected layer.

2.1 LeNet's network structure

 $Input \rightarrow Layer \ 1 \rightarrow ReLu \rightarrow Pooling \rightarrow Layer \ 2 \rightarrow ReLu \rightarrow Pooling \rightarrow FC1 \rightarrow ReLu \rightarrow FC2 \rightarrow ReLu \rightarrow FC3 \rightarrow Yhat (using Softmax)$

2.2 The different training results





You may not see the different X training effects from the above picture, but you can see from the table in the next section that there may be over-fitting when X is larger.

3 Accuracy for Classifiers

Classifier	Training Accuracy	Testing Accuracy
K-NN(k=1)	0.9	0.81
K-NN(k=2)	0.855	0.76
K-NN(k=3)	0.835	0.8
K-NN(k=4)	0.785	0.76
K-NN(k=5)	0.785	0.78
K-NN(k=6)	0.765	0.78
K-NN(k=7)	0.785	0.75
K-NN(k=8)	0.76	0.7
K-NN(k=9)	0.77	0.69
K-NN(k=10)	0.77	0.72
CNN(x=20)	0.975	0.94
CNN(x=50)	0.99	0.9
CNN(x=100)	0.98	0.94