[1]
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.manifold import TSNE
import time
import matplotlib.pyplot as plt
plt.style.use('seaborn-whitegrid')
%matplotlib inline
```

[23]
```
def accuracy_score(matrix):
    tp_sum = 0
    score = 0
    np.array(matrix)
    for i in range(len(matrix)):
        tp_sum += matrix[i][i]

    score = tp_sum / np.sum(matrix)
    return score

def knn(train_data, test_data, train_label, test_label):
    errors = []
    scores = []
    for i in range(5,51,5):
        start_time = time.time()
        knn_e = KNeighborsClassifier(n_neighbors=i)
        knn_e.fit(train_data, train_label)
        pred_label = knn_e.predict(test_data)
        end_time = time.time()
        errors.append(np.mean(pred_label != test_label)) # storing mean-e

        print("=====================================================")
        print("\nReport using k=", i, ":\n")
        print(classification_report(test_label, pred_label))
        matrix = confusion_matrix(test_label, pred_label)
        accuracy = accuracy_score(matrix)*100
        print("\nAccuracy score: ", "%.2f" % accuracy, "%","    Execution
        print("=====================================================")
        scores.append("%.2f" % accuracy)

    plt.plot(range(5,51,5), scores, color='green', linestyle='dashed', ma
    plt.xticks(np.arange(0, 56, step=5))
    plt.yticks(np.arange(90, 95.2, step=0.2))
    plt.xlabel("value of k")
    plt.ylabel("accuracy")
    plt.show()
```

[3]
```
data = pd.read_csv("mnist_test.csv")
```

[4]
```
data.head(5)
```

	label	1x1	1x2	1x3	1x4	1x5	1x6	1x7	1x8	1x9
0	7	0	0	0	0	0	0	0	0	0
1	2	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	0	0	0	0	0	0	0	0	0

5 rows × 785 columns

[5]
```
features = data.drop("label", axis=1)
labels = data.iloc[:,0]
```

[6]
```
# Converting data into int64 to float64
features = features.astype('float64') #
```

[7]
```
# Objects for data optimization
m_scale = MinMaxScaler()
s_scale = StandardScaler()
e_data = TSNE(n_components=2, perplexity=30, random_state=100)
```

[8]
```
# Optimizing data
m_scale_optimized_data = m_scale.fit_transform(features)
s_scale_optimized_data = s_scale.fit_transform(features)
embeded_data = e_data.fit_transform(features)
```

[9]
```
# Optimizing embeded data
m_scale_embeded_data = m_scale.fit_transform(embeded_data)
s_scale_embeded_data = s_scale.fit_transform(embeded_data)
```

[10]
```
# Spliting data into training and test data
r_train_data, r_test_data, r_train_label, r_test_label = train_test_split
m_train_data, m_test_data, m_train_label, m_test_label = train_test_split
s_train_data, s_test_data, s_train_label, s_test_label = train_test_split
e_train_data, e_test_data, e_train_label, e_test_label = train_test_split
```

[11]
```
# Spliting optimized embeded data into training and test data
me_train_data, me_test_data, me_train_label, me_test_label = train_test_s
se_train_data, se_test_data, se_train_label, se_test_label = train_test_s
```

kNN with raw data

[24]
```
knn(r_train_data, r_test_data, r_train_label, r_test_label)
```

```
=====================================================

Report using k= 5 :

              precision    recall  f1-score   support

           0       0.95      0.99      0.97       302
           1       0.90      1.00      0.94       355
           2       0.98      0.93      0.95       284
           3       0.95      0.96      0.96       297
           4       0.97      0.90      0.93       302
           5       0.95      0.92      0.93       262
           6       0.98      0.97      0.98       302
           7       0.95      0.94      0.95       323
           8       0.98      0.91      0.94       278
           9       0.90      0.93      0.91       295

   micro avg       0.95      0.95      0.95      3000
   macro avg       0.95      0.95      0.95      3000
weighted avg       0.95      0.95      0.95      3000


Accuracy score:  94.77 %     Execution time:  50.491 s
=====================================================
=====================================================

Report using k= 10 :

              precision    recall  f1-score   support

           0       0.93      0.99      0.96       302
           1       0.87      1.00      0.93       355
           2       0.98      0.90      0.94       284
```

kNN with min-max optimized raw data

[25]
```
knn(m_train_data, m_test_data, m_train_label, m_test_label)
```

```
====================================================

Report using k= 5 :

              precision    recall  f1-score   support

           0       0.96      0.99      0.97       273
           1       0.89      0.99      0.94       344
           2       0.98      0.89      0.93       307
           3       0.94      0.95      0.95       310
           4       0.94      0.92      0.93       297
           5       0.95      0.92      0.94       262
           6       0.95      0.97      0.96       269
           7       0.93      0.94      0.94       308
           8       0.97      0.92      0.95       302
           9       0.94      0.93      0.93       328

   micro avg       0.94      0.94      0.94      3000
   macro avg       0.95      0.94      0.94      3000
weighted avg       0.94      0.94      0.94      3000


Accuracy score:  94.30 %     Execution time:  38.923 s
====================================================
====================================================

Report using k= 10 :

              precision    recall  f1-score   support

           0       0.95      0.99      0.97       273
           1       0.87      0.99      0.93       344
           2       0.98      0.88      0.93       307
```

kNN with standard scaler optimized raw data

[26]
```
knn(s_train_data, s_test_data, s_train_label, s_test_label)
```

```
====================================================

Report using k= 5 :

              precision    recall  f1-score   support

           0       0.93      0.98      0.95       316
           1       0.90      0.99      0.94       339
           2       0.93      0.88      0.91       304
           3       0.88      0.96      0.91       294
           4       0.89      0.91      0.90       294
           5       0.92      0.88      0.90       284
```

```
           6       0.95      0.94      0.94       279
           7       0.90      0.92      0.91       277
           8       0.96      0.81      0.88       297
           9       0.90      0.86      0.88       316

   micro avg       0.91      0.91      0.91      3000
   macro avg       0.92      0.91      0.91      3000
weighted avg       0.91      0.91      0.91      3000


Accuracy score:  91.37 %     Execution time:  47.251 s
====================================================
====================================================

Report using k= 10 :

              precision    recall  f1-score   support

           0       0.92      0.98      0.95       316
           1       0.86      0.99      0.92       339
```

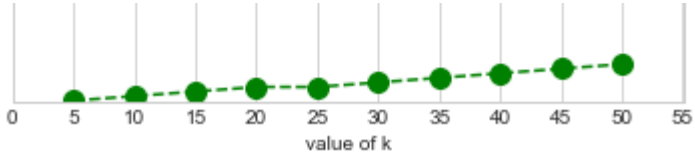
kNN with embeded data

```
[27]  knn(e_train_data, e_test_data, e_train_label, e_test_label)
```

```
           0       0.98      0.97      0.97       293
           1       0.95      1.00      0.97       339
           2       0.98      0.94      0.96       296
           3       0.94      0.95      0.95       317
           4       0.95      0.91      0.93       301
           5       0.91      0.93      0.92       265
           6       0.95      0.98      0.97       289
           7       0.93      0.94      0.94       298
           8       0.94      0.90      0.92       295
           9       0.92      0.91      0.92       307

   micro avg       0.94      0.94      0.94      3000
   macro avg       0.94      0.94      0.94      3000
weighted avg       0.94      0.94      0.94      3000


Accuracy score:  94.47 %     Execution time:  0.113 s
====================================================
```



kNN with min-max optimized embeded data

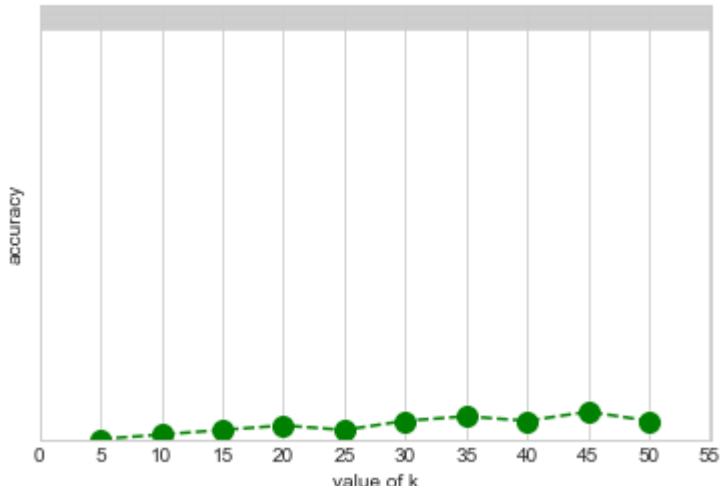
[28] `knn(me_train_data, me_test_data, me_train_label, me_test_label)`

```
              precision    recall  f1-score   support

           0       0.97      0.98      0.97       312
           1       0.92      1.00      0.96       346
           2       0.98      0.90      0.94       294
           3       0.95      0.93      0.94       329
           4       0.93      0.92      0.93       295
           5       0.93      0.93      0.93       274
           6       0.96      0.97      0.97       274
           7       0.93      0.94      0.94       300
           8       0.95      0.93      0.94       296
           9       0.93      0.94      0.93       280

   micro avg       0.94      0.94      0.94      3000
   macro avg       0.95      0.94      0.94      3000
weighted avg       0.95      0.94      0.94      3000


Accuracy score:  94.47 %     Execution time:  0.098 s
======================================================
```



kNN with standard scaler optimized embeded data

[29] `knn(se_train_data, se_test_data, se_train_label, se_test_label)`

1	0.92	1.00	0.96	362
2	0.99	0.93	0.96	297
3	0.93	0.94	0.93	305
4	0.97	0.92	0.94	314
5	0.92	0.90	0.91	263
6	0.95	1.00	0.98	275
7	0.94	0.93	0.94	311
8	0.94	0.90	0.92	301
9	0.92	0.93	0.92	284
micro avg	0.94	0.94	0.94	3000
macro avg	0.94	0.94	0.94	3000
weighted avg	0.94	0.94	0.94	3000

Accuracy score: 94.40 %   Execution time: 0.092 s

==========

==========

Report using k= 50 :

	precision	recall	f1-score	support
0	0.97	0.98	0.97	288
1	0.92	1.00	0.96	362
2	0.99	0.93	0.96	297
3	0.93	0.94	0.93	305
4	0.97	0.92	0.94	314
5	0.92	0.90	0.91	263
6	0.95	1.00	0.98	275
7	0.94	0.93	0.94	311
8	0.94	0.90	0.92	301
9	0.92	0.93	0.92	284