5318_ass2_2 (1)

May 22, 2022

bind colab with google cloud drive

[1]:
```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Mounted at /content/gdrive
```

import necessary functions and packages

[2]:
```
import numpy as np
import csv
import pandas as pd
from sklearn.model_selection import train_test_split
import os
from sklearn import model_selection
from sklearn import tree
from sklearn import metrics
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import normalize
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
```

print file names in gdrive

[3]:
```
file_path="/content/gdrive/My Drive/datasets"
file_names=os.listdir(file_path)
print(file_names)
```

```
['emnist-byclass-train.csv', 'emnist-byclass-test.csv']
```

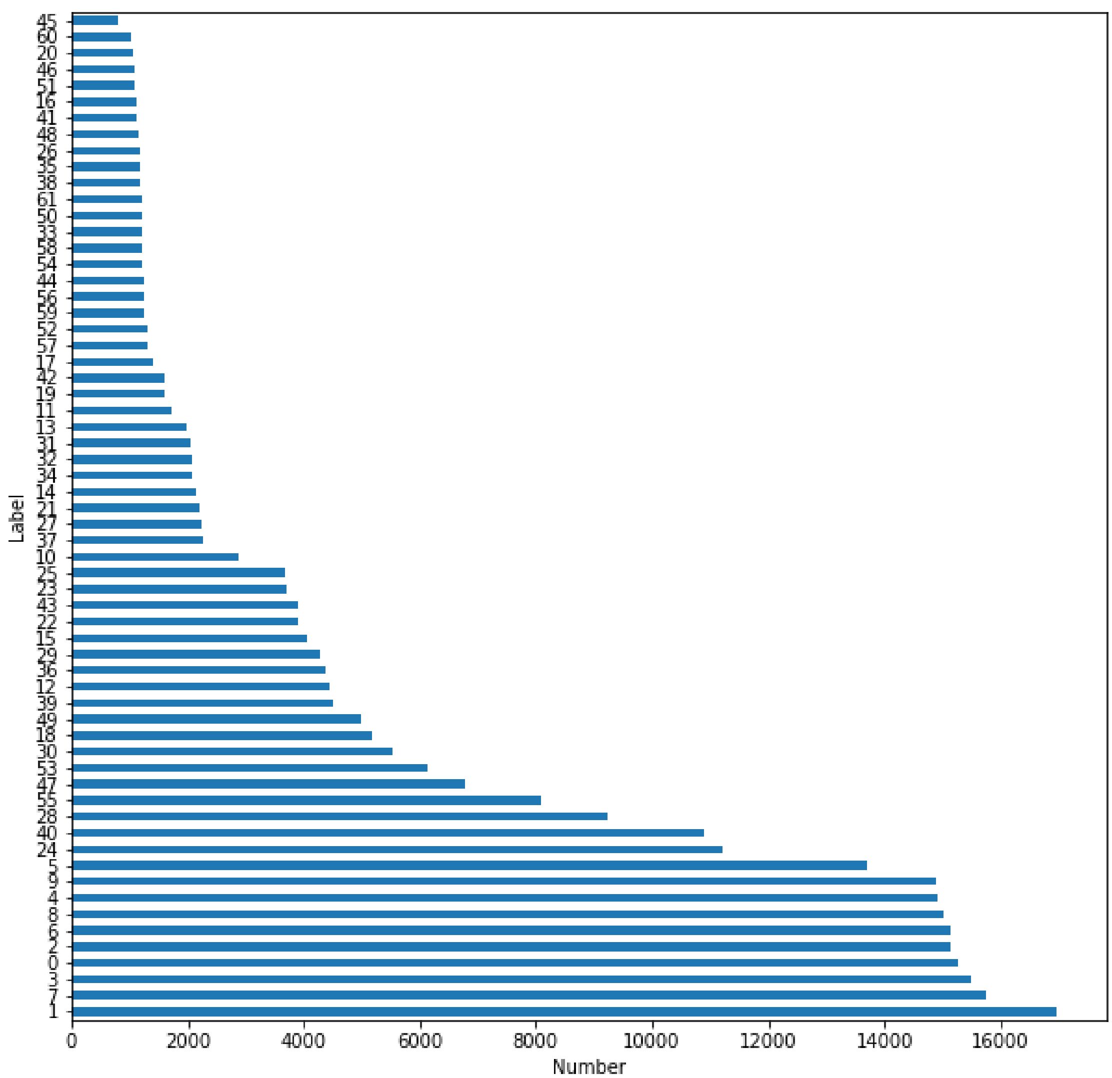
import the train and test dataset

[4]:
```
train_pd = pd.read_csv('/content/gdrive/My Drive/datasets/emnist-byclass-train.csv',delimiter=",", nrows=308016,header=None)
test_pd = pd.read_csv('/content/gdrive/My Drive/datasets/emnist-byclass-test.csv',delimiter=",", nrows=70000, header=None)
```

show the numbers of each label

[5]:
```
train_pd.iloc[:,0].value_counts().plot(kind='barh',figsize=(10,10))
plt.xlabel('Number')
plt.ylabel('Label')
```

[5]:
```
Text(0, 0.5, 'Label')
```



select features and labels from train and test dataset

[6]:
```
data_train_feature = train_pd.loc[:, "1":"784"].to_numpy()
data_train_label = train_pd.iloc[:, 0].to_numpy()
data_test_feature = test_pd.loc[:, "1":"784"].to_numpy()
data_test_label = test_pd.iloc[:, 0].to_numpy()
```

show the shape of each dataset

[7]:
```
print(data_train_feature.shape,
data_train_label.shape,
data_test_feature.shape,
data_test_label.shape)
```

```
(308016, 784) (308016,) (70000, 784) (70000,)
```

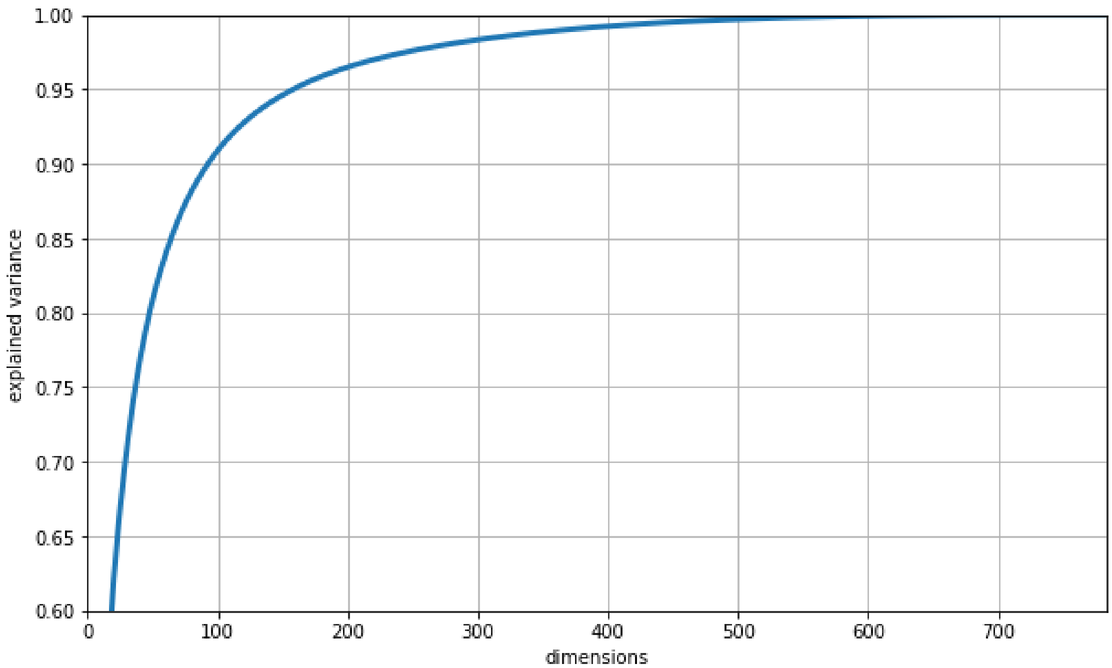
normalisation and standardisation for the feature in train and test dataset

[8]:
```
%%time
data_train_standerd_1= StandardScaler().fit_transform(data_train_feature)
train_normal_1 = normalize(data_train_standerd_1)

data_test_standerd_1= StandardScaler().fit_transform(data_test_feature)
test_normal_1 = normalize(data_test_standerd_1)
```

```
CPU times: user 6.41 s, sys: 893 ms, total: 7.3 s
Wall time: 7.25 s
```

principle component analysis

[9]:
```
pca = PCA()
pca.fit(train_normal_1)
cumsum = np.cumsum(pca.explained_variance_ratio_)

plt.figure(figsize=(10,6))
plt.plot(cumsum, linewidth = 3)
plt.axis([0, 784, 0.6, 1])
plt.xlabel("dimensions")
plt.ylabel("explained variance")
plt.grid(True)
plt.show()
```



choose minimal 90% of the principal components

[10]:
```
pca = PCA(n_components=100)
train_normal_11 = pca.fit_transform(train_normal_1)
test_normal_11 = pca.fit_transform(test_normal_1)
```

hyperparameter turning for SVM

As there are too much data in our dataset, it is hard to turn the hyperparameter for one time. The first block below shows the results of (C=1, gamma=1), (C=1, gamma=3) and (C=3, gamma=1). The second block below shows the results of C=3, gamma=3. We think there is no influence for us to get the best hyperparameter. Based on the scores in the grid search, we can get the conclusion that C=3 and gamma=1 are the best hyperparameter for SVM model.

[ ]:
```
%%time

param_grid={'C': [1,3],'gamma' : [1,3]}
grid_search = GridSearchCV(SVC(), param_grid, cv=2, verbose=3)
grid_search.fit(train_normal_11, data_train_label)


print("Best parameters: {}".format(grid_search.best_params_))
print("Best cross-validation score: {:.4f}".format(grid_search.best_score_))
print("Best estimator:\n{}".format(grid_search.best_estimator_))
```

```
Fitting 2 folds for each of 4 candidates, totalling 8 fits
[CV 1/2] END …C=1, gamma=1;, score=0.827 total time=65.1min
```

```
[CV 2/2] END …C=1, gamma=1;, score=0.828 total time=65.1min
[CV 1/2] END …C=1, gamma=3;, score=0.829 total time=98.6min
[CV 2/2] END …C=1, gamma=3;, score=0.830 total time=97.9min
[CV 1/2] END …C=3, gamma=1;, score=0.836 total time=61.1min
[CV 2/2] END …C=3, gamma=1;, score=0.837 total time=62.2min
```

[12]:
```
%%time

param_grid={'C': [3],'gamma' : [3]}
grid_search = GridSearchCV(SVC(), param_grid, cv=2, verbose=3)
grid_search.fit(train_normal_11, data_train_label)


print("Best parameters: {}".format(grid_search.best_params_))
print("Best cross-validation score: {:.4f}".format(grid_search.best_score_))
print("Best estimator:\n{}".format(grid_search.best_estimator_))
```

```
Fitting 2 folds for each of 1 candidates, totalling 2 fits
[CV 1/2] END …C=3, gamma=3;, score=0.828 total time=89.3min
[CV 2/2] END …C=3, gamma=3;, score=0.830 total time=87.6min
Best parameters: {'C': 3, 'gamma': 3}
Best cross-validation score: 0.8293
Best estimator:
SVC(C=3, gamma=3)
CPU times: user 4h 32min 29s, sys: 29 s, total: 4h 32min 58s
Wall time: 4h 31min 49s
```

Hyperparameter turning for random forest

[ ]:
```
%%time

param_grid={'n_estimators': [100, 200, 300]}
grid_search = GridSearchCV(RandomForestClassifier(n_jobs =-1), param_grid,␣
↪cv=2, verbose=3)
grid_search.fit(train_normal_11, data_train_label)


print("Best parameters: {}".format(grid_search.best_params_))
print("Best cross-validation score: {:.4f}".format(grid_search.best_score_))
print("Best estimator:\n{}".format(grid_search.best_estimator_))
```

```
Fitting 2 folds for each of 3 candidates, totalling 6 fits
[CV 1/2] END …n_estimators=100;, score=0.749 total time= 1.3min
[CV 2/2] END …n_estimators=100;, score=0.750 total time= 1.3min
[CV 1/2] END …n_estimators=200;, score=0.755 total time= 2.6min
[CV 2/2] END …n_estimators=200;, score=0.755 total time= 2.6min
[CV 1/2] END …n_estimators=300;, score=0.757 total time= 3.8min
[CV 2/2] END …n_estimators=300;, score=0.758 total time= 3.8min
```

```
Best parameters: {'n_estimators': 300}
Best cross-validation score: 0.7573
Best estimator:
RandomForestClassifier(n_estimators=300, n_jobs=-1)
CPU times: user 1h 9min 51s, sys: 47.1 s, total: 1h 10min 38s
Wall time: 23min 41s
```

the best model of support vector machine

[11]:
```
%%time

svc_classifier = SVC(C=3, gamma=1, verbose=3)
svc_classifier.fit(train_normal_11 , data_train_label)
y_pred_svc = svc_classifier.predict(test_normal_11)
print("Accuracy on test set y: {:.5f}".format(accuracy_score(data_test_label,␣
 ↪y_pred_svc)))
accuracy_SVM = accuracy_score(data_test_label, y_pred_svc)
print(classification_report(data_test_label, y_pred_svc))
```

```
[LibSVM]Accuracy on test set y: 0.37684
              precision    recall  f1-score   support

           0       0.51      0.61      0.56      3461
           1       0.55      0.46      0.50      3860
           2       0.17      0.25      0.20      3559
           3       0.48      0.68      0.56      3577
           4       0.30      0.35      0.32      3411
           5       0.23      0.23      0.23      3115
           6       0.74      0.77      0.75      3426
           7       0.66      0.63      0.64      3768
           8       0.39      0.56      0.46      3375
           9       0.51      0.43      0.47      3390
          10       0.26      0.44      0.33       647
          11       0.19      0.17      0.18       395
          12       0.30      0.28      0.29      1080
          13       0.25      0.20      0.22       446
          14       0.08      0.11      0.09       521
          15       0.10      0.18      0.13       874
          16       0.34      0.44      0.38       254
          17       0.33      0.21      0.26       331
          18       0.32      0.09      0.14      1237
          19       0.20      0.25      0.22       391
          20       0.03      0.03      0.03       232
          21       0.07      0.03      0.04       476
          22       0.59      0.75      0.66       872
          23       0.19      0.26      0.22       804
          24       0.50      0.35      0.41      2470
          25       0.33      0.14      0.20       828
```

```
          26       0.19      0.32      0.24       257
          27       0.14      0.31      0.20       493
          28       0.42      0.37      0.40      2099
          29       0.37      0.26      0.31       965
          30       0.20      0.12      0.15      1209
          31       0.30      0.29      0.30       489
          32       0.34      0.28      0.31       467
          33       0.12      0.14      0.13       266
          34       0.18      0.16      0.17       462
          35       0.01      0.01      0.01       274
          36       0.15      0.27      0.19       955
          37       0.29      0.32      0.31       505
          38       0.20      0.00      0.01       243
          39       0.12      0.09      0.10      1036
          40       0.56      0.48      0.52      2462
          41       0.12      0.03      0.05       259
          42       0.08      0.16      0.11       375
          43       0.56      0.34      0.42       900
          44       0.53      0.12      0.20       263
          45       0.07      0.02      0.03       188
          46       0.30      0.20      0.24       283
          47       0.24      0.02      0.03      1533
          48       0.50      0.01      0.02       269
          49       0.38      0.69      0.49      1116
          50       0.00      0.00      0.00       283
          51       0.38      0.08      0.14       224
          52       0.10      0.11      0.11       295
          53       0.16      0.09      0.11      1352
          54       0.00      0.00      0.00       272
          55       0.41      0.36      0.39      1773
          56       0.08      0.00      0.01       274
          57       0.18      0.13      0.15       302
          58       0.34      0.05      0.08       283
          59       0.13      0.15      0.14       279
          60       0.06      0.04      0.05       231
          61       0.06      0.02      0.02       264

    accuracy                          0.38     70000
   macro avg       0.27      0.24      0.24     70000
weighted avg       0.38      0.38      0.37     70000

CPU times: user 1h 18min 53s, sys: 8.07 s, total: 1h 19min 1s
Wall time: 1h 18min 37s

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
```

```
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318:
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0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

the best model of random forest

[11]:

```
%%time

ran_for = RandomForestClassifier(n_estimators=300, n_jobs=-1)
ran_for.fit(train_normal_11 , data_train_label)
y_pred_rf = ran_for.predict(test_normal_11)
print("Random forest ensemble - accuracy on test set:")
print(accuracy_score(data_test_label, y_pred_rf))
accuracy_forest = accuracy_score(data_test_label, y_pred_rf)
print(classification_report(data_test_label, y_pred_rf))
```

```
Random forest ensemble - accuracy on test set:
0.4611857142857143
              precision    recall  f1-score   support

           0       0.53      0.75      0.62      3461
           1       0.63      0.83      0.72      3860
           2       0.21      0.42      0.28      3559
           3       0.37      0.66      0.48      3577
           4       0.40      0.71      0.51      3411
           5       0.21      0.26      0.23      3115
           6       0.62      0.92      0.74      3426
           7       0.62      0.83      0.71      3768
           8       0.33      0.48      0.39      3375
           9       0.63      0.55      0.59      3390
          10       0.44      0.34      0.38       647
          11       0.50      0.00      0.01       395
          12       0.43      0.20      0.27      1080
          13       0.73      0.07      0.12       446
          14       0.39      0.02      0.04       521
          15       0.34      0.10      0.15       874
          16       0.89      0.10      0.18       254
          17       0.67      0.04      0.08       331
          18       0.56      0.21      0.31      1237
          19       0.67      0.07      0.13       391
```

20	0.64	0.11	0.18	232
21	0.60	0.05	0.09	476
22	0.61	0.81	0.69	872
23	0.37	0.28	0.32	804
24	0.47	0.33	0.39	2470
25	0.50	0.07	0.12	828
26	0.96	0.09	0.17	257
27	0.43	0.11	0.17	493
28	0.57	0.42	0.49	2099
29	0.51	0.37	0.43	965
30	0.35	0.16	0.22	1209
31	0.51	0.15	0.23	489
32	0.52	0.46	0.49	467
33	0.44	0.09	0.15	266
34	0.51	0.08	0.13	462
35	0.00	0.00	0.00	274
36	0.61	0.30	0.40	955
37	0.67	0.15	0.25	505
38	0.00	0.00	0.00	243
39	0.18	0.07	0.10	1036
40	0.61	0.68	0.64	2462
41	0.00	0.00	0.00	259
42	0.00	0.00	0.00	375
43	0.68	0.51	0.59	900
44	0.88	0.09	0.16	263
45	0.78	0.04	0.07	188
46	0.50	0.02	0.05	283
47	0.39	0.05	0.09	1533
48	0.00	0.00	0.00	269
49	0.53	0.77	0.63	1116
50	0.00	0.00	0.00	283
51	1.00	0.00	0.01	224
52	0.00	0.00	0.00	295
53	0.31	0.25	0.28	1352
54	0.00	0.00	0.00	272
55	0.57	0.60	0.59	1773
56	0.00	0.00	0.00	274
57	0.59	0.05	0.10	302
58	0.68	0.13	0.22	283
59	0.35	0.04	0.07	279
60	0.00	0.00	0.00	231
61	0.89	0.03	0.06	264
accuracy			0.46	70000
macro avg	0.46	0.24	0.25	70000
weighted avg	0.47	0.46	0.42	70000

```
CPU times: user 1h 5min 21s, sys: 20.9 s, total: 1h 5min 42s
```

```
Wall time: 8min 21s

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
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  _warn_prf(average, modifier, msg_start, len(result))
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  _warn_prf(average, modifier, msg_start, len(result))
```