wine_classification

October 31, 2020

[2]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import␣
 ↪classification_report,confusion_matrix,accuracy_score
```

Load Data

[4]:

```
from sklearn.datasets import load_wine
data = load_wine(return_X_y=False)
print(data.DESCR)
```

```
.. _wine_dataset:

Wine recognition dataset
------------------------

**Data Set Characteristics:**

    :Number of Instances: 178 (50 in each of three classes)
    :Number of Attributes: 13 numeric, predictive attributes and the class
    :Attribute Information:
                - Alcohol
                - Malic acid
                - Ash
                - Alcalinity of ash
                - Magnesium
                - Total phenols
                - Flavanoids
                - Nonflavanoid phenols
                - Proanthocyanins
                - Color intensity
                - Hue
                - OD280/OD315 of diluted wines
                - Proline
    - class:
            - class_0
            - class_1
            - class_2

    :Summary Statistics:

    ============================= ==== ===== ======= =====
                                   Min   Max   Mean     SD
    ============================= ==== ===== ======= =====
    Alcohol:                      11.0  14.8    13.0   0.8
    Malic Acid:                   0.74  5.80    2.34  1.12
    Ash:                          1.36  3.23    2.36  0.27
    Alcalinity of Ash:            10.6  30.0    19.5   3.3
    Magnesium:                    70.0 162.0    99.7  14.3
    Total Phenols:                0.98  3.88    2.29  0.63
    Flavanoids:                   0.34  5.08    2.03  1.00
    Nonflavanoid Phenols:         0.13  0.66    0.36  0.12
    Proanthocyanins:              0.41  3.58    1.59  0.57
    Colour Intensity:              1.3  13.0     5.1   2.3
    Hue:                          0.48  1.71    0.96  0.23
    OD280/OD315 of diluted wines: 1.27  4.00    2.61  0.71
    Proline:                       278  1680     746   315
    ============================= ==== ===== ======= =====

    :Missing Attribute Values: None
    :Class Distribution: class_0 (59), class_1 (71), class_2 (48)
    :Creator: R.A. Fisher
    :Donor: Michael Marshall (MARSHALL%PLU@io.arc.nasa.gov)
    :Date: July, 1988
```

This is a copy of UCI ML Wine recognition datasets.
https://archive.ics.uci.edu/ml/machine-learning-databases/wine/wine.data

The data is the results of a chemical analysis of wines grown in the same region in Italy by three different cultivators. There are thirteen different measurements taken for different constituents found in the three types of wine.

Original Owners:

Forina, M. et al, PARVUS -
An Extendible Package for Data Exploration, Classification and Correlation.
Institute of Pharmaceutical and Food Analysis and Technologies,
Via Brigata Salerno, 16147 Genoa, Italy.

Citation:

```
Lichman, M. (2013). UCI Machine Learning Repository
[https://archive.ics.uci.edu/ml]. Irvine, CA: University of California,
School of Information and Computer Science.

.. topic:: References

  (1) S. Aeberhard, D. Coomans and O. de Vel,
  Comparison of Classifiers in High Dimensional Settings,
  Tech. Rep. no. 92-02, (1992), Dept. of Computer Science and Dept. of
  Mathematics and Statistics, James Cook University of North Queensland.
  (Also submitted to Technometrics).

  The data was used with many others for comparing various
  classifiers. The classes are separable, though only RDA
  has achieved 100% correct classification.
  (RDA : 100%, QDA 99.4%, LDA 98.9%, 1NN 96.1% (z-transformed data))
  (All results using the leave-one-out technique)

  (2) S. Aeberhard, D. Coomans and O. de Vel,
  "THE CLASSIFICATION PERFORMANCE OF RDA"
  Tech. Rep. no. 92-01, (1992), Dept. of Computer Science and Dept. of
  Mathematics and Statistics, James Cook University of North Queensland.
  (Also submitted to Journal of Chemometrics).
```

[5]:

```
data = load_wine(return_X_y=True)
X = data[0]
t = data[1]
X=pd.DataFrame(X)
t=pd.DataFrame(t)

#print(X)
#print(t)
```

Setup division of data

[225]:

```
#X_train, X_test, t_train, t_test = train_test_split(X, t, test_size = 0.3)
X_train, X_validate, X_test = np.split(X.sample(frac=1, random_state=42), [int(.
 ↪6*len(X)), int(.8*len(X))])
t_train, t_validate, t_test = np.split(t.sample(frac=1, random_state=42), [int(.
 ↪6*len(t)), int(.8*len(t))])
X_validate.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 36 entries, 139 to 155
Data columns (total 13 columns):
```

```
0     36 non-null float64
1     36 non-null float64
2     36 non-null float64
3     36 non-null float64
4     36 non-null float64
5     36 non-null float64
6     36 non-null float64
7     36 non-null float64
8     36 non-null float64
9     36 non-null float64
10    36 non-null float64
11    36 non-null float64
12    36 non-null float64
dtypes: float64(13)
memory usage: 3.9 KB
```

[226]:

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaler.fit(X_train)
X_train = scaler.transform(X_train)
X_validate= scaler.transform(X_validate)
X_test = scaler.transform(X_test)
```

[227]:

```
mlp = MLPClassifier(activation='logistic', alpha=1e-5,  solver = 'lbfgs', hidden_layer_sizes=(30,30,30))
```

train the model

[228]:

```
mlp.fit(X_train, t_train)
predictions = mlp.predict(X_validate)
print(classification_report(t_validate,predictions))
print(accuracy_score(t_validate, predictions))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        12
           1       1.00      0.93      0.96        14
           2       0.91      1.00      0.95        10

    accuracy                           0.97        36
   macro avg       0.97      0.98      0.97        36
weighted avg       0.97      0.97      0.97        36

0.9722222222222222

//anaconda3/lib/python3.7/site-
packages/sklearn/neural_network/multilayer_perceptron.py:921:
DataConversionWarning: A column-vector y was passed when a 1d array was
```

```
expected. Please change the shape of y to (n_samples, ), for example using
ravel().
  y = column_or_1d(y, warn=True)
```

test the model

[229]:
```
y=mlp.predict(X_test)
print(classification_report(t_test,y))
print(accuracy_score(t_test, y))
```

```
              precision    recall  f1-score   support

           0       0.92      1.00      0.96        11
           1       0.93      0.93      0.93        14
           2       1.00      0.91      0.95        11

    accuracy                           0.94        36
   macro avg       0.95      0.95      0.95        36
weighted avg       0.95      0.94      0.94        36

0.9444444444444444
```

Q1: tune the learning rate and batch size

[230]:
```
# learning rate
learning_rate = np.arange(0.01, 0.3, 0.01)
accuracy = []
for i in learning_rate:
    clf = MLPClassifier(random_state=1, learning_rate_init=i).fit(X_train,␣
 ↪t_train)
    accuracy.append(clf.score(X_test, t_test))
plt.title('Accuracy with Learning Rate')
plt.plot(learning_rate, accuracy)
print('The optimal learning rate is',learning_rate[accuracy.
 ↪index(max(accuracy))],'with accuracy = ',max(accuracy))
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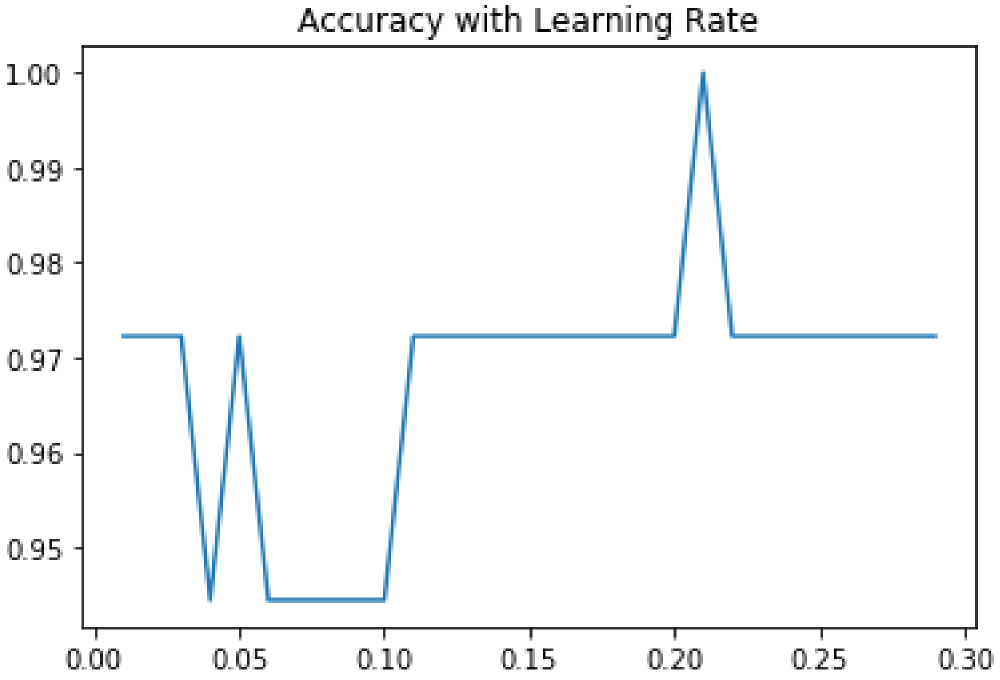
```

```
The optimal learning rate is 0.21000000000000002 with accuracy =  1.0
```



[231]:

```
#Batch Size#
Batch_Size = np.arange(10, 200, 10)
accuracy = []
for j in Batch_Size:
    clf = MLPClassifier(random_state=1, max_iter=300,batch_size=j).fit(X_train,␣
 ↪t_train)
    accuracy.append(clf.score(X_test, t_test))
plt.title('Accuracy with Batch Size')
plt.plot(Batch_Size, accuracy)
print('The optimal Batch Size is',Batch_Size[accuracy.
 ↪index(max(accuracy))],'with accuracy = ',max(accuracy))
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`batch_size` less than 1 or larger than sample size. It is going to be clipped
  warnings.warn("Got `batch_size` less than 1 or larger than "
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DataConversionWarning: A column-vector y was passed when a 1d array was
expected. Please change the shape of y to (n_samples, ), for example using
ravel().
  y = column_or_1d(y, warn=True)
//anaconda3/lib/python3.7/site-
packages/sklearn/neural_network/multilayer_perceptron.py:350: UserWarning: Got
`batch_size` less than 1 or larger than sample size. It is going to be clipped
  warnings.warn("Got `batch_size` less than 1 or larger than "
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```
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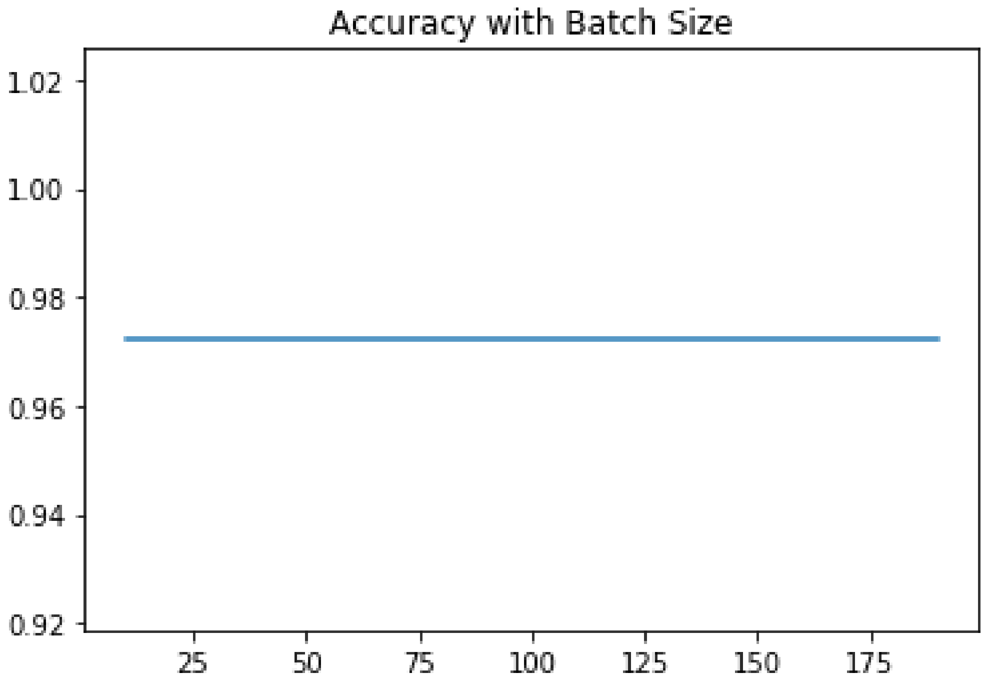
`batch_size` less than 1 or larger than sample size. It is going to be clipped
  warnings.warn("Got `batch_size` less than 1 or larger than "

The optimal Batch Size is 10 with accuracy =  0.9722222222222222
```



Q2. use 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% of the total training dataset

[289]:
```python
td_percent=np.arange(0.2,1,0.1)
accuracy = []
for a in td_percent:
    X_train, X_test, t_train, t_test = train_test_split(X, t, test_size = a)
    mlp = MLPClassifier(activation='logistic',alpha=1e-5,learning_rate_init=0.
 ↪2,solver = 'lbfgs',batch_size=10,hidden_layer_sizes=(30,30,30))
    clf = mlp.fit(X_train, t_train)
    accuracy.append(clf.score(X_test, t_test))
plt.title('Accuracy with training dataset percent')
plt.plot((1-td_percent), accuracy)
print('The optimal training dataset percent is',1-td_percent[accuracy.
 ↪index(max(accuracy))],'with accuracy = ',max(accuracy))
```

```
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packages/sklearn/neural_network/multilayer_perceptron.py:921:
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The optimal training dataset percent is 0.7 with accuracy =  0.8148148148148148
```

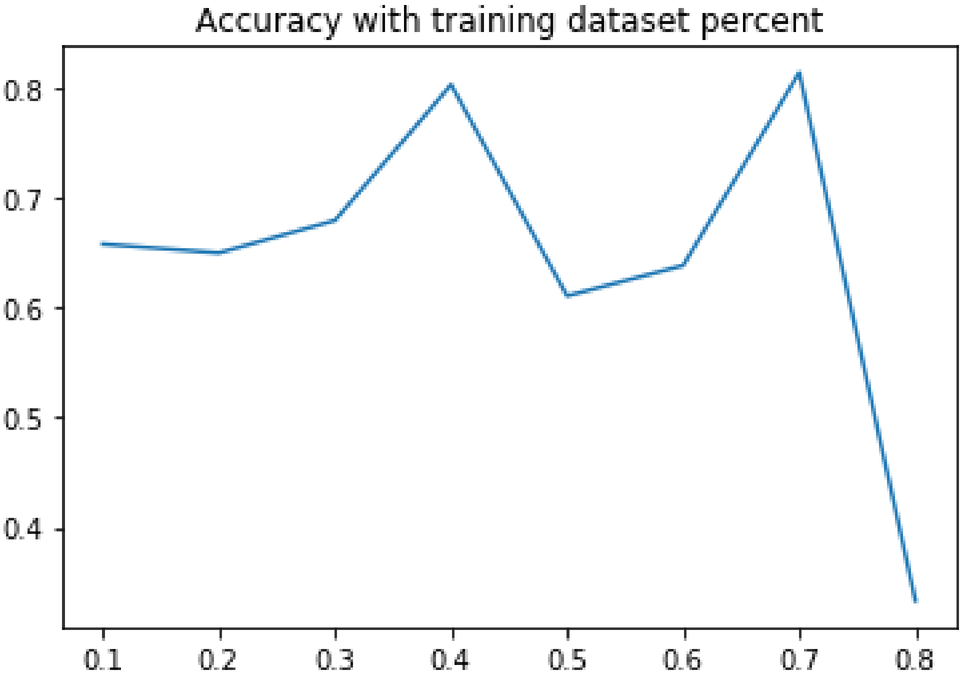

Q3. use 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% of the features

[299]:

```
import random
frange = [0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0]
featuresnumber = [3,4,5,7,8,9,10,12,13]
accuracy=[]
for b in featuresnumber:
    data = load_wine(return_X_y=True)
    X = data[0]
    t = data[1]
    X=pd.DataFrame(X)
    t=pd.DataFrame(t)
    findex = random.sample([0,1,2,3,4,5,6,7,8,9,10,11,12],b)
    X=X.iloc[:,findex]
    X_train, X_test, t_train, t_test = train_test_split(X, t, test_size = 0.3)
    mlp = MLPClassifier(activation='logistic',alpha=1e-5,learning_rate_init=0.
 ↪2,solver = 'lbfgs',batch_size=10,hidden_layer_sizes=(30,30,30))
    clf = mlp.fit(X_train, t_train)
    accuracy.append(clf.score(X_test, t_test))
#print(accuracy)
plt.title('Accuracy with feature percent')
plt.plot(frange, accuracy)
print('The optimal features percent is',frange[accuracy.
 ↪index(max(accuracy))],'with accuracy = ',max(accuracy))
```

```
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packages/sklearn/neural_network/multilayer_perceptron.py:921:
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expected. Please change the shape of y to (n_samples, ), for example using
ravel().
  y = column_or_1d(y, warn=True)

The optimal features percent is 0.7 with accuracy =  0.9444444444444444
```

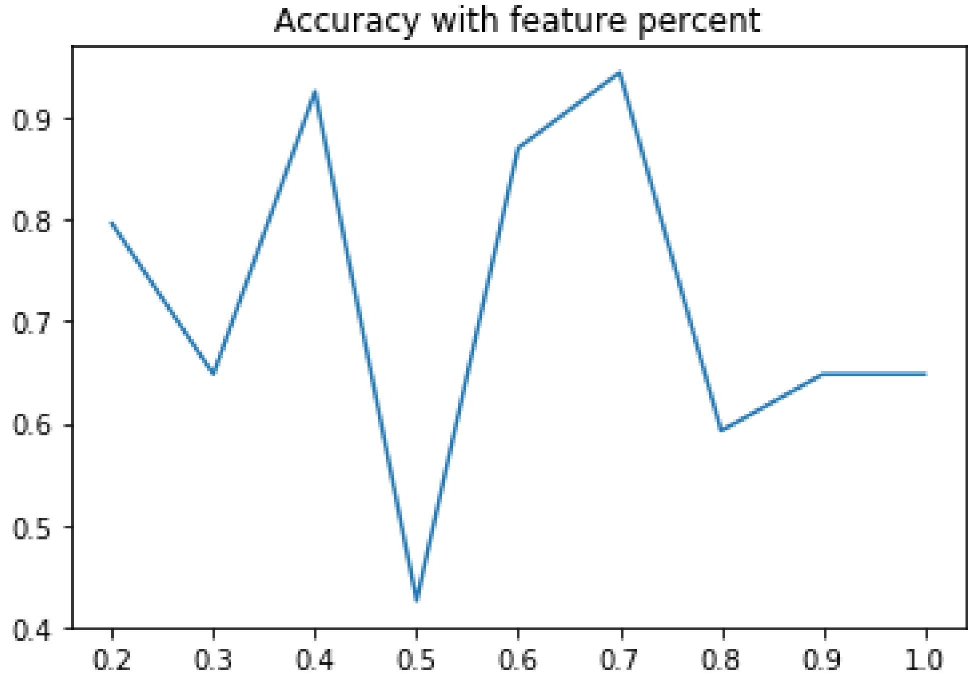
Accuracy with feature percent