Classification Model

April 11, 2022

[1]:

```
# Import pertinent packages

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn as sk
import seaborn as sns
import os
from sklearn.metrics import RocCurveDisplay
```

[2]:

```
# Read in .csv and print summary
data = pd.read_csv("breast_tumor_classification.csv")
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 32 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   id                       569 non-null    int64
 1   diagnosis                569 non-null    object
 2   radius_mean              569 non-null    float64
 3   texture_mean             569 non-null    float64
 4   perimeter_mean           569 non-null    float64
 5   area_mean                569 non-null    float64
 6   smoothness_mean          569 non-null    float64
 7   compactness_mean         569 non-null    float64
 8   concavity_mean           569 non-null    float64
 9   concave points_mean      569 non-null    float64
 10  symmetry_mean            569 non-null    float64
 11  fractal_dimension_mean   569 non-null    float64
 12  radius_se                569 non-null    float64
 13  texture_se               569 non-null    float64
 14  perimeter_se             569 non-null    float64
 15  area_se                  569 non-null    float64
 16  smoothness_se            569 non-null    float64
 17  compactness_se           569 non-null    float64
 18  concavity_se             569 non-null    float64
 19  concave points_se        569 non-null    float64
 20  symmetry_se              569 non-null    float64
 21  fractal_dimension_se     569 non-null    float64
 22  radius_worst             569 non-null    float64
 23  texture_worst            569 non-null    float64
 24  perimeter_worst          569 non-null    float64
 25  area_worst               569 non-null    float64
 26  smoothness_worst         569 non-null    float64
 27  compactness_worst        569 non-null    float64
 28  concavity_worst          569 non-null    float64
 29  concave points_worst     569 non-null    float64
 30  symmetry_worst           569 non-null    float64
 31  fractal_dimension_worst  569 non-null    float64
dtypes: float64(30), int64(1), object(1)
memory usage: 142.4+ KB
```

[3]:

```python
# Change "M" (malignant) and "B" (benign) markers to 1 and 0, respectively
data.diagnosis = [1 if each == "M" else 0 for each in data.diagnosis]

# Print number of each class (M vs B) to check for even-ness
data['diagnosis'].value_counts()
```

[3]:

```
0    357
1    212
Name: diagnosis, dtype: int64
```

[4]:

```python
# Check for missing (NaN) values
if any(data.isnull().sum()):
    raise ValueError("Data has missing values!")

# Drop ID column - not a predictor
data.drop('id', axis=1, inplace = True)

# Check columns visually
data.head()
```

[4]:

```
   diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
0          1        17.99         10.38          122.80     1001.0
1          1        20.57         17.77          132.90     1326.0
2          1        19.69         21.25          130.00     1203.0
3          1        11.42         20.38           77.58      386.1
4          1        20.29         14.34          135.10     1297.0

   smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
0          0.11840           0.27760          0.3001              0.14710
1          0.08474           0.07864          0.0869              0.07017
2          0.10960           0.15990          0.1974              0.12790
```

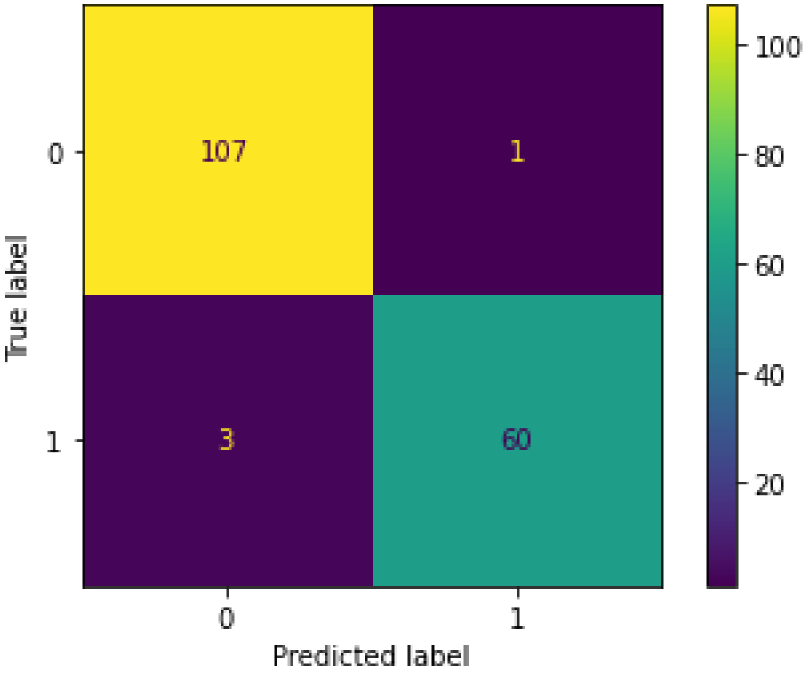
```
3          0.14250           0.28390          0.2414              0.10520
4          0.10030           0.13280          0.1980              0.10430

   symmetry_mean  …  radius_worst  texture_worst  perimeter_worst  \
0         0.2419  …         25.38          17.33           184.60
1         0.1812  …         24.99          23.41           158.80
2         0.2069  …         23.57          25.53           152.50
3         0.2597  …         14.91          26.50            98.87
4         0.1809  …         22.54          16.67           152.20

   area_worst  smoothness_worst  compactness_worst  concavity_worst  \
0      2019.0            0.1622             0.6656           0.7119
1      1956.0            0.1238             0.1866           0.2416
2      1709.0            0.1444             0.4245           0.4504
3       567.7            0.2098             0.8663           0.6869
4      1575.0            0.1374             0.2050           0.4000

   concave points_worst  symmetry_worst  fractal_dimension_worst
0                0.2654          0.4601                  0.11890
1                0.1860          0.2750                  0.08902
2                0.2430          0.3613                  0.08758
3                0.2575          0.6638                  0.17300
4                0.1625          0.2364                  0.07678

[5 rows x 31 columns]
```

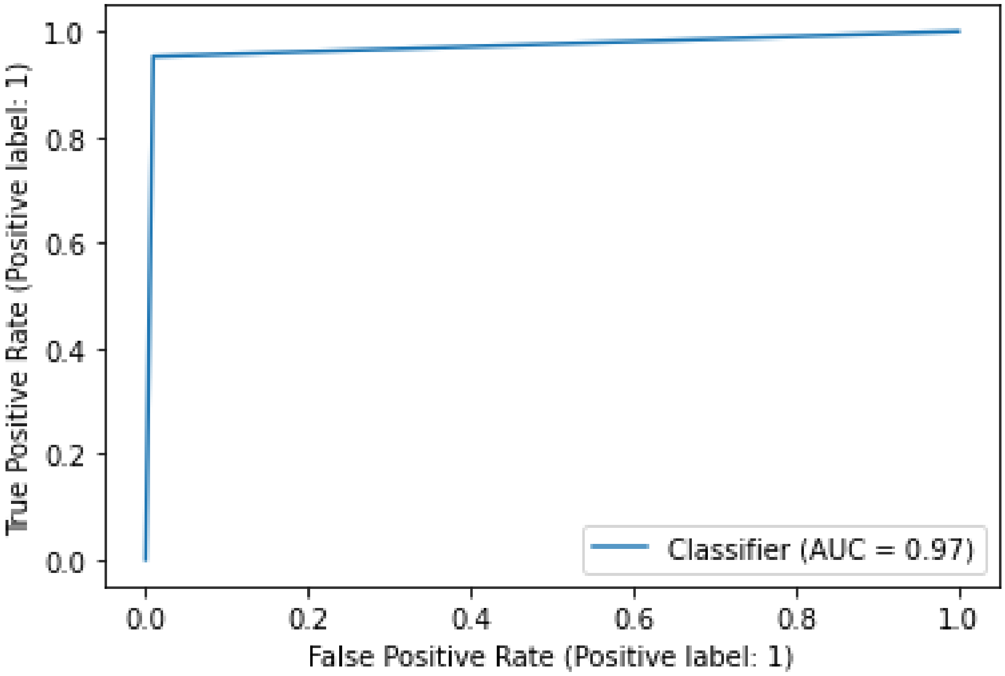
[5]:

```python
# Select Features
feature = data.drop('diagnosis', axis=1)

# Select Target
target = data['diagnosis']

# Set Training and Testing Data
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(feature, target, shuffle =␣
 ↪True, test_size=0.3, random_state=42)
```

[70]:

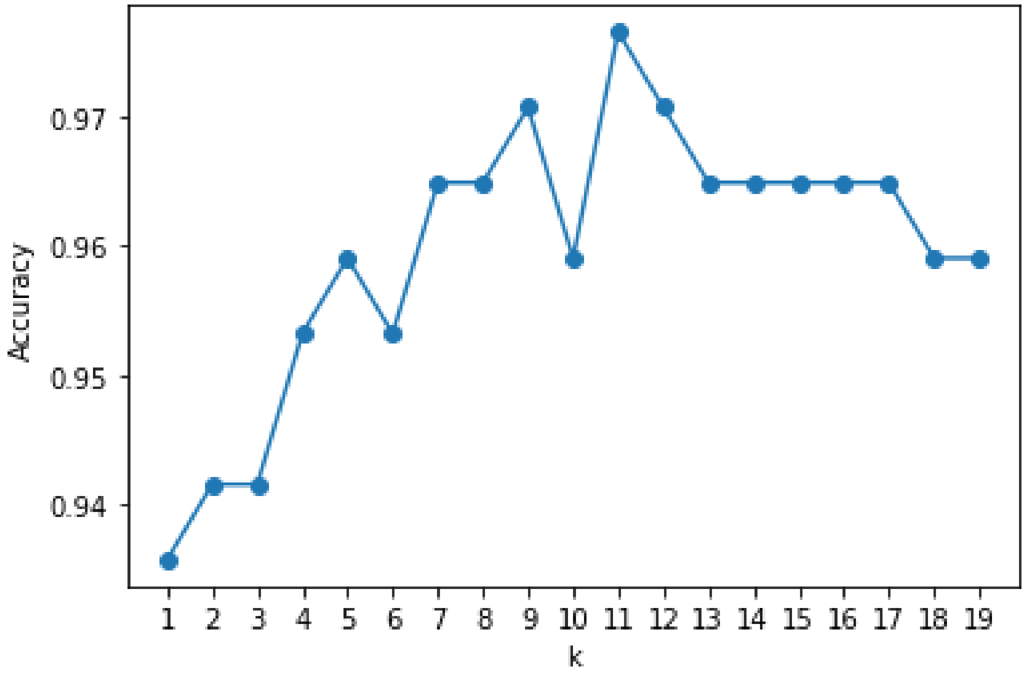
```python
# k Nearest Neighbours

from sklearn.neighbors import KNeighborsClassifier

def kNN(plot=True, **kwargs):
    # Train
    model = KNeighborsClassifier(**kwargs)
    model = model.fit(x_train, y_train)
    y_predict = model.predict(x_test)
    # Test
    acc = model.score(x_test, y_test)
    confusion = sk.metrics.confusion_matrix(y_test, y_predict)

    # Plotting
    if plot: # option to disable plotting (for looping)

        # Confusion Matrix
        disp = sk.metrics.ConfusionMatrixDisplay(confusion)
        disp.plot()
        plt.show()

        # ROC curve
        RocCurveDisplay.from_predictions(y_test, y_predict)
        plt.show()

    return (acc, confusion)


kNN(n_neighbors=11)
```





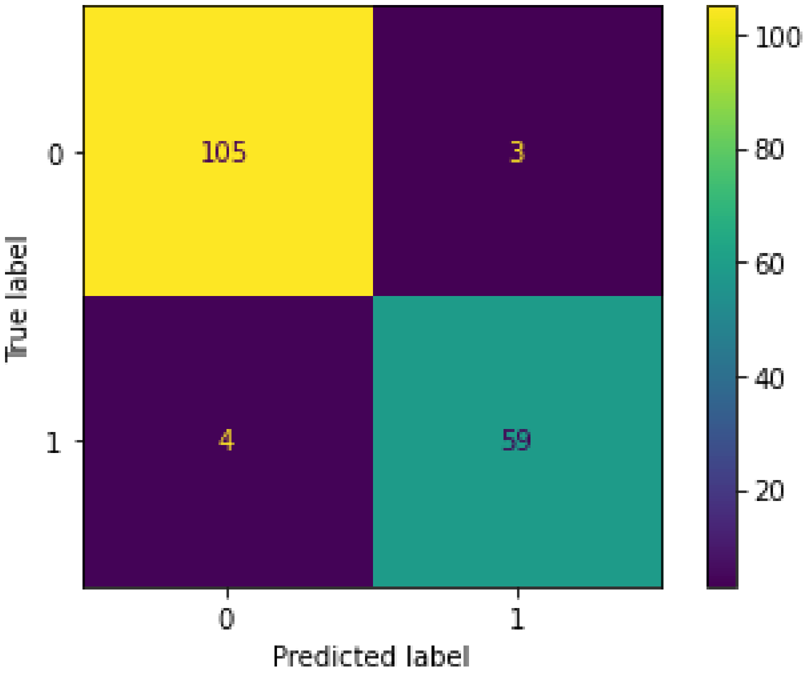
[70]:
```
(0.9766081871345029,
 array([[107,   1],
        [  3,  60]]))
```

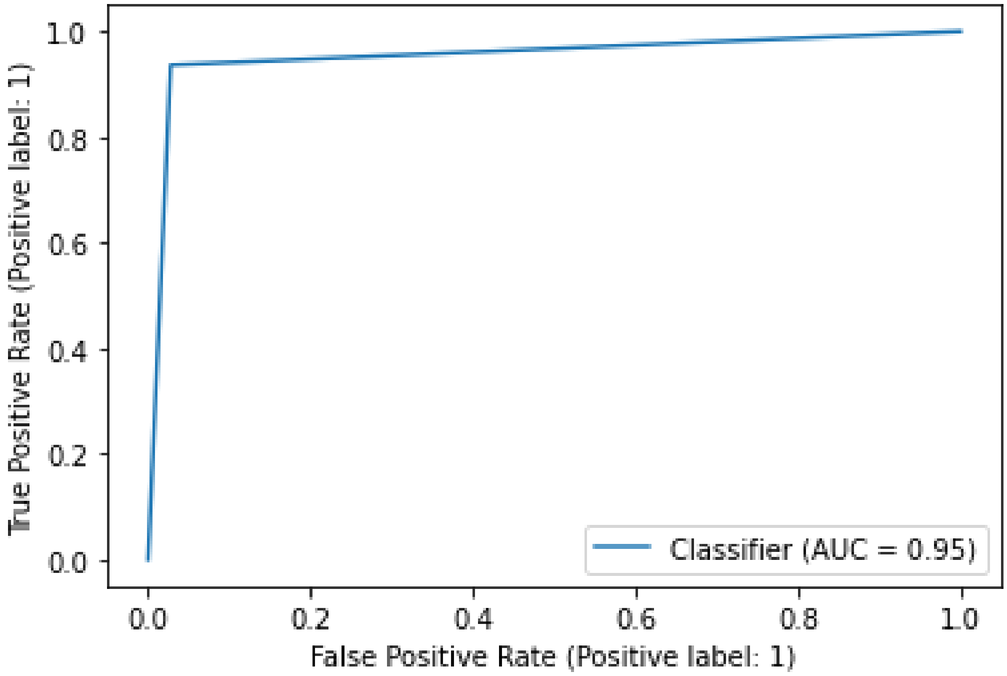
[77]:
```
# Loop for optimizing kNN neighbors

# initialize arrays
k = []
accs = []

# Loop over range of reasonable values, calculate, and append
for i in np.arange(1, 20):
    k.append(i)
    (acc, confusion) = kNN(n_neighbors=i, plot=False)
    accs.append(acc)

# Plot k vs accuracy
plt.plot(k, accs, '-o')
plt.xlabel("k")
plt.ylabel("Accuracy")
plt.xticks(np.arange(min(k), max(k)+1, 1.0))
plt.show()
```



[72]:
```
from sklearn.ensemble import BaggingClassifier

def Bagged(**kwargs):
    # Train
    model = BaggingClassifier(**kwargs)
    model = model.fit(x_train, y_train)
    y_predict = model.predict(x_test)

    # Test
    acc = model.score(x_test, y_test)
    confusion = sk.metrics.confusion_matrix(y_test, y_predict)

    # Plotting
    if plot: # option to disable plotting (for looping)

        # Confusion Matrix
        disp = sk.metrics.ConfusionMatrixDisplay(confusion)
        disp.plot()
        plt.show()

        # ROC curve
        RocCurveDisplay.from_predictions(y_test, y_predict)
        plt.show()

    return (acc, confusion)
```

```
Bagged(n_estimators=100)
```



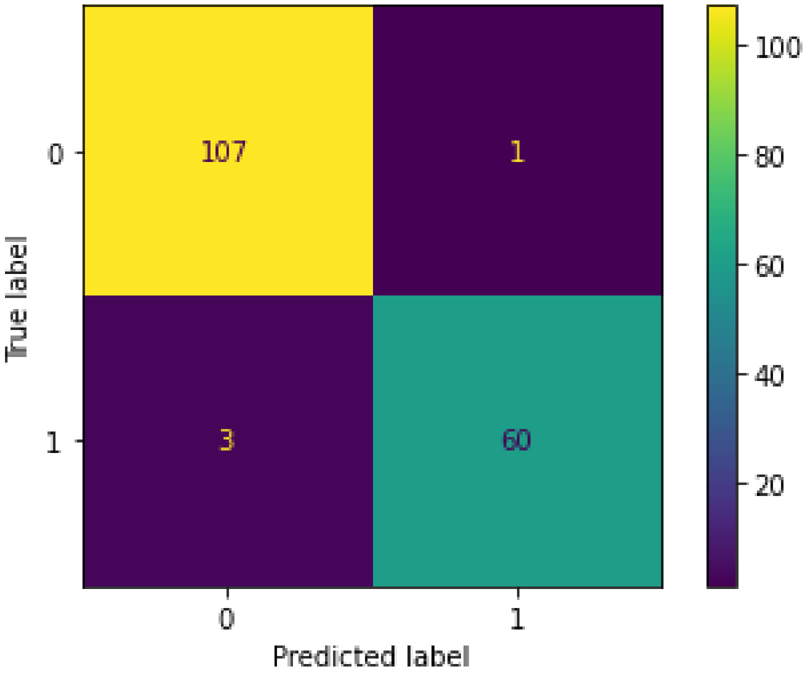


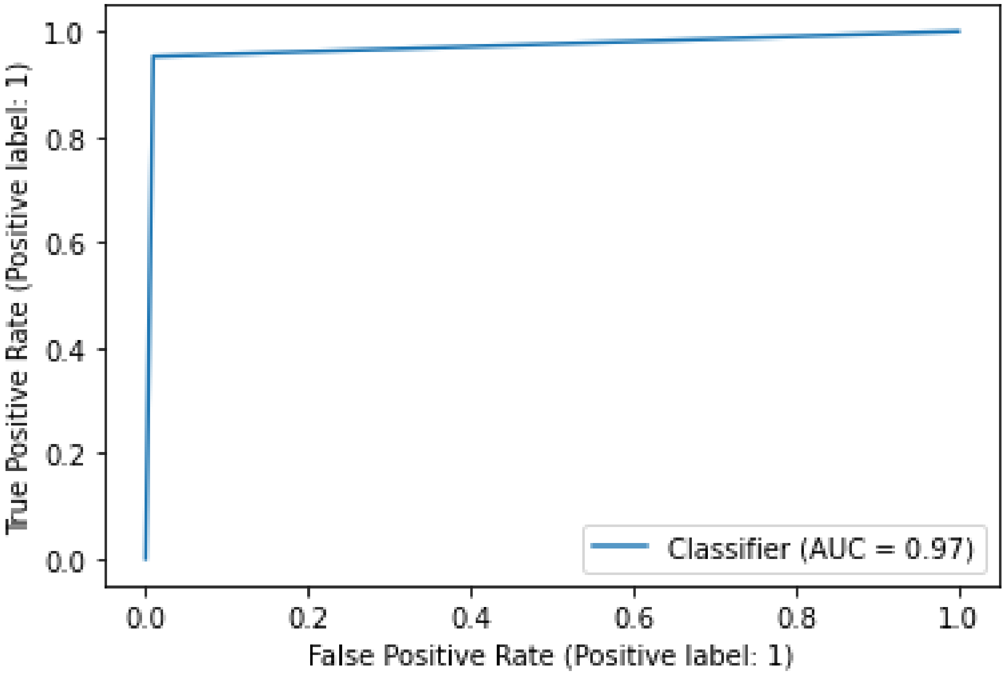
[72]:

```
(0.9590643274853801,
 array([[105,   3],
        [  4,  59]]))
```

[75]:

```
# Random Forest

from sklearn.ensemble import RandomForestClassifier

def random_forest(**kwargs):
    # Train
    model = RandomForestClassifier(**kwargs)
    model = model.fit(x_train, y_train)
    y_predict = model.predict(x_test)

    # Test
    acc = model.score(x_test, y_test)
    confusion = sk.metrics.confusion_matrix(y_test, y_predict)

    # Plotting
    if plot: # option to disable plotting (for looping)

        # Confusion Matrix
        disp = sk.metrics.ConfusionMatrixDisplay(confusion)
        disp.plot()
        plt.show()

        # ROC curve
        RocCurveDisplay.from_predictions(y_test, y_predict)
        plt.show()

    return (acc, confusion)


random_forest()
```





```
[75]: (0.9766081871345029,
       array([[107,   1],
[  3,  60]]))
```