svm example 3

July 13, 2022

```
[ ]: import pandas as pd
     import matplotlib.pyplot as plt
     import numpy as np
```

```
[ ]: df = pd.read_csv('Social_Network_Ads.csv')
```

```
[ ]: df.head()
```

```
[ ]:     User ID  Gender  Age  EstimatedSalary  Purchased
     0  15624510    Male   19            19000          0
     1  15810944    Male   35            20000          0
     2  15668575  Female   26            43000          0
     3  15603246  Female   27            57000          0
     4  15804002    Male   19            76000          0
```

```
[ ]: df.info()
```

```
    <class 'pandas.core.frame.DataFrame'>
    RangeIndex: 400 entries, 0 to 399
    Data columns (total 5 columns):
     #   Column           Non-Null Count  Dtype
    ---  ------           --------------  -----
     0   User ID          400 non-null    int64
     1   Gender           400 non-null    object
     2   Age              400 non-null    int64
     3   EstimatedSalary  400 non-null    int64
     4   Purchased        400 non-null    int64
    dtypes: int64(4), object(1)
    memory usage: 15.8+ KB
```

```
[ ]: df.describe()
```

```
[ ]:             User ID         Age  EstimatedSalary   Purchased
     count  4.000000e+02  400.000000       400.000000  400.000000
     mean   1.569154e+07   37.655000     69742.500000    0.357500
     std    7.165832e+04   10.482877     34096.960282    0.479864
     min    1.556669e+07   18.000000     15000.000000    0.000000
     25%    1.562676e+07   29.750000     43000.000000    0.000000
```

```
50%    1.569434e+07   37.000000    70000.000000    0.000000
75%    1.575036e+07   46.000000    88000.000000    1.000000
max    1.581524e+07   60.000000   150000.000000    1.000000
```

[ ]:

```
X = df[['Age', 'EstimatedSalary']]
y = df['Purchased']
```

[ ]:

```
Xarr = X.to_numpy()
```

[ ]:

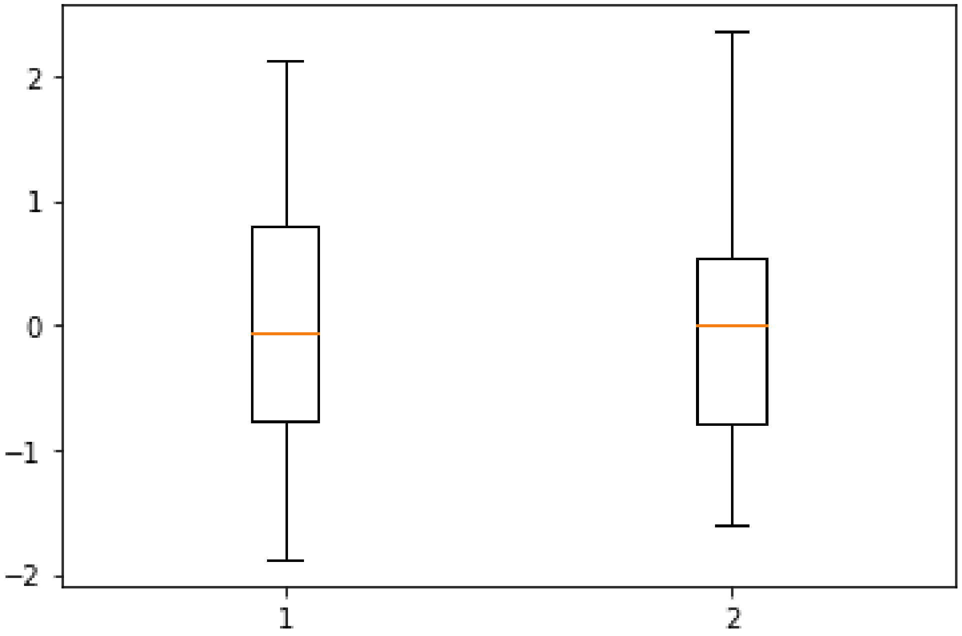
```
yarr = y.to_numpy()
```

[ ]:

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
X = scaler.fit_transform(Xarr)
```

[ ]:

```
plt.boxplot(X)
plt.show()
```



[ ]:

```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, yarr, test_size = 0.2)
X.shape, X_train.shape, X_test.shape
```

[ ]:

```
((400, 2), (320, 2), (80, 2))
```

[ ]:

```
from sklearn.svm import SVC

classifier = SVC(kernel = 'linear', C = 1)
classifier.fit(X_train, y_train)
y_pred = classifier.predict(X_test)
y_pred
```

[ ]:

```
array([1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

[ ]:

```
from sklearn.metrics import confusion_matrix
compare = confusion_matrix(y_test, y_pred)
compare
```

[ ]:

```
array([[54,  2],
       [10, 14]])
```

[ ]:

```
accuracy = (compare[0][0] + compare[1][1])/compare.sum()
accuracy
```

[ ]:

```
0.85
```

[ ]:

```
from sklearn.metrics import accuracy_score

test_acc = accuracy_score(y_test, y_pred)
test_acc
```

[ ]:

```
0.85
```

[ ]:

```
print(classifier.predict([[1, -1.5]]))
```

```
[0]
```

[ ]:

```
print(classifier.predict([[1, 0]]))
```

```
[1]
```

1 Next: Plot a scatter plot with the decision boundary and the parallels

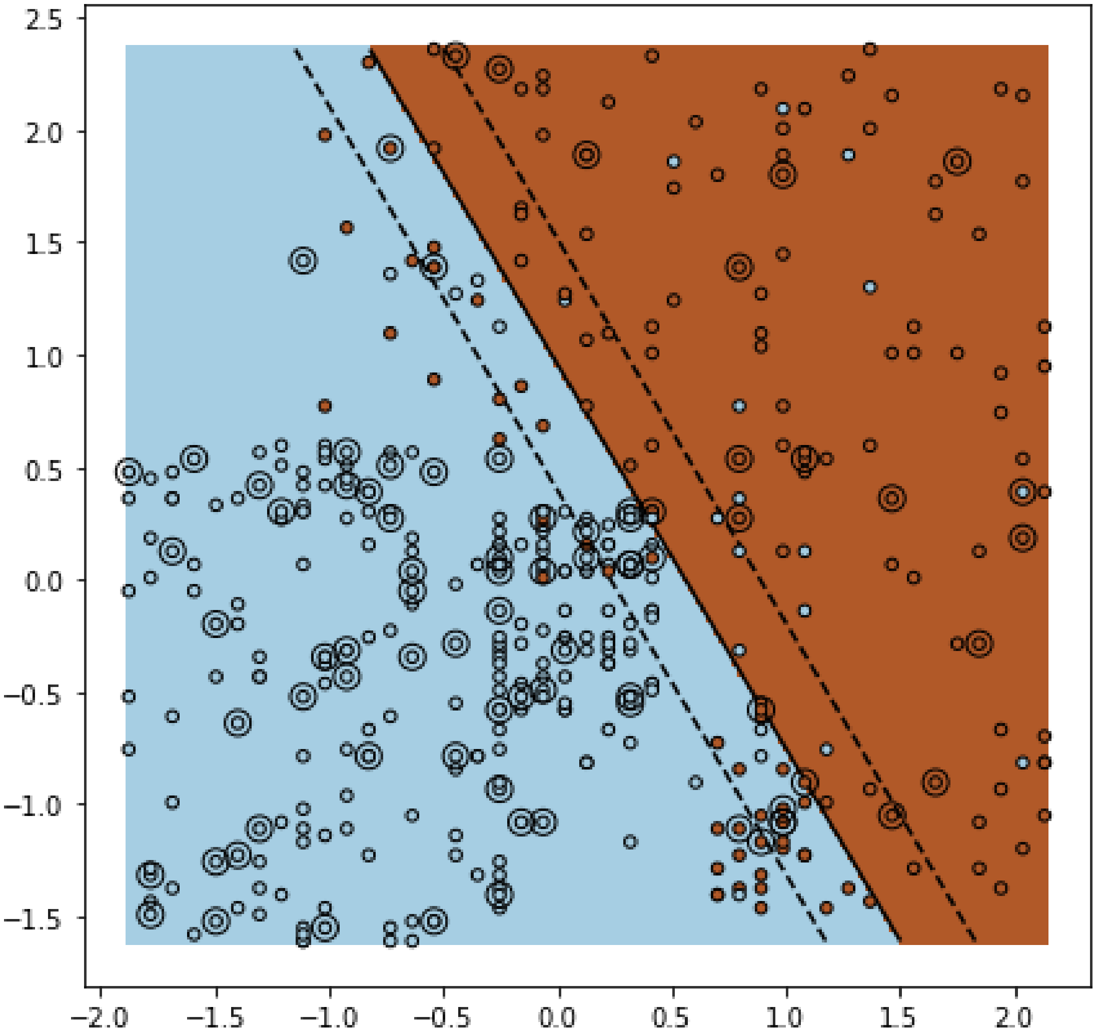
[ ]:

```
def plot_support_vector_machine(svm):
    plt.scatter(X[:, 0], X[:, 1], c = yarr, zorder = 10, cmap = plt.cm.Paired,␣
 ↪edgecolor = 'k', s = 20)

    plt.scatter(X_test[:, 0], X_test[:, 1], s = 100, facecolors = 'none',␣
 ↪zorder = 10, edgecolor = 'k')
```

```
    plt.axis('tight')
    x_min = X[:, 0].min()
    x_max = X[:, 0].max()
    y_min = X[:, 1].min()
    y_max = X[:, 1].max()

    XX, YY = np.mgrid[x_min:x_max:200j, y_min:y_max:200j]
    Z = svm.decision_function(np.c_[XX.ravel(), YY.ravel()])

    Z = Z.reshape(XX.shape)
    plt.pcolormesh(XX, YY, Z > 0, cmap = plt.cm.Paired, shading = 'auto')
    plt.contour(XX, YY, Z, colors = ['k', 'k', 'k'], linestyles = ['--', '-',␣
↪'--'], levels = [-.5, 0, .5])
```

[ ]:

```
plt.figure(figsize = (7, 7))
plot_support_vector_machine(classifier)
```



2 Poly SVM and RBF

[ ]:

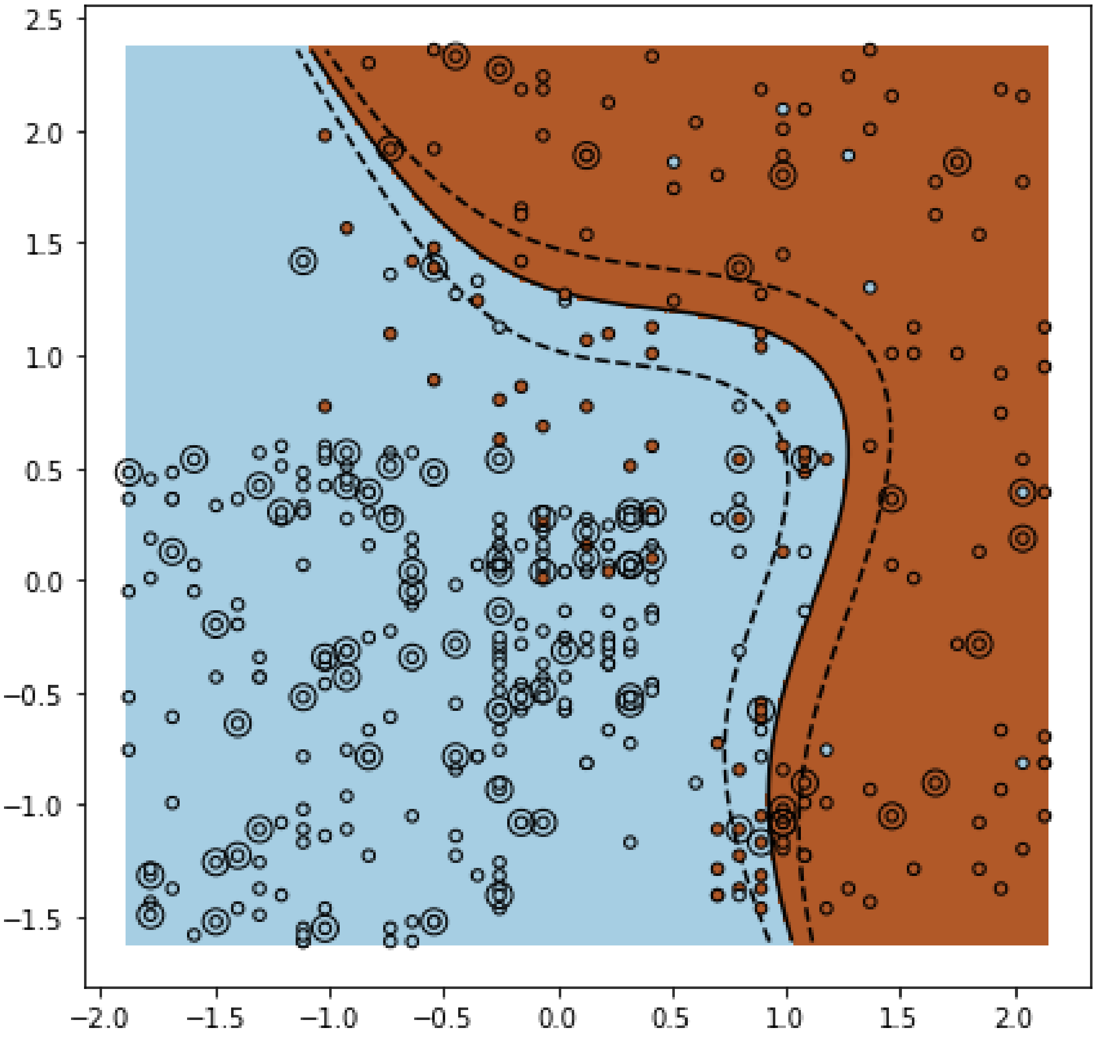
```
poly_svc = SVC(kernel = 'poly')
poly_svc.fit(X_train, y_train)

y_pred = poly_svc.predict(X_test)
y_pred
```

[ ]:

```
array([1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0,
       1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

[ ]:

```
plt.figure(figsize = (7, 7))
plot_support_vector_machine(poly_svc)
```



[ ]:
```
from sklearn.metrics import accuracy_score

test_acc = accuracy_score(y_test, y_pred)
test_acc
```

[ ]:
```
0.8875
```

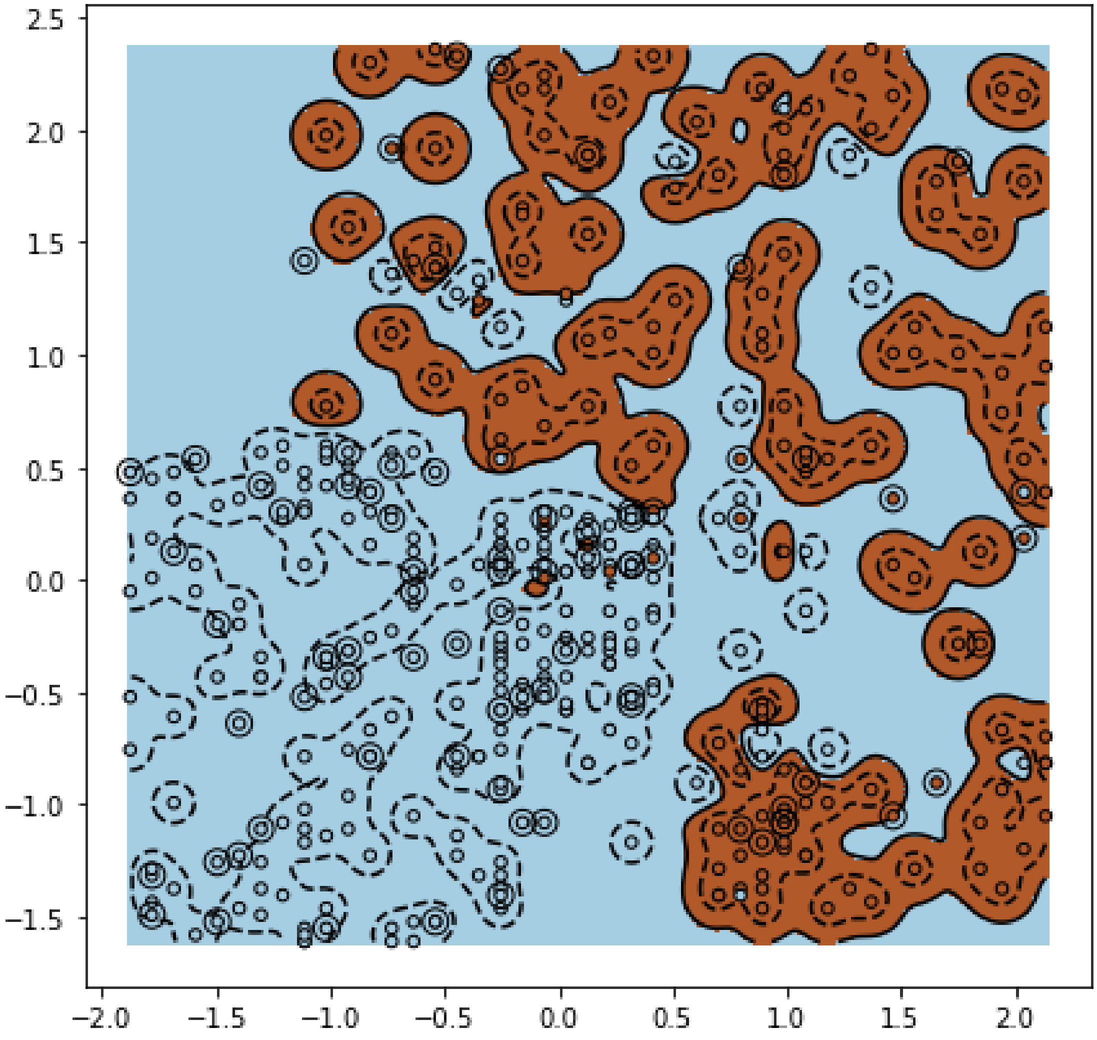
[ ]:
```
rbf_svc = SVC(kernel = 'rbf', gamma = 100, C = 1)
rbf_svc.fit(X_train, y_train)

y_pred = rbf_svc.predict(X_test)
y_pred
```

[ ]:

```
array([0, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0,
       1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
```

[ ]:

```
plt.figure(figsize = (7, 7))
plot_support_vector_machine(rbf_svc)
```



[ ]:

```
from sklearn.metrics import accuracy_score

test_acc = accuracy_score(y_test, y_pred)
test_acc
```

[ ]:

```
0.8625
```

3 Parameter Tuning

[ ]:
```
from sklearn.model_selection import GridSearchCV
```

[ ]:
```
params = [
    {"kernel": ["linear"], "C": [0.1, 0.5, 1, 5, 10, 30]},
    {"kernel": ["poly"], "C": [0.1, 0.5, 1, 5, 10, 30]},
    {"kernel": ["rbf"], "C": [0.1, 0.5, 1, 5, 10, 30],
        "gamma": [0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10.0],}
]
```

[ ]:
```
grid_cv = GridSearchCV(classifier, params, cv = 5, n_jobs = -1)
grid_cv.fit(X_train, y_train)
```

[ ]:
```
GridSearchCV(cv=5, estimator=SVC(C=1, kernel='linear'), n_jobs=-1,
             param_grid=[{'C': [0.1, 0.5, 1, 5, 10, 30], 'kernel': ['linear']},
                         {'C': [0.1, 0.5, 1, 5, 10, 30], 'kernel': ['poly']},
                         {'C': [0.1, 0.5, 1, 5, 10, 30],
                          'gamma': [0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10.0],
                          'kernel': ['rbf']}])
```

[ ]:
```
print(f"Highest score of parameter search is: {grid_cv.best_score_:.4f}")
```

```
Highest score of parameter search is: 0.9187
```

[ ]:
```
print("The parameter of the highest score is as follows")
for key, value in grid_cv.best_params_.items():
    print(f"{key}: {value}")
```

```
The parameter of the highest score is as follows
C: 5
gamma: 3.0
kernel: rbf
```

[ ]:
```
best_test_acc = accuracy_score(y_test, y_pred)
```

[ ]:
```
print(f"Highest parameter test accuracy is {best_test_acc:.3f}")
```

```
Highest parameter test accuracy is 0.863
```

[ ]:
```

```