Plot scikit-learn (sklearn) SVM decision boundary / surface

Asked 3 years, 5 months ago Active 1 year, 6 months ago Viewed 26k times

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I am currently performing multi class SVM with linear kernel using python's scikit library. The sample training data and testing data are as given below:

Model data:

```
x = [[20,32,45,33,32,44,0],[23,32,45,12,32,66,11],[16,32,45,12,32,44,23],
[120,2,55,62,82,14,81],[30,222,115,12,42,64,91],[220,12,55,222,82,14,181],
[30,222,315,12,222,64,111]]
y = [0,0,0,1,1,2,2]
```

I want to plot the decision boundary and visualize the datasets. Can someone please help to plot this type of data.

The data given above is just mock data so feel free to change the values. It would be helpful if at least if you could suggest the steps that are to followed. Thanks in advance

python python-2.7 scikit-learn svm data-science Edit tags

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edited Jul 25 '18 at 10:00

seralouk
25.3k 5 90 109

asked Jul 12 '18 at 4:43

Yoganand.N
877 1 10 24

this should help. – Bal Krishna Jha Jul 12 '18 at 4:53

@krishna Iris data set has only two length and width, but in my case there are 7 points in a single data array. – Yoganand.N Jul 12 '18 at 4:57

@Yoganand.N see my answer and let me know – seralouk Jul 12 '18 at 9:03

3 Answers

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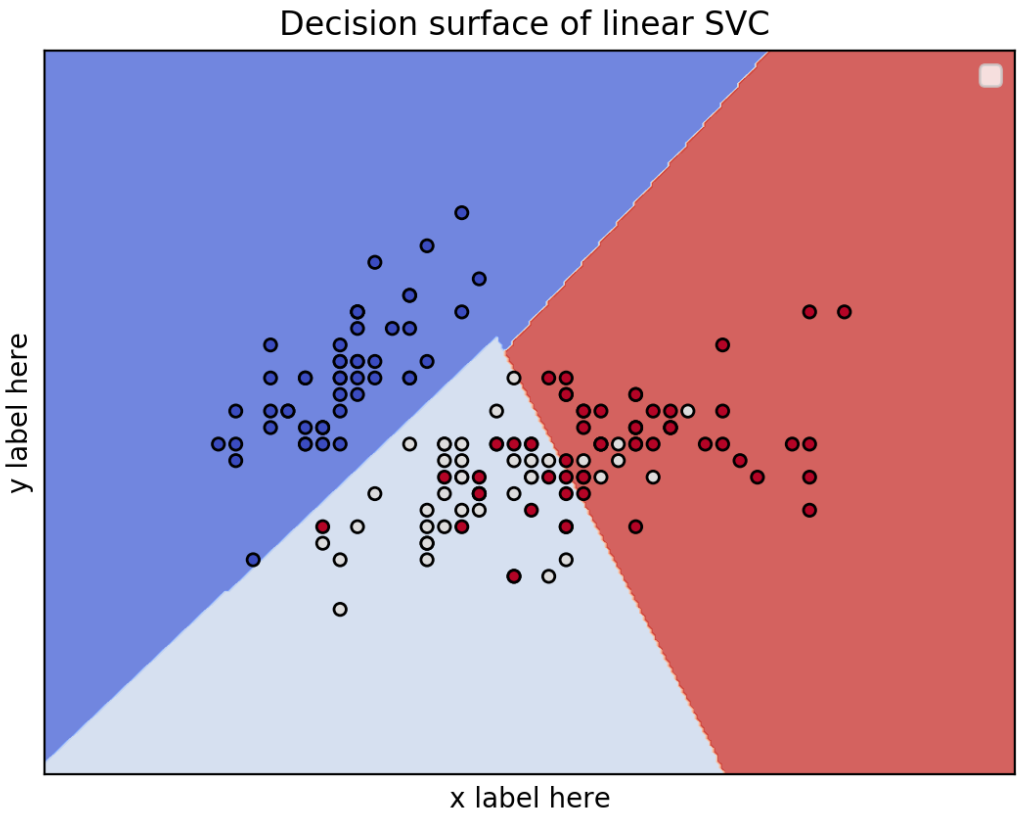
You have to choose only 2 features to do this. The reason is that you cannot plot a 7D plot. After selecting the 2 features use only these for the visualization of the decision surface.

(I have also written an article about this here: https://towardsdatascience.com/support-vector-machines-svm-clearly-explained-a-python-tutorial-for-classification-problems-29c539f3ad8?source=friends_link&sk=80f72ab272550d76a0cc3730d7c8af35)

Now, the next question that you would ask: *How can I choose these 2 features?*. Well, there are a lot of ways. You could do a **univariate F-value (feature ranking) test** and see what features/variables are the most important. Then you could use these for the plot. Also, we could reduce the dimensionality from 7 to 2 using *PCA* for example.

2D plot for 2 features and using the iris dataset

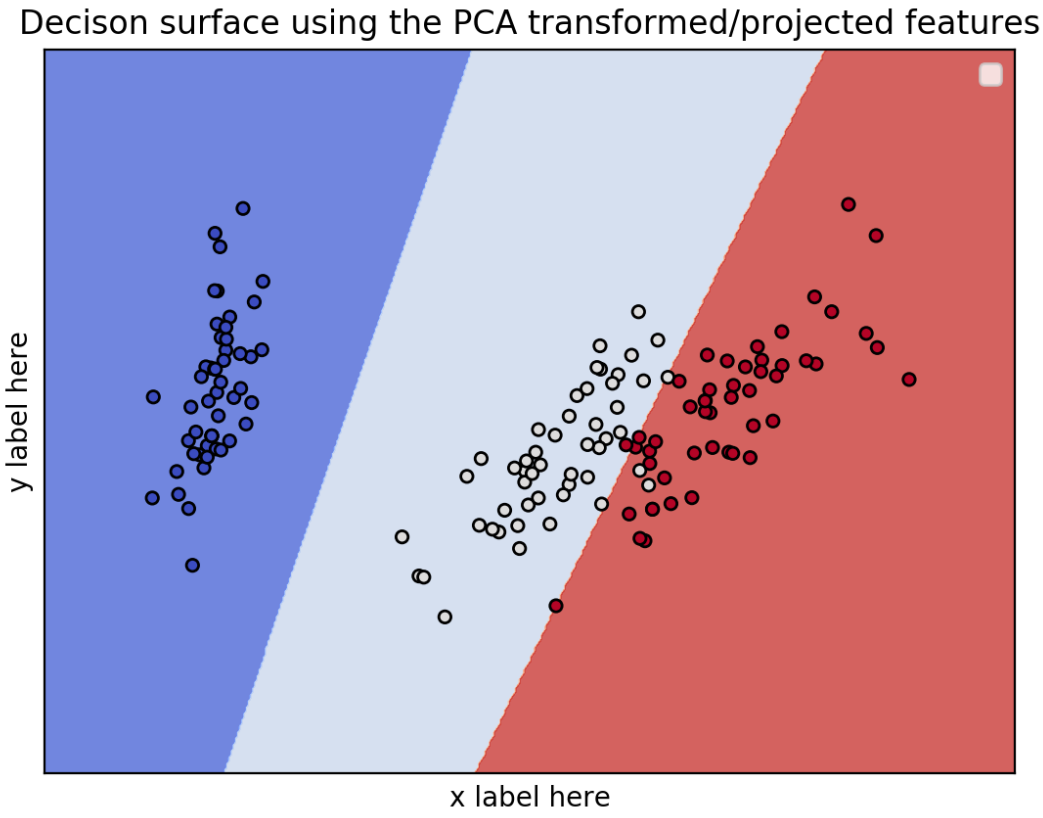
```
from sklearn.svm import SVC
import numpy as np
import matplotlib.pyplot as plt
from sklearn import svm, datasets

iris = datasets.load_iris()
# Select 2 features / variable for the 2D plot that we are going to create.
X = iris.data[:, :2]  # we only take the first two features.
y = iris.target

def make_meshgrid(x, y, h=.02):
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    out = ax.contourf(xx, yy, Z, **params)
    return out

model = svm.SVC(kernel='linear')
clf = model.fit(X, y)

fig, ax = plt.subplots()
# title for the plots
title = ('Decision surface of linear SVC ')
# Set-up grid for plotting.
X0, X1 = X[:, 0], X[:, 1]
xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.coolwarm, alpha=0.8)
ax.scatter(X0, X1, c=y, cmap=plt.cm.coolwarm, s=20, edgecolors='k')
ax.set_ylabel('y label here')
ax.set_xlabel('x label here')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```



EDIT: Apply PCA to reduce dimensionality.

```
from sklearn.svm import SVC
import numpy as np
import matplotlib.pyplot as plt
from sklearn import svm, datasets
from sklearn.decomposition import PCA

iris = datasets.load_iris()

X = iris.data
y = iris.target

pca = PCA(n_components=2)
Xreduced = pca.fit_transform(X)

def make_meshgrid(x, y, h=.02):
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_max, h))
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    out = ax.contourf(xx, yy, Z, **params)
    return out

model = svm.SVC(kernel='linear')
clf = model.fit(Xreduced, y)

fig, ax = plt.subplots()
# title for the plots
```

```
title = ('Decision surface of linear SVC ')
# Set-up grid for plotting.
X0, X1 = Xreduced[:, 0], Xreduced[:, 1]
xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.coolwarm, alpha=0.8)
ax.scatter(X0, X1, c=y, cmap=plt.cm.coolwarm, s=20, edgecolors='k')
ax.set_ylabel('PC2')
ax.set_xlabel('PC1')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title('Decison surface using the PCA transformed/projected features')
ax.legend()
plt.show()
```

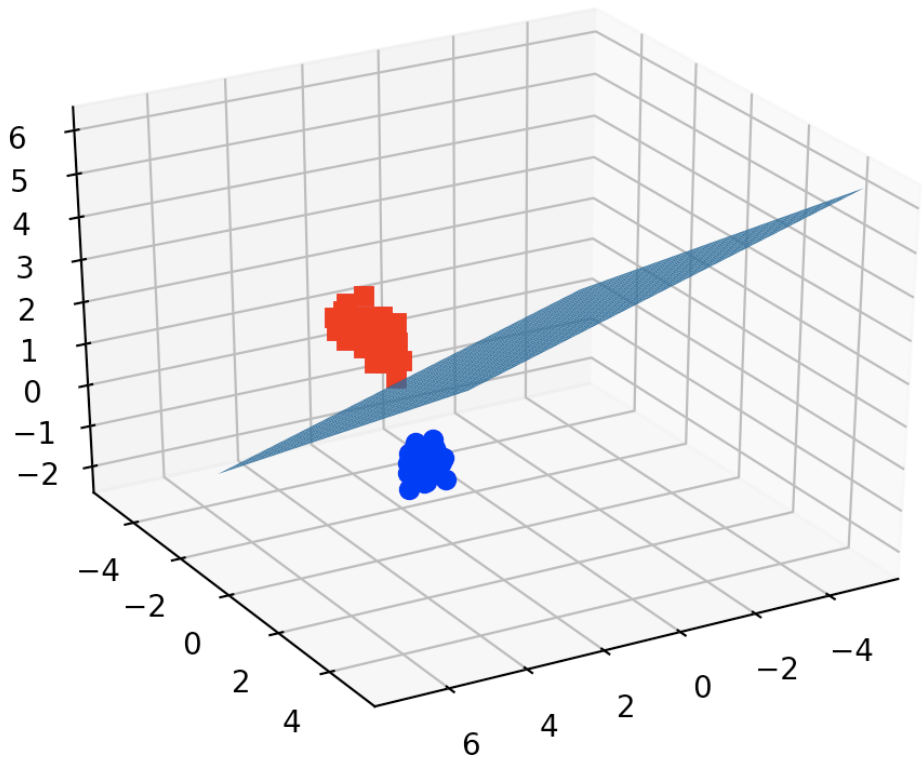


EDIT 1 (April 15th, 2020):

Case: 3D plot for 3 features and using the iris dataset

```
from sklearn.svm import SVC
import numpy as np
import matplotlib.pyplot as plt
from sklearn import svm, datasets
from mpl_toolkits.mplot3d import Axes3D

iris = datasets.load_iris()
X = iris.data[:, :3]  # we only take the first three features.
Y = iris.target

#make it binary classification problem
X = X[np.logical_or(Y==0,Y==1)]
```

```
Y = Y[np.logical_or(Y==0,Y==1)]

model = svm.SVC(kernel='linear')
clf = model.fit(X, Y)

# The equation of the separating plane is given by all x so that np.dot(svc.coef_[0],
x) + b = 0.
# Solve for w3 (z)
z = lambda x,y: (-clf.intercept_[0]-clf.coef_[0][0]*x -clf.coef_[0][1]*y) /
clf.coef_[0][2]

tmp = np.linspace(-5,5,30)
x,y = np.meshgrid(tmp,tmp)

fig = plt.figure()
ax  = fig.add_subplot(111, projection='3d')
ax.plot3D(X[Y==0,0], X[Y==0,1], X[Y==0,2],'ob')
ax.plot3D(X[Y==1,0], X[Y==1,1], X[Y==1,2],'sr')
ax.plot_surface(x, y, z(x,y))
ax.view_init(30, 60)
plt.show()
```



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edited Jun 4 '20 at 13:58

answered Jul 12 '18 at 9:01

seralouk
25.3k 5 90 109

I cant choose two features, because it is a sequence of data. I came across something called as ''dimension reduction technique" in the following link stats.stackexchange.com/a/155158 . But I am yet to figure it out. It has been said that if linear SVM is used, then data can be reduced to 2-dimensions using algorithms such as PCA. – Yoganand.N Jul 12 '18 at 9:18

1 yes this is exactly what I mentioned in my answer. You can either select 2 or do PCA for example to

reduce to 2 dimensions and then use the projected data (reduced dimemensions = 2) to feed them in the SVM and finally plot the decision surface. Do you want me to update my answer using PCA? – seralouk Jul 12 '18 at 9:29

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You can use mlxtend. It's quite clean.

First do a `pip install mlxtend` , and then:

```
from sklearn.svm import SVC
import matplotlib.pyplot as plt
from mlxtend.plotting import plot_decision_regions

svm = SVC(C=0.5, kernel='linear')
svm.fit(X, y)
plot_decision_regions(X, y, clf=svm, legend=2)
plt.show()
```

Where *X* is a two-dimensional data matrix, and *y* is the associated vector of training labels.

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edited Oct 7 '19 at 7:33

answered Oct 7 '19 at 6:30

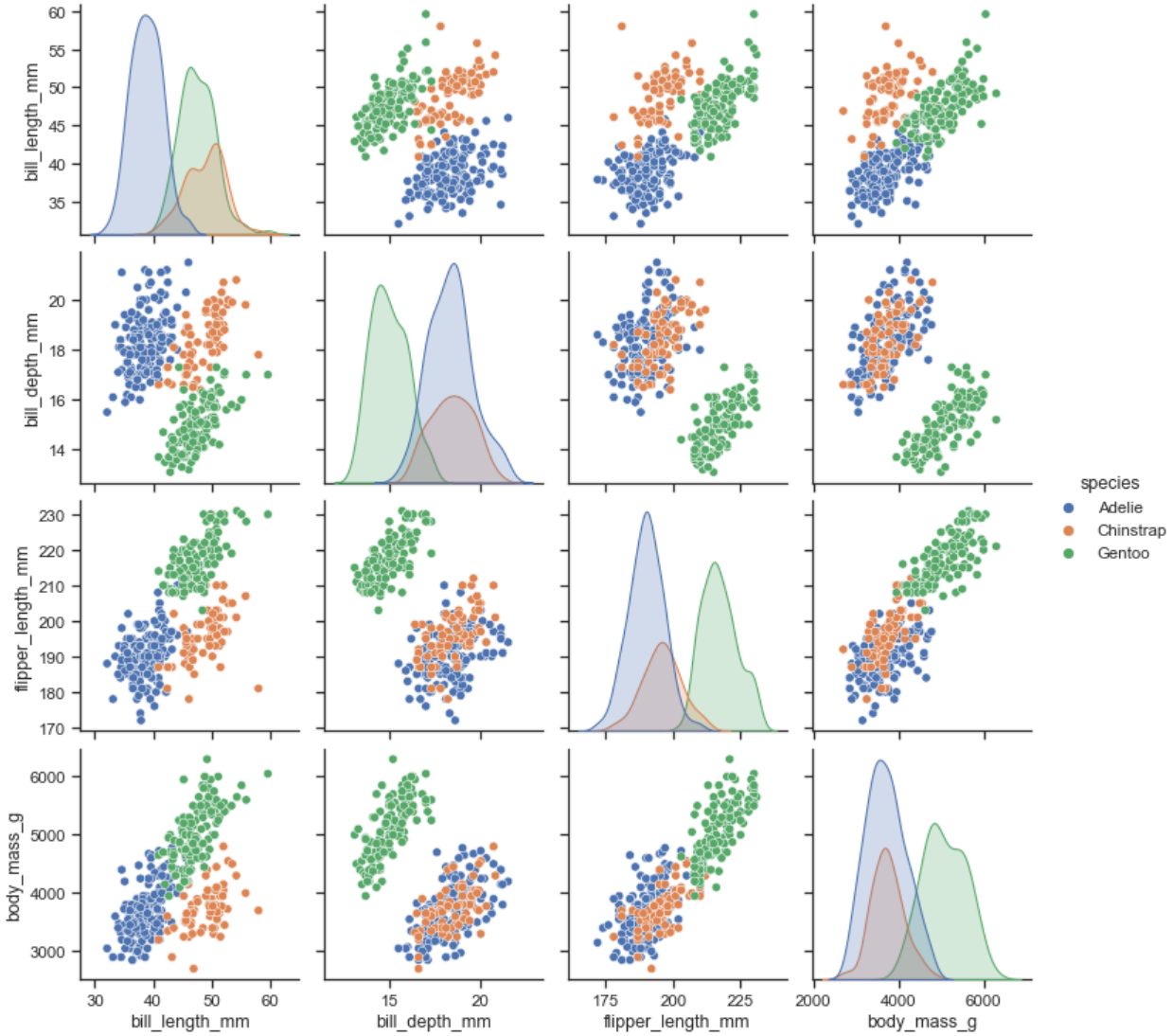
Debvrat Varshney

191 1 3 11

0

This post is hidden. It was deleted 2 years ago by Martijn Pieters ♦.

You can also use the package seaborn where you have the option to do feature-to-feature scatterplots as can be seen here.



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answered Jul 13 '18 at 9:46

stackoverFloris

57 7

This does not answer the question that was asked. – Trenton McKinney Oct 7 '19 at 6:53

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