SVM in multiclass classification

Data set: Iris flower dataset

The data set consists of 50 samples from each of three species of Iris (Iris setosa, Iris virginica and Iris versicolor), so 150 total samples. Four features were measured from each sample: the length and the width of the sepals and petals, in centimeters.

import libararies

In [3]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Load the data

In [5]:
```
iris = sns.load_dataset('iris')
```

In [7]:
```
type(iris)
```

Out[7]:
```
pandas.core.frame.DataFrame
```

In [8]:
```
iris.columns
```

Out[8]:
```
Index(['sepal_length', 'sepal_width', 'petal_length', 'petal_width',
       'species'],
      dtype='object')
```

In [9]:
```
iris.shape
```

Out[9]:
```
(150, 5)
```

In [10]:
```
iris.head(5)
```

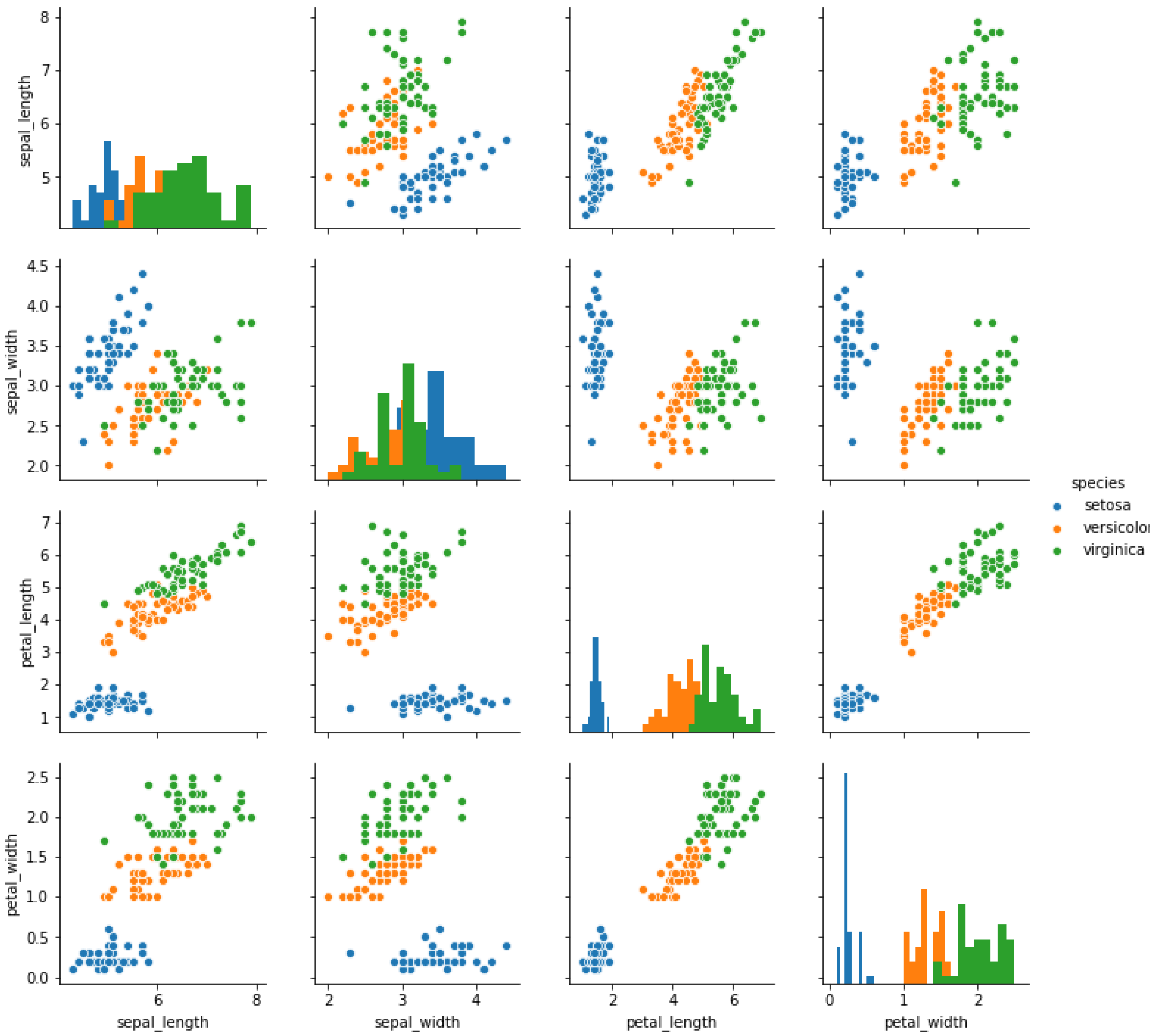
Out[10]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa

visualizing the data

In [40]:
```
sns.pairplot(data =iris, hue='species', diag_kind='hist')
```

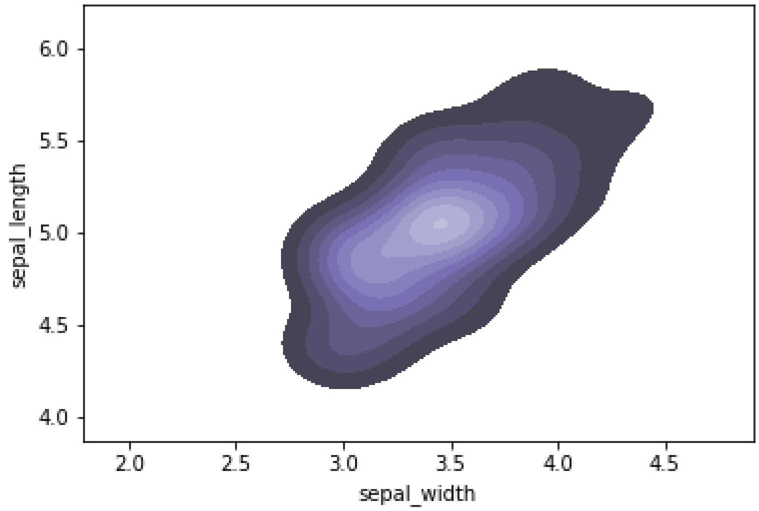
Out[40]: <seaborn.axisgrid.PairGrid at 0x21fc3e2b6a0>



From the figures, setosa is more separable from the two others.

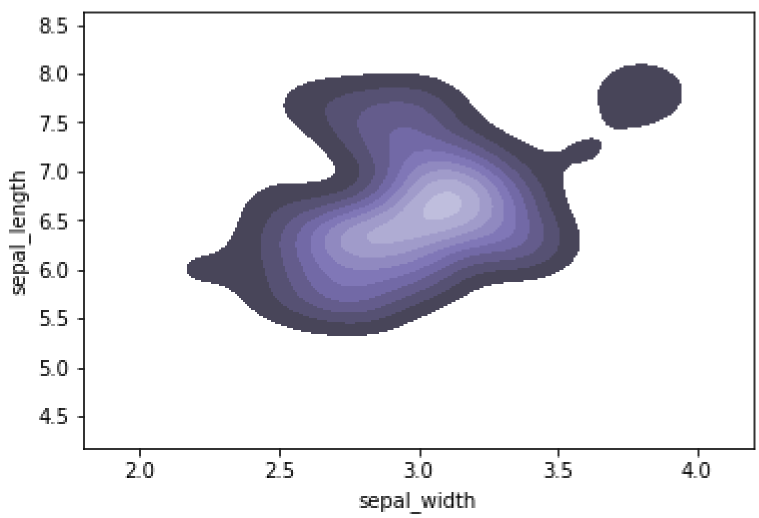
In [44]:
```
# bivariate density function plot
sns.kdeplot(iris[iris['species']=='setosa'].sepal_width,iris[iris['species']==
'setosa'].sepal_length,shade=True,shade_lowest=False,cmap="Purples_d")
```

Out[44]: <matplotlib.axes._subplots.AxesSubplot at 0x21fc5dec710>



In [48]:
```
# bivariate density function plot
sns.kdeplot(iris[iris['species']=='virginica'].sepal_width,iris[iris['species'
]=='virginica'].sepal_length,shade=True,shade_lowest=False,cmap="Purples_d")
```

Out[48]: <matplotlib.axes._subplots.AxesSubplot at 0x21fc6051748>



In [ ]:
```
# bivariate density function plot
sns.kdeplot(iris[iris['species']=='versicolor'].sepal_width,iris[iris['specie
s']=='versicolor'].sepal_length,shade=True,shade_lowest=False,cmap="Purples_d"
)
```

build SVM model

Using grid search for parameters

In [11]:
```python
X = iris.drop(columns=['species'], axis=1)
y = iris['species']
```

In [31]:
```python
X.shape
```

Out[31]:
```
(150, 4)
```

In [33]:
```python
X.head(3)
```

Out[33]:

	sepal_length	sepal_width	petal_length	petal_width
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2

In [34]:
```python
y.head(3)
```

Out[34]:
```
0    setosa
1    setosa
2    setosa
Name: species, dtype: object
```

In [14]:
```python
from sklearn.model_selection import train_test_split
```

In [15]:
```python
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.30, rando
m_state=101)
```

In [16]:
```python
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV
```

In [18]:
```python
param_grid = {'C': [0.1,1, 10, 100, 1000], 'gamma': [1,0.1,0.01,0.001,0.0001],
'kernel': ['rbf']}
grid = GridSearchCV(SVC(), param_grid, refit=True, verbose=2, cv =3)
```

In [19]:
```
grid.fit(X_train,y_train)
```

```
Fitting 3 folds for each of 25 candidates, totalling 75 fits
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=1, kernel=rbf ......................................
[CV] ....................... C=0.1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=0.1, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=0.1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] .................... C=0.1, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] C=0.1, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=0.1, gamma=0.001, kernel=rbf, total=   0.0s
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[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf ........................................
[CV] ......................... C=1, gamma=1, kernel=rbf, total=   0.0s
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[CV] ....................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] ....................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf ......................................
[CV] ....................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.01, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.01, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.01, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=rbf ...................................
[CV] .................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
```

```
[CV] C=1, gamma=0.0001, kernel=rbf ..................................
[CV] ................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=rbf ..................................
[CV] ................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=rbf ......................................
[CV] ....................... C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=rbf ......................................
[CV] ....................... C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=rbf ......................................
[CV] ....................... C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] ..................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.01, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=10, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=10, gamma=0.0001, kernel=rbf, total=   0.0s
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[CV] .................. C=10, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=rbf .....................................
[CV] ...................... C=100, gamma=1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=rbf .....................................

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent worke
rs.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.
0s
```

```
[CV] ....................... C=100, gamma=1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=rbf ......................................
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[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.01, kernel=rbf ...................................
[CV] .................... C=100, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] C=100, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=100, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=100, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=1, kernel=rbf .....................................
[CV] ...................... C=1000, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=1, kernel=rbf .....................................
[CV] ...................... C=1000, gamma=1, kernel=rbf, total=   0.0s
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[CV] .................... C=1000, gamma=0.1, kernel=rbf, total=   0.0s
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[CV] ................... C=1000, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] ................... C=1000, gamma=0.01, kernel=rbf, total=   0.0s
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[CV] .................. C=1000, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=rbf .................................
[CV] .................. C=1000, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=rbf ................................
[CV] ................. C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=rbf ................................
[CV] ................. C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=rbf ................................
[CV] ................. C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
```

```
[Parallel(n_jobs=1)]: Done  75 out of  75 | elapsed:    0.2s finished
```

Out[19]:
```
GridSearchCV(cv=3, error_score='raise-deprecating',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.1, 1, 10, 100, 1000], 'gamma': [1, 0.1, 0.01, 0.00
1, 0.0001], 'kernel': ['rbf']},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=2)
```

In [21]:
```
grid.best_params_
```

Out[21]:
```
{'C': 1, 'gamma': 0.1, 'kernel': 'rbf'}
```

In [22]:
```
grid.best_estimator_
```

Out[22]:
```
SVC(C=1, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.1, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

Predictions

In [25]:
```
pred = grid.predict(X_test)
pred_train = grid.predict(X_train)
```

Evaluation

In [27]:
```
from sklearn.metrics import confusion_matrix, classification_report, accuracy_
score
```

In [28]:
```
def eval_print(y_true, prediction):
    print('accuracy = %.2f' %(accuracy_score(y_true, prediction)))
    print(confusion_matrix(y_true, prediction))
    print(classification_report(y_true, prediction))
#print(grid.score(X_test,y_test))
```

In [29]:
```
print('test data:')
eval_print(y_test, pred)
```

```
test data:
accuracy = 0.98
[[13  0  0]
 [ 0 19  1]
 [ 0  0 12]]
              precision    recall  f1-score   support

      setosa       1.00      1.00      1.00        13
  versicolor       1.00      0.95      0.97        20
   virginica       0.92      1.00      0.96        12

   micro avg       0.98      0.98      0.98        45
   macro avg       0.97      0.98      0.98        45
weighted avg       0.98      0.98      0.98        45
```

In [30]:
```
print('train data:')
eval_print(y_train, pred_train)
```

```
train data:
accuracy = 0.98
[[37  0  0]
 [ 0 28  2]
 [ 0  0 38]]
              precision    recall  f1-score   support

      setosa       1.00      1.00      1.00        37
  versicolor       1.00      0.93      0.97        30
   virginica       0.95      1.00      0.97        38

   micro avg       0.98      0.98      0.98       105
   macro avg       0.98      0.98      0.98       105
weighted avg       0.98      0.98      0.98       105
```