

MA 506 Probability and Statistical Inference

Lecture 21: Classification Introduction ¶

```
In [1]: import numpy as np
import matplotlib.pyplot as plt
from sklearn.datasets import load_iris
```

Getting a classification dataset

```
In [2]: D = load_iris()
print(D.keys())

dict_keys(['data', 'target', 'frame', 'target_names', 'DESCR', 'feature_names', 'filename', 'data_module'])
```

```
In [3]: print(D.DESCR)

.. _iris_dataset:

Iris plants dataset
-----

**Data Set Characteristics:**

 :Number of Instances: 150 (50 in each of three classes)
 :Number of Attributes: 4 numeric, predictive attributes and the class
 :Attribute Information:
   - sepal length in cm
   - sepal width in cm
   - petal length in cm
   - petal width in cm
   - class:
     - Iris-Setosa
     - Iris-Versicolour
     - Iris-Virginica

 :Summary Statistics:
```

```
=====  =====  =====  =====  =====
              Min    Max    Mean    SD    Class Correlation
```

```

=====
sepal length:  4.3  7.9   5.84  0.83   0.7826
sepal width:   2.0  4.4   3.05  0.43  -0.4194
petal length:  1.0  6.9   3.76  1.76   0.9490 (high!)
petal width:   0.1  2.5   1.20  0.76   0.9565 (high!)
=====

```

```

:Missing Attribute Values: None
:Class Distribution: 33.3% for each of 3 classes.
:Creator: R.A. Fisher
:Donor: Michael Marshall (MARSHALL%PLU@io.arc.nasa.gov)
:Date: July, 1988

```

The famous Iris database, first used by Sir R.A. Fisher. The dataset is taken from Fisher's paper. Note that it's the same as in R, but not as in the UCI Machine Learning Repository, which has two wrong data points.

This is perhaps the best known database to be found in the pattern recognition literature. Fisher's paper is a classic in the field and is referenced frequently to this day. (See Duda & Hart, for example.) The data set contains 3 classes of 50 instances each, where each class refers to a type of iris plant. One class is linearly separable from the other 2; the latter are NOT linearly separable from each other.

.. topic:: References

- Fisher, R.A. "The use of multiple measurements in taxonomic problems" Annual Eugenics, 7, Part II, 179-188 (1936); also in "Contributions to Mathematical Statistics" (John Wiley, NY, 1950).
- Duda, R.O., & Hart, P.E. (1973) Pattern Classification and Scene Analysis. (Q327.D83) John Wiley & Sons. ISBN 0-471-22361-1. See page 218.
- Dasarathy, B.V. (1980) "Nosing Around the Neighborhood: A New System Structure and Classification Rule for Recognition in Partially Exposed Environments". IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. PAMI-2, No. 1, 67-71.
- Gates, G.W. (1972) "The Reduced Nearest Neighbor Rule". IEEE Tr

ansactions

on Information Theory, May 1972, 431–433.

– See also: 1988 MLC Proceedings, 54–64. Cheeseman et al's AUTOCLASS II

conceptual clustering system finds 3 classes in the data.

– Many, many more ...

```
In [4]: X = D.data  
        y = D.target
```

```
In [5]: print(f'X shape: {X.shape}')  
        print(f'y shape: {y.shape}')
```

```
X shape: (150, 4)  
y shape: (150,)
```

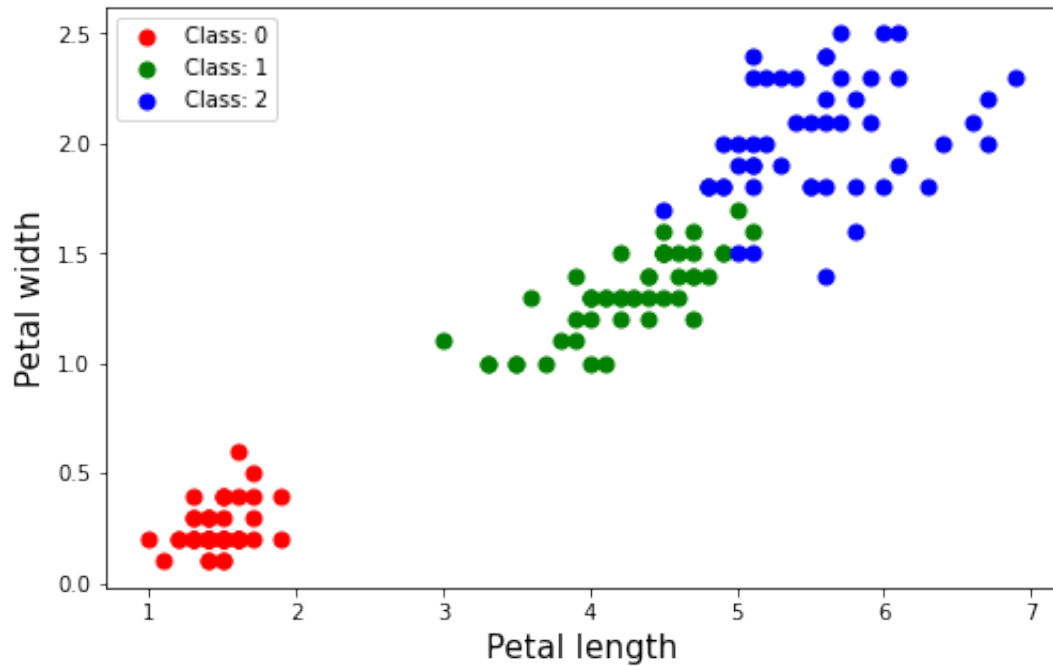
Visualizing the dataset

Considering petal width and petal length as our feature of choice. Considering just two features will help with better visualization

```
In [6]: Xc = X[:, [2, 3]]  
        print(Xc.shape)
```

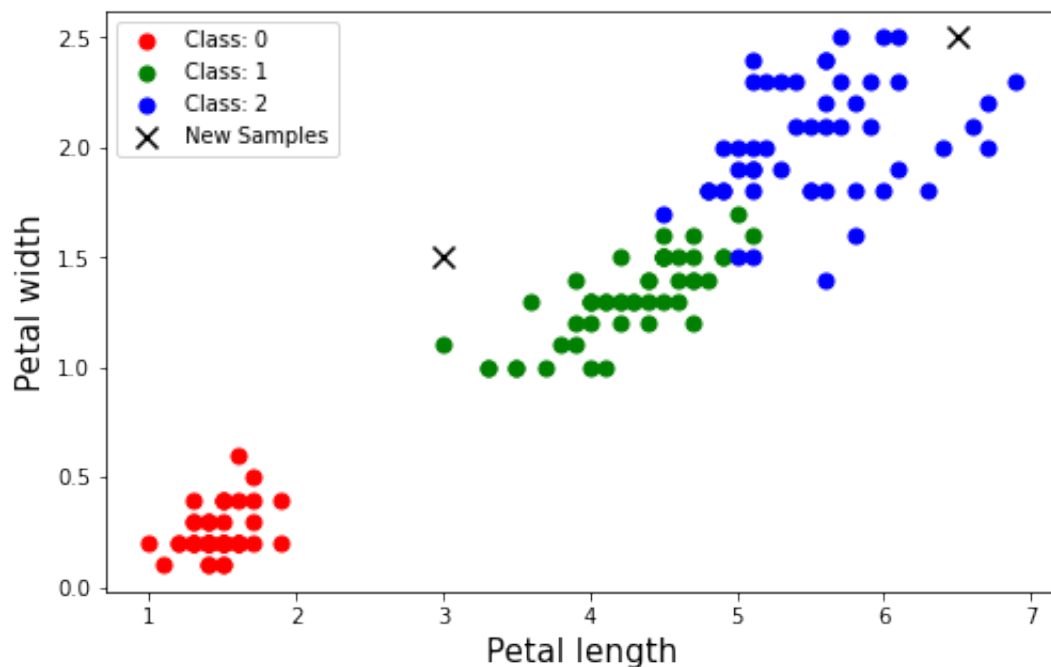
```
(150, 2)
```

```
In [7]: fig = plt.figure(figsize=(8,5))
ax = fig.add_subplot(1,1,1)
col = ['r','g','b']
plt.scatter(Xc[y ==0,0],Xc[y == 0,1],s = 50,color = col[0], label = 'C0')
plt.scatter(Xc[y ==1,0],Xc[y == 1,1],s = 50,color = col[1], label = 'C1')
plt.scatter(Xc[y ==2,0],Xc[y == 2,1],s = 50,color = col[2], label = 'C2')
plt.xlabel('Petal length',size = 15)
plt.ylabel('Petal width',size = 15)
plt.legend()
plt.show()
```



Looking at the plot below guess the class for the two new samples denoted by black cross markers:

```
In [8]: fig = plt.figure(figsize=(8,5))
ax = fig.add_subplot(1,1,1)
col = ['r','g','b']
plt.scatter(Xc[y ==0,0],Xc[y == 0,1],s = 50,color = col[0], label = 'C
plt.scatter(Xc[y ==1,0],Xc[y == 1,1],s = 50,color = col[1], label = 'C
plt.scatter(Xc[y ==2,0],Xc[y == 2,1],s = 50,color = col[2], label = 'C
plt.xlabel('Petal length',size = 15)
plt.ylabel('Petal width',size = 15)
plt.scatter(6.5,2.5,s = 100,color = 'k',marker = 'x', label = 'New Sam
plt.scatter(3,1.5,s = 100,color = 'k',marker = 'x')
plt.legend()
plt.show()
```



Using Logistic Regression to classify these samples

```
In [9]: from sklearn.linear_model import LogisticRegression
```

```
In [10]: clf = LogisticRegression(random_state=0).fit(Xc, y)
```

```
In [11]: # Predicting for samples
Xpred = np.array([[6.5,2.5],[3,1.5]])
pred = clf.predict(Xpred)
```

```
In [12]: print(f'For (6.5,2.5): class: {pred[0]}')  
         print(f'For (3,1.5): class: {pred[1]}')
```

```
For (6.5,2.5): class: 2  
For (3,1.5): class: 1
```

```
In [13]: clf.predict_proba(Xpred)
```

```
Out[13]: array([[1.81829063e-08, 1.27905943e-03, 9.98720922e-01],  
                [2.70482252e-01, 7.26104333e-01, 3.41341506e-03]])
```

```
In [ ]:
```

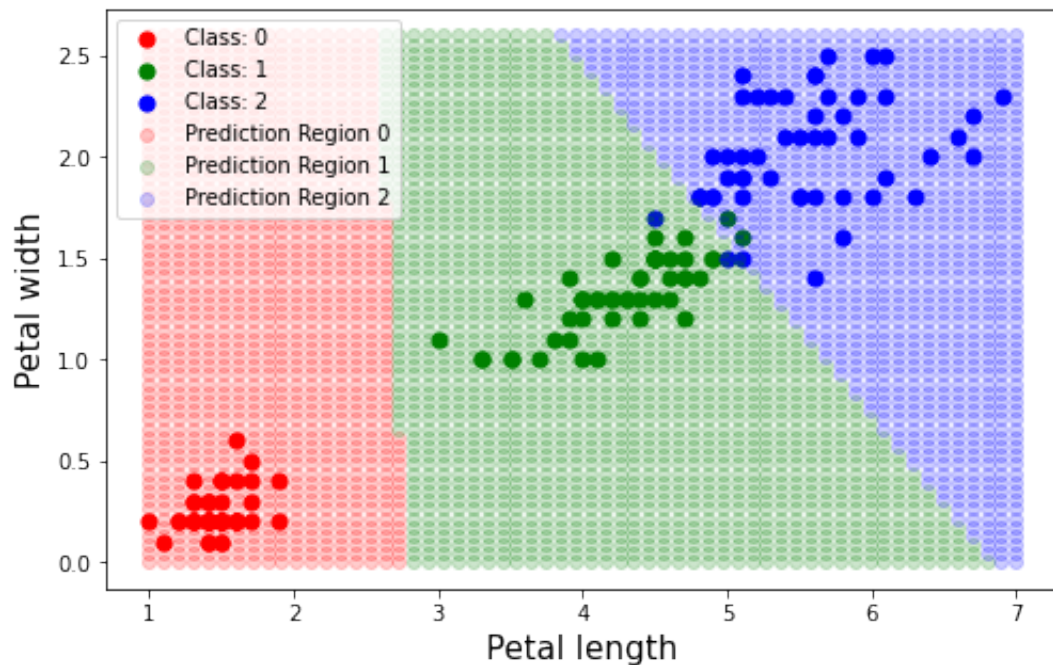
Trying to visualize the boundary Logistic Regression Learnt

1. Predict the label for all point in the 2 dimensional grid.
2. Plot them with colors so that the boundary becomes visible

```
In [18]: xx = np.linspace(1,7,60)  
         yy = np.linspace(0,2.6,60)  
         Xpred = []  
         for i in xx:  
             for j in yy:  
                 Xpred.append([i,j])  
         Xpred = np.array(Xpred)  
         pred = clf.predict(Xpred)
```

```
In [22]: fig = plt.figure(figsize=(8,5))
ax = fig.add_subplot(1,1,1)
col = ['r','g','b']
plt.scatter(Xc[y == 0,0],Xc[y == 0,1],s = 50,color = col[0], label = 'C
plt.scatter(Xc[y == 1,0],Xc[y == 1,1],s = 50,color = col[1], label = 'C
plt.scatter(Xc[y == 2,0],Xc[y == 2,1],s = 50,color = col[2], label = 'C
plt.xlabel('Petal length',size = 15)
plt.ylabel('Petal width',size = 15)

## Plotting the predictions at all points
plt.scatter(Xpred[pred == 0,0],Xpred[pred == 0,1],color = col[0], label = 'C
plt.scatter(Xpred[pred == 1,0],Xpred[pred == 1,1],color = col[1], label = 'C
plt.scatter(Xpred[pred == 2,0],Xpred[pred == 2,1],color = col[2], label = 'C
plt.legend()
plt.show()
```



In []:

In []:

In []:

