In [4]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.datasets import load_digits
```

In [5]:
```
import matplotlib.pyplot as plt
%matplotlib inline
```

In [6]:
```
digits=load_digits()
digits
```

Out[6]:
```
{'data': array([[ 0.,  0.,  5., ...,  0.,  0.,  0.],
        [ 0.,  0.,  0., ..., 10.,  0.,  0.],
        [ 0.,  0.,  0., ..., 16.,  9.,  0.],
        ...,
        [ 0.,  0.,  1., ...,  6.,  0.,  0.],
        [ 0.,  0.,  2., ..., 12.,  0.,  0.],
        [ 0.,  0., 10., ..., 12.,  1.,  0.]]),
 'target': array([0, 1, 2, ..., 8, 9, 8]),
 'target_names': array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
 'images': array([[[ 0.,  0.,  5., ...,  1.,  0.,  0.],
         [ 0.,  0., 13., ..., 15.,  5.,  0.],
         [ 0.,  3., 15., ..., 11.,  8.,  0.],
         ...,
         [ 0.,  4., 11., ..., 12.,  7.,  0.],
         [ 0.,  2., 14., ..., 12.,  0.,  0.],
         [ 0.,  0.,  6., ...,  0.,  0.,  0.]],

        [[ 0.,  0.,  0., ...,  5.,  0.,  0.],
         [ 0.,  0.,  0., ...,  9.,  0.,  0.],
         [ 0.,  0.,  3., ...,  6.,  0.,  0.],
         ...,
         [ 0.,  0.,  1., ...,  6.,  0.,  0.],
         [ 0.,  0.,  1., ...,  6.,  0.,  0.],
         [ 0.,  0.,  0., ..., 10.,  0.,  0.]],

        [[ 0.,  0.,  0., ..., 12.,  0.,  0.],
         [ 0.,  0.,  3., ..., 14.,  0.,  0.],
         [ 0.,  0.,  8., ..., 16.,  0.,  0.],
         ...,
         [ 0.,  9., 16., ...,  0.,  0.,  0.],
         [ 0.,  3., 13., ..., 11.,  5.,  0.],
         [ 0.,  0.,  0., ..., 16.,  9.,  0.]],

        ...,

        [[ 0.,  0.,  1., ...,  1.,  0.,  0.],
         [ 0.,  0., 13., ...,  2.,  1.,  0.],
         [ 0.,  0., 16., ..., 16.,  5.,  0.],
```

```
         ...,
         [ 0.,  0., 16., ..., 15.,  0.,  0.],
         [ 0.,  0., 15., ..., 16.,  0.,  0.],
         [ 0.,  0.,  2., ...,  6.,  0.,  0.]],

        [[ 0.,  0.,  2., ...,  0.,  0.,  0.],
         [ 0.,  0., 14., ..., 15.,  1.,  0.],
         [ 0.,  4., 16., ..., 16.,  7.,  0.],
         ...,
         [ 0.,  0.,  0., ..., 16.,  2.,  0.],
         [ 0.,  0.,  4., ..., 16.,  2.,  0.],
         [ 0.,  0.,  5., ..., 12.,  0.,  0.]],

        [[ 0.,  0., 10., ...,  1.,  0.,  0.],
         [ 0.,  2., 16., ...,  1.,  0.,  0.],
         [ 0.,  0., 15., ..., 15.,  0.,  0.],
         ...,
         [ 0.,  4., 16., ..., 16.,  6.,  0.],
         [ 0.,  8., 16., ..., 16.,  8.,  0.],
         [ 0.,  1.,  8., ..., 12.,  1.,  0.]]]),
 'DESCR': ".. _digits_dataset:\n\nOptical recognition of handwritten digits dataset\n--------------------------------
------------------\n\n**Data Set Characteristics:**\n\n    :Number of Instances: 5620\n    :Number of Attributes: 6
4\n    :Attribute Information: 8x8 image of integer pixels in the range 0..16.\n    :Missing Attribute Values: None
\n    :Creator: E. Alpaydin (alpaydin '@' boun.edu.tr)\n    :Date: July; 1998\n\nThis is a copy of the test set of t
he UCI ML hand-written digits datasets\nhttps://archive.ics.uci.edu/ml/datasets/Optical+Recognition+of+Handwritten+D
igits\n\nThe data set contains images of hand-written digits: 10 classes where\neach class refers to a digit.\n\nPre
processing programs made available by NIST were used to extract\nnormalized bitmaps of handwritten digits from a pre
printed form. From a\ntotal of 43 people, 30 contributed to the training set and different 13\nto the test set. 32x3
2 bitmaps are divided into nonoverlapping blocks of\n4x4 and the number of on pixels are counted in each block. This
generates\nan input matrix of 8x8 where each element is an integer in the range\n0..16. This reduces dimensionality
and gives invariance to small\ndistortions.\n\nFor info on NIST preprocessing routines, see M. D. Garris, J. L. Blu
e, G.\nT. Candela, D. L. Dimmick, J. Geist, P. J. Grother, S. A. Janet, and C.\nL. Wilson, NIST Form-Based Handprint
Recognition System, NISTIR 5469,\n1994.\n\n.. topic:: References\n\n  - C. Kaynak (1995) Methods of Combining Multip
le Classifiers and Their\n    Applications to Handwritten Digit Recognition, MSc Thesis, Institute of\n    Graduate
Studies in Science and Engineering, Bogazici University.\n  - E. Alpaydin, C. Kaynak (1998) Cascading Classifiers, K
ybernetika.\n  - Ken Tang and Ponnuthurai N. Suganthan and Xi Yao and A. Kai Qin.\n    Linear dimensionalityreductio
n using relevance weighted LDA. School of\n    Electrical and Electronic Engineering Nanyang Technological Universit
y.\n    2005.\n  - Claudio Gentile. A New Approximate Maximal Margin Classification\n    Algorithm. NIPS. 2000."}
```

In [9]:
```
dir(load_digits)
```

Out[9]:
```
['__annotations__',
 '__call__',
 '__class__',
 '__closure__',
 '__code__',
 '__defaults__',
 '__delattr__',
 '__dict__',
 '__dir__',
 '__doc__',
 '__eq__',
 '__format__',
 '__ge__',
 '__get__',
 '__getattribute__',
 '__globals__',
 '__gt__',
 '__hash__',
 '__init__',
 '__init_subclass__',
 '__kwdefaults__',
 '__le__',
 '__lt__',
 '__module__',
 '__name__',
 '__ne__',
 '__new__',
 '__qualname__',
 '__reduce__',
 '__reduce_ex__',
 '__repr__',
 '__setattr__',
 '__sizeof__',
 '__str__',
 '__subclasshook__']
```

In [10]:
```
X_train,X_test,y_train,y_test=train_test_split(digits.data,digits.target,test_size=0.2)
```

In [12]:
```
model=LogisticRegression()
model.fit(X_train,y_train)
model.score(X_test,y_test)
```

```
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432: FutureWarnin
g: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:469: FutureWarnin
g: Default multi_class will be changed to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
```

Out[12]:
```
0.9722222222222222
```

In [13]:
```
svm=SVC()
svm.fit(X_train,y_train)
svm.score(X_test,y_test)
```

```
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\svm\base.py:193: FutureWarning: The default
value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma ex
plicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
```

Out[13]:
```
0.4305555555555556
```

In [16]:
```
rf=RandomForestClassifier(n_estimators=40)
rf.fit(X_train,y_train)
rf.score(X_test,y_test)
```

Out[16]:
```
0.9805555555555555
```

In [27]:
```
from sklearn.model_selection import StratifiedKFold
```

In [30]:
```
folds=StratifiedKFold(n_splits=3)
```

In [31]:
```python
from sklearn.model_selection import cross_val_score
```

In [37]:
```python
cross_val_score(LogisticRegression(),digits.data,digits.target)
```

```
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarni
ng: The default value of cv will change from 3 to 5 in version 0.22. Specify it explicitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432: FutureWarnin
g: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:469: FutureWarnin
g: Default multi_class will be changed to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432: FutureWarnin
g: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:469: FutureWarnin
g: Default multi_class will be changed to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432: FutureWarnin
g: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:469: FutureWarnin
g: Default multi_class will be changed to 'auto' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)
```

Out[37]:
```
array([0.89534884, 0.94991653, 0.90939597])
```

In [33]:
```python
cross_val_score(RandomForestClassifier(n_estimators=40),digits.data,digits.target)
```

```
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarni
ng: The default value of cv will change from 3 to 5 in version 0.22. Specify it explicitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
```

Out[33]:
```
array([0.93521595, 0.93489149, 0.93120805])
```

In [34]:
```
cross_val_score(SVC(),digits.data,digits.target)
```

```
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarni
ng: The default value of cv will change from 3 to 5 in version 0.22. Specify it explicitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\svm\base.py:193: FutureWarning: The default
value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma ex
plicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\svm\base.py:193: FutureWarning: The default
value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma ex
plicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
C:\Users\Akshay\AppData\Local\Continuum\anaconda3\lib\site-packages\sklearn\svm\base.py:193: FutureWarning: The default
value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma ex
plicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
```

Out[34]:
```
array([0.39368771, 0.41068447, 0.45973154])
```

In [41]:
```
df1=pd.DataFrame([0.39368771, 0.41068447, 0.45973154])
df1.mean()
```

Out[41]:
```
0    0.421368
dtype: float64
```

In [ ]:
```

```