In [2]:
```
import re
import pandas as pd
from sklearn.datasets import load_digits
from sklearn.model_selection import train_test_split
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn import metrics

%matplotlib inline
digits=load_digits()
```

In [3]:
```
print(digits)
```

```
{'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]), 'frame': None, 'feature_names': ['pixel_0_0', 'pixel_0_1', 'pixel_
0_2', 'pixel_0_3', 'pixel_0_4', 'pixel_0_5', 'pixel_0_6', 'pixel_0_7', 'pixel
_1_0', 'pixel_1_1', 'pixel_1_2', 'pixel_1_3', 'pixel_1_4', 'pixel_1_5', 'pixe
l_1_6', 'pixel_1_7', 'pixel_2_0', 'pixel_2_1', 'pixel_2_2', 'pixel_2_3', 'pix
el_2_4', 'pixel_2_5', 'pixel_2_6', 'pixel_2_7', 'pixel_3_0', 'pixel_3_1', 'pi
xel_3_2', 'pixel_3_3', 'pixel_3_4', 'pixel_3_5', 'pixel_3_6', 'pixel_3_7', 'p
ixel_4_0', 'pixel_4_1', 'pixel_4_2', 'pixel_4_3', 'pixel_4_4', 'pixel_4_5',
'pixel_4_6', 'pixel_4_7', 'pixel_5_0', 'pixel_5_1', 'pixel_5_2', 'pixel_5_3',
'pixel_5_4', 'pixel_5_5', 'pixel_5_6', 'pixel_5_7', 'pixel_6_0', 'pixel_6_1',
'pixel_6_2', 'pixel_6_3', 'pixel_6_4', 'pixel_6_5', 'pixel_6_6', 'pixel_6_7',
'pixel_7_0', 'pixel_7_1', 'pixel_7_2', 'pixel_7_3', 'pixel_7_4', 'pixel_7_5',
'pixel_7_6', 'pixel_7_7'], '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.],
        ...,
```

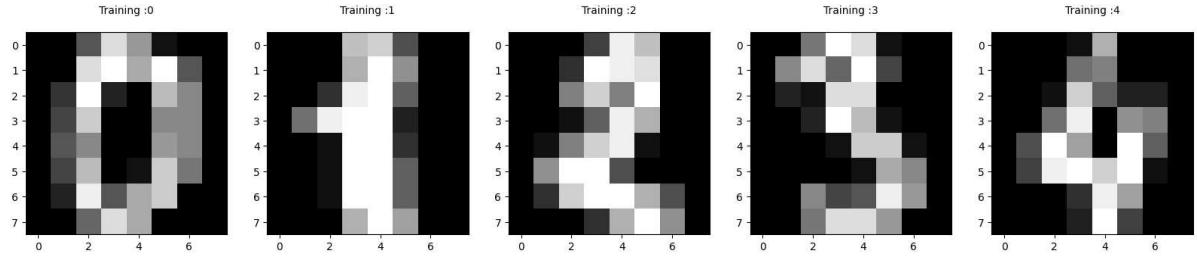
```
        [ 0.,  0.,  0., ..., 16.,  2.,  0.],
        [ 0.,  0.,  4., ..., 16.,  2.,  0.],
        [ 0.,  0.,  5., ..., 12.,  0.,  0.]],

       [[ 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_datase
t:\n\nOptical recognition of handwritten digits dataset\n--------------------
-----------------------------\n\n**Data Set Characteristics:**\n\n    :Numbe
r of Instances: 1797\n    :Number of Attributes: 64\n    :Attribute Informati
on: 8x8 image of integer pixels in the range 0..16.\n    :Missing Attribute V
alues: None\n    :Creator: E. Alpaydin (alpaydin '@' boun.edu.tr)\n    :Date:
July; 1998\n\nThis is a copy of the test set of the UCI ML hand-written digit
s datasets\nhttps://archive.ics.uci.edu/ml/datasets/Optical+Recognition+of+Ha
ndwritten+Digits\n\nThe data set contains images of hand-written digits: 10 c
lasses where\neach class refers to a digit.\n\nPreprocessing programs made av
ailable by NIST were used to extract\nnormalized bitmaps of handwritten digit
s from a preprinted form. From a\ntotal of 43 people, 30 contributed to the t
raining set and different 13\nto the test set. 32x32 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 intege
r in the range\n0..16. This reduces dimensionality and gives invariance to sm
all\ndistortions.\n\nFor info on NIST preprocessing routines, see M. D. Garri
s, J. L. Blue, G.\nT. Candela, D. L. Dimmick, J. Geist, P. J. Grother, S. A.
Janet, and C.\nL. Wilson, NIST Form-Based Handprint Recognition System, NISTI
R 5469,\n1994.\n\n.. topic:: References\n\n  - C. Kaynak (1995) Methods of Co
mbining Multiple Classifiers and Their\n    Applications to Handwritten Digit
Recognition, MSc Thesis, Institute of\n    Graduate Studies in Science and En
gineering, Bogazici University.\n  - E. Alpaydin, C. Kaynak (1998) Cascading
Classifiers, Kybernetika.\n  - Ken Tang and Ponnuthurai N. Suganthan and Xi Y
ao and A. Kai Qin.\n    Linear dimensionalityreduction using relevance weight
ed LDA. School of\n    Electrical and Electronic Engineering Nanyang Technolo
gical University.\n    2005.\n  - Claudio Gentile. A New Approximate Maximal
Margin Classification\n    Algorithm. NIPS. 2000.\n"}
```

In [4]:
```
print("Image Data Shape",digits.data.shape)
print("Label Data Shape",digits.target.shape)
```

```
Image Data Shape (1797, 64)
Label Data Shape (1797,)
```

In [5]:
```
plt.figure(figsize=(20,4))
for index,(image,label)in enumerate(zip(digits.data[0:5],digits.target[0:5])):
    plt.subplot(1,5,index+1)
    plt.imshow(np.reshape(image,(8,8)),cmap=plt.cm.gray)
    plt.title('Training :%i\n'%label,fontsize=10)
```




In [6]:
```
x_train,x_test,y_train,y_test = train_test_split(digits.data,digits.target,tes
```

In [7]:
```
print(x_train.shape)
```

```
(1257, 64)
```

In [8]:
```
print(x_train.size)
```

```
80448
```

In [9]:
```
print(y_train.shape)
```

```
(1257,)
```

In [10]:
```
print(y_train.size)
```

```
1257
```

In [11]:
```
from sklearn.linear_model import LogisticRegression
```

In [12]:
```
logisticRegr=LogisticRegression(max_iter=10000)
logisticRegr.fit(x_train,y_train)
```

Out[12]:
```
LogisticRegression
LogisticRegression(max_iter=10000)
```

In [13]:
```
print(logisticRegr.predict(x_test))
```

```
[4 0 9 1 8 7 1 5 1 6 6 7 6 1 5 5 8 6 2 7 4 6 4 1 5 2 9 5 4 6 5 6 3 4 0 9 9
 8 4 6 8 8 5 7 9 8 9 6 1 7 0 1 9 7 3 3 1 8 8 8 9 8 5 8 4 9 3 5 8 4 3 1 3 8
 7 3 3 0 8 7 2 8 5 3 8 7 6 4 6 2 2 0 1 1 5 3 5 7 1 8 2 2 6 4 6 7 3 7 3 9 4
 7 0 3 5 1 5 0 3 9 2 7 3 2 0 8 1 9 2 1 5 1 0 3 4 3 0 8 3 2 2 7 3 1 6 7 2 8
 3 1 1 6 4 8 2 1 8 4 1 3 1 1 9 5 4 8 7 4 8 9 5 7 6 9 4 0 4 0 0 9 0 6 5 8 8
 3 7 9 2 0 8 2 7 3 0 2 1 9 2 7 0 6 9 3 1 1 3 5 2 5 5 2 1 2 9 4 6 5 5 5 9 7
 1 5 9 6 3 7 1 7 5 1 7 2 7 5 5 4 8 6 6 2 8 7 3 7 8 0 9 5 7 4 3 4 1 0 3 3 5
 4 1 3 1 2 5 1 4 0 3 1 5 5 7 4 0 1 0 9 5 5 5 4 0 1 8 6 2 1 1 1 7 9 6 7 9 7
 0 4 9 6 9 2 7 2 1 0 8 2 8 6 5 7 8 4 5 7 8 6 4 2 6 9 3 0 0 8 0 6 6 7 1 4 5
 6 9 7 2 8 5 1 2 4 1 8 8 7 6 0 8 0 6 1 5 7 8 0 4 1 4 5 9 2 2 3 9 1 3 9 3 2
 8 0 6 5 6 2 5 2 3 2 6 1 0 7 6 0 6 2 7 0 3 2 4 2 3 6 9 7 7 0 3 5 4 1 2 2 1
 2 7 7 0 4 9 8 5 6 1 6 5 2 0 8 2 4 3 3 2 9 3 8 9 9 5 9 0 3 4 7 9 8 5 7 5 0
 5 3 5 0 2 7 3 0 4 3 6 6 1 9 6 3 4 6 4 6 7 2 7 6 3 0 3 0 1 3 6 1 0 4 3 8 4
 3 3 4 8 6 9 6 3 3 0 5 7 8 9 1 5 3 2 5 1 7 6 0 6 9 5 2 4 4 7 2 0 5 6 2 0 8
 4 4 4 7 1 0 4 1 9 2 1 3 0 5 3 9 8 2 6 0 0 4]
```

In [14]:
```
score=logisticRegr.score(x_test,y_test)
print(score)
```

```
0.9537037037037037
```