tranquoclongt1 / **ML**

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1 contributor

```
1.55 MB
```

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Bài tập 2: Handwritting digits - clustering

K-means

In [19]:

```
#import libs
from time import time
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [20]:

```
#import scikit-learn
from sklearn import metrics
from sklearn.cluster import KMeans
from sklearn.datasets import load_digits
```

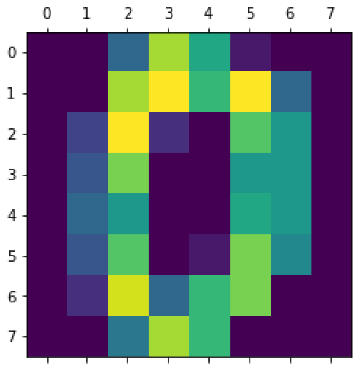
In [21]:

```
digits = load_digits();
print(digits.data.shape);
```

```
(1797, 64)
```

In [22]:

```
%matplotlib inline
#plt.gray();
plt.matshow(digits.images[0]);
```



In [23]:

```
nClusters = 10
model1 = KMeans(nClusters)
labels_kmeans = model1.fit_predict(digits.data)
```

In [24]:

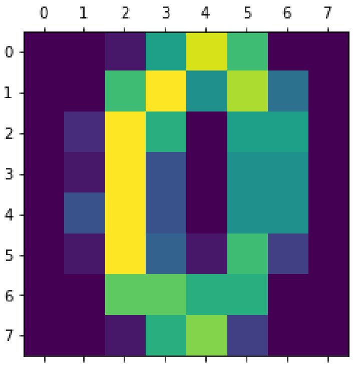
```
df = pd.DataFrame({'labels':labels_kmeans,'Truth labels':digits.target})
ct = pd.crosstab(df['labels'],df['Truth labels'])
print(ct)
```

```
Truth labels    0   1    2    3    4    5    6    7   8    9
labels
0               0   1   13  155    0    0    0    0   2    6
1               0   0    2   13    0   43    0    0  52  139
2               0   2    0    0    0    1  177    0   2    0
3               0  55    2    0    5    0    1    2   6   20
4               0  24  148    0    0    0    0    0   3    0
5               1   0    0    0  164    1    0    0   0    0
6               0  99    8    7    3    0    2    2  99    1
7             177   0    1    0    0    0    1    0   0    0
8               0   0    3    6    9    0    0  170   2    7
9               0   1    0    2    0  137    0    5   8    7
```

In [25]:

```
n = 10
%matplotlib inline
plt.matshow(digits.images[n])
print('Predict Label:', labels_kmeans[n])

print('Truth: ', digits.target[n])
```

```
Predict Label: 7
Truth:  0
```

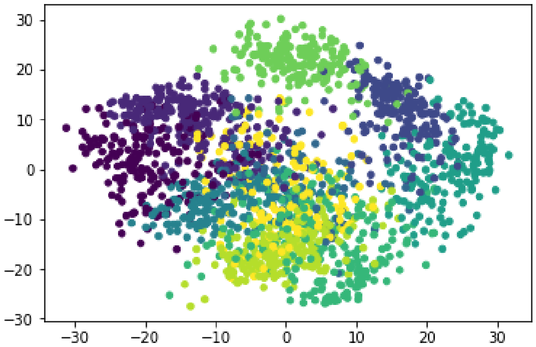


Visualization - Kmeans

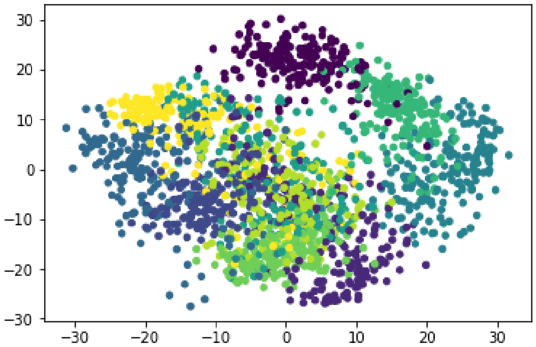
In [26]:
```
#import libs
import numpy as np
from sklearn.decomposition import PCA
```

PCA

In [27]:
```
nComponents = 2
vPCA = PCA(nComponents)
digitData_to_2D = vPCA.fit_transform(digits.data)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= labels_kmeans, s=20)
plt.show()
```



In [29]:
```
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= digits.target, s=20)
plt.show()
```



In [ ]:

Speactral clustering

In [44]:
```
# Spectral_clustering

from sklearn.cluster import spectral_clustering
from sklearn.feature_extraction import image
import numpy as np
```

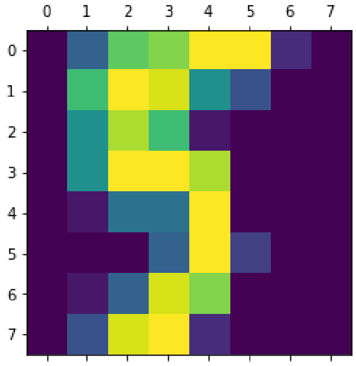
```
from sklearn.neighbors import DistanceMetric
from sklearn.metrics.pairwise import cosine_similarity

# dist = DistanceMetric.get_metric('euclidean')
# graph=dist.pairwise(digits.data)

graph = cosine_similarity(digits.data)
label_spectral = spectral_clustering(graph, n_clusters=10)
```

In [45]:
```
df1 = pd.DataFrame({'labels':label_spectral,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)
```

```
Truth labels    0   1    2    3    4    5    6    7    8    9
labels
0               0  58    5    5    1    0    0   15   40   36
1               0   0    1  146    0    0    0    0    6    2
2               0   0    0    4    0  157    0    0    3    3
3               0   2    0    1    0    2  172    0   13    0
4               0   0    0   16    0   20    2    0    7  133
5             177   0    1    0    1    1    0    0    0    3
6               0   0    2    2   11    0    0  154    3    2
7               0  36  115    4    0    0    0    0    1    0
8               1   0    0    0  163    2    0    0    0    0
9               0  86   53    5    5    0    7   10  101    1
```

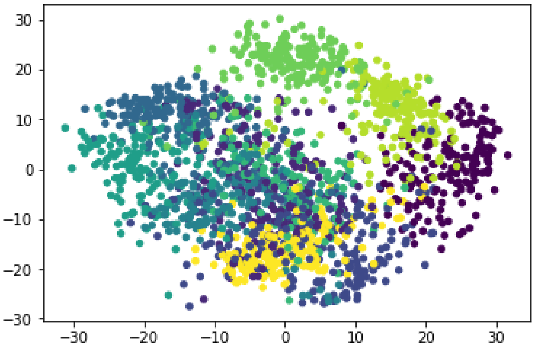
In [46]:
```
n = 15
plt.matshow(digits.images[n])
print('lables_predict:',label_spectral[n])
print(' True: ', digits.target[n])
```

```
lables_predict: 2
 True:  5
```



Visualization - Spectral Clustering

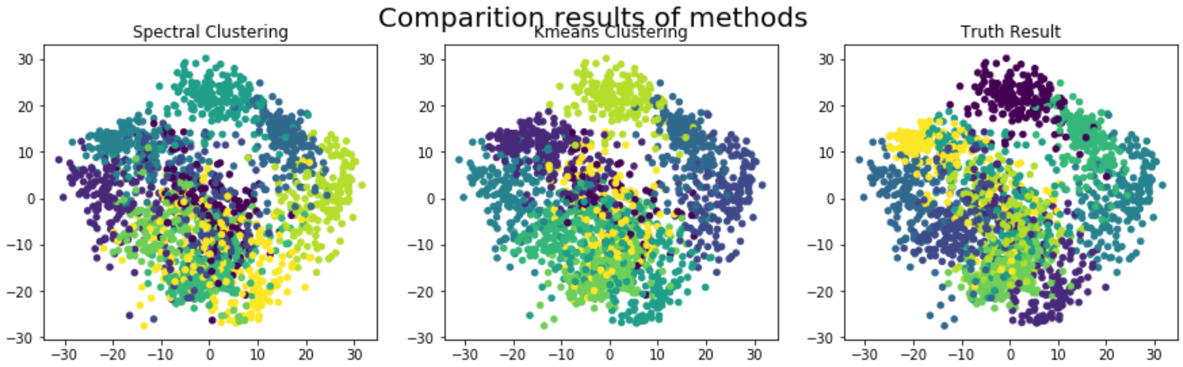
In [15]:
```
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= label_spectral, s=20)
plt.show()
```



Visualize results to compare - Using PCA

In [58]:
```
fig = plt.figure(figsize=(15,4))
fig.suptitle('Comparition results of methods', fontsize=20)

ax = fig.add_subplot(1,3,1)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= label_spectral, s=20)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= label_spectral, s=20)
ax.set_title('Spectral Clustering')

ax = fig.add_subplot(1,3,2)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= labels_kmeans, s=20)
ax.set_title('Kmeans Clustering')

ax = fig.add_subplot(1,3,3)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= digits.target, s=20)
ax.set_title('Truth Result')
```

```
Out[58]: <matplotlib.text.Text at 0x23de36f9be0>
```



DBSCAN

```
In [26]: import numpy as np
         import matplotlib.pyplot as plt
         from sklearn.cluster import DBSCAN
         from sklearn import metrics
         from sklearn.datasets.samples_generator import make_blobs
         from sklearn.preprocessing import StandardScaler

         #import scikit-learn
         from sklearn import metrics
         from sklearn.cluster import KMeans
         from sklearn.datasets import load_digits
         from sklearn.preprocessing import scale
         from sklearn.decomposition import PCA
```

```
In [27]: digits = load_digits()
         data = digits.data
         data = StandardScaler().fit_transform(data)

         n_samples, n_features = data.shape
         n_digits = len(np.unique(digits.target))
         labels = digits.target

         sample_size = 300

         print("n_digits: %d, \t n_samples %d, \t n_features %d"
               % (n_digits, n_samples, n_features))

         n_digits: 10,    n_samples 1797,         n_features 64
```

```
In [28]: print(data)

         [[ 0.         -0.33501649 -0.04308102 ..., -1.14664746 -0.5056698
           -0.19600752]
          [ 0.         -0.33501649 -1.09493684 ...,  0.54856067 -0.5056698
           -0.19600752]
          [ 0.         -0.33501649 -1.09493684 ...,  1.56568555  1.6951369
           -0.19600752]
          ...,
          [ 0.         -0.33501649 -0.88456568 ..., -0.12952258 -0.5056698
           -0.19600752]
          [ 0.         -0.33501649 -0.67419451 ...,  0.8876023  -0.5056698
           -0.19600752]
          [ 0.         -0.33501649  1.00877481 ...,  0.8876023  -0.26113572
           -0.19600752]]
```

```
In [45]: db = DBSCAN(eps=1, min_samples=1,algorithm='kd_tree').fit(data)
```

In [46]:
```
print(db)
```

```
DBSCAN(algorithm='kd_tree', eps=1, leaf_size=30, metric='euclidean',
    metric_params=None, min_samples=1, n_jobs=1, p=None)
```

In [47]:
```
print(db.labels_)
print(sum(db.labels_== -1))
```

```
[   0    1    2 ..., 1793 1794 1795]
0
```

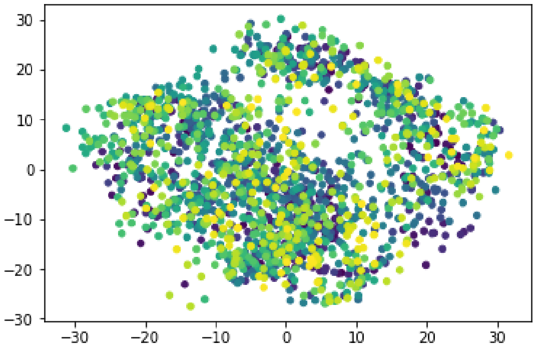
In [48]:
```
import pandas as pd
df1 = pd.DataFrame({'labels':db.labels_,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)
```

```
Truth labels  0  1  2  3  4  5  6  7  8  9
labels
0             1  0  0  0  0  0  0  0  0  0
1             0  1  0  0  0  0  0  0  0  0
2             0  0  1  0  0  0  0  0  0  0
3             0  0  0  1  0  0  0  0  0  0
4             0  0  0  0  1  0  0  0  0  0
5             0  0  0  0  0  1  0  0  0  0
6             0  0  0  0  0  0  1  0  0  0
7             0  0  0  0  0  0  0  1  0  0
8             0  0  0  0  0  0  0  0  1  0
9             0  0  0  0  0  0  0  0  0  1
10            1  0  0  0  0  0  0  0  0  0
11            0  1  0  0  0  0  0  0  0  0
12            0  0  1  0  0  0  0  0  0  0
13            0  0  0  1  0  0  0  0  0  0
14            0  0  0  0  1  0  0  0  0  0
15            0  0  0  0  0  1  0  0  0  0
16            0  0  0  0  0  0  1  0  0  0
17            0  0  0  0  0  0  0  1  0  0
18            0  0  0  0  0  0  0  0  1  0
19            0  0  0  0  0  0  0  0  0  1
20            1  0  0  0  0  0  0  0  0  0
21            0  1  0  0  0  0  0  0  0  0
22            0  0  1  0  0  0  0  0  0  0
23            0  0  0  1  0  0  0  0  0  0
24            0  0  0  0  1  0  0  0  0  0
25            0  0  0  0  0  1  0  0  0  0
26            0  0  0  0  0  0  1  0  0  0
27            0  0  0  0  0  0  0  1  0  0
28            0  0  0  0  0  0  0  0  1  0
29            0  0  0  0  0  0  0  0  0  1
...          .. .. .. .. .. .. .. .. .. ..
1766          0  0  0  0  1  0  0  0  0  0
1767          1  0  0  0  0  0  0  0  0  0
1768          0  0  0  0  0  1  0  0  0  0
1769          0  0  0  1  0  0  0  0  0  0
1770          0  0  0  0  0  0  1  0  0  0
1771          0  0  0  0  0  0  0  0  0  1
1772          0  0  0  0  0  0  1  0  0  0
1773          0  1  0  0  0  0  0  0  0  0
1774          0  0  0  0  0  0  0  1  0  0
1775          0  0  0  0  0  1  0  0  0  0
1776          0  0  0  0  1  0  0  0  0  0
1777          0  0  0  0  1  0  0  0  0  0
1778          0  0  0  0  0  0  0  1  0  0
1779          0  0  1  0  0  0  0  0  0  0
1780          0  0  0  0  0  0  0  0  1  0
1781          0  0  1  0  0  0  0  0  0  0
1782          0  0  1  0  0  0  0  0  0  0
1783          0  0  0  0  0  1  0  0  0  0
1784          0  0  0  0  0  0  0  1  0  0
1785          0  0  0  0  0  0  0  0  0  1
1786          0  0  0  0  0  1  0  0  0  0
1787          0  0  0  0  1  0  0  0  0  0
1788          0  0  0  0  0  0  0  0  1  0
1789          0  0  0  0  0  0  0  0  1  0
1790          0  0  0  0  1  0  0  0  0  0
1791          0  0  0  0  0  0  0  0  0  1
1792          1  0  0  0  0  0  0  0  0  0
1793          0  0  0  0  0  0  0  0  1  0
1794          0  0  0  0  0  0  0  0  0  1
1795          0  0  0  0  0  0  0  0  1  0
```

```
[1796 rows x 10 columns]
```

In [49]:

```
nComponents = 2
vPCA = PCA(nComponents)
digitData_to_2D = vPCA.fit_transform(digits.data)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= db.labels_, s=20)
plt.show()
```



Agglomerative Clustering

In [53]:

```
from sklearn.cluster import AgglomerativeClustering
```

In [57]:

```
Agglomerative_model = AgglomerativeClustering(n_clusters = 10)
```

In [58]:

```
db = Agglomerative_model.fit(data)
```

In [59]:

```
print(db.labels_)
```

```
[5 1 1 ..., 1 1 1]
```

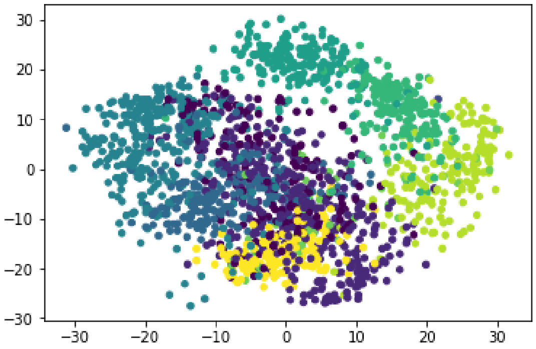
In [60]:

```
import pandas as pd
df1 = pd.DataFrame({'labels':db.labels_,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)
```

```
Truth labels    0    1    2    3    4    5    6    7    8    9
labels
0               0    1    0    0    1  168    0    1    1    3
1               0  150   15   11    4    0    1    1  168   38
2               0    0    1    0    1    0    0    0    0    0
3               0   27  160    4    0    1    0    0    3    0
4               0    0    1  168    0   12    0    1    2  135
5             178    0    0    0    0    0    0    0    0    0
6               0    0    0    0    0    1  180    0    0    1
7               0    0    0    0   12    0    0   25    0    3
8               0    4    0    0  163    0    0    0    0    0
9               0    0    0    0    0    0    0  151    0    0
```

In [61]:

```
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= db.labels_, s=20)
plt.show()
```



Comparison of cluster methods

In [84]:

```
#import libs
```

```
from time import time
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [85]:

```
#import scikit-learn
from sklearn import metrics
from sklearn.cluster import KMeans, spectral_clustering, DBSCAN, AgglomerativeClustering
from sklearn.datasets import load_digits
from sklearn.neighbors import DistanceMetric
from sklearn.metrics.pairwise import cosine_similarity
```

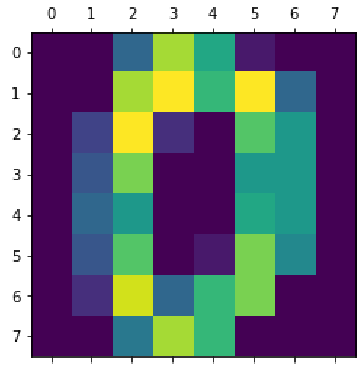
In [86]:

```
digits = load_digits();
print(digits.data.shape);
```

```
(1797, 64)
```

In [87]:

```
%matplotlib inline
#plt.gray();
plt.matshow(digits.images[0]);
```



Clustering

In [100]:

```
#Kmeans
nClusters = 10
t0 = time()
kmeans_model = KMeans(nClusters)
t_kmeans = time()- t0
labels_kmeans = kmeans_model.fit_predict(digits.data)
```

In [101]:

```
#Spectral_clustering
t0 = time()
graph = cosine_similarity(digits.data)
t_spectral = time()- t0
labels_spectral = spectral_clustering(graph, n_clusters=10)
```

In [102]:

```
#DBSCAN
data = digits.data
t0 = time()
data = StandardScaler().fit_transform(data)
labels_dbscan = DBSCAN(eps=1, min_samples=1,algorithm='kd_tree').fit_predict(data)
t_dbscan = time()- t0
```

In [103]:

```
#Agglomerative Clustering
t0 = time()
Agglomerative_model = AgglomerativeClustering(n_clusters = nClusters)
labels_AgglomerativeClustering = Agglomerative_model.fit_predict(data)
t_agg = time() - t0
```

Cross table

In [104]:

```
#Kmeans
print('Kmeans:\n')
df1 = pd.DataFrame({'labels':labels_kmeans,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)

#Spectral_clustering
```

```
#Spectral clustering
print('\n\n\n')
print('Spectral clustering:\n')
df1 = pd.DataFrame({'labels':labels_spectral,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)

#DBSCAN
print('\n\n\n')
print('DBSCAN:\n')
df1 = pd.DataFrame({'labels':labels_dbscan,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)

#Agglomerative Clustering
print('\n\n\n')
print('Agglomerative Clustering:\n')
df1 = pd.DataFrame({'labels':labels_AgglomerativeClustering,'Truth labels':digits.target})
ct2 = pd.crosstab(df1['labels'],df1['Truth labels'])
print(ct2)
```

```
Kmeans:

Truth labels    0   1    2    3    4    5    6    7    8    9
labels
0               0  99    8    7    3    0    2    2  102    2
1               0   0    2   11    0   42    0    0   48  139
2               0   0    3    7    9    0    0  175    5    7
3               0   1   13  155    0    1    0    0    4    6
4               0  55    2    0    5    0    1    2    6   20
5               0   2    0    0    0    1  177    0    2    0
6             177   0    1    0    0    0    1    0    0    0
7               1   0    0    0  164    2    0    0    0    0
8               0   1    0    2    0  136    0    0    4    6
9               0  24  148    1    0    0    0    0    3    0




Spectral clustering:

Truth labels    0   1    2    3    4    5    6    7    8    9
labels
0             177   0    1    0    1    1    0    0    0    3
1               1   0    0    0  163    2    0    0    0    0
2               0   0    1  145    0    0    0    0    6    2
3               0  58    5    5    1    0    0   14   36   35
4               0   0    0    4    0  157    0    0    3    3
5               0   0    2    2   11    0    0  155    3    2
6               0   0    0   16    0   20    3    0    7  134
7               0   2    0    1    0    2  172    0   14    0
8               0  36  115    4    0    0    0    0    1    0
9               0  86   53    6    5    0    6   10  104    1




DBSCAN:

Truth labels  0  1  2  3  4  5  6  7  8  9
labels
0             1  0  0  0  0  0  0  0  0  0
1             0  1  0  0  0  0  0  0  0  0
2             0  0  1  0  0  0  0  0  0  0
3             0  0  0  1  0  0  0  0  0  0
4             0  0  0  0  1  0  0  0  0  0
5             0  0  0  0  0  1  0  0  0  0
6             0  0  0  0  0  0  1  0  0  0
7             0  0  0  0  0  0  0  1  0  0
8             0  0  0  0  0  0  0  0  1  0
9             0  0  0  0  0  0  0  0  0  1
10            1  0  0  0  0  0  0  0  0  0
11            0  1  0  0  0  0  0  0  0  0
12            0  0  1  0  0  0  0  0  0  0
13            0  0  0  1  0  0  0  0  0  0
14            0  0  0  0  1  0  0  0  0  0
15            0  0  0  0  0  1  0  0  0  0
16            0  0  0  0  0  0  1  0  0  0
17            0  0  0  0  0  0  0  1  0  0
18            0  0  0  0  0  0  0  0  1  0
```

```
19           0  0  0  0  0  0  0  0  0  1
20           1  0  0  0  0  0  0  0  0  0
21           0  1  0  0  0  0  0  0  0  0
22           0  0  1  0  0  0  0  0  0  0
23           0  0  0  1  0  0  0  0  0  0
24           0  0  0  0  1  0  0  0  0  0
25           0  0  0  0  0  1  0  0  0  0
26           0  0  0  0  0  0  1  0  0  0
27           0  0  0  0  0  0  0  1  0  0
28           0  0  0  0  0  0  0  0  1  0
29           0  0  0  0  0  0  0  0  0  1
...         .. .. .. .. .. .. .. .. .. ..
1766         0  0  0  0  1  0  0  0  0  0
1767         1  0  0  0  0  0  0  0  0  0
1768         0  0  0  0  0  1  0  0  0  0
1769         0  0  0  1  0  0  0  0  0  0
1770         0  0  0  0  0  0  1  0  0  0
1771         0  0  0  0  0  0  0  0  0  1
1772         0  0  0  0  0  0  1  0  0  0
1773         0  1  0  0  0  0  0  0  0  0
1774         0  0  0  0  0  0  0  1  0  0
1775         0  0  0  0  0  1  0  0  0  0
1776         0  0  0  0  1  0  0  0  0  0
1777         0  0  0  0  1  0  0  0  0  0
1778         0  0  0  0  0  0  0  1  0  0
1779         0  0  1  0  0  0  0  0  0  0
1780         0  0  0  0  0  0  0  0  1  0
1781         0  0  1  0  0  0  0  0  0  0
1782         0  0  1  0  0  0  0  0  0  0
1783         0  0  0  0  0  1  0  0  0  0
1784         0  0  0  0  0  0  0  1  0  0
1785         0  0  0  0  0  0  0  0  0  1
1786         0  0  0  0  0  1  0  0  0  0
1787         0  0  0  0  1  0  0  0  0  0
1788         0  0  0  0  0  0  0  0  1  0
1789         0  0  0  0  0  0  0  0  1  0
1790         0  0  0  0  1  0  0  0  0  0
1791         0  0  0  0  0  0  0  0  0  1
1792         1  0  0  0  0  0  0  0  0  0
1793         0  0  0  0  0  0  0  0  1  0
1794         0  0  0  0  0  0  0  0  0  1
1795         0  0  0  0  0  0  0  0  1  0

[1796 rows x 10 columns]



Agglomerative Clustering:

Truth labels    0    1    2    3    4    5    6    7    8    9
labels
0               0    1    0    0    1  168    0    1    1    3
1               0  150   15   11    4    0    1    1  168   38
2               0    0    1    0    1    0    0    0    0    0
3               0   27  160    4    0    1    0    0    3    0
4               0    0    1  168    0   12    0    1    2  135
5             178    0    0    0    0    0    0    0    0    0
6               0    0    0    0    0    1  180    0    0    1
7               0    0    0    0   12    0    0   25    0    3
8               0    4    0    0  163    0    0    0    0    0
9               0    0    0    0    0    0    0  151    0    0
```

Comparison

In [112]:

```
#print frame
print("n_digits: %d, \t n_samples %d, \t n_features %d"
      % (n_digits, n_samples, n_features))

print(82 * '_')
print('init\t\ttime\tinertia\thomo\tcompl\tv-meas\tARI\tAMI\tsilhouette')


data = digits.data
#define a function to measure and print out
def bench_clustering(method_name, time_, labels):
    print('%-9s\t%.2fs\t%.3f\t%.3f\t%.3f\t%.3f\t%.3f\t%.3f'
          % (method_name, time_,
             metrics.homogeneity_score(digits.target, labels),
             metrics.completeness_score(digits.target, labels),
             metrics.v_measure_score(digits.target, labels),
             metrics.adjusted_rand_score(digits.target, labels),
             metrics.adjusted_mutual_info_score(digits.target,  labels),
             metrics.silhouette_score(data, labels,
                                      metric='euclidean',
                                      sample_size=sample_size)))


#Kmeans
bench_clustering('K-means', t_kmeans, labels_kmeans)
#Spectral_clustering
bench_clustering('spectral', t_spectral, labels_spectral)

#Agglomerative clustering
bench_clustering('Agg.', t_agg, labels_AgglomerativeClustering)
#DBSCAN ==> Problems with raw data
#bench_clustering('DBSCAN', t_dbscan, labels_dbscan)
print('-----------\nProblems with raw data cause noise with DBSCAN method')
```

```
n_digits: 10,    n_samples 1797,         n_features 64
__________________________________________________________________________________
init            time    inertia homo    compl   v-meas  ARI     AMI     silhouette
K-means         0.00s   0.739   0.747   0.743   0.669   0.736   0.178
spectral        0.03s   0.711   0.716   0.713   0.625   0.708   0.165
Agg.            0.15s   0.758   0.836   0.796   0.664   0.756   0.127
-----------
Problems with raw data cause noise with DBSCAN method
```

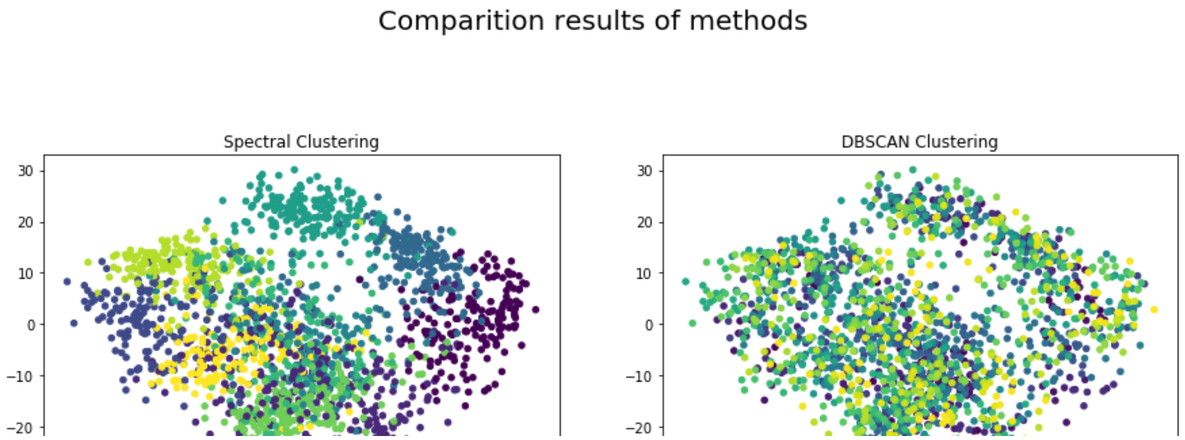
Visualization

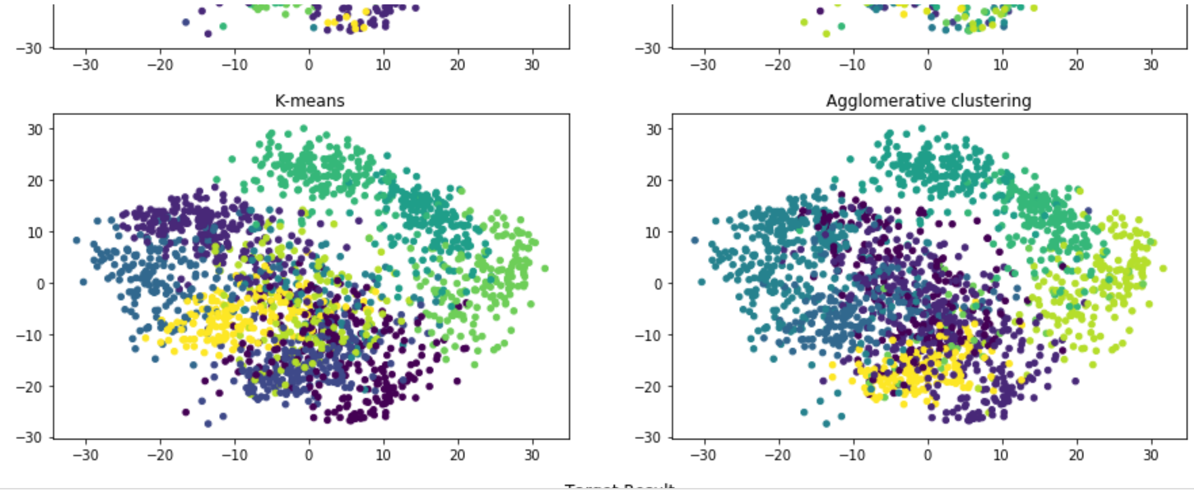
In [149]:

```
nComponents = 2
vPCA = PCA(nComponents)
digitData_to_2D = vPCA.fit_transform(digits.data)

fig = plt.figure(figsize=(15,15))
fig.suptitle('Comparition results of methods', fontsize=20)

ax = fig.add_subplot(3,2,1)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= label_spectral, s=20)
ax.set_title('Spectral Clustering')

ax = fig.add_subplot(3,2,2)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= labels_dbscan, s=20)
ax.set_title('DBSCAN Clustering')

ax = fig.add_subplot(3,2,3)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= labels_kmeans, s=20)
ax.set_title('K-means')

ax = fig.add_subplot(3,2,4)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= labels_AgglomerativeClustering, s=20)
ax.set_title('Agglomerative clustering')

ax = fig.add_subplot(3,1,3)
plt.scatter(digitData_to_2D[:,0], digitData_to_2D[:,1],  c= digits.target, s=20)
ax.set_title('Target Result')
```

Out[149]:

```
<matplotlib.text.Text at 0x22075511a90>
```




−30
−30
−20
−10
0
10
20
30
K-means
Agglomerative clustering
30
20
10
0
−10
−20
−30
−30
−20
−10
0
10
20
30
Target Result