In [1]:

```
# MNIST dataset downloaded from Kaggle :
#https://www.kaggle.com/c/digit-recognizer/data

# Functions to read and show images.

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt



d0 = pd.read_csv('./mnist_train.csv')

print(d0.head(5)) # print first five rows of d0.

# save the labels into a variable l.
l = d0['label']

# Drop the label feature and store the pixel data in d.
d = d0.drop("label",axis=1)
```

```
   label  pixel0  pixel1  pixel2  pixel3  pixel4  pixel5  pixel6  pixel7  \
0      1       0       0       0       0       0       0       0       0
1      0       0       0       0       0       0       0       0       0
2      1       0       0       0       0       0       0       0       0
3      4       0       0       0       0       0       0       0       0
4      0       0       0       0       0       0       0       0       0

   pixel8    ...     pixel774  pixel775  pixel776  pixel777  pixel778  \
0       0    ...            0         0         0         0         0
1       0    ...            0         0         0         0         0
2       0    ...            0         0         0         0         0
3       0    ...            0         0         0         0         0
4       0    ...            0         0         0         0         0

   pixel779  pixel780  pixel781  pixel782  pixel783
0         0         0         0         0         0
1         0         0         0         0         0
2         0         0         0         0         0
3         0         0         0         0         0
4         0         0         0         0         0

[5 rows x 785 columns]
```

In [5]:

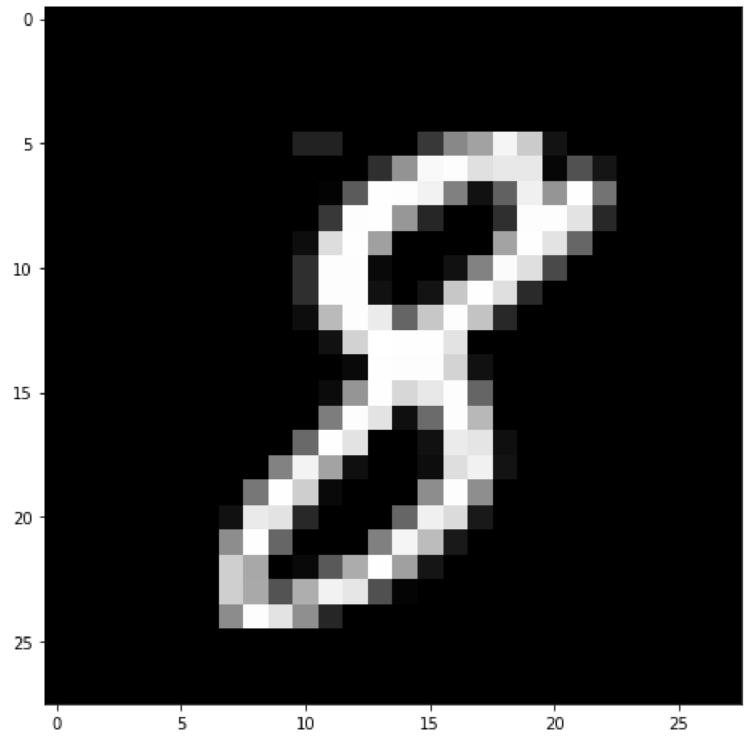
```
print(l.shape)
print(d.shape)
```

```
(42000,)
(42000, 784)
```

In [6]:

```
plt.figure(figsize=(8,8))
idx = 20

grid_data = d.iloc[idx].as_matrix().reshape(28,28)  # reshape from 1d to 2d pixel array
plt.imshow(grid_data, interpolation = "none", cmap = "gray")
plt.show()

print(l[idx])
```

```
C:\ProgramData\Anaconda3\lib\site-packages\ipykernel_launcher.py:4: FutureWarning: Method .as_matrix wi
ll be removed in a future version. Use .values instead.
  after removing the cwd from sys.path.
```



```
8
```

In [7]:

```
# Pick first 15K data-points to work on for time-effeciency.
#Excercise: Perform the same analysis on all of 42K data-points.

labels = l.head(42000)
data = d.head(42000)

print("the shape of sample data = ", data.shape)
```

```
the shape of sample data =  (42000, 784)
```

In [9]:

```
# Data-preprocessing: Standardizing the data

from sklearn.preprocessing import StandardScaler
standardized_data = StandardScaler().fit_transform(data)
print(standardized_data.shape)
sample_data = standardized_data
```

```
(42000, 784)
```

In [11]:

```
from sklearn import decomposition
pca = decomposition.PCA()
```

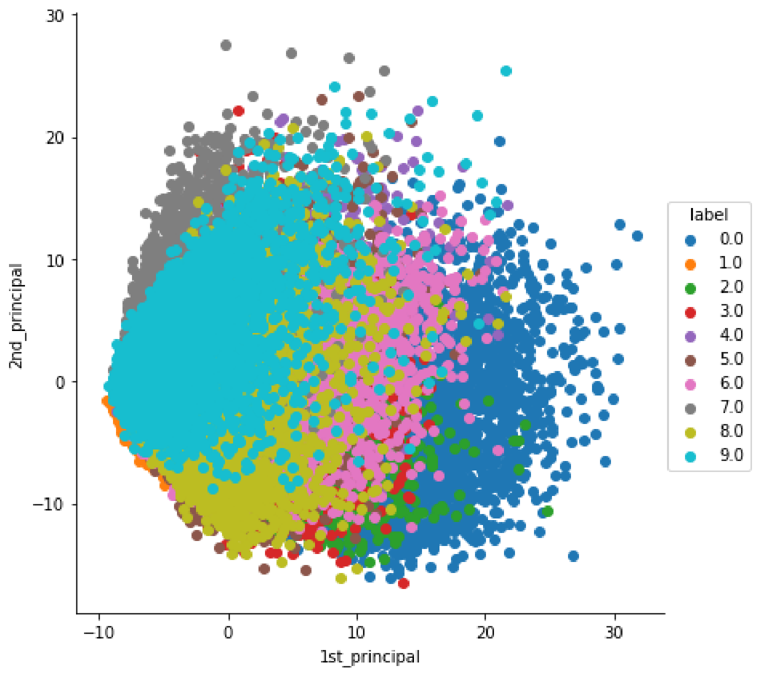
In [17]:

```
# configuring the parameteres
# the number of components = 2
pca.n_components = 2
pca_data = pca.fit_transform(sample_data)

# pca_reduced will contain the 2-d projects of simple data
print("shape of pca_reduced.shape = ", pca_data.shape)
```

```
shape of pca_reduced.shape =  (42000, 2)
```

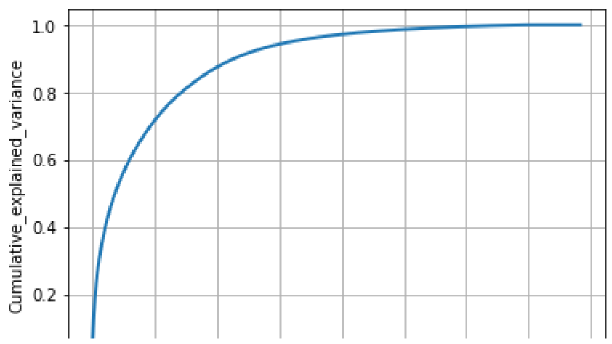
In [18]:

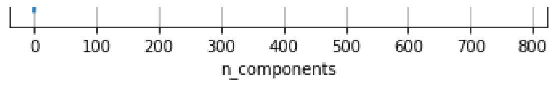
```
# attaching the label for each 2-d data point
import seaborn as sn
pca_data = np.vstack((pca_data.T, labels)).T

# creating a new data fram which help us in ploting the result data
pca_df = pd.DataFrame(data=pca_data, columns=("1st_principal", "2nd_principal", "label"))
#print(pca_df.head())
sn.FacetGrid(pca_df, hue="label", size=6).map(plt.scatter, '1st_principal', '2nd_principal').add_legend
()
plt.show()
```



In [19]:

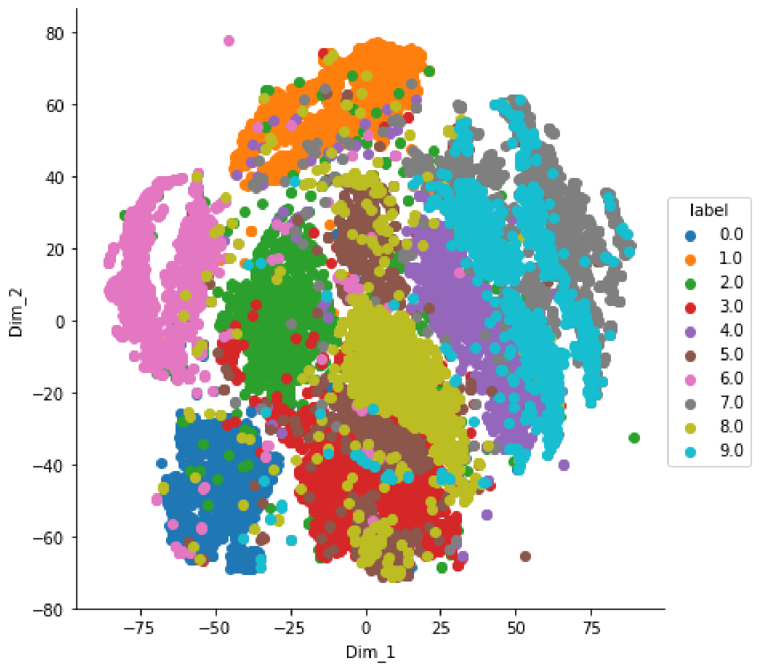
```
# PCA for dimensionality redcution (non-visualization)

pca.n_components = 784
pca_data = pca.fit_transform(sample_data)

percentage_var_explained = pca.explained_variance_ / np.sum(pca.explained_variance_);

cum_var_explained = np.cumsum(percentage_var_explained)

# Plot the PCA spectrum
plt.figure(1, figsize=(6, 4))

plt.clf()
plt.plot(cum_var_explained, linewidth=2)
plt.axis('tight')
plt.grid()
plt.xlabel('n_components')
plt.ylabel('Cumulative_explained_variance')
plt.show()
```





In [20]:

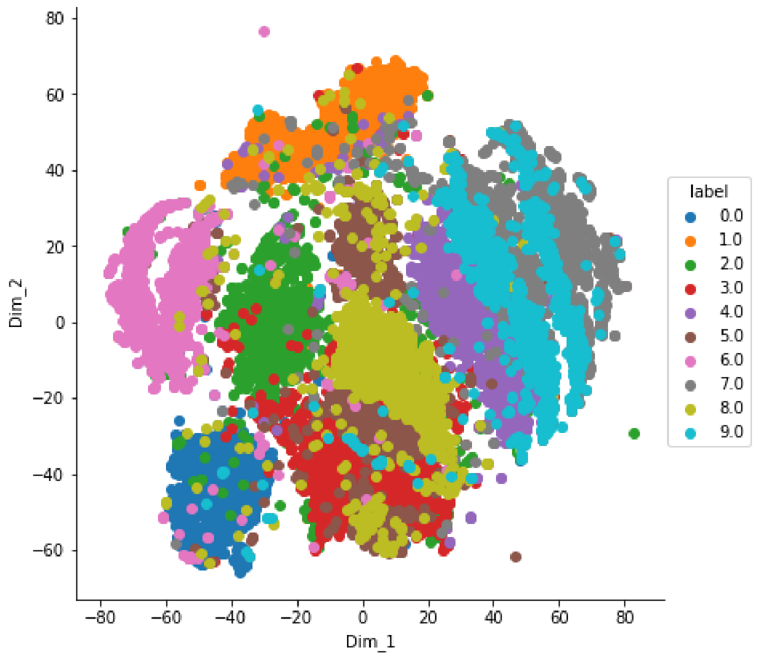
```
# TSNE

from sklearn.manifold import TSNE

# Picking the top 1000 points as TSNE takes a lot of time for 15K points
data_15000 = standardized_data[0:15000,:]
labels_15000 = labels[0:15000]

model = TSNE(n_components=2, random_state=0)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000

tsne_data = model.fit_transform(data_15000)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, labels_15000)).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sn.FacetGrid(tsne_df, hue="label", size=6).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend()
plt.show()
```



In [21]:

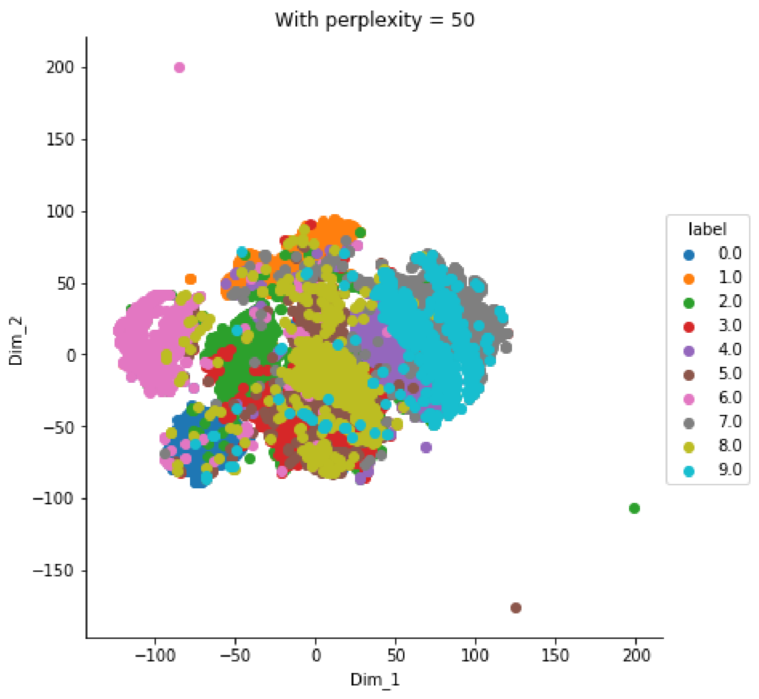
```
model = TSNE(n_components=2, random_state=0, perplexity=50)
tsne_data = model.fit_transform(data_15000)

# creating a new data fram which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, labels_15000)).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sn.FacetGrid(tsne_df, hue="label", size=6).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend()
plt.title('With perplexity = 50')
plt.show()
```

With perplexity = 50



In [22]:

```
model = TSNE(n_components=2, random_state=0, perplexity=50 ,n_iter=5000)
tsne_data = model.fit_transform(data_15000)

# creating a new data fram which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, labels_15000)).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sn.FacetGrid(tsne_df, hue="label", size=6).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend()
plt.title('With perplexity = 50')
plt.show()
```



In [4]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
a = np.array([[1,2,3],[4,5,6]])
b = np.array([7,8,9])
c = np.vstack([a,b])
```

```
d = np.vstack([a,b]).T
e = np.array([10,11,23])
f = np.hstack([b,e])
print(a)
print(b)
print(c)
print(d)
print(f)
```

```
[[1 2 3]
 [4 5 6]]
[7 8 9]
[[1 2 3]
 [4 5 6]
 [7 8 9]]
[[1 4 7]
 [2 5 8]
 [3 6 9]]
[ 7  8  9 10 11 23]
```