LINEAR ALGEBRA ASSIGNMENT -UNIT 4

UE20MA251

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Dimension Reduction on MNIST Upload and visualization of the MNIST Dataset

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```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sn
import warnings # Current version of Seaborn generates a bunch of warnings that will be ignored.
warnings.filterwarnings('ignore')
warnings.simplefilter('ignore')
```

```
[ ] d0 = pd.read_csv('/content/train.csv')
    print(d0.head(5)) # checking the data
```

```
   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  pixel779  \
0       0  ...         0         0         0         0         0         0
1       0  ...         0         0         0         0         0         0
2       0  ...         0         0         0         0         0         0
3       0  ...         0         0         0         0         0         0
4       0  ...         0         0         0         0         0         0
```

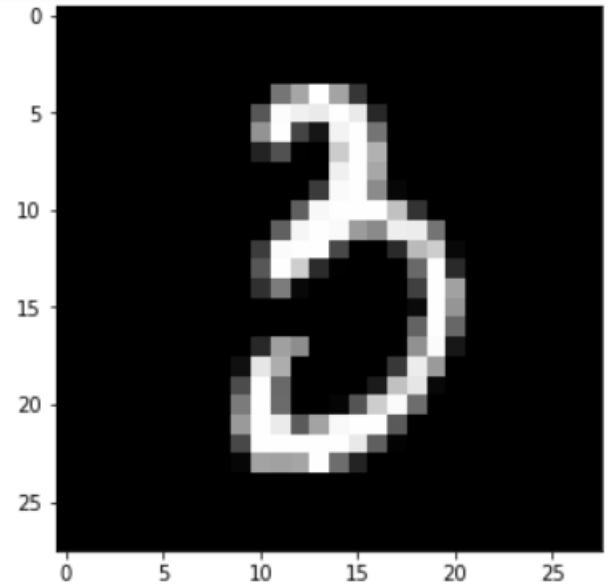
```
   pixel780  pixel781  pixel782  pixel783
0         0         0         0         0
1         0         0         0         0
2         0         0         0         0
3         0         0         0         0
4         0         0         0         0

[5 rows x 785 columns]
```

```
[ ] # separating the labels from the dataset
    l = d0['label']
    d = d0.drop('label',axis = 1)
```

```
[ ] # confriming with the shapes
    print(l.shape)
    print(d.shape)
```

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

```
[ ] # ploting a sample number visually
    plt.figure(figsize=(5,5))
    idx = 150

    grid_data=d.iloc[idx].values.reshape(28,28) # reshaping from 1d to 2d
    plt.imshow(grid_data,interpolation='none',cmap='gray')
    plt.show()

    print('The above values is',l[idx])
```




```
The above values is 3
```

```
# Creating 15k data set with its labels
label = l.head(15000)
data = d.head(15000)
print('The shape of data is ',data.shape)
```

```
The shape of data is  (15000, 784)
```

```
[ ] from sklearn.preprocessing import StandardScaler
standard_data = StandardScaler().fit_transform(data)
print(standard_data.shape)
```

```
(15000, 784)
```

```
[ ] # creating same data sample for co-variance matrix : A^T * A
    sample_data = standard_data

    # Matrix multiplication with numpy
    covar_matrix = np.matmul(sample_data.T,sample_data)
    print('The shape of co-variance matrix = ',covar_matrix.shape)
```

```
The shape of co-variance matrix =  (784, 784)
```

```
[ ] # working with eigen-vectors and eigen-values
    from scipy.linalg import eigh # from scipy of linear algebra
    values, vectors = eigh(covar_matrix,eigvals=(782,783)) # returns the values and vectors from co-var matrix, top two(782,783)
    print('The shape of eigen vectors is ', vectors.shape)
    vectors = vectors.T
    print('The updated shape of eigen vectors is',vectors.shape)
```

```
The shape of eigen vectors is  (784, 2)
The updated shape of eigen vectors is (2, 784)
```

```
[ ] # reducing the dimentions of 784-d data set into 2-d data set by the above eigen vector
    new_coordinates = np.matmul(vectors,sample_data.T)
    print('The resultent new data points\' shape is ', vectors.shape, 'X', sample_data.T.shape, '=', new_coordinates.shape)
```

```
The resultent new data points' shape is  (2, 784) X (784, 15000) = (2, 15000)
```

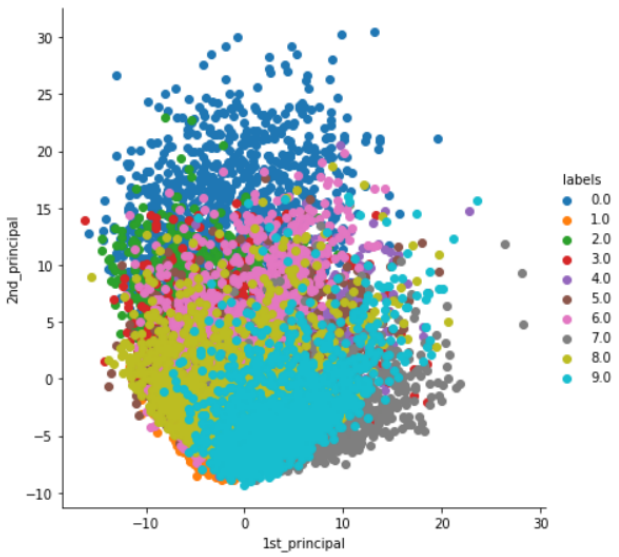
```
print('The shape of new data set is ',new_coordinates.shape)
```

```
The shape of new data set is  (15000, 3)
```

```
[ ] # Creating the data frame
    matrix_df = pd.DataFrame(data= new_coordinates,columns=('1st_principal','2nd_principal','labels'))
    print(matrix_df.head(5))
```

```
   1st_principal  2nd_principal  labels
0      -5.558661      -5.043558     1.0
1       6.193635      19.305278     0.0
2      -1.909878      -7.678775     1.0
3       5.525748      -0.464845     4.0
4       6.366527      26.644289     0.0
```

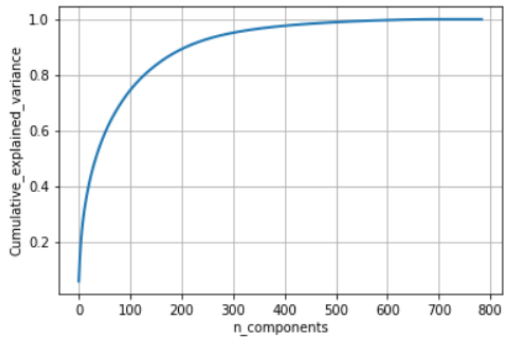
```
sn.FacetGrid(matrix_df,hue='labels',size=6).map(plt.scatter,'1st_principal','2nd_principal').add_legend()
plt.show()
```



```
# using SKlearn importing PCA
from sklearn import decomposition
pca = decomposition.PCA()
```

```
# 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()


# If we take 200-dimensions, approx. 90% of variance is expalined.
```

[ ]



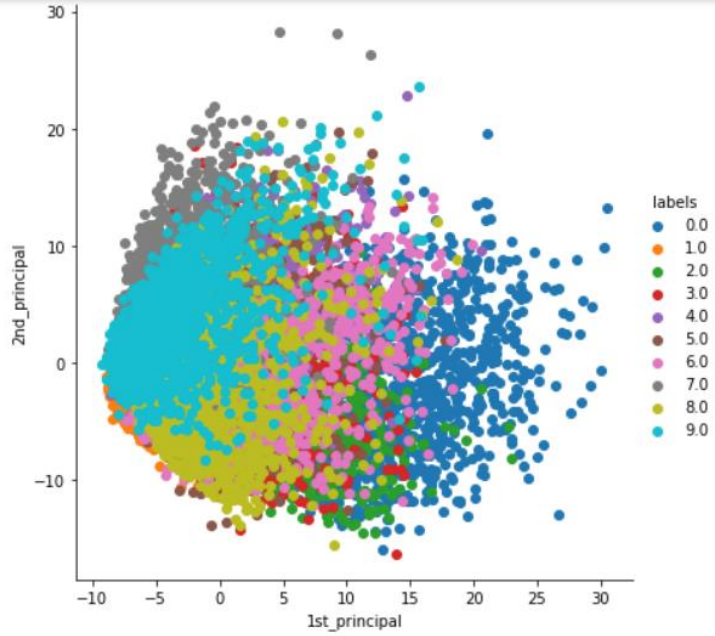

```
[ ] # directly entering parameters
pca.n_components = 2
pca_data = pca.fit_transform(sample_data)

print('shape of pca_reduced data = ',pca_data.shape)
```

```
shape of pca_reduced data =  (15000, 2)
```

```
# Data massaging - adding label colomn to the reduced matrix
pca_data = np.vstack((pca_data.T,label)).T
```

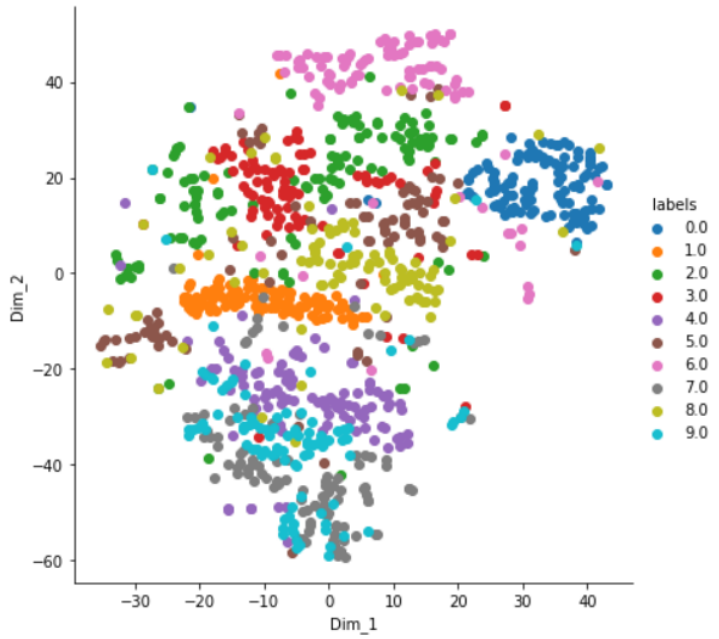
```
[ ] # dataframing and plotting the pca data
pca_df = pd.DataFrame(data=pca_data,columns=('1st_principal','2nd_principal','labels'))
sn.FacetGrid(pca_df,hue='labels',size=6).map(plt.scatter,'1st_principal','2nd_principal').add_legend()
plt.show()
```

[ ]

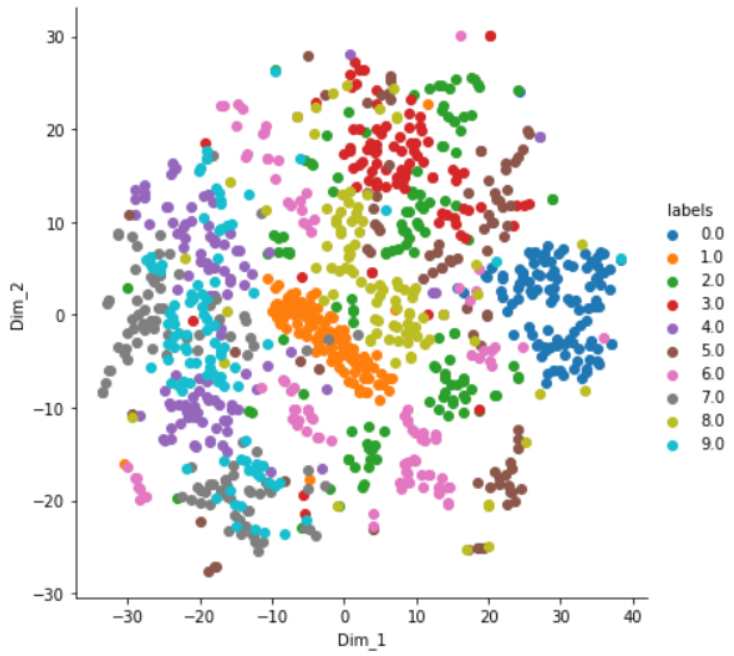



```
from sklearn.manifold import TSNE

# picking 1000 datapoints
data_1000 = standard_data[0:1000,:]
label_1000 = label[0:1000]

# designing model with default values perplexity = 30, n_iteration = 1000
model = TSNE(n_components=2,random_state=0)
tsne_data = model.fit_transform(data_1000)

tsne_data = np.vstack((tsne_data.T,label_1000)).T
```

```
tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
plt.show()
```

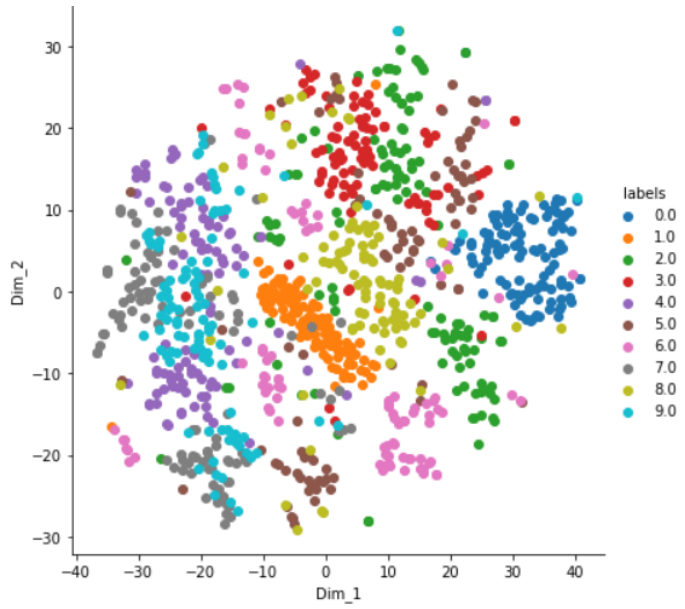



```
[ ] # Designing model with perpelexity = 50

    model = TSNE(n_components=2,perplexity=50,random_state=0)
    tsne_data = model.fit_transform(data_1000)
    tsne_data = np.vstack((tsne_data.T,label_1000)).T
    tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
    sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
```



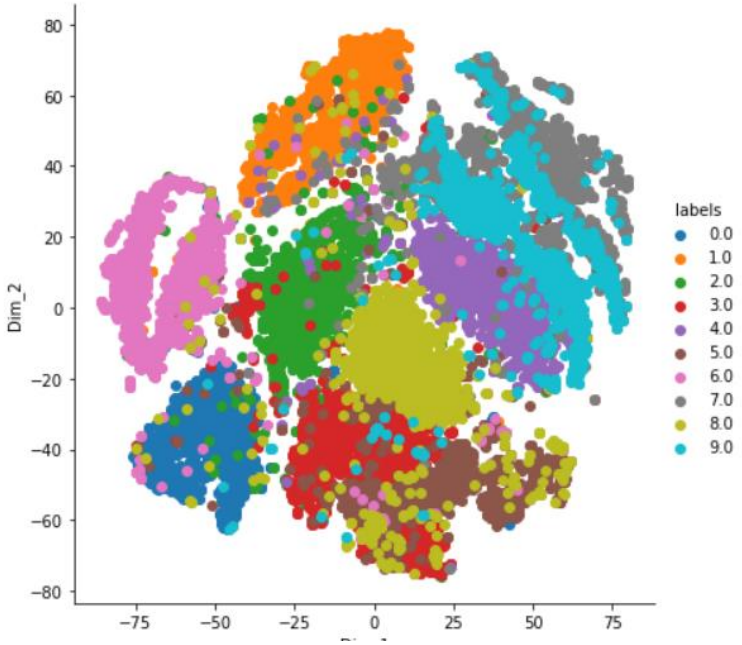

```
# Designing the model with perplexity = 50 and iteration  = 5000

model = TSNE(n_components=2,random_state=0,perplexity=50,n_iter=5000)
tsne_data = model.fit_transform(data_1000)
tsne_data = np.vstack((tsne_data.T,label_1000)).T
tsne_df = pd.DataFrame(data= tsne_data,columns=('Dim_1','Dim_2','labels'))
sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
plt.show()
```

[ ]

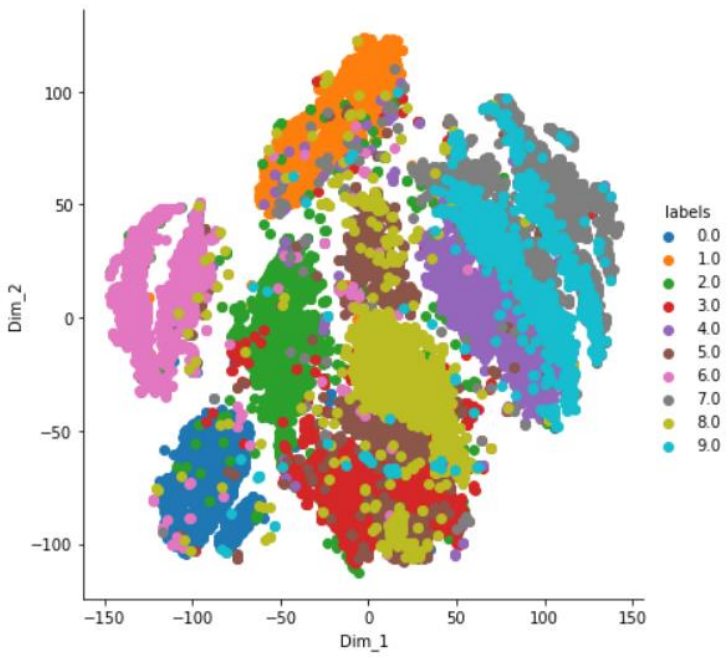



```
# building models with 15k data set
data_15k = standard_data[0:15000,:]
label_15k = label[0:15000]

model = TSNE(n_components=2,random_state=0)
tsne_data = model.fit_transform(data_15k)
tsne_data = np.vstack((tsne_data.T,label_15k)).T
tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
plt.show()
```

```
# building models with 15k data set
data_15k = standard_data[0:15000,:]
label_15k = label[0:15000]

model = TSNE(n_components=2,random_state=0)
tsne_data = model.fit_transform(data_15k)
tsne_data = np.vstack((tsne_data.T,label_15k)).T
tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
plt.show()
```



```
# Data modeling with 15k Training data set and 5000
model =  TSNE(n_components=2,random_state=0,perplexity=40,n_iter=5000)
tsne_data = model.fit_transform(data_15k)
tsne_data = np.vstack((tsne_data.T,label_15k)).T
tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
plt.show()
```



```
[ ]  # Data modeling with whole Training data set(42k)
     data_42k = standard_data
     label_42k = label
     model = TSNE(n_components=2,random_state=0)
     tsne_data = model.fit_transform(data_42k)
     tsne_data = np.vstack((tsne_data.T,label_42k)).T
     tsne_df = pd.DataFrame(data=tsne_data,columns=('Dim_1','Dim_2','labels'))
     sn.FacetGrid(tsne_df,hue='labels',size=6).map(plt.scatter,'Dim_1','Dim_2').add_legend()
     plt.show()
```