In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier #using knn as it's a distance based algo
from sklearn.metrics import accuracy_score
import time
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import cross_val_score
```

In [2]:
```
df = pd.read_csv('diabetes.csv')
df
```

Out[2]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1
...	...	...	...	...	...	...	...	...	...
763	10	101	76	48	180	32.9	0.171	63	0
764	2	122	70	27	0	36.8	0.340	27	0
765	5	121	72	23	112	26.2	0.245	30	0
766	1	126	60	0	0	30.1	0.349	47	1
767	1	93	70	31	0	30.4	0.315	23	0

768 rows × 9 columns

In [3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Pregnancies               768 non-null    int64  
 1   Glucose                   768 non-null    int64  
 2   BloodPressure             768 non-null    int64  
 3   SkinThickness             768 non-null    int64  
 4   Insulin                   768 non-null    int64  
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64  
 8   Outcome                   768 non-null    int64  
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

In [4]:
```
x_p = df.iloc[:,0:8]
y_p = df.iloc[:,8]

x_p_train,x_p_test,y_p_train,y_p_test = train_test_split(x_p,y_p,test_size=0.3,random_state=41)

knn = KNeighborsClassifier()
knn.fit(x_p_train,y_p_train)

start = time.time()
y_p_pred = knn.predict(x_p_test)
print(f"the accuracy without PCA in 8 dimensions(features) is : {accuracy_score(y_p_test,y_p_pred)}, and the ti

scores_p = cross_val_score(knn, x_p, y_p, cv=10)
print(f"Cross-validated accuracy with 8 components: {scores_p.mean():.4f}")
```

```
the accuracy without PCA in 8 dimensions(features) is : 0.7186147186147186, and the time taken is : 0.0269277095
79467773
Cross-validated accuracy with 8 components: 0.7214
```

In [5]:
```
scaler = StandardScaler()
df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
df
```

```
C:\Users\Admin\AppData\Local\Temp\ipykernel_14124\1327023116.py:2: FutureWarning: Setting an item of incompatibl
e dtype is deprecated and will raise in a future error of pandas. Value '[ 0.63994726 -0.84488505  1.23388019 -0
.84488505 -1.14185152  0.3429808
```

```
-0.25095213  1.82781311 -0.54791859  1.23388019  0.04601433  1.82781311
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ease explicitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
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e dtype is deprecated and will raise in a future error of pandas. Value '[ 8.48323795e-01 -1.12339636e+00  1.943
72388e+00 -9.98207780e-01
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  1.28648383e+00 -3.09670582e-01 -4.34859164e-01  3.47569469e-01
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  1.53686099e+00 -1.15469351e+00 -7.79127762e-01  1.28489452e-01
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  3.45980161e-02  3.30087080e-03  1.59786597e-01 -8.73019198e-01]' has dtype incompatible with int64, please exp
licitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
C:\Users\Admin\AppData\Local\Temp\ipykernel_14124\1327023116.py:2: FutureWarning: Setting an item of incompatibl
e dtype is deprecated and will raise in a future error of pandas. Value '[ 0.14964075 -0.16054575 -0.26394125 -0
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 -0.36733675  0.35643175  0.04624525  0.14964075 -0.47073225  0.04624525]' has dtype incompatible with int64, pl
ease explicitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
C:\Users\Admin\AppData\Local\Temp\ipykernel_14124\1327023116.py:2: FutureWarning: Setting an item of incompatibl
e dtype is deprecated and will raise in a future error of pandas. Value '[ 0.90726993  0.53090156 -1.28821221  0
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-1.28821221  0.7818138   1.15818217 -0.15910711  1.5972786   0.40544544
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 -0.22183517 -1.28821221  1.03272605 -0.03365099 -0.15910711 -1.28821221
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 -1.28821221  1.72273472  0.40544544  0.15453319 -1.28821221  0.65635768]' has dtype incompatible with int64, pl
ease explicitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
C:\Users\Admin\AppData\Local\Temp\ipykernel_14124\1327023116.py:2: FutureWarning: Setting an item of incompatibl
e dtype is deprecated and will raise in a future error of pandas. Value '[-0.69289057 -0.69289057 -0.69289057  0
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 -0.69289057  0.87003069 -0.69289057  0.27959377 -0.69289057 -0.69289057]' has dtype incompatible with int64, pl
ease explicitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
C:\Users\Admin\AppData\Local\Temp\ipykernel_14124\1327023116.py:2: FutureWarning: Setting an item of incompatibl
e dtype is deprecated and will raise in a future error of pandas. Value '[ 1.4259954  -0.19067191 -0.10558415 -1
.04154944 -0.0204964  -0.27575966
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-0.95646168 -0.0204964   2.02160968  1.34090765 -0.95646168 -0.87137393
-0.61611067  0.31985461 -0.36084741 -0.27575966  1.08564439 -0.78628618
-1.04154944  1.34090765 -0.44593516  0.91546889  1.2558199  -0.36084741
-0.36084741  2.5321362   2.7023117   2.87248721 -0.27575966 -0.27575966
-0.36084741 -1.04154944 -0.95646168  1.00055664 -0.70119842 -1.04154944
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-0.10558415  0.14967911 -0.78628618 -0.95646168 -1.04154944 -0.70119842
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```

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  3.12775047  0.57511787  0.83038113  1.00055664  1.34090765 -1.04154944
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 -0.0204964   2.5321362  -0.53102292 -0.27575966  1.17073215 -0.87137393]' has dtype incompatible with int64, pl
ease explicitly cast to a compatible dtype first.
  df.iloc[:,0:8] = scaler.fit_transform(df.iloc[:,0:8])
```

Out[5]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	0.639947	0.848324	0.149641	0.907270	-0.692891	0.204013	0.468492	1.425995	1
1	-0.844885	-1.123396	-0.160546	0.530902	-0.692891	-0.684422	-0.365061	-0.190672	0
2	1.233880	1.943724	-0.263941	-1.288212	-0.692891	-1.103255	0.604397	-0.105584	1
3	-0.844885	-0.998208	-0.160546	0.154533	0.123302	-0.494043	-0.920763	-1.041549	0
4	-1.141852	0.504055	-1.504687	0.907270	0.765836	1.409746	5.484909	-0.020496	1
...	...	...	...	...	...	...	...	...	...
763	1.827813	-0.622642	0.356432	1.722735	0.870031	0.115169	-0.908682	2.532136	0
764	-0.547919	0.034598	0.046245	0.405445	-0.692891	0.610154	-0.398282	-0.531023	0
765	0.342981	0.003301	0.149641	0.154533	0.279594	-0.735190	-0.685193	-0.275760	0
766	-0.844885	0.159787	-0.470732	-1.288212	-0.692891	-0.240205	-0.371101	1.170732	1
767	-0.844885	-0.873019	0.046245	0.656358	-0.692891	-0.202129	-0.473785	-0.871374	0

768 rows × 9 columns

In [6]:
```
covar_mat = np.cov([df.iloc[:,0],df.iloc[:,1],df.iloc[:,2],df.iloc[:,3],df.iloc[:,4],df.iloc[:,5],df.iloc[:,6],(
print(f"The Covariance matrix shape = {covar_mat.shape}")
```

```
The Covariance matrix shape = (8, 8)
```

In [7]:
```
eigen_values,eigen_vectors = np.linalg.eig(covar_mat)
print(f"The eigen value matrix shape = {eigen_values.shape} \nThe eigen vector matrix shape = {eigen_vectors.sha
```

```
The eigen value matrix shape = (8,)
The eigen vector matrix shape = (8, 8)
```

In [8]:
```
pc = eigen_vectors[0:3]
pc.shape
trf_df = np.dot(df.iloc[: , 0:8],pc.T) # df = 768*8 , pc.T = 8*5
trf_df.shape
new_df = pd.DataFrame(trf_df,columns=['PC1','PC2','PC3'])
new_df['Target'] = df['Outcome'].values
new_df.head()
```

Out[8]:

	PC1	PC2	PC3	Target
0	-0.355075	-0.507317	-0.194276	1
1	0.768246	1.102389	0.239011	0
2	-1.749747	-0.514054	-0.904311	1
3	0.615796	0.918929	0.250838	0
4	0.919575	2.358007	0.302449	1

In [9]:
```
x_n = new_df.iloc[:,0:3]
x_n.shape
y_n = new_df.iloc[:,3]
y_n
```

Out[9]:
```
0      1
1      0
2      1
3      0
4      1
      ..
763    0
764    0
765    0
766    1
767    0
Name: Target, Length: 768, dtype: int64
```

In [10]:
```
x_n_train,x_n_test,y_n_train,y_n_test = train_test_split(x_n,y_n,test_size=0.3,random_state=41)
knn = KNeighborsClassifier()
knn.fit(x_n_train,y_n_train)

start = time.time()
y_n_pred = knn.predict(x_n_test)
print(f"the accuracy with PCA in 3 dimensions(features) is : {accuracy_score(y_n_test,y_n_pred)}, and the time

scores = cross_val_score(knn, x_n, y_n, cv=10)
print(f"Cross-validated accuracy with 3 components: {scores.mean():.4f}")
```

```
the accuracy with PCA in 3 dimensions(features) is : 0.7316017316017316, and the time taken is : 0.0199475288391
11328
Cross-validated accuracy with 3 components: 0.6862
```

In [11]:
```
sum = eigen_values.sum()
eigen_val_var = eigen_values/sum
np.cumsum(eigen_val_var)
```

Out[11]:
```
array([0.26179749, 0.47819876, 0.53067578, 0.58123354, 0.66656209,
       0.76185514, 0.87129627, 1.        ])
```

In [12]:
```
plt.plot(np.cumsum(eigen_val_var))
```

Out[12]:
```
[<matplotlib.lines.Line2D at 0x1b4c50457f0>]
```