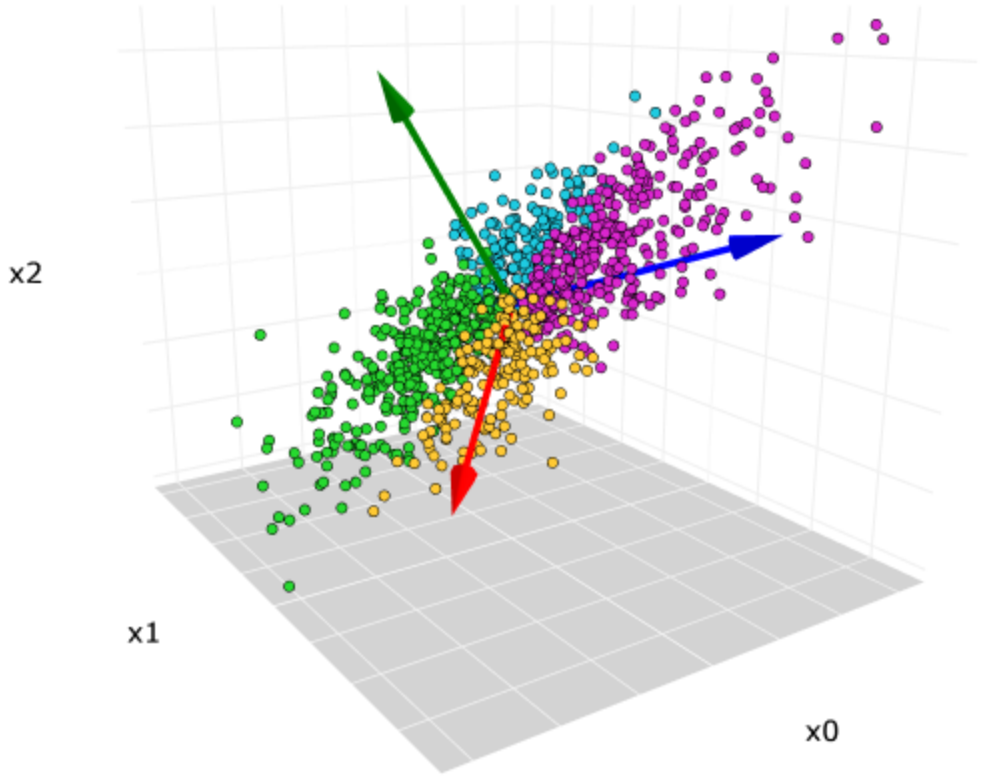
Feature Engineering 101

Topic - 14

PCA

Principal Component Analysis



PCA (Principal Component Analysis)

In [1]:

```
import numpy as np
import pandas as pd

np.random.seed(23)

mu_vec1 = np.array([0,0,0])
cov_mat1 = np.array([[1,0,0],[0,1,0],[0,0,1]])
class1_sample = np.random.multivariate_normal(mu_vec1, cov_mat1, 20)

df = pd.DataFrame(class1_sample,columns=['feature1','feature2','feature3'])
df['target'] = 1

mu_vec2 = np.array([1,1,1])
cov_mat2 = np.array([[1,0,0],[0,1,0],[0,0,1]])
class2_sample = np.random.multivariate_normal(mu_vec2, cov_mat2, 20)

df1 = pd.DataFrame(class2_sample,columns=['feature1','feature2','feature3'])

df1['target'] = 0

df = df.append(df1,ignore_index=True)

df = df.sample(40)
```

In [2]:

```
df.head()
```

Out[2]:

	feature1	feature2	feature3	target
2	-0.367548	-1.137460	-1.322148	1

	feature1	feature2	feature3	target
34	0.177061	-0.598109	1.226512	0
14	0.420623	0.411620	-0.071324	1
11	1.968435	-0.547788	-0.679418	1
12	-2.506230	0.146960	0.606195	1

In [3]:

```
import plotly.express as px
#y_train_trf = y_train.astype(str)
fig = px.scatter_3d(df, x=df['feature1'], y=df['feature2'], z=df['feature3'],
                    color=df['target'].astype('str'))
fig.update_traces(marker=dict(size=12,
                              line=dict(width=2,
                                        color='DarkSlateGrey')),
                  selector=dict(mode='markers'))

fig.show()
```

In [4]:

```
# Step 1 - Apply standard scaling
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()

df.iloc[:,0:3] = scaler.fit_transform(df.iloc[:,0:3])
```

In [5]:

```
# Step 2 - Find Covariance Matrix
covariance_matrix = np.cov([df.iloc[:,0],df.iloc[:,1],df.iloc[:,2]])
print('Covariance Matrix:\n', covariance_matrix)
```

```
Covariance Matrix:
 [[1.02564103 0.20478114 0.080118  ]
 [0.20478114 1.02564103 0.19838882]
 [0.080118   0.19838882 1.02564103]]
```

In [6]:
```
# Step 3 - Finding EV and EVs
eigen_values, eigen_vectors = np.linalg.eig(covariance_matrix)
```

In [7]:
```
eigen_values
```

Out[7]:
```
array([1.3536065 , 0.94557084, 0.77774573])
```

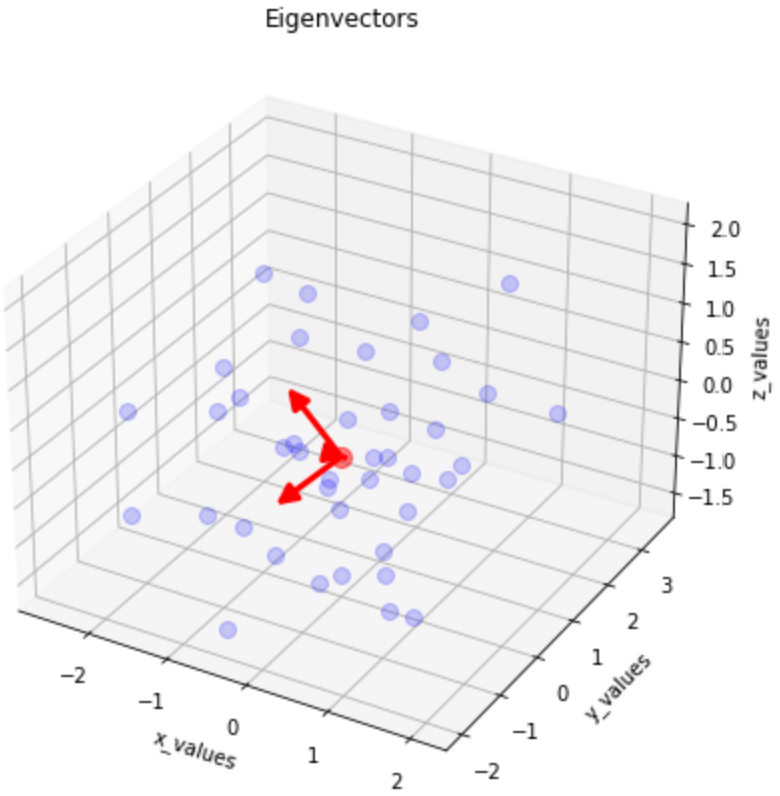
In [8]:
```
eigen_vectors
```

Out[8]:
```
array([[-0.53875915, -0.69363291,  0.47813384],
       [-0.65608325, -0.01057596, -0.75461442],
       [-0.52848211,  0.72025103,  0.44938304]])
```

In [9]:
```
%pylab inline

from matplotlib import pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from mpl_toolkits.mplot3d import proj3d
from matplotlib.patches import FancyArrowPatch


class Arrow3D(FancyArrowPatch):
    def __init__(self, xs, ys, zs, *args, **kwargs):
        FancyArrowPatch.__init__(self, (0,0), (0,0), *args, **kwargs)
        self._verts3d = xs, ys, zs

    def draw(self, renderer):
        xs3d, ys3d, zs3d = self._verts3d
        xs, ys, zs = proj3d.proj_transform(xs3d, ys3d, zs3d, renderer.M)
        self.set_positions((xs[0],ys[0]),(xs[1],ys[1]))
        FancyArrowPatch.draw(self, renderer)

fig = plt.figure(figsize=(7,7))
ax = fig.add_subplot(111, projection='3d')

ax.plot(df['feature1'], df['feature2'], df['feature3'], 'o', markersize=8, color='blue', a
ax.plot([df['feature1'].mean()], [df['feature2'].mean()], [df['feature3'].mean()], 'o', ma
for v in eigen_vectors.T:
    a = Arrow3D([df['feature1'].mean(), v[0]], [df['feature2'].mean(), v[1]], [df['feature
    ax.add_artist(a)
ax.set_xlabel('x_values')
ax.set_ylabel('y_values')
ax.set_zlabel('z_values')

plt.title('Eigenvectors')

plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
C:\Users\HP\AppData\Local\Temp/ipykernel_88008/3713440988.py:16: MatplotlibDeprecationWarn
ing:
```

```
The M attribute was deprecated in Matplotlib 3.4 and will be removed two minor releases la
ter. Use self.axes.M instead.
```



In [10]:
```
pc = eigen_vectors[0:2]
pc
```

Out[10]:
```
array([[-0.53875915, -0.69363291,  0.47813384],
       [-0.65608325, -0.01057596, -0.75461442]])
```

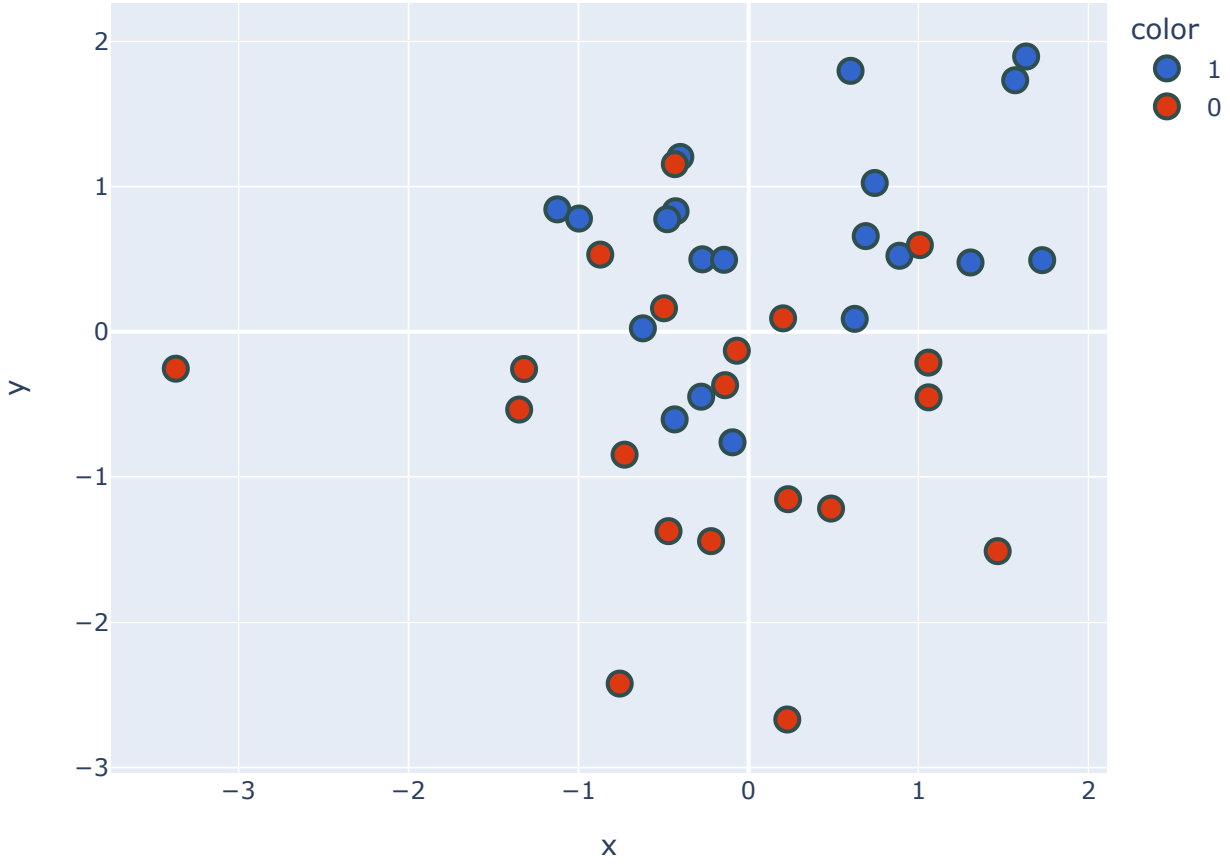
In [11]:
```
transformed_df = np.dot(df.iloc[:,0:3],pc.T)
# 40,3 - 3,2
new_df = pd.DataFrame(transformed_df,columns=['PC1','PC2'])
new_df['target'] = df['target'].values
new_df.head()
```

Out[11]:

	PC1	PC2	target
0	0.599433	1.795862	1
1	1.056919	-0.212737	0
2	-0.271876	0.498222	1
3	-0.621586	0.023110	1
4	1.567286	1.730967	1

In [12]:
```
new_df['target'] = new_df['target'].astype('str')
fig = px.scatter(x=new_df['PC1'],
                 y=new_df['PC2'],
                 color=new_df['target'],
                 color_discrete_sequence=px.colors.qualitative.G10
                )

fig.update_traces(marker=dict(size=12,
```

```
                                line=dict(width=2,
                                          color='DarkSlateGrey')),
                  selector=dict(mode='markers'))
fig.show()
```



Show In-depth praticle :

1. https://www.kaggle.com/code/kanav0183/pca-analysis-for-geneclassification

2. https://www.kaggle.com/code/sid321axn/principal-component-analysis-pca

3. https://www.kaggle.com/code/faressayah/support-vector-machine-pca-tutorial-for-beginner#4.-Principal-Component-Analysis (Special)

4. https://towardsdatascience.com/principal-component-analysis-pca-explained-visually-with-zero-math-1cbf392b9e7d (Medium)

In [ ]: