```python
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)

df.head()
```

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

```python
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()

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

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

# 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]]
```

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

```
eigen_values
```

```
array([1.3536065 , 0.94557084, 0.77774573])
```

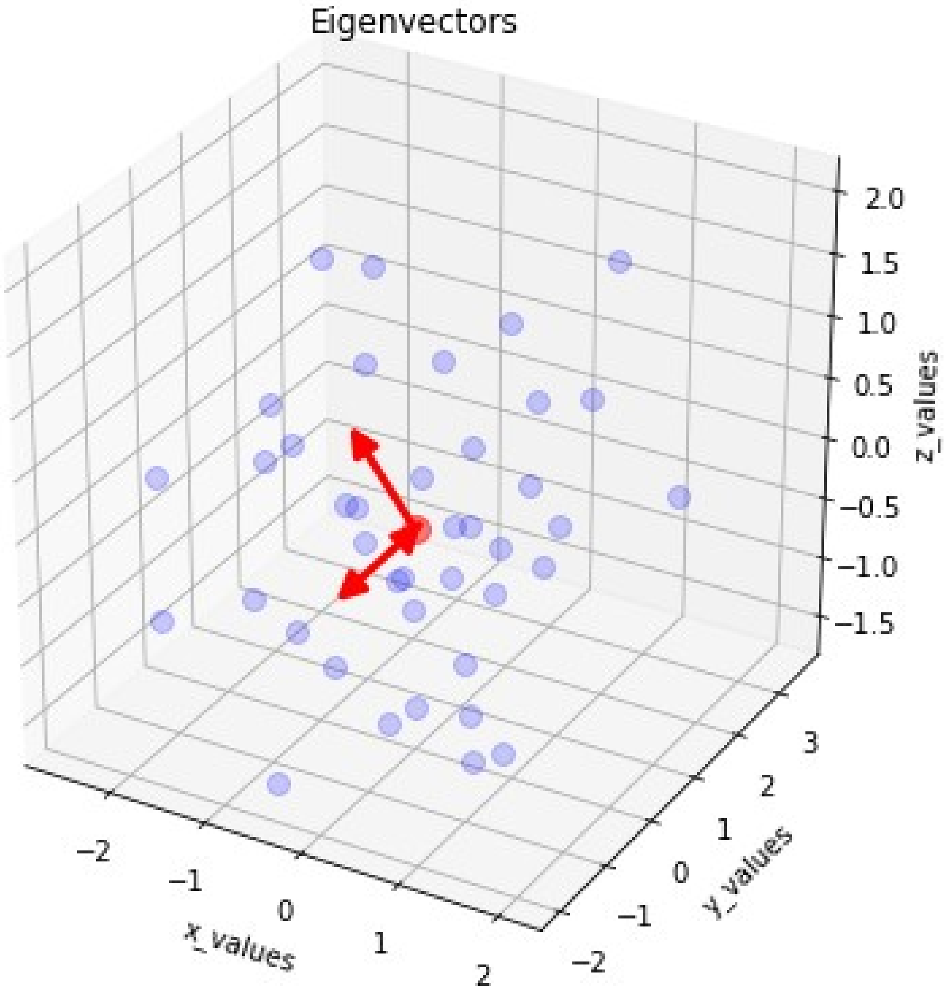
```
eigen_vectors
```

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

```
%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', alpha=0.2)
ax.plot([df['feature1'].mean()], [df['feature2'].mean()],
[df['feature3'].mean()], 'o', markersize=10, color='red', alpha=0.5)
```

```
for v in eigen_vectors.T:
    a = Arrow3D([df['feature1'].mean(), v[0]], [df['feature2'].mean(),
v[1]], [df['feature3'].mean(), v[2]], mutation_scale=20, lw=3,
arrowstyle="-|>", color="r")
    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
```



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

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

```
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()
```

```
        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
```

```
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()
```