# 04_Exercise2_MoG_EM

May 20, 2018

## 1 Task:

Mixture of Gaussian, EM-Algorithm Apply EM algorithm to fit a mixture of gaussian distribution to the following datasets:

```
In [79]: import numpy as np
         import matplotlib.pyplot as plt
         from sklearn.mixture import GaussianMixture as GMM
         from scipy.stats import multivariate_normal as mvn
         from matplotlib.patches import Ellipse
         import matplotlib as mpl
         from matplotlib.patches import Patch
         import seaborn as sns; sns.set;
         from sklearn.cluster import KMeans
```

```
In [ ]: #from sklearn.mixture import GaussianMixture
```

### 1.1 Dataset 1

```
In [60]: # Make some random data in 2D.
         np.random.seed(150)
         means = np.array([[2.1, 4.5],
                           [2.0, 2.7],
                           [3.5, 5.6]])
         covariances = [np.array([[0.20, 0.10], [0.10, 0.60]]),
                        np.array([[0.35, 0.22], [0.22, 0.15]]),
                        np.array([[0.06, 0.05], [0.05, 1.30]])]
         amplitudes = [5, 1, 2]
         factor = 100
         data = np.zeros((1, 2))
         for i in range(len(means)):
             data = np.concatenate([data,
                  np.random.multivariate_normal(means[i], covariances[i],
                                                size=factor * amplitudes[i])])
         data1 = data[1:, :]
         print(data1.shape)
```

```
(800, 2)
```

### 1.2 Dataset 2

```
In [62]:     # Make some random data in 2D.
             np.random.seed(150)
             means = np.array([[1.1, 6.5],
                               [2.5, 4.7],
                               #[3.0, 2.6],
                               [3.0, 3.3]])
             covariances = [np.array([[0.55, -0.10], [-0.10, 0.25]]),
                            np.array([[0.35, 0.22], [0.22, 0.20]]),
                            #np.array([[0.06, 0.05], [0.05, 1.30]]),
                            np.array([[0.06, 0.05], [0.05, 1.30]])]
             amplitudes = [4, 1, 3]
             factor = 100

             data = np.zeros((1, 2))
             for i in range(len(means)):
                 data = np.concatenate([data,
                     np.random.multivariate_normal(means[i], covariances[i],
                                                   size=factor * amplitudes[i])])
         data2 = data[1:, :]
         print(data2.shape)
```

```
(800, 2)
```

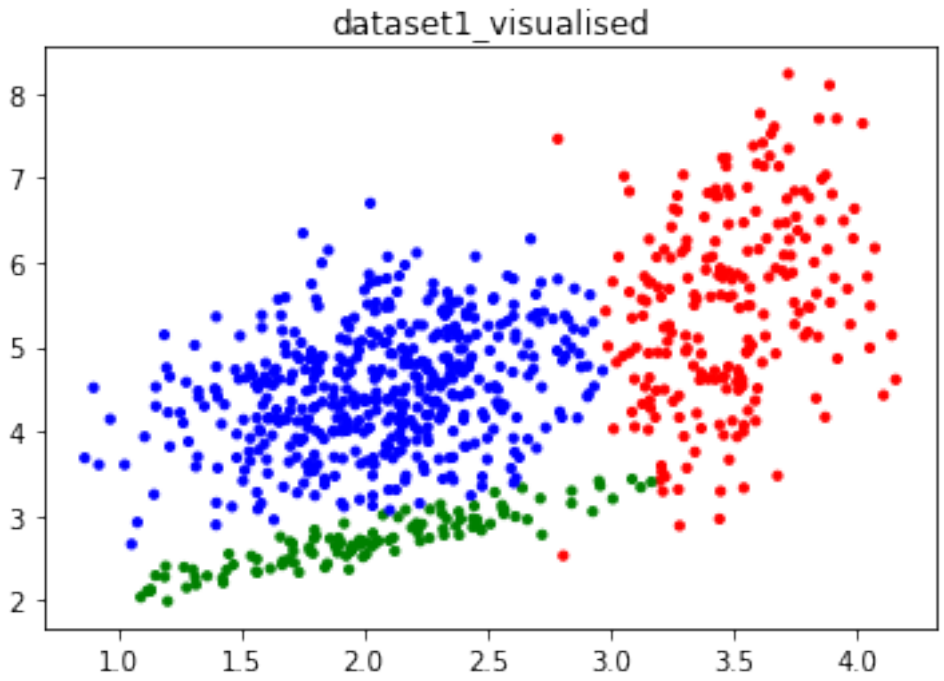
Visualise the results (plot the samples color coded by fit mixture component, plot ellipsoids for Gaussians)

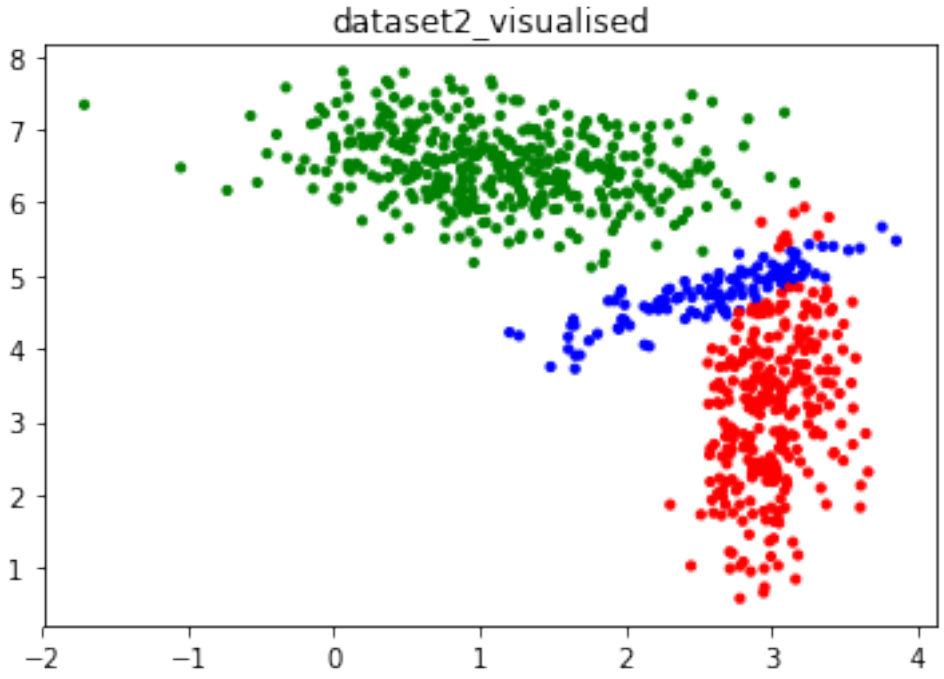
## 2 Results

The output for the Dataset1 can look like:

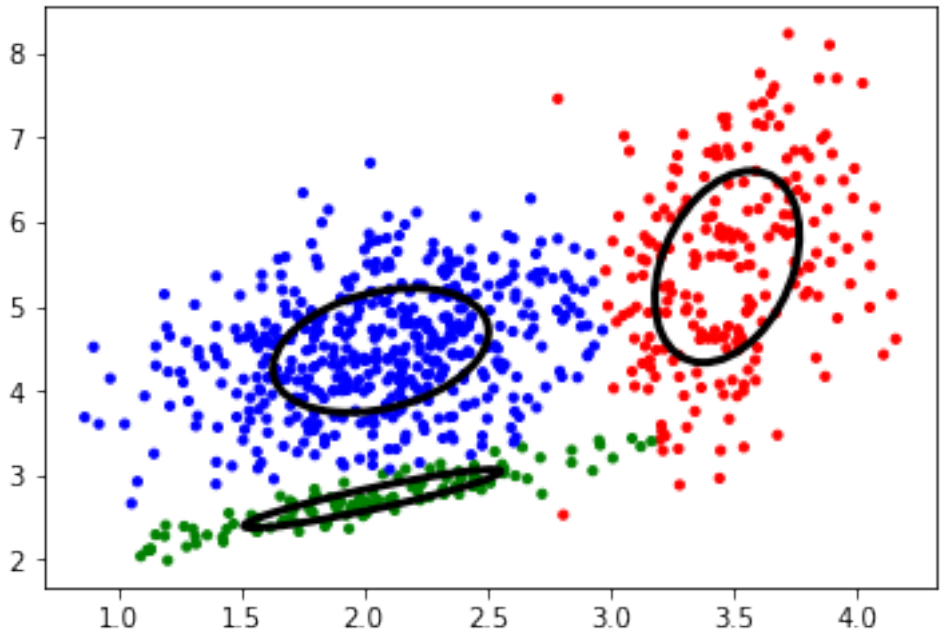
```
In [108]: # kmeans = KMeans(3, random_state=0)
          # labels = kmeans.fit(data).predict(data)
          # plt.scatter(data[:,0],data[:,1],c=labels,s=40,cmap='viridis')

          def rgb(labels):
              color = {0:'g',1:'r',2:'b'}
              for i in labels:
                  return [color[i] for i in labels]
          # n_colors = 3

          def guassian_model_mix(n_component,randomstate,data):
              gmm = GMM(n_components=n_colors, random_state=randomstate).fit(data)
```

```
    labels = gmm.predict(data)
#     print(labels)
    plt.scatter(data[:,0],data[:,1],c= rgb(labels),s=10)
    plt.show()
    return gmm

def draw_ellipse(position, covariance, ax=None, **kwargs):
    """Draw an ellipse with a given position and covariance"""
    ax = plt.gca()

    # Convert covariance to principal axes
    if covariance.shape == (2, 2):
        U, s, Vt = np.linalg.svd(covariance)
        angle = np.degrees(np.arctan2(U[1, 0], U[0, 0]))
        width, height = 2 * np.sqrt(s)
    else:
        angle = 0
        width, height = 2 * np.sqrt(covariance)

    # Draw the Ellipse
    for nsig in range(1, 2):
        ax.add_patch(Ellipse(position, nsig * width, nsig * height,
                             angle,fill=False, linewidth=3))

def plot_gmm(gmm, X, label=True, ax=None):
    ax = plt.gca()
    labels = gmm.fit(X).predict(X)
    if label:
        ax.scatter(X[:, 0], X[:, 1], c=rgb(labels), s=10, zorder=1)
    else:
        ax.scatter(X[:, 0], X[:, 1], s=40, zorder=2)
#     ax.axis('equal')

    w_factor = 0.2 / gmm.weights_.max()
    for pos, covar, w in zip(gmm.means_, gmm.covariances_, gmm.weights_):
        draw_ellipse(pos, covar, alpha=w * w_factor)


plt.title("dataset1_visualised")
gmm_1 = guassian_model_mix(3, 40, data1)
plt.title("dataset2_visualised")
gmm_2 = guassian_model_mix(3, 40, data2)
```

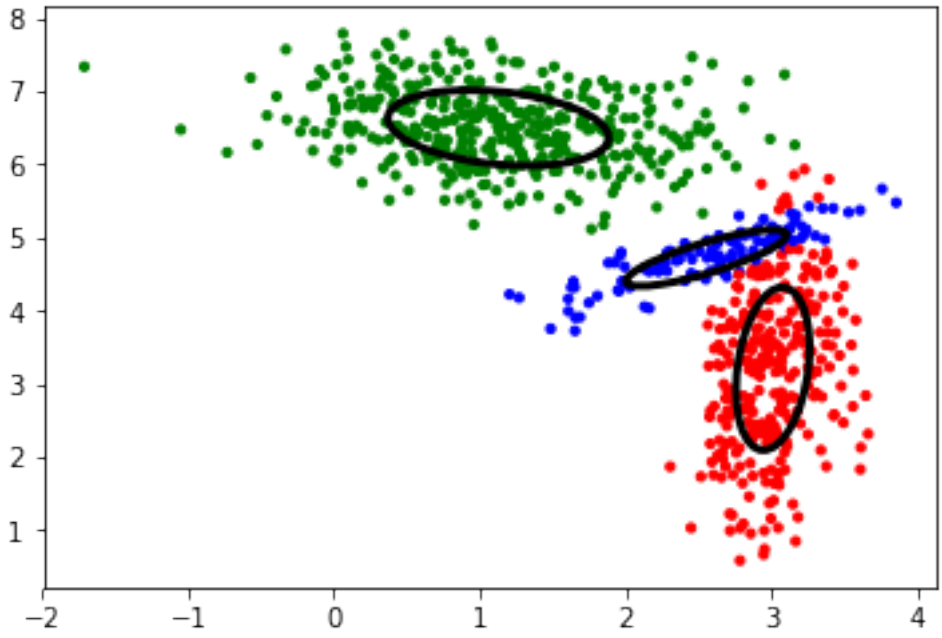



```
In [109]: print("Plotting ellipsoid for data1")
          plot_gmm(gmm_1, data1)
```




```
In [110]: print("Plotting ellipsoid for data2")
          plot_gmm(gmm_2, data2)
```




Reference : https://jakevdp.github.io/PythonDataScienceHandbook/05.12-gaussian-mixtures.html