04_Exercise2_MoG_EM

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1 Task:

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

```
In [181]: import numpy as np
          %matplotlib inline
```

1.1 Dataset 1

```
In [182]: # 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])])
          dataset_1 = data[1:, :]
```

1.2 Dataset 2

```
In [183]: # 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])])
dataset_2 = data[1:, :]
```

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

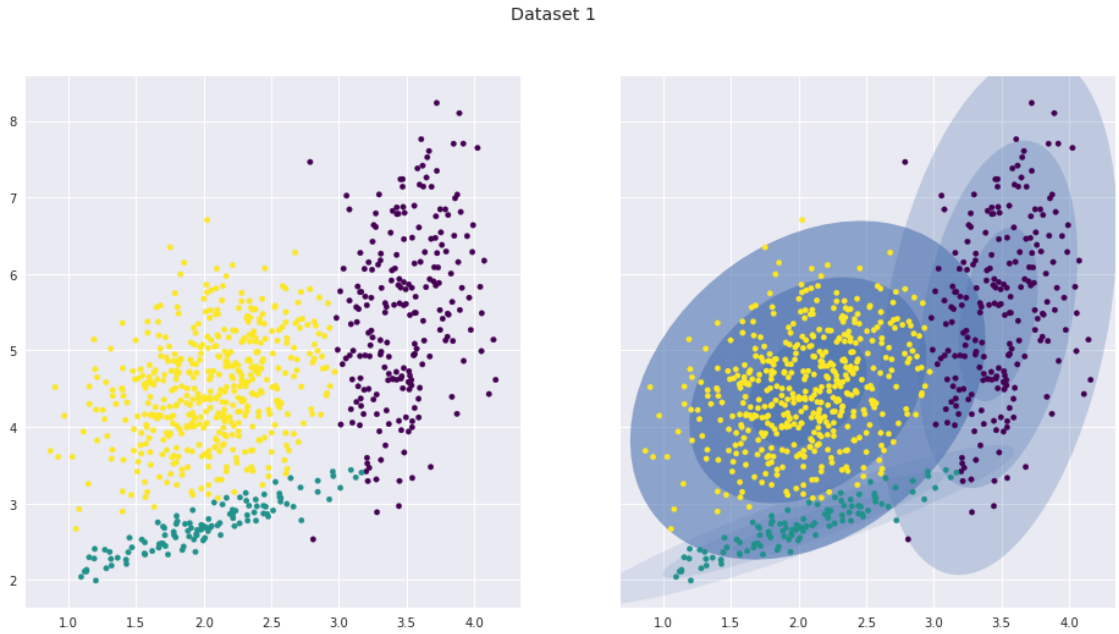
2 Results

The output for the Dataset1 can look like:

```
In [ ]: # Ref: https://jakevdp.github.io/PythonDataScienceHandbook/05.12-gaussian-mixtures.html

In [184]: import matplotlib.pyplot as plt
          import seaborn as sns; sns.set()
          from sklearn.mixture import GaussianMixture
          from matplotlib.patches import Ellipse

In [185]: plt.rcParams["figure.figsize"] = (16,8)

In [186]: def draw_ellipse(position, covariance, ax=None, **kwargs):
              """Draw an ellipse with a given position and covariance"""
              ax = ax or 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, 4):
                  ax.add_patch(Ellipse(position, nsig * width, nsig * height, angle, **kwargs))

          def plot_gmm(gmm, X, ax=None):
              ax = ax or plt.gca()
              labels = gmm.fit(X).predict(X)
```

```
        ax.scatter(X[:, 0], X[:, 1], c=labels, s=20, cmap='viridis', zorder=2)

        for pos, covar, w in zip(gmm.means_, gmm.covariances_, gmm.weights_):
            draw_ellipse(pos, covar, alpha=w)

    def visualize_mog(X, n_components, title=''):
        fig, (ax1, ax2) = plt.subplots(1, 2, sharex=True, sharey=True)
        fig.suptitle(title)

        gmm = GaussianMixture(n_components=n_components, covariance_type='full').fit(X)
        labels = gmm.predict(X)

        ax1.scatter(X[:, 0], X[:, 1], c=labels, s=20, cmap='viridis');

        plot_gmm(gmm, X, ax2)

        plt.show()
```

In [192]:
```
# Visualize Dataset 1
visualize_mog(dataset_1, 3, 'Dataset 1')
```



In [193]:
```
# Visualize Dataset 2
visualize_mog(dataset_2, 3, 'Dataset 2')
```

Dataset 2