04_Exercise2_MoG_EM

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1 Team Members

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2 Task:

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

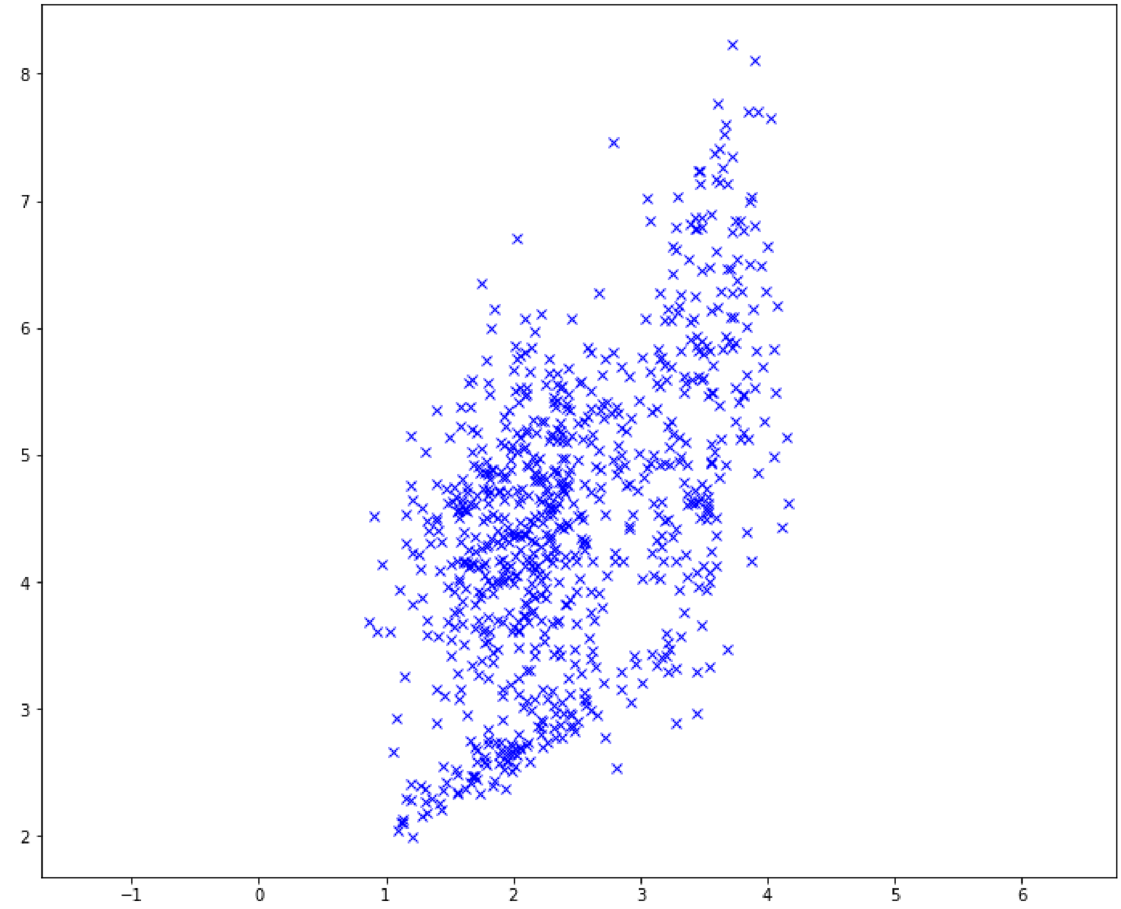
```
In [7]: import numpy as np
        import matplotlib.pyplot as plt
        from matplotlib.patches import Ellipse
        from sklearn.mixture import GaussianMixture
        %matplotlib inline
```

```
In [1]: from sklearn.mixture import GaussianMixture
```

2.1 Dataset 1

```
In [8]: # 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])])
        data = data[1:, :]
            #data
```

```
In [9]: plt.figure(figsize=(12,10))
        plt.plot(data[:,0], data[:,1], 'bx')
        plt.axis('equal')
        plt.show()
```

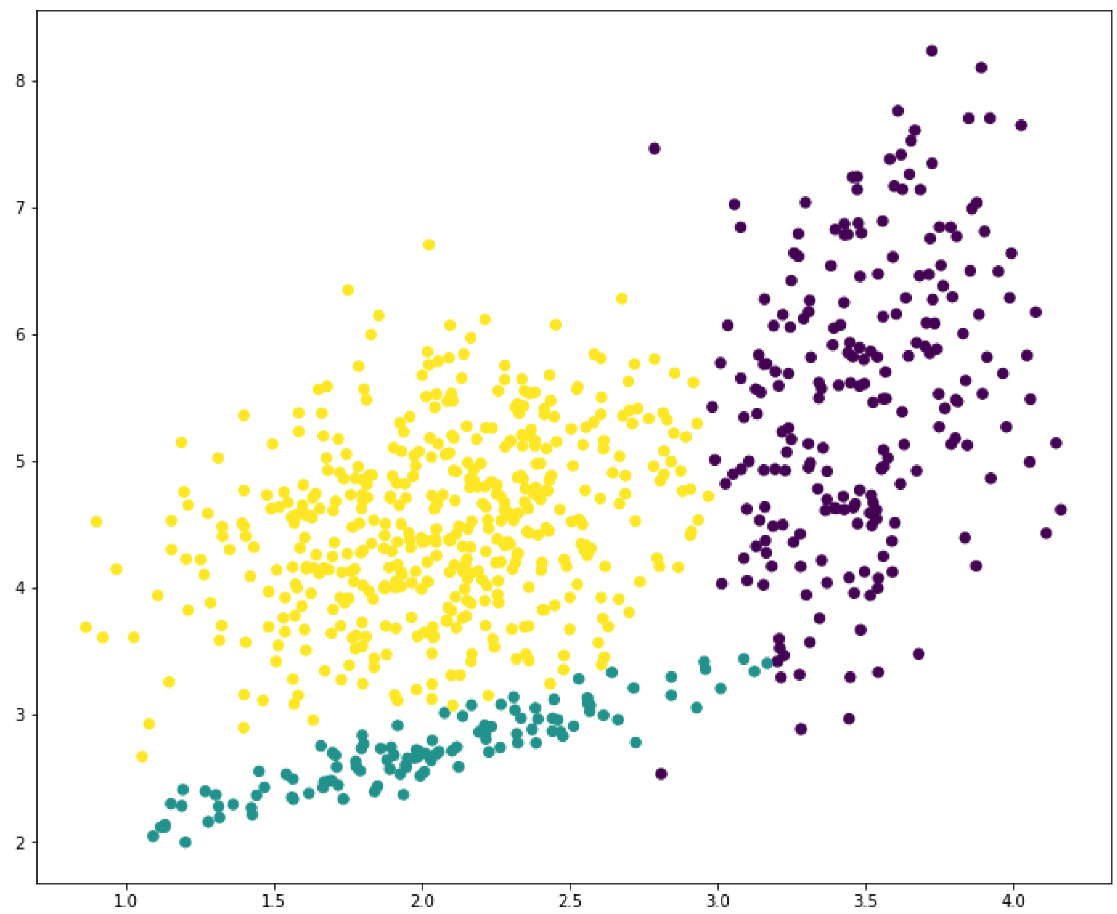


```
In [10]: gmm = GaussianMixture(n_components=3)
         gmm.fit(data)
```

```
Out[10]: GaussianMixture(covariance_type='full', init_params='kmeans', max_iter=100,
                 means_init=None, n_components=3, n_init=1, precisions_init=None,
                 random_state=None, reg_covar=1e-06, tol=0.001, verbose=0,
                 verbose_interval=10, warm_start=False, weights_init=None)
```

```
In [11]: print("Means : ")
         print(gmm.means_)
         print('\n')
         print("Covariances_ : ")
         print(gmm.covariances_)

Means :
[[ 3.4753287   5.47075048]
 [ 2.03417068  2.72313909]
 [ 2.06836917  4.48075646]]


Covariances_ :
[[[ 0.08623651  0.11000934]
  [ 0.11000934  1.28855809]]

 [[ 0.27110053  0.16767028]
  [ 0.16767028  0.12021932]]

 [[ 0.19179388  0.09628772]
  [ 0.09628772  0.54246666]]]
```

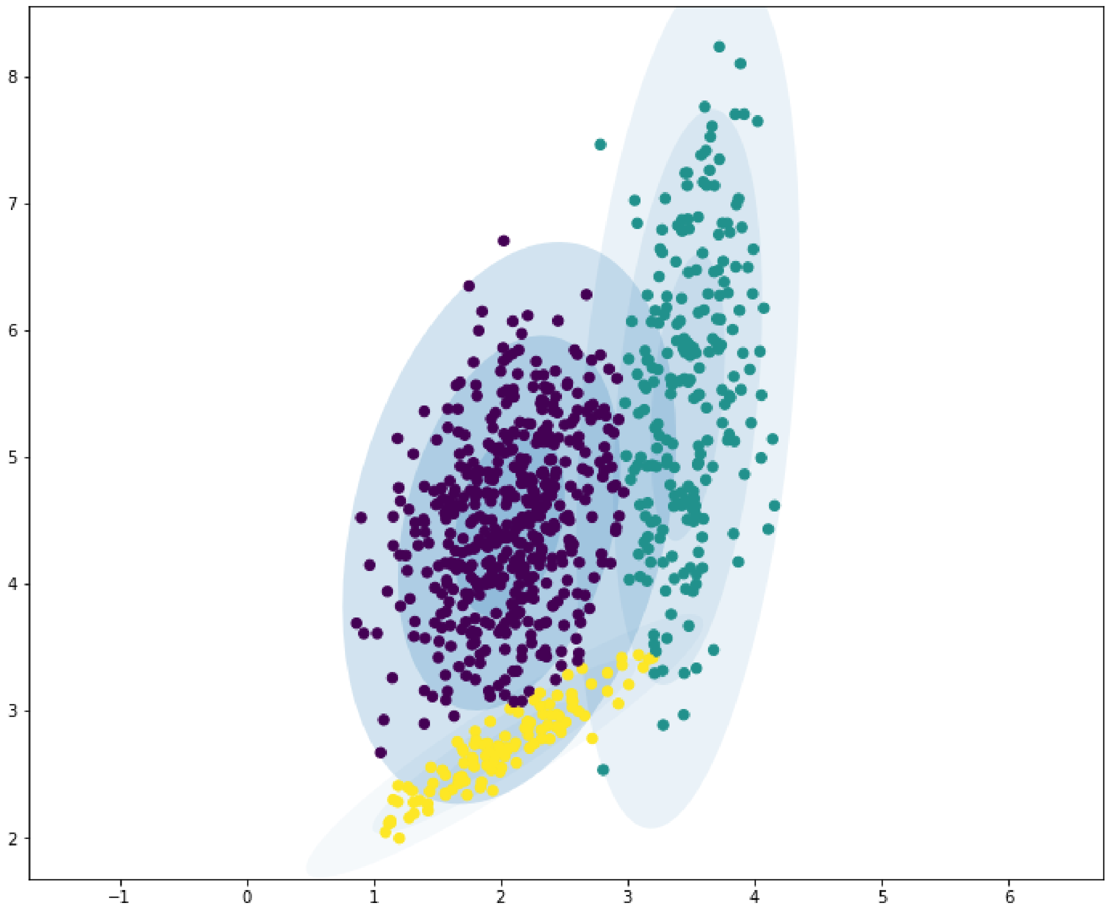
```
In [12]: labels = gmm.predict(data)
         plt.figure(figsize=(12,10))
         plt.scatter(data[:, 0], data[:, 1], c=labels, s=40, cmap='viridis');
```



```
In [13]: 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, label=True, ax=None):
            ax = ax or plt.gca()
            labels = gmm.fit(X).predict(X)
            if label:
                ax.scatter(X[:, 0], X[:, 1], c=labels, s=40, cmap='viridis', zorder=2)
            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)
```

```
In [14]: plt.figure(figsize=(12,10))
         plot_gmm(gmm, data)
```

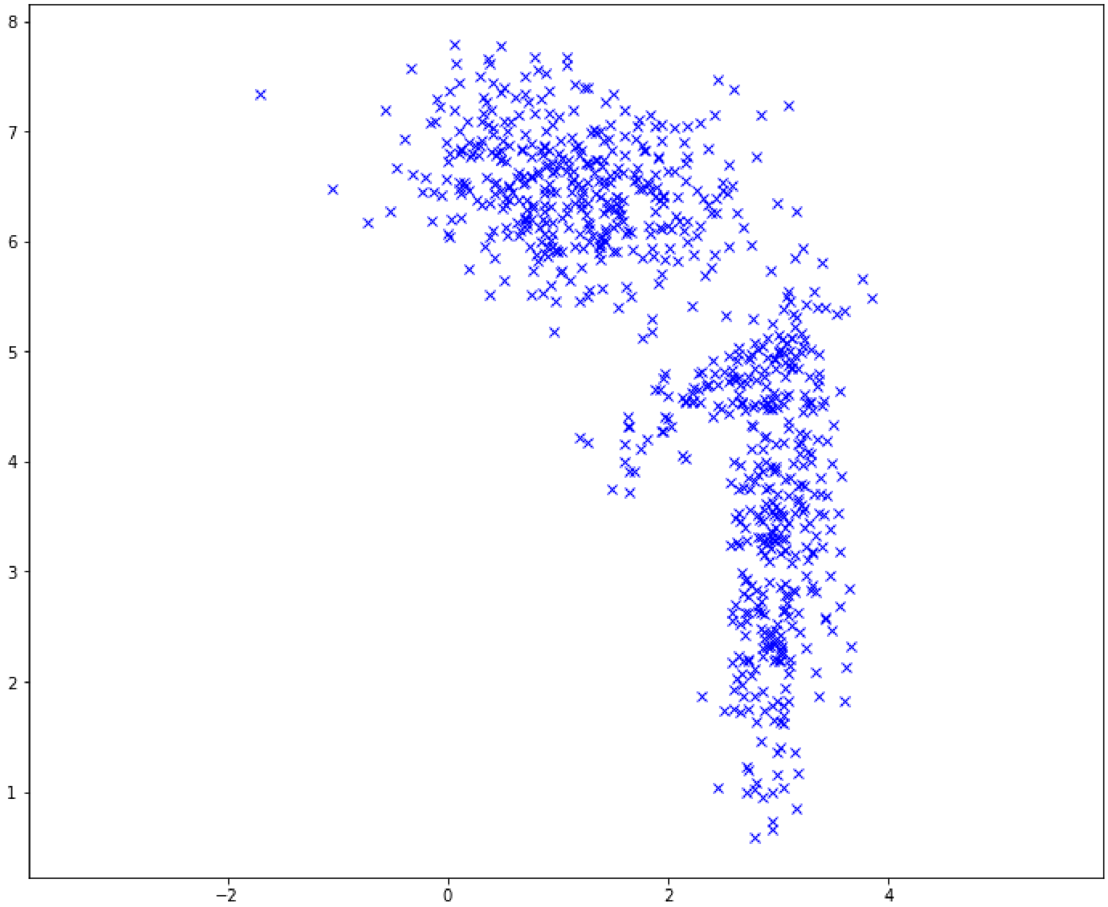


2.2 Dataset 2

```
In [15]:     # 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])])
        data = data[1:, :]
```

```
In [16]: plt.figure(figsize=(12,10))
         plt.plot(data[:,0], data[:,1], 'bx')
         plt.axis('equal')
         plt.show()
```

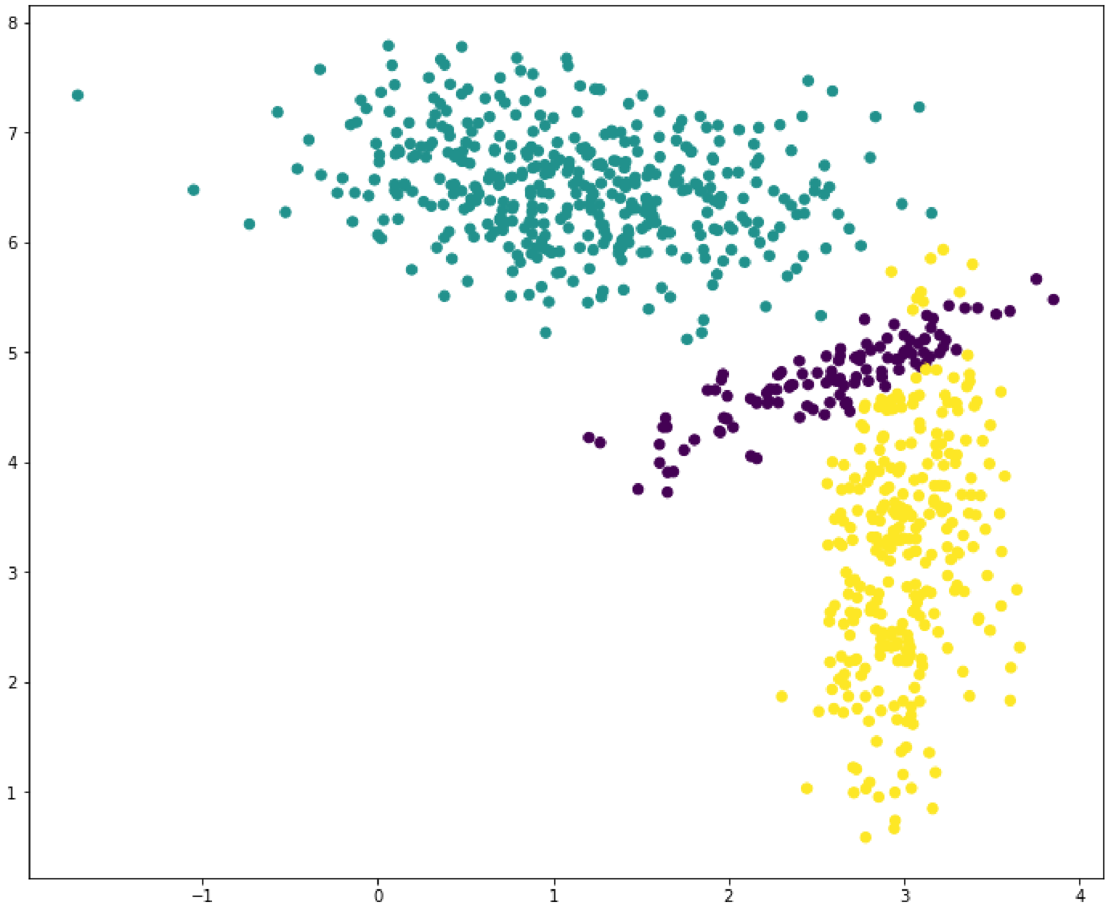


```
In [17]: gmm = GaussianMixture(n_components=3)
         gmm.fit(data)

Out[17]: GaussianMixture(covariance_type='full', init_params='kmeans', max_iter=100,
                 means_init=None, n_components=3, n_init=1, precisions_init=None,
                 random_state=None, reg_covar=1e-06, tol=0.001, verbose=0,
                 verbose_interval=10, warm_start=False, weights_init=None)
```

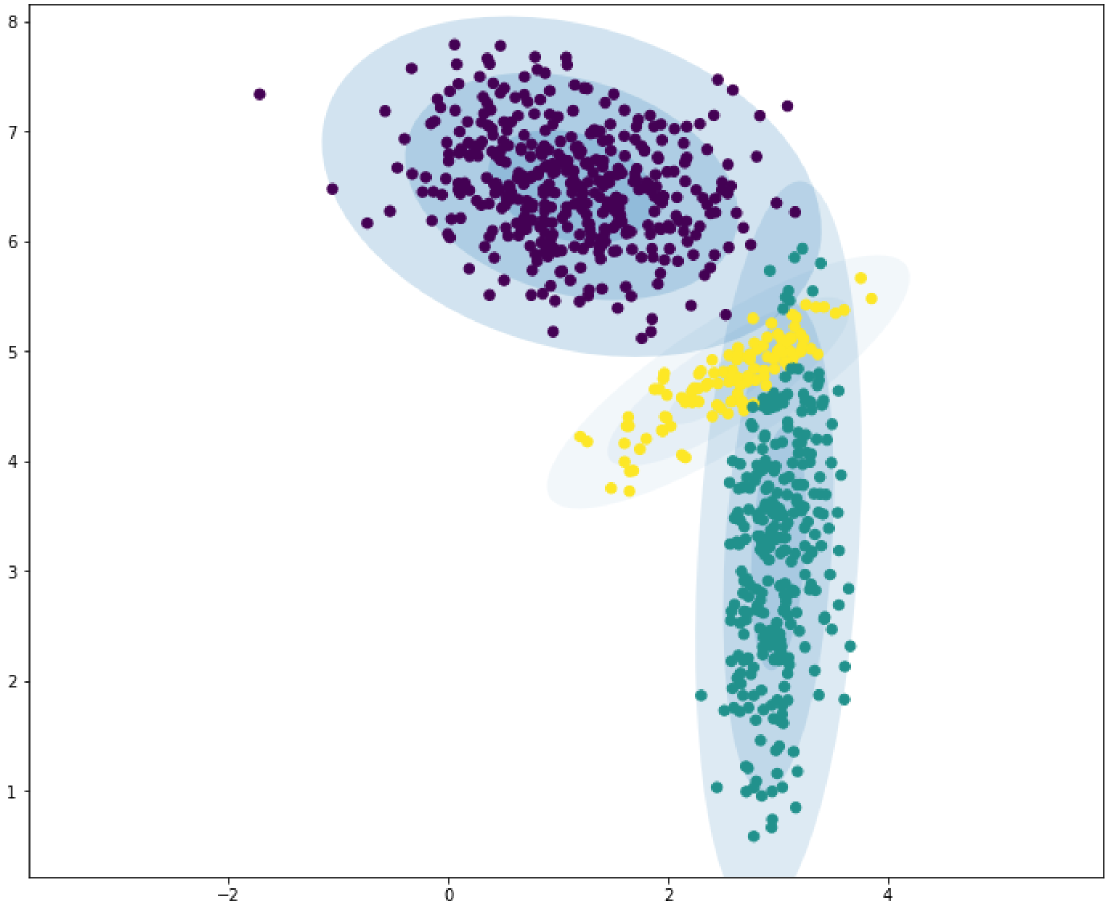
```
In [18]: print("Means : ")
         print(gmm.means_)
         print('\n')
         print("Covariances_ : ")
         print(gmm.covariances_)
```

```
Means :
[[ 2.54491534  4.71958763]
 [ 1.12515922  6.49886926]
 [ 3.00719991  3.21614687]]


Covariances_ :
[[[ 0.30318316  0.17523653]
  [ 0.17523653  0.14791356]]

 [[ 0.57208469 -0.10067756]
  [-0.10067756  0.2670085 ]]

 [[ 0.06349794  0.07185531]
  [ 0.07185531  1.2492168 ]]]
```

```
In [20]: labels = gmm.predict(data)
         plt.figure(figsize=(12,10))
         plt.scatter(data[:, 0], data[:, 1], c=labels, s=40, cmap='viridis')

Out[20]: <matplotlib.collections.PathCollection at 0x7fa7263dcc90>
```



```
In [21]: plt.figure(figsize=(12,10))
         plot_gmm(gmm, data)
```


8
7
6
5
4
3
2
1
−2
0
2
4