

Homework 4 Exercise 2

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1 Homework 4 Exercise 2

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In this exercise we will extend the EM algorithm from Exercise 1 to adapt the covariance matrices and prior probabilities of the mixtures.

1.1 Exercise 1 Code

The following is merely code copied over from Exercise 1, duplicated here for the purposes of splitting the assignment into separate notebooks:

```
In [1]: import csv, copy, gzip, pickle

import numpy as np
import matplotlib.pyplot as plt

from scipy.stats import chi2

%matplotlib inline

with open('data/faithful.txt', 'rt') as csvfile:
    dataReader = csv.reader(csvfile, delimiter=' ')
    # initialize an empty array
    data = []
    for row in dataReader:
        data.append(np.array(row).astype(np.float))
    # convert data into a numpy array
    data = np.asarray(data)

ngmm = 2 # quantity of Gaussian Mixture Model
mu = np.asarray([[2, 70],
                 [4, 80]]
                 ).astype('float')

sigma = np.asarray([[1, 0],
                    [0, 3]],
```

```

        [[0.5, 0.2],
         [0.2, 0.6]])
        ).astype('float')
def covmatIsLegal(sigma):
    for covmat in sigma:
        if not(np.allclose(covmat, covmat.T)) or np.any(np.linalg.eigvals(covmat) <= 0):
            return False
    return True

print("Covariance Matrices are Legal? : %r" % covmatIsLegal(sigma))
gmm = [{'mean': mu[m], 'covariance': sigma[m], 'prior': 1.0/ngmm} for m in range(ngmm)]

def plotGaussianModel2D(mu, sigma, pltopt='k'):
    if sigma.any():
        # calculate ellipse constants
        c = chi2.ppf(0.9, 2) # use confidence interval 0.9
        # get eigen vector and eigen values
        eigenValue, eigenVector = np.linalg.eig(sigma)
        # calculate points on ellipse
        t = np.linspace(0, 2*np.pi, 100) # draw 100 points
        u = [np.cos(t), np.sin(t)]
        w = c * eigenVector.dot(np.diag(np.sqrt(eigenValue))).dot(u)
        z = w.T + mu
    else:
        z = mu
    # plot ellipse by connecting sample points on curve
    plt.plot(z[:,0], z[:,1], pltopt)

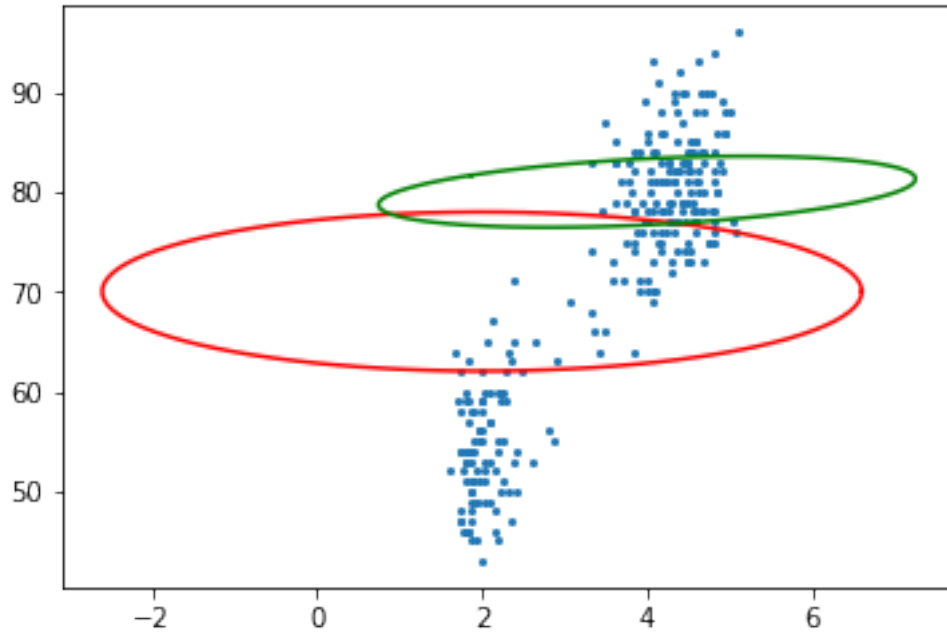
def colorPicker(index):
    colors = 'rgbcmyk'
    return colors[np.remainder(index, len(colors))]

def gmmplot(data, gmm):
    # plot data points
    plt.scatter(data[:, 0], data[:, 1], s=4)
    # plot Gaussian model
    color = 'rgb'
    for index, model in enumerate(gmm):
        plotGaussianModel2D(model['mean'], model['covariance'], colorPicker(index))

gmmplot(data, gmm)
gmm = [{'mean': mu[m], 'covariance': sigma[m], 'prior': 1.0/ngmm} for m in range(ngmm)]

```

Covariance Matrices are Legal? : True



1.1.1 Optimizing Covariance and Priors

Optimizing the covariance is as simple as calling `maximization` instead of `maximization_mean`. `Maximization` updates the means as before, but also calculates the priors and values of the covariance matrices for each cluster. Unfortunately, there appears to be a bug in my implementation of this function that cascades down to affect the updated means and corrupts the output. Despite my best efforts to fix it and comparing my implementation with a peer's working solution line-by-line, tracing intermediate variable values, etc, I have been unable to fix it, but I am convinced that, while it may have a large impact on the data, it is a small error somewhere that causes values to diverge. Updating the priors and covariance matrices follows the EM equations for the priors and $\Sigma_{k'}$ respectively.

```
In [3]: from gmmlib import expectation, maximization, maximization_mean

        # make a true copy of our model
        gmmcp = copy.deepcopy(gmm)

        # create figure
        plt.figure(figsize=(16, 8))
        # improve model with EM-Algorithm
        # fixed number of iterations so it doesn't crash from diverging values
        for i in range(5):
            # plot current status
            plt.subplot(231 + i)
            gmmplot(data, gmmcp)
            # excute EM-Algorithm
```

```

    for j in range(5):
        posterior = expectation(data, gmmcp)
        gmmcp = maximization(posterior, data, gmmcp)
    # plot final status
    plt.subplot(236)
    gmmplot(data, gmmcp)

```

There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [3.6 79.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [1.8 54.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [3.333 74.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [2.283 62.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [4.533 85.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [2.883 55.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]
 prior: 5.0775642727696796e-18
 There was an error calculating p_k_xn. Not sure why it does this but it messes things up
 xn: [4.7 88.]
 mean: [4.383 82.]
 covar: [[6.53095993e-20 -3.48005886e-32]
 [-3.48005886e-32 7.42457323e-31]]

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.6 85. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.95 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.35 85. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.917 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.2 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 47. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.7 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.167 52. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 62. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.6 52. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.25 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.8 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 47. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.45 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.067 69. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.533 74. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.6 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.967 55. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.083 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.85 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.433 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.3 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.467 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.367 66. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.033 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.833 74. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.017 52. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 48. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.833 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]

```



```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.783 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.35 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.883 58. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.567 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 58. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.533 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.317 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.833 64. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.1 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.633 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2. 59.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.716 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.833 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.733 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.883 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.717 71. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.667 64. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.567 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.317 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.233 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 48. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

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```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.817 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.4 92. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.167 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.7 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.067 65. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.7 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.033 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.967 56. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 71.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.983 62. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 5.067 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.017 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.567 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.883 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.6 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.133 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.333 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.1 70. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.633 65. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.067 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.933 88. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.95 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

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```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.517 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.167 48. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 86.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.2 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.333 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 50. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.817 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 63. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.3 72. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.667 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.75 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.9 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.483 62. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.367 88. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.1 49. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```



```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.05 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 47. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.7 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.783 52. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.85 86. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.683 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.733 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

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```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.3 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.9 89. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.417 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.7 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.633 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.317 50. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.6 85. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.817 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.417 87. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.617 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.067 69. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.25 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.967 56. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.6 88. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.767 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.917 45. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.267 55. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.65 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 45. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.167 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.8 56. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.333 89. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 46. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]

```

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prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.383 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.883 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.933 86. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.033 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.733 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.233 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.233 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.533 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

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prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.817 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.333 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.983 59. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.633 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.017 49. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 5.1 96. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.8 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 5.033 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 77.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.4 65. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.6 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.567 71. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 70.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.083 93. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.8 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

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```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.967 89. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.2 45. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.15 86. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2. 58.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.833 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.5 66. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.583 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.367 63. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

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prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 5. 88.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.933 52. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.617 93. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.917 49. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.083 57. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.583 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.333 68. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.167 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.333 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.417 50. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 85.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.167 74. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.883 55. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.583 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.25 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

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prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.767 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.033 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.433 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.083 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 46. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.417 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.183 55. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.833 57. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.1 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.966 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.233 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.5 87. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.366 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.25 51. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.667 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.1 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.35 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.133 91. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.6 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.783 46. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.367 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.85 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.933 49. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.383 71. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.7 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 49. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.833 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.417 64. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.233 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.4 53. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.8 94. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2. 55.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.15 76. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.867 50. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.267 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.75 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.483 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4. 78.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.117 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.083 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.267 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.917 70. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.55 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.083 70. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```



```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.417 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.183 86. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.217 50. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.45 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.883 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.85 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.283 77. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.95 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.333 64. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.15 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.35 47. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.933 86. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.9 63. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.583 85. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.833 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.083 57. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.367 82. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.133 67. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.35 74. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.2 54. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.45 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.567 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.5 73. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.15 88. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
         [-3.48005886e-32 7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.817 80. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 3.917 71. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.45 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2. 56.]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.283 79. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.767 78. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.533 84. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.85 58. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]

```

```

prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.25 83. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.983 43. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.25 60. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.75 75. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.117 81. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 2.15 46. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.417 90. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 1.817 46. ]
mean: [ 4.383 82. ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32 7.42457323e-31]]

```

```
prior: 5.0775642727696796e-18
There was an error calculating p_k_xn. Not sure why it does this but it messes things up
xn: [ 4.467 74.   ]
mean: [ 4.383 82.   ]
covar: [[ 6.53095993e-20 -3.48005886e-32]
        [-3.48005886e-32  7.42457323e-31]]
prior: 5.0775642727696796e-18
```

```
/home/jonsnow/Repositories/bmcfarland491/gmmlib.py:33: RuntimeWarning: divide by zero encountered
  posteriors[n] = [i/mean_normalizers[k] for i in posteriors[n]]
/home/jonsnow/Repositories/bmcfarland491/gmmlib.py:33: RuntimeWarning: invalid value encountered
  posteriors[n] = [i/mean_normalizers[k] for i in posteriors[n]]
/home/jonsnow/Repositories/bmcfarland491/gmmlib.py:77: RuntimeWarning: invalid value encountered
  mean /= p_k # normalize the mean
```

LinAlgError

Traceback (most recent call last)

```
<ipython-input-3-f2da6f4a0264> in <module>()
    11     # plot current status
    12     plt.subplot(231 + i)
---> 13     gmmplot(data, gmmcp)
    14     # excute EM-Algorithm
    15     for j in range(5):

<ipython-input-1-671a82dbc6f8> in gmmplot(data, gmm)
    63     color = 'rgb'
    64     for index, model in enumerate(gmm):
---> 65         plotGaussianModel2D(model['mean'], model['covariance'], colorPicker(index))
    66
    67 gmmplot(data, gmm)

<ipython-input-1-671a82dbc6f8> in plotGaussianModel2D(mu, sigma, pltopt)
    42     c = chi2.ppf(0.9, 2) # use confidence interval 0.9
    43     # get eigen vector and eigen values
---> 44     eigenValue, eigenVector = np.linalg.eig(sigma)
    45     # calculate points on ellipse
    46     t = np.linspace(0, 2*np.pi, 100) # draw 100 points

/usr/lib/python3.6/site-packages/numpy/linalg/linalg.py in eig(a)
1141     _assertRankAtLeast2(a)
```

```

1142     _assertNdSquareness(a)
-> 1143     _assertFinite(a)
1144     t, result_t = _commonType(a)
1145

```

```

/usr/lib/python3.6/site-packages/numpy/linalg/linalg.py in _assertFinite(*arrays)
214     for a in arrays:
215         if not (isfinite(a).all()):
--> 216             raise LinAlgError("Array must not contain infs or NaNs")
217
218 def _isEmpty2d(arr):

```

LinAlgError: Array must not contain infs or NaNs

