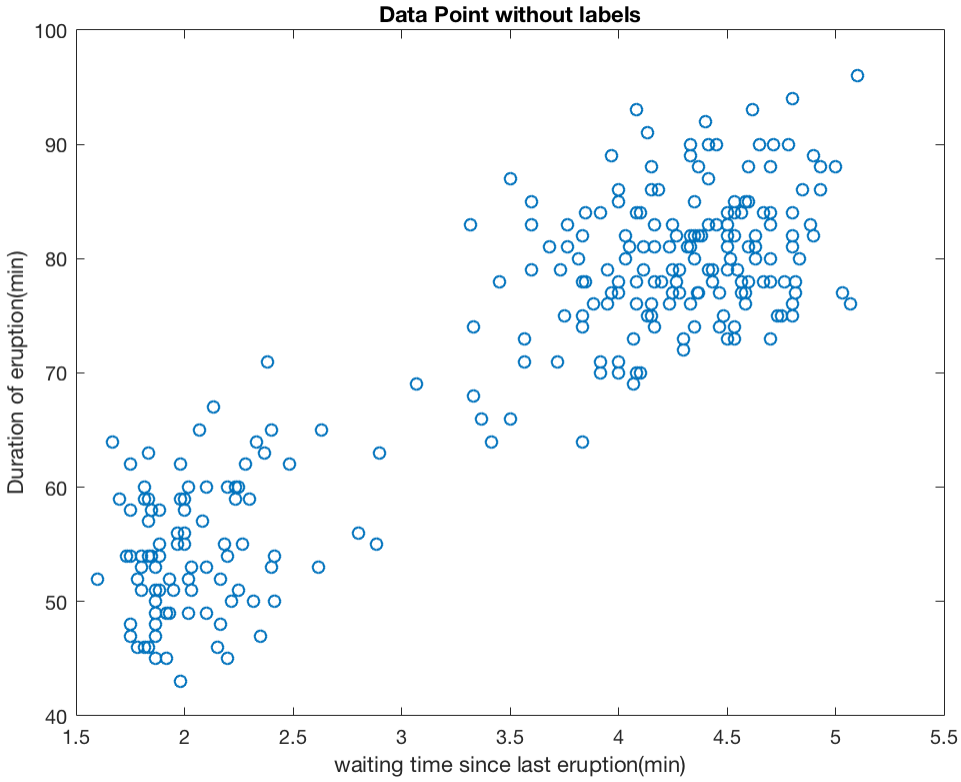
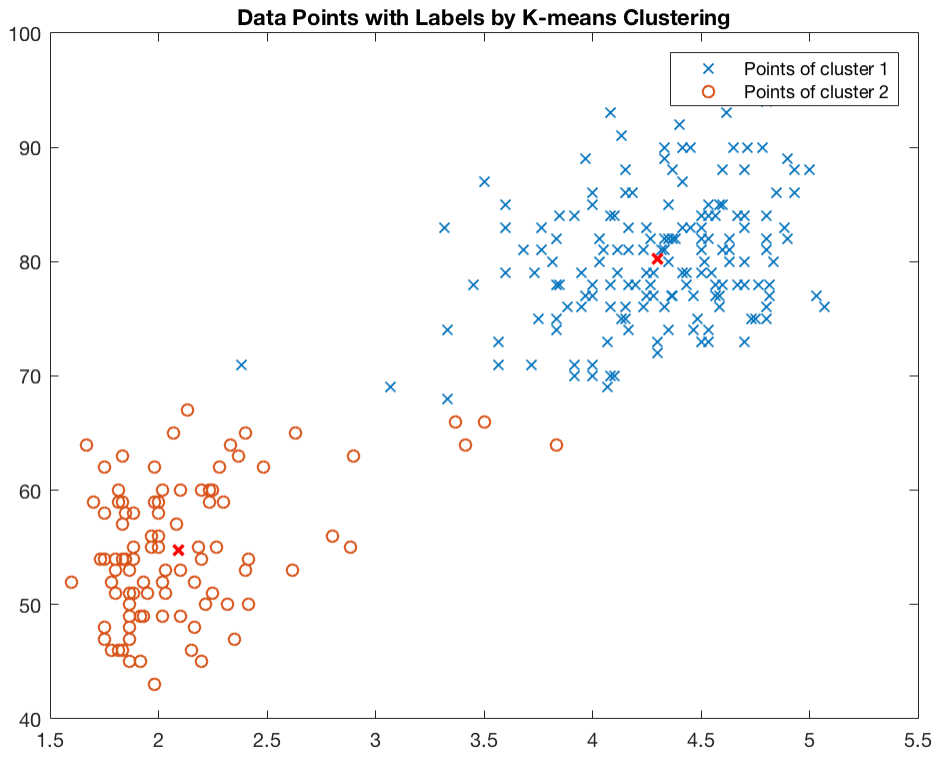
```
clear all; close all; clc;
max = 272;
X= zeros(max,2);

%Waiting Time and Eruption duration
eruption_duration= [3.600 1.800 3.333 2.283 4.533 2.883 4.700 3.600
 1.950 4.350 1.833 3.917 4.200 1.750 4.700 2.167 1.750 4.800 1.600
 4.250 1.800 1.750 3.450 3.067 4.533 3.600 1.967 4.083 3.850 4.433
 4.300 4.467 3.367 4.033 3.833 2.017 1.867 4.833 1.833 4.783 4.350
 1.883 4.567 1.750 4.533 3.317 3.833 2.100 4.633 2.000 4.800 4.716
 1.833 4.833 1.733 4.883 3.717 1.667 4.567 4.317 2.233 4.500 1.750
 4.800 1.817 4.400 4.167 4.700 2.067 4.700 4.033 1.967 4.500 4.000
 1.983 5.067 2.017 4.567 3.883 3.600 4.133 4.333 4.100 2.633 4.067
 4.933 3.950 4.517 2.167 4.000 2.200 4.333 1.867 4.817 1.833 4.300
 4.667 3.750 1.867 4.900 2.483 4.367 2.100 4.500 4.050 1.867 4.700
 1.783 4.850 3.683 4.733 2.300 4.900 4.417 1.700 4.633 2.317 4.600
 1.817 4.417 2.617 4.067 4.250 1.967 4.600 3.767 1.917 4.500 2.267
 4.650 1.867 4.167 2.800 4.333 1.833 4.383 1.883 4.933 2.033 3.733
 4.233 2.233 4.533 4.817 4.333 1.983 4.633 2.017 5.100 1.800 5.033
 4.000 2.400 4.600 3.567 4.000 4.500 4.083 1.800 3.967 2.200 4.150
 2.000 3.833 3.500 4.583 2.367 5.000 1.933 4.617 1.917 2.083 4.583
 3.333 4.167 4.333 4.500 2.417 4.000 4.167 1.883 4.583 4.250 3.767
 2.033 4.433 4.083 1.833 4.417 2.183 4.800 1.833 4.800 4.100 3.966
 4.233 3.500 4.366 2.250 4.667 2.100 4.350 4.133 1.867 4.600 1.783
 4.367 3.850 1.933 4.500 2.383 4.700 1.867 3.833 3.417 4.233 2.400
 4.800 2.000 4.150 1.867 4.267 1.750 4.483 4.000 4.117 4.083 4.267
 3.917 4.550 4.083 2.417 4.183 2.217 4.450 1.883 1.850 4.283 3.950
 2.333 4.150 2.350 4.933 2.900 4.583 3.833 2.083 4.367 2.133 4.350
 2.200 4.450 3.567 4.500 4.150 3.817 3.917 4.450 2.000 4.283 4.767
 4.533 1.850 4.250 1.983 2.250 4.750 4.117 2.150 4.417 1.817 4.467];
Waiting_time= [79 54 74 62 85 55 88 85 51 85 54 84 78 47 83 52 62 84
 52 79 51 47 78 69 74 83 55 76 78 79 73 77 66 80 74 52 48 80 59 90 80
 58 84 58 73 83 64 53 82 59 75 90 54 80 54 83 71 64 77 81 59 84 48 82
 60 92 78 78 65 73 82 56 79 71 62 76 60 78 76 83 75 82 70 65 73 88 76
 80 48 86 60 90 50 78 63 72 84 75 51 82 62 88 49 83 81 47 84 52 86 81
 75 59 89 79 59 81 50 85 59 87 53 69 77 56 88 81 45 82 55 90 45 83 56
 89 46 82 51 86 53 79 81 60 82 77 76 59 80 49 96 53 77 77 65 81 71 70
 81 93 53 89 45 86 58 78 66 76 63 88 52 93 49 57 77 68 81 81 73 50 85
 74 55 77 83 83 51 78 84 46 83 55 81 57 76 84 77 81 87 77 51 78 60 82
 91 53 78 46 77 84 49 83 71 80 49 75 64 76 53 94 55 76 50 82 54 75 78
 79 78 78 70 79 70 54 86 50 90 54 54 77 79 64 75 47 86 63 85 82 57 82
 67 74 54 83 73 73 88 80 71 83 56 79 78 84 58 83 43 60 75 81 46 90 46
 74];

%Adding the data to one vector for processing
for index = 1:max
    X(index,1)= eruption_duration(index);
    X(index,2)= Waiting_time(index);
end

%scattered data and data points after k-means clustering
figure(1);
```

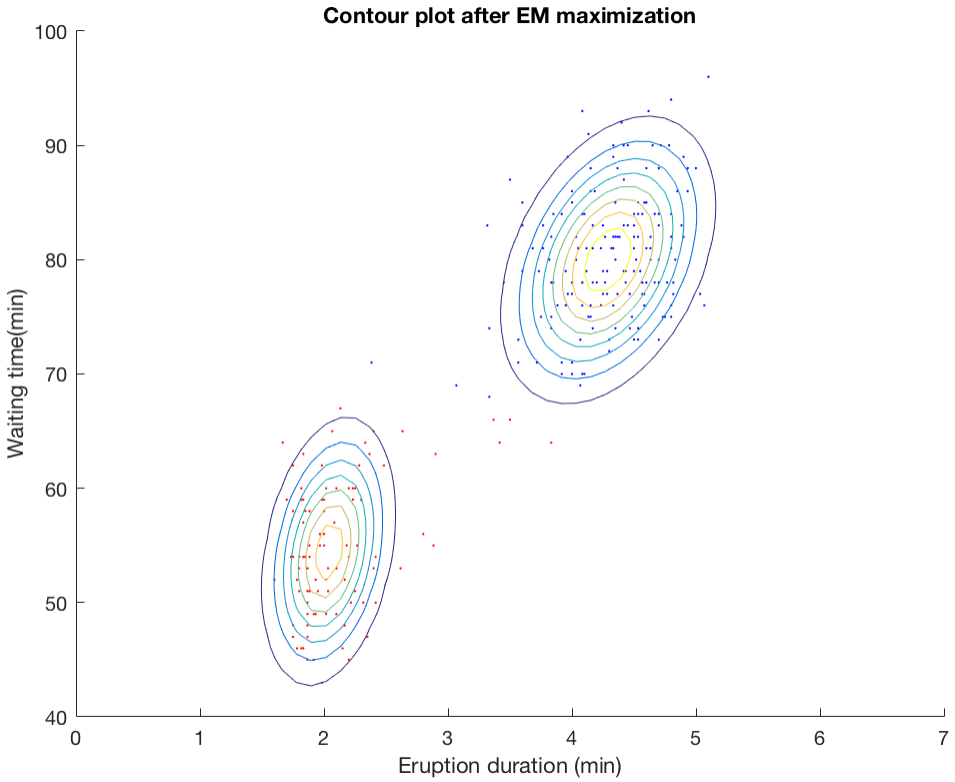
```
plot(X(:,1), X(:,2), 'o');
[y,C]= kmeans(X,2);
title('Data Point without labels');
xlabel('waiting time since last eruption(min)');
ylabel('Duration of eruption(min)');

figure(2)
plot(X(y==1,1),X(y==1,2), 'x');
hold on
plot(X(y==2,1),X(y==2,2), 'o');
plot(C(1,1),C(1,2), 'rx','LineWidth',2);
plot(C(2,1),C(2,2), 'rx','LineWidth',2);
legend('Points of cluster 1','Points of cluster 2')
title('Data Points with Labels by K-means Clustering')
hold off

%Seperating the data points into two sub-poulation to use it in EM
%maximization
X1_index= 1;
X2_index= 1;
for index = 1:max
    if(y(index,1)==1)
        X1(X1_index,1)= X(index,1);
        X1(X1_index,2)= X(index,2);
        X1_index= X1_index+1;
    elseif(y(index,1)==2)
        X2(X2_index,1)= X(index,1);
        X2(X2_index,2)= X(index,2);
        X2_index= X2_index+1;
    end
end

X_GMM= [X1;X2];
figure(3);

hold on
scatter(X1(:,1),X1(:,2),10,'b.');
hold on
scatter(X2(:,1),X2(:,2),10,'r.');
hold on

%EM Maximization and pdf contour plotting
opt = statset('Display','final');
Expectation_Max = gmdistribution.fit(X_GMM,2,'Options',opt);
h = ezcontour(@(x,y)pdf(Expectation_Max,[x y]),[0,7],[40,100]);
title('Contour plot after EM maximization'); xlabel('Eruption duration
 (min)');
ylabel('Waiting time(min)');
hold off

figure(4);
y = pdf(Expectation_Max,X_GMM);
ezsurf(@(x,y)pdf(Expectation_Max,[x y]),[0,7],[40 100]);
xlabel('Eruption duration (min)');
```

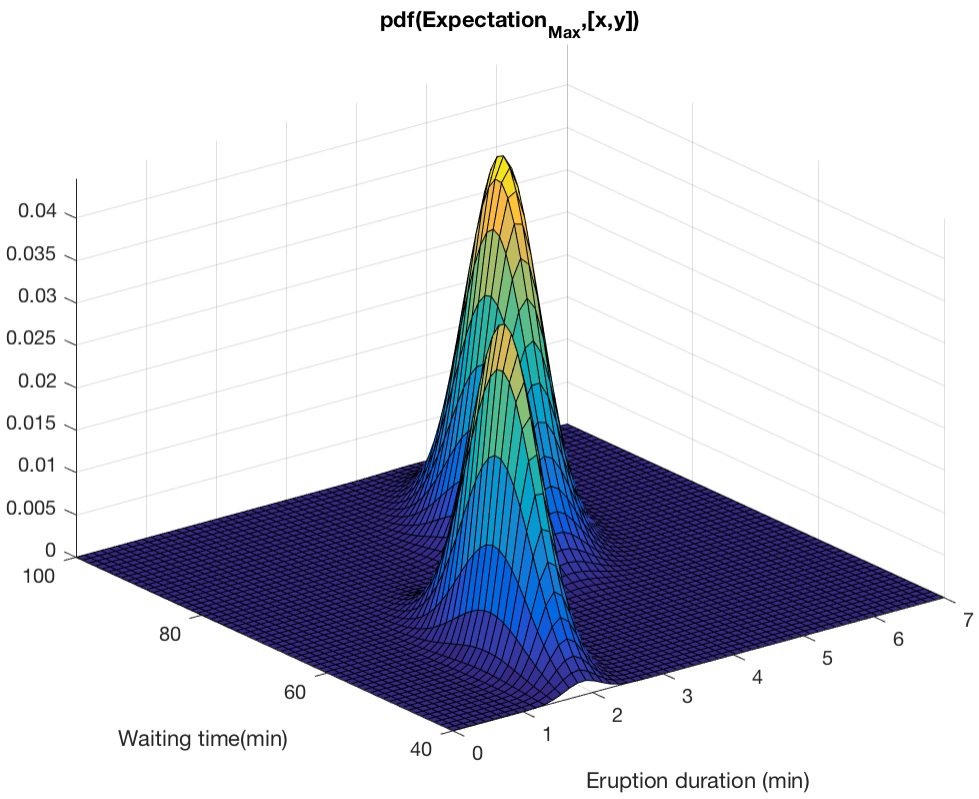
```
ylabel('Waiting time(min)');
```

```
33 iterations, log-likelihood = -1130.26
```




Data Points with Labels by K-means Clustering
Points of cluster 1
Points of cluster 2
100
90
80
70
60
50
40
1.5
2
2.5
3
3.5
4
4.5
5
5.5


Contour plot after EM maximization
Waiting time(min)
Eruption duration (min)
100
90
80
70
60
50
40
0
1
2
3
4
5
6
7



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