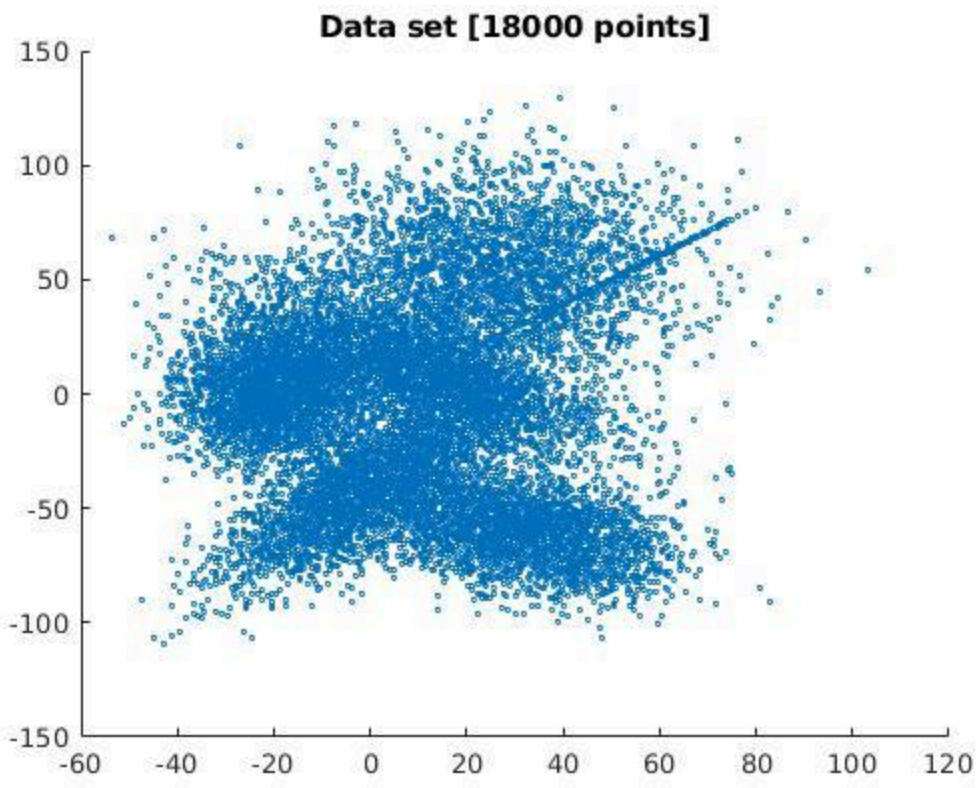
# Table of Contents



```
%%Skylar Tamke - Project 3 EM Clustering
% I have estimated 6 clusters for this set of data.  This parameter
 can be
% changed easily by modifying the variable M. When using the algorithm
 the
% initial conditions are very key to how
% successful the algorithm is.  If the starting conditions are bad the
% algorithm will cluster badly for a 2d array.

clc
clear
close all
warning('off','all')

%number of clusterings
M = 6;

%load data file
load("data.mat");

%initialize data set
x = data;
[N, d] = size(x);
mean = zeros(M,2);
pi_val = zeros(1,M);
pi_val(:) = 1/M;

%plot Data
scatter(data(:,1),data(:,2),3);
hold on
title("Data set [18000 points]")


%automatically finds clusters based on the kmeans method, initial
 guess
[idx1,C1] = kmeans(data,M);
% C1 = rand(6,2)*100

%getting the mean for each point. initially
for i = 1:M
   mu(i,:) = C1(i,:);
end
```

```
% scatter(C1(:,1),C1(:,2),100)

% initialize cov values for each Gaussian (M) scalable
for m = 1:M
    Em(:,:,m) = eye(2);
end


% creating booleans to use when determining if continued EM is needed
boolean = 1;
covarience_threshhold = .01
loopcount = 0
```

```
covarience_threshhold =

    0.0100


loopcount =

     0
```



# Algorithm

The algorithm will run until the end condition is met

```
while( boolean)

    loopcount = loopcount + 1;
    % Expectation algorithm step
    cond_sum = zeros(N,1);
    for i = 1:N
        % first the probability that the data point is in a certain
 cluster
        for m=1:M
%             cond_prob(i,m) = mvnpdf(x(i,:),mu(m,:),Em(:,:,m));
            cond_prob(i,m) =
 (((2*pi)^(d/2))*((det(Em(:,:,m)))^(-.5))) ...
            * exp((-.5*(x(i,:)-mu(m,:))*(inv(Em(:,:,m)))*(x(i,:)-
(mu(m,:)))'));
        end

        for m =1:M
            cond_sum(i) = cond_prob(i,m)*pi_val(m) + cond_sum(i);
        end
        % calculate the expectation of each data point
        for m=1:M
            z(i,m) = cond_prob(i,m)*pi_val(m)/cond_sum(i);
        end
    end
    %getting rid of any NaNs, which are the result of the
    %conditional_probabilities that ended up being zero.
    for i = 1:N
        for m = 1:M
            if(isnan(z(i,m)))
               z(i,m) = 0;
            end
        end
    end


    %resetting this sumation so that algorithm doesn't run away
    cov_num = zeros(2,2,6);
    % % % M step
    for m = 1:M

        z_sum = sum(z(:,m));
        for i = 1:N
            cov_num(:,:,m)  = z(i,m) * (x(i,:) - mu(m,:))' * (x(i,:) -
 mu(m,:)) + cov_num(:,:,m);
        end
        %calculate new covarience matrices
        Em(:,:,m) = cov_num(:,:,m)/sum(z(:,m));

        %record old means so we can compare to check convergence
```

```
        old_mu = mu;
        for i = 1:N
          mu_num(i,:) = z(i,m) * x(i,:);
        end
        sum_num = sum(mu_num);
        %calculate new means
        mu(m,:) = sum_num/(z_sum);
        %calculate new prior probabilities
        pi_val(m) = z_sum/N;

    end
```

# Threshdold difference

This is where convergence of EM properties are checked to see if the algorithm is successfull or not

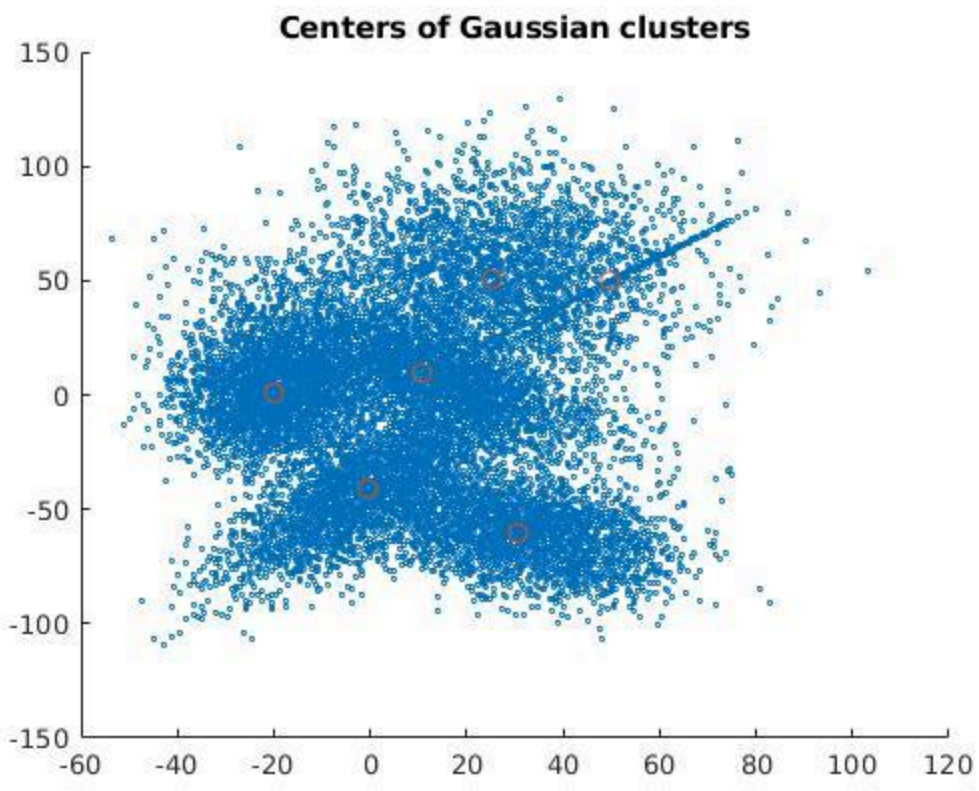
```
    %reset convergence check
    mu_difference = 0;
    for m = 1:M
       mu_difference = abs(old_mu(m) - mu(m)) + mu_difference;
    end

    if(mu_difference < covarience_threshhold)
        boolean = 0;
    end
```

# Centriod plot

plot each centriod change, commented out for publish scatter(mu(:,1),mu(:,2),50)

```
end

% A count of how many times the algorithm ran before finding a
loopcount
% A plot of the completed centers
scatter(mu(:,1),mu(:,2),50)
title("Centers of Gaussian clusters")
```

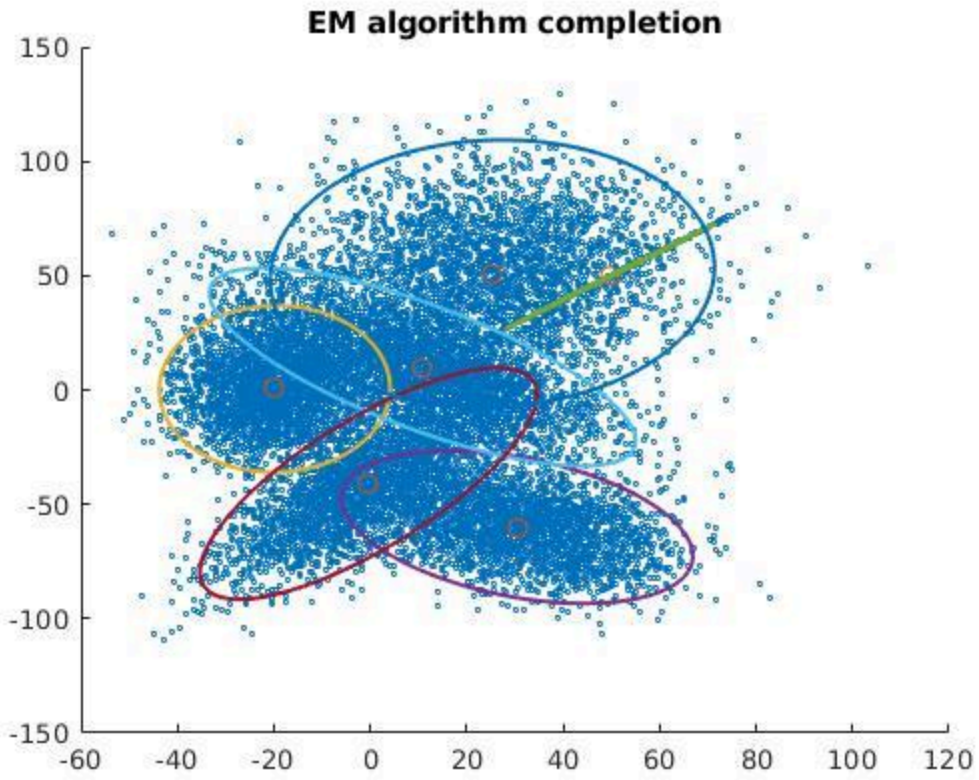
```
loopcount =

    42
```




# Ellipse plotting

this is a function linked for the class to use to

```
for m = 1:M
   error_ellipse(Em(:,:,m),mu(m,:))
end
title("EM algorithm completion")

%do not use
            % conditional prob. of generating xi given mth model
%             easyCond(i,m) =
 (((2*pi)^(d/2))*((det(Em(:,:,m)))^(-.5))) ...
%             * exp((-.5*(x(i,:)-mu(m,:))*(inv(Em(:,:,m)))*(x(i,:)-
(mu(m,:)))'));
            %using the function
```

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