CLP Lab 7 Report

Albert Aparicio Isarn
albert.aparicio.isarn@alu-etsetb.upc.edu

Héctor Esteban Cabezos
hect.esteban@gmail.com

1. Programación de método de clasificación

El script main_2_1 contiene el código del ejercicio 1. En la sección 4.1 se puede ver su código fuente.

La sección 2 de este ejercicio corresponde a la función CLP_Kmeans, cuyo código fuente se muestra en la sección 4.2.

A continuación se muestran los resultados de este ejercicio. En la figura **??** se muestra la base de datos creada por CLP_Generate (código fuente en la sección **??**) y el resultado de la clasificación con 4, 9 y 10 *clusters*.

2. Cuantificación de imágenes

More text.

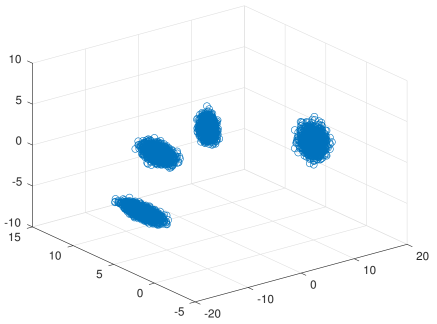
3. Identificación de clústeres en una base de datos propia

4. Código fuente

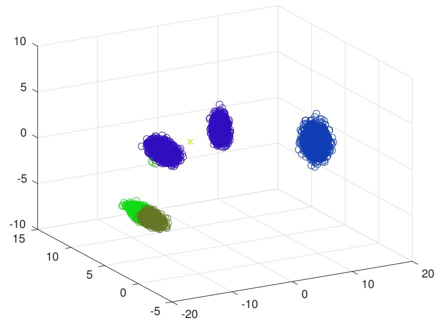
A continuación se encuentra el código fuente generado para la resolución de este laboratorio

4.1. main_2_1

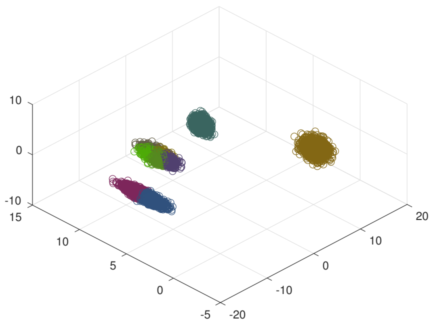
```
%% Exercise 2.1 script of the K-Means classifier
clear
close all

% Switch to activate or deactivate the plotting of all classifiers
plot_clusters = 1;

%% Section 1
% Generate DB
```



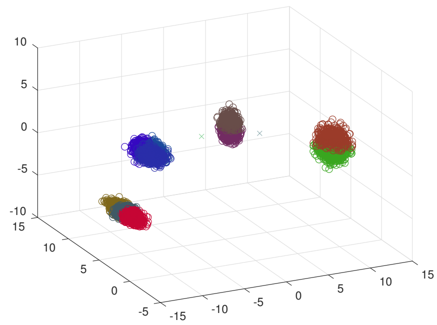
(a) $P_{min} = 0{,}75$



(b) $P_{min} = 0{,}85$



(c) $P_{min} = 1$



(d) $P_{min} = 0{,}85$

Figura 1: Imagenes resultantes de las labels con varios valores de P_{min}

```
% Initialize parameters
L = 4;
N = 10000;
d = 3;
th = 0.0005;

% Compute a priori probabilities for each cluster
probabilities = rand(L,1);
probabilities = probabilities./sum(probabilities);

% Generate DB samples
[DB, Nnew] = CLP_Generate(L,N,d,probabilities);

% Draw clusters
scatter3(DB(1,:), DB(2,:), DB(3,:))%, hold on

%% Section 3
% Classify with K-Means clustering
```

```matlab
% Preallocate results from the classifier
J = cell(9,1);
minimized_J = zeros(9,1);

trace1 = zeros(9,1);
trace2 = zeros(9,1);

Sw = zeros(d,d,9);
Sb = zeros(d,d,9);

for K=2:10
    [Centroides, Labels, n , J{K-1}, trace1(K-1), trace2(K-1), ...
        Sw(:,:,K-1), Sb(:,:,K-1)] = CLP_Kmeans(DB(1:d, :),K, d, th);

    minimized_J(K-1) = J{K-1}(end);

    if plot_clusters
        % Plot DB with color labeling
        figure, hold on
        for i=1:K
            c = rand(1,3);
            scatter3(DB(1,Labels==i), DB(2,Labels==i), DB(3,Labels==i),
    ...
                'MarkerEdgeColor', c/sum(c))
            scatter3(Centroides(1,i,:), Centroides(2,i,:), Centroides(3,i
    ,:),...
                'x', 'MarkerEdgeColor', 1 - c/sum(c))
        end
        grid on
        hold off
    end
end

%% Section 4
% Analyze classification metrics

figure, hold on
plot(2:10, minimized_J)
grid on
title('J function')
hold off

figure, hold on
plot(2:10, trace1)
grid on
title('Trace 1')
hold off

figure, hold on
plot(2:10, trace2)
grid on
title('Trace 2')
hold off
```

```
% Trace 2 is great, Trace 1 not good, because it decays constantly. It
    does so
% because as we increase the number of clusters, each of them is more
    compact,
% so the "within" metric improves.
%
% The J function behaves sometimes roughly like Trace 1
%
% We want to minimize Trace 1 and maximize Trace 2
%
% Trace 2 increases greatly when different clusters are classified as
    such,
% while Trace 1 does slightly decrease in the same situation.
%
% Because of this, Trace 2 is the best metric
```

../src/main_2_1.m

4.2. CLP_Kmeans

```
function [Centroids, Labels, n, J, tr1, tr2, Sw, Sb] = CLP_Kmeans(DB, K,
    d, th)
%CLP_Kmeans Classify matrix with a K-Means algorithm
%
%   [ Centroids, Labels, n, J, tr_1, tr_2, Sw, Sb ] = CLP_Kmeans(DB, K, d
    )
%
%   Detailed explanation goes here

%% Initialize centroids and labels matrices

Centroids = datasample(DB, K, 2, 'Replace', false);

%% Classify database
% threshold = 0.0005;

Labels = zeros(length(DB), 1);
n = 1;

J = zeros(50,1);


% Iterate while the cost function variates enough
condition = n <= 2;
while condition == 1

    J(n) = 0; % Cost function

    % Classify database
    for i = 1:length(DB)
        norms = sum(abs(repmat(...
            double(DB(:,i)), 1, K) - double(Centroids(:,:,end))).^2,1);
        [Minimum_value, Labels(i)] = min(norms);
```

```
        J(n) = Minimum_value + J(n);
    end

    % Update centroids
    for i = 1:K
        Centroids(:, i, n) = mean(double(DB(:, Labels==i)), 2);
    end

    if n > 1
        diff = J(n-1) - J(n);
        condition = (diff) > th;
    end

    n = n+1;
end

% Take actual values of J (eliminate the rests of preallocated data)
J = J(1:n-1);

%% Compute error metrics
% Within-cluster scatter matrix
Sw = zeros(d,d);
ni = zeros(1,K);

for i = 1:length(DB)
    Sw = Sw + (double(DB(:,i))-double(Centroids(:,Labels(i),end)))*...
        (double(DB(:,i))-double(Centroids(:,Labels(i),end)))';
    ni(Labels(i)) = ni(Labels(i)) + 1; % Add one sample to detected class
end

% Between-cluster scatter matrix
Sb = zeros(d,d);

for j = 1:K
    m = (1/length(DB))*ni*double(Centroids(:,:,end))';
    Sb = Sb + ni(j)*(double(Centroids(:,j,end))-m')*(double(Centroids(:,j
    ,end))-m')';
end

% Total scatter matrix
St = Sb+Sw;

% Trace metrics
tr1 = trace(St\Sw);
tr2 = trace(Sw\Sb);

end
```

../src/CLP_Kmeans.m