Fuzzy C-Means Clustering for Iris Data

This example shows how to use Fuzzy C-Means clustering for Iris dataset.

Try it in MATLAB

Load Data

The dataset is obtained from the data file 'iris.dat'. This dataset was collected by botanist Anderson and contains random samples of flowers belonging to three species of iris flowers *setosa* , *versicolor* , and *virginica*. For each of the species, 50 observations for sepal length, sepal width, petal length, and petal width are recorded.

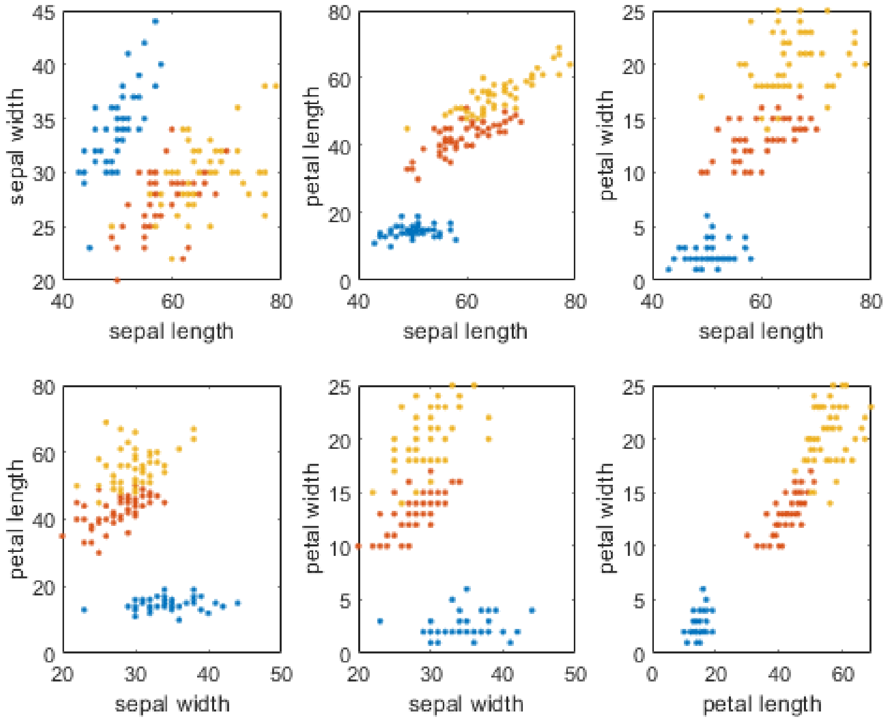
The dataset is partitioned into three groups named *setosa* , *versicolor* , and *virginica*. This is shown in the following code snippet.

```
load iris.dat
setosa = iris((iris(:,5)==1),:);        % data for setosa
versicolor = iris((iris(:,5)==2),:);    % data for versicolor
virginica = iris((iris(:,5)==3),:);     % data for virginica
obsv_n = size(iris, 1);                 % total number of observations
```

Plot Data in 2-D

The data to be clustered is 4-dimensional data and represents sepal length, sepal width, petal length, and petal width. From each of the three groups(setosa, versicolor and virginica), two characteristics (for example, sepal length vs. sepal width) of the flowers are plotted in a 2-dimensional plot. This is done using the following code snippet.

```
Characteristics = {'sepal length','sepal width','petal length','petal width'};
pairs = [1 2; 1 3; 1 4; 2 3; 2 4; 3 4];
h = figure;
for j = 1:6,
    x = pairs(j, 1);
    y = pairs(j, 2);
    subplot(2,3,j);
    plot([setosa(:,x) versicolor(:,x) virginica(:,x)],...
         [setosa(:,y) versicolor(:,y) virginica(:,y)], '.');
    xlabel(Characteristics{x},'FontSize',10);
    ylabel(Characteristics{y},'FontSize',10);
end
```



Setup Parameters

Next, the parameters required for Fuzzy C-Means clustering such as number of clusters, exponent for the partition matrix, maximum number of iterations and minimum improvement are defined and set. This are shown in the following code snippet.

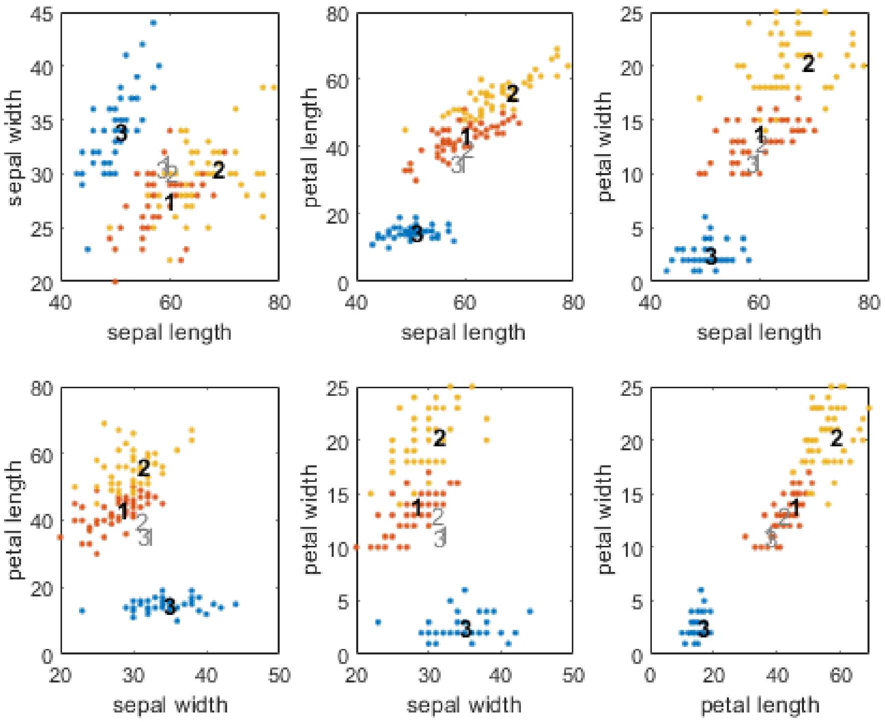
```
cluster_n = 3;                          % Number of clusters
expo = 2.0;                             % Exponent for U
max_iter = 100;                         % Max. iteration
min_impro = 1e-6;                       % Min. improvement
```

Compute Clusters

Fuzzy C-Means clustering is an iterative process. First, the initial fuzzy partition matrix is generated and the initial fuzzy cluster centers are calculated. In each step of the iteration, the cluster centers and the membership grade point are updated and the objective function is minimized to find the best location for the clusters. The process stops when the maximum number of iterations is reached, or when the objective function improvement between two consecutive iterations is less than the minimum amount of improvement specified. This is shown in the following code snippet.

```
% initialize fuzzy partition
U = initfcm(cluster_n, obsv_n);
% plot the data if the figure window is closed
if ishghandle(h)
    figure(h);
else
    for j = 1:6,
        x = pairs(j, 1);
        y = pairs(j, 2);
        subplot(2,3,j);
        plot([setosa(:,x) versicolor(:,x) virginica(:,x)],...
             [setosa(:,y) versicolor(:,y) virginica(:,y)], '.');
        xlabel(Characteristics{x},'FontSize',10);
        ylabel(Characteristics{y},'FontSize',10);
    end
end
% iteration
for i = 1:max_iter,
    [U, center, obj] = stepfcm(iris, U, cluster_n, expo);
    fprintf('Iteration count = %d, obj. fcn = %f\n', i, obj);
    % refresh centers
    if i>1 && (abs(obj - lastobj) < min_impro)
        for j = 1:6,
            subplot(2,3,j);
            for k = 1:cluster_n,
                text(center(k, pairs(j,1)), center(k,pairs(j,2)), int2str(k), 'FontWeight', 'bold');
            end
        end
        break;
    elseif i==1
        for j = 1:6,
            subplot(2,3,j);
            for k = 1:cluster_n,
                text(center(k, pairs(j,1)), center(k,pairs(j,2)), int2str(k), 'color', [0.5 0.5 0.5]);
            end
        end
    end
    lastobj = obj;
end
```

```
Iteration count = 1, obj. fcn = 28838.424340
Iteration count = 2, obj. fcn = 21010.880067
Iteration count = 3, obj. fcn = 15272.280943
Iteration count = 4, obj. fcn = 11029.756194
Iteration count = 5, obj. fcn = 10550.015503
Iteration count = 6, obj. fcn = 10301.776800
Iteration count = 7, obj. fcn = 9283.793786
Iteration count = 8, obj. fcn = 7344.379868
Iteration count = 9, obj. fcn = 6575.117093
Iteration count = 10, obj. fcn = 6295.215539
Iteration count = 11, obj. fcn = 6167.772051
Iteration count = 12, obj. fcn = 6107.998500
Iteration count = 13, obj. fcn = 6080.461019
Iteration count = 14, obj. fcn = 6068.116247
Iteration count = 15, obj. fcn = 6062.713326
Iteration count = 16, obj. fcn = 6060.390433
Iteration count = 17, obj. fcn = 6059.403978
Iteration count = 18, obj. fcn = 6058.988494
Iteration count = 19, obj. fcn = 6058.814438
Iteration count = 20, obj. fcn = 6058.741777
Iteration count = 21, obj. fcn = 6058.711512
Iteration count = 22, obj. fcn = 6058.698925
Iteration count = 23, obj. fcn = 6058.693695
Iteration count = 24, obj. fcn = 6058.691523
Iteration count = 25, obj. fcn = 6058.690622
Iteration count = 26, obj. fcn = 6058.690247
Iteration count = 27, obj. fcn = 6058.690092
Iteration count = 28, obj. fcn = 6058.690028
Iteration count = 29, obj. fcn = 6058.690001
Iteration count = 30, obj. fcn = 6058.689990
Iteration count = 31, obj. fcn = 6058.689985
Iteration count = 32, obj. fcn = 6058.689983
Iteration count = 33, obj. fcn = 6058.689983
```



The figure shows the initial and final fuzzy cluster centers. The bold numbers represent the final fuzzy cluster centers obtained by updating them iteratively.