

Spectral Graph Clustering Algorithm

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Clearing previous variables and command window

```
clc; clear ; close all;
```

Reading dataset from ./data and visualising the dataset

File path to the dataset example1.dat or example2.dat

```
dataset_path = fullfile('.', 'data', 'example1.dat');
```

Reading the csv data from the file path

```
dataset = csvread(dataset_path);
```

Getting the source nodes and destination node

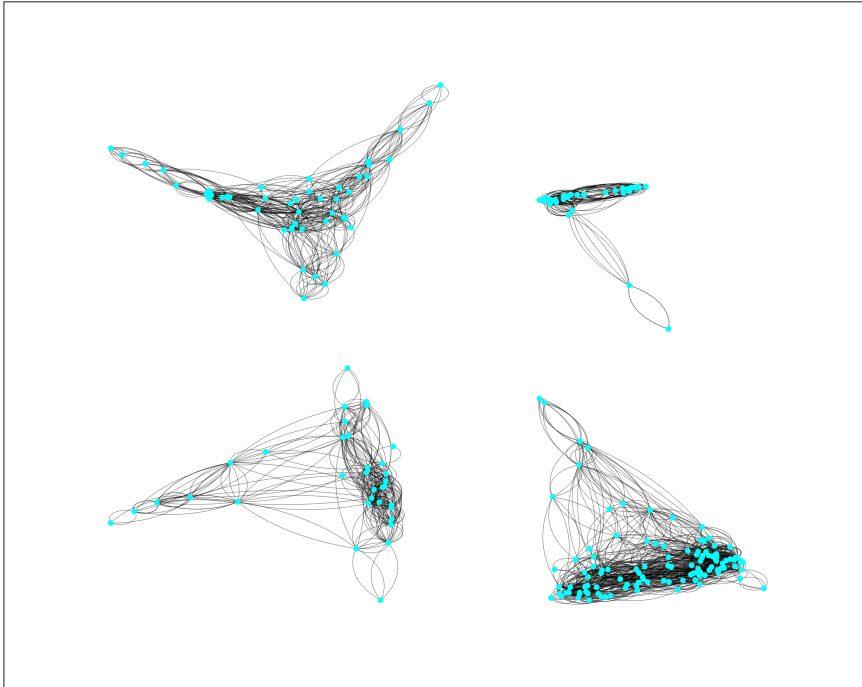
```
source_nodes = dataset(:,1);  
destination_nodes = dataset(:,2);
```

Adding edges to graph

```
G = graph(source_nodes, destination_nodes);
```

Displaying the Graph

```
figure('Name', 'Original graph without clusters');  
p = plot(G);  
p.LineWidth = 0.2500;  
p.LineStyle = '-';  
p.Marker = '.';  
p.NodeColor = 'c';  
p.EdgeColor = 'k';  
p.MarkerSize = 10;
```



Algorithm

Construct the adjacency matrix (affinity matrix)

```
max_ids = max(max(source_nodes, destination_nodes));
As = sparse(source_nodes, destination_nodes, 1, max_ids, max_ids);
A = full(As);
```

Construct diagonal matrix

```
Di = diag(sum(A,2));
```

Construct normalized laplacian matrix ($L = D^{-1/2}AD^{-1/2}$)

```
L = (Di^(-0.5)) * A * (Di^(-0.5));
```

Calculating k largest eigenvectors of L and stack them into X

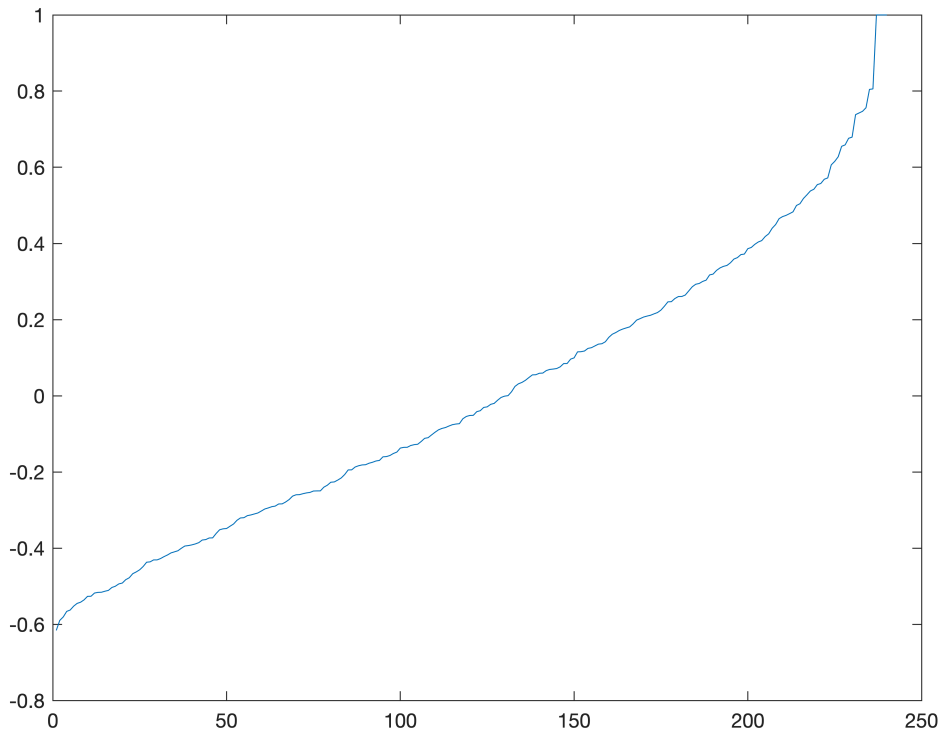
```
% [X,D1] = eigs(L, k);
[X, D1] = eigs(L, size(L,1)-1);
% size(L) - 1 to use eigs() instead of eig()
```

Construct eigenvalues for D1

```
eigenvalues = diag(D1);
eig_gaps = -1*diff(eigenvalues);
% -1* used because eigenvalues is sorted
% in desc. order so diffs are negatives.
```

Plot Eigenvalues of sorted normalized of Laplacian matrix

```
figure('Name', 'Eigenvalues of sorted normalized of Laplacian matrix ');
plot(sort(eigenvalues));
```



```
% plotting the eigenvalues (ascending order) and normalized (unit "length") eigenvectors
```

Calculating optimal value of k

```
[~,k] = max(eig_gaps);
```

Constructing Matrix X by stacking eigen values

```
X = X(:, (1:k));
```

Create Y by renormalizing each of X's rows to have unit length

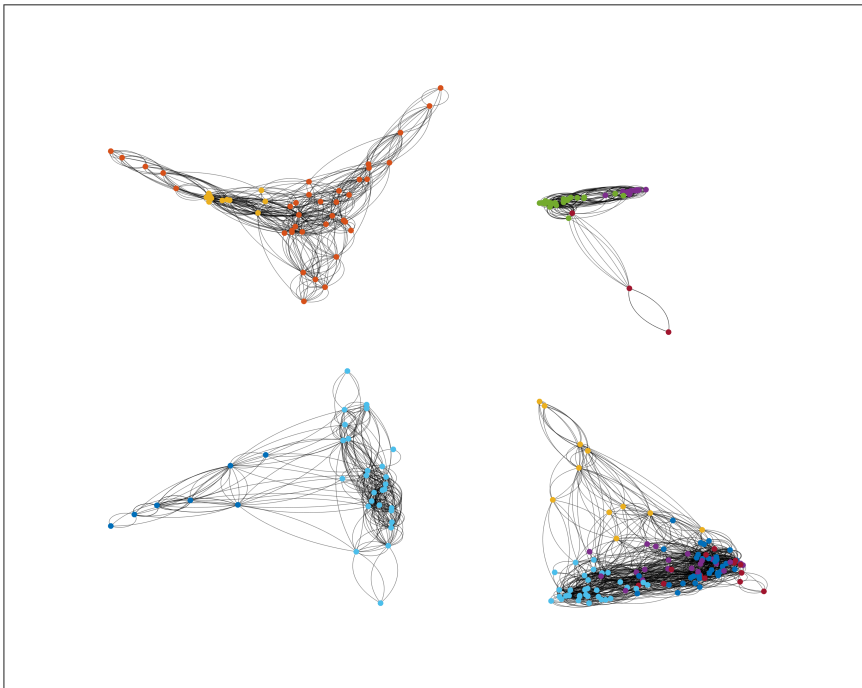
```
Y = X./ (sum(X.^2,2)).^(0.5);
```

Apply K-means to rows of Y

```
Idx = kmeans(Y, k);
```

Display graphs with clusters

```
figure('Name','Graph with clusters');  
p = plot(G);  
p.EdgeColor = 'k';  
p.LineWidth= 0.2500;  
p.LineStyle= '-';  
p.Marker = '.';  
p.MarkerSize = 10;  
cmap = lines();  
  
for i=1:size(Idx,1)  
    cluster = Idx(i,1);  
    highlight(p,i,'NodeColor',cmap(cluster,:));  
end
```

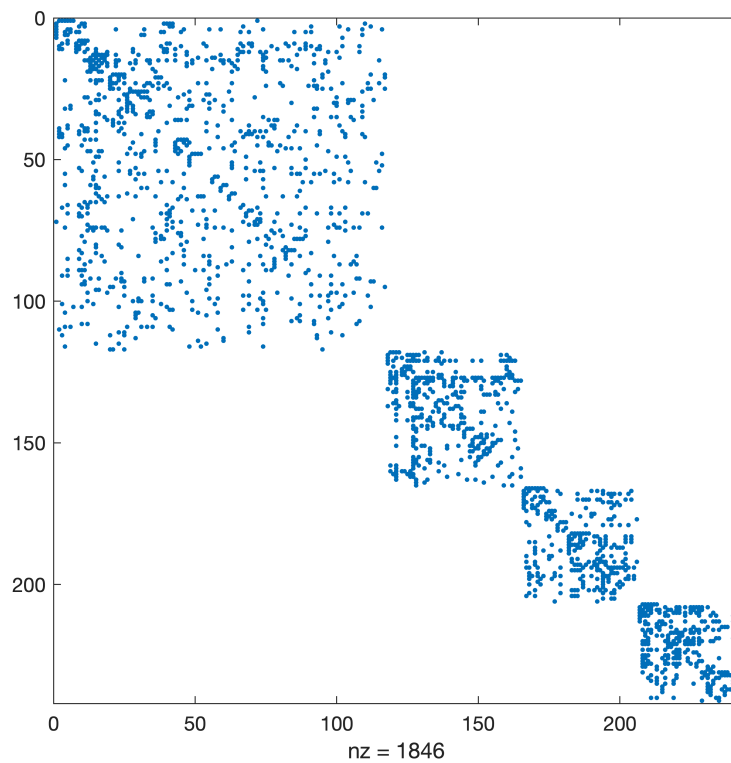


Find communities using the Fiedler Vector

Display sparsity pattern

```
figure('Name','Sparsity Pattern');
```

```
spy(A);
```



Construct laplacian matrix

```
H = simplify(G);  
new_L = laplacian(H);
```

Get eigenvalues from laplacian matrix

```
[v,new_D] = eigs(new_L,k,'smallestreal');
```

Construct Fiedler Vector

```
fv = v(:,2);
```

Plot the sorted Fiedler vector

```
figure('Name','Sorted Fiedler Vector');  
plot(sort(fv));
```

