ELEC 406/506: Project. Oral Presentation: 12/01/23 (or 11/29/23 if ready)

Version: 11/20/2023

Teams:

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• **Problem 1: all groups**

Load: `usroads.mat` from Canvas.

This is a graph with over 50 connected components and $129,164$ nodes.
Using the `Matlab` function `conncomp`, single out component number 28 which has $126,146$ vertices.

Then:

(1) Normalize the adjacency matrix so that a column-stochastic matrix results.

(2) Find the page rank of this network, using power iteration.
Verify the result using the method discussed in class on 11/15 and 11/17. Choose $\alpha = .9$.
Determine the sensitivity of the PageRank as a function of α and plot it for $0.50 \leq \alpha \leq 0.99$.
What conclusion do you draw?

(3) Find the first 1000 singular values (eigenvalues) of the column stochastic adjacency matrix, using the RSVD.

(4) What is the minimal number of steps required to go from node $1,000$ to node $1,100$?

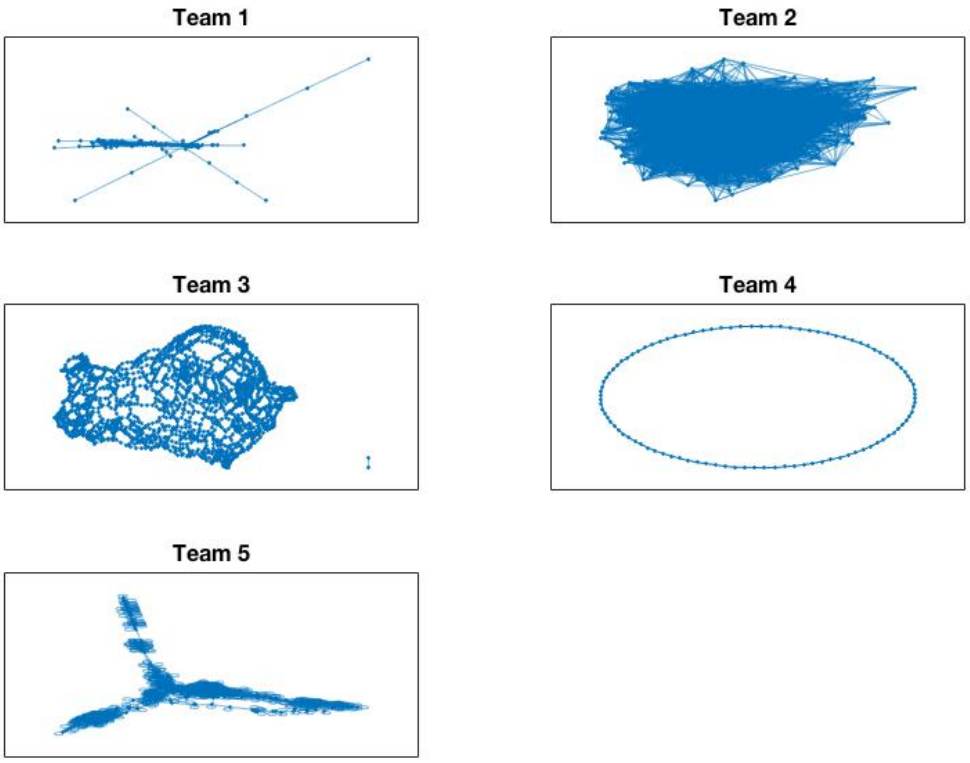
(5) Split the network in two parts using the Fiedler method and the `eigs` command in `Matlab`.
Verify that the vector obtained is indeed the Fiedler vector. What is the cut?

Remark: as it turns out there are exactly 4237 triangles in this network.

• **Individual problems for each team**

```
>> load('as-22july06.mat')   %%%%%%%% Team 1
>> Problem =
  struct with fields:

      name: 'Newman/as-22july06'
     title: '(symmetrized) structure of internet routers as of July 22, 2006'
         A: [22963x22963 double]
        id: 2390
      date: '2006'
    author: 'M. Newman'
      kind: 'undirected graph'
     notes: [7x75 char]
       aux: [1x1 struct]
        ed: 'M. Newman'

>> load('G58')  %%%%%%%%%%%%%% Team 2
>> Problem =
  struct with fields:

     title: 'Random matrix, nodes 1..n descreasing average degree.G58=pattern of G59'
         A: [5000x5000 double]
      name: 'Gset/G58'
        id: 522
      kind: 'duplicate undirected random graph'
     notes: 'This matrix is the nonzero pattern of Gset/G59'
      date: '1996'
    author: 'C. Helmberg'
        ed: 'Y. Ye'

>> load('minnesota.mat') %%%%%%%%%% Team 3
>> Problem =
  struct with fields:

      name: 'Gleich/minnesota'
     title: 'Minnesota road network (with xy coordinates)'
         A: [2642x2642 double]
        id: 2331
      date: '2010'
    author: 'D. Gleich'
        ed: 'T. Davis'
      kind: 'undirected graph'
       aux: [1?1 struct]

>> load('G49.mat') %%%%%%%%%% Team 4
>> Problem =
  struct with fields:
```

```
     title: '2D torus, 100-by-30'
         A: [3000x3000 double]
      name: 'Gset/G49'
        id: 512
      kind: 'undirected random graph'
      date: '1996'
    author: 'C. Helmberg'
        ed: 'Y. Ye'

>> load('1138_bus.mat')  %%%%%%%%%% Team 5
>> Problem =
  struct with fields:

     title: 'S ADMITTANCE MATRIX 1138 BUS POWER SYSTEM, D.J.TYLAVSKY, JULY 1985.'
         A: [1138x1138 double]
      name: 'HB/1138_bus'
        id: 1
      date: '1985'
    author: 'D. Tylavsky'
        ed: 'I. Duff, R. Grimes, J. Lewis'
      kind: 'power network problem'

%%%%%%%%%%%% The 5 problems

>> load('as-22july06')
>> A1=Problem.A;
>> G1=graph(A1);

>> load('G58')
>> A2=Problem.A;
>> G2=graph(A2);

>> load('minnesota.mat')
>> A3=Problem.A;
>> G3=graph(A3);

>> load('G49')
>> A4=Problem.A;
>> G4=graph(A4);

>> load('1138_bus.mat')
>> A5=Problem.A;
>> G5=graph(A5);

>> size(A1) =       22963       22963
>> size(A2) =        5000        5000
>> size(A3) =        2642        2642
>> size(A4) =        3000        3000
>> size(A5) =        1138        1138
```



Problems: same as for the `'usroads'` graph, plus:

1. Using the associated Laplacians partition the graphs in four components. Determine the **cut** in each case, i.e. how many edges need to be cut to partition the graphs. Then, determine the Dirichlet PageRank for the smallest among these networks.

2. Determine the centrality of nodes for the smallest graph (among the four) using the matrix exponential.

3. Whenever appropriate, plot the graphs and subgraphs obtained.