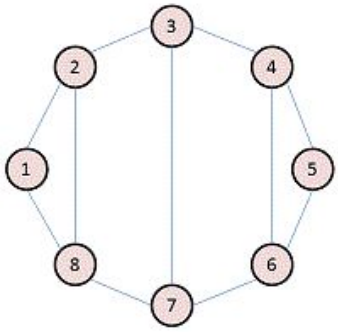
# Communities

**Question 1**:

For the following graph:




Write the adjacency matrix A, the degree matrix D, and the Laplacian matrix L. For each, find the sum of all entries and the number of nonzero entries.

Adjacency matrix A-

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 3 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 4 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 7 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 8 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

Sum of all entries=22

No of non zero entries=22

Degree Matrix D-

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

Sum of all entries=8  No of non zero entries=8

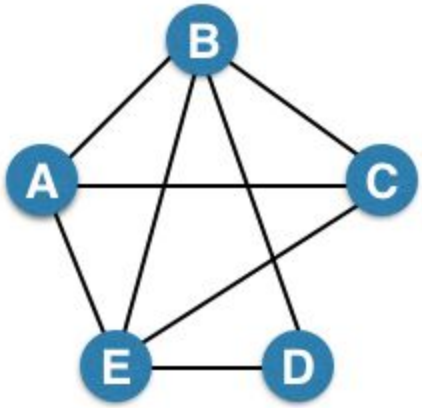
Laplacian Matrix L=D-A

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | -1 | 0 | 0 | 0 | 0 | 0 | -1 |
| 2 | -1 | 3 | -1 | 0 | 0 | 0 | 0 | -1 |
| 3 | 0 | -1 | 3 | -1 | 0 | 0 | -1 | 0 |
| 4 | 0 | 0 | -1 | 3 | -1 | -1 | 0 | 0 |
| 5 | 0 | 0 | 0 | -1 | 2 | -1 | 0 | 0 |
| 6 | 0 | 0 | 0 | -1 | -1 | 3 | -1 | 0 |
| 7 | 0 | 0 | -1 | 0 | 0 | -1 | 3 | -1 |
| 8 | -1 | -1 | 0 | 0 | 0 | 0 | -1 | 3 |

Sum of all entries=0  No of non zero entries=30

**Question 2**:

Consider the following undirected graph (i.e., edges may be considered bidirectional):




Run the "trawling" algorithm for finding dense communities on this graph and find all complete bipartite subgraphs of types $K_{3,2}$ and $K_{2,2}$. Note: In the case of $K_{2,2}$, we consider {{W, X}, {Y, Z}} and {{Y, Z}, {W, X}} to be identical.

(2)

From the graph -

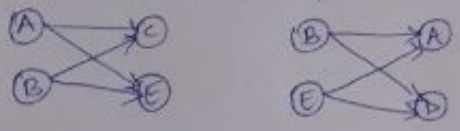
A = {B, C, E}, B = {A, C, D, E}

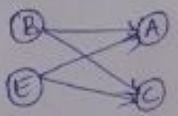
C = {A, B, E}, D = {B, E}, E = {A, B, C, D}

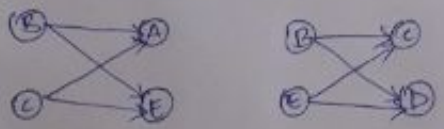
B & E have more support

Bipartite sub-graph of $K_{3,2}$ -


Bipartite subgraph of $K_{3,2}$ -

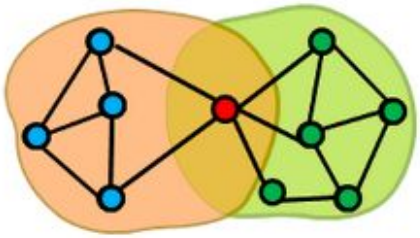


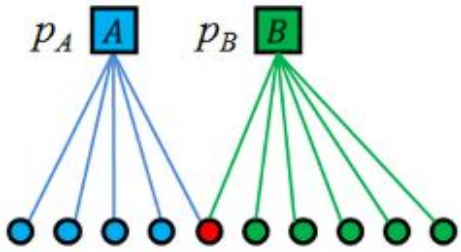



**Question 3**:

We fit AGM to the network on the left, and found the parameters on the right:



Network




Learned AGM parameters

Find the optimal values for $p_A$ and $p_B$.

$p_A$=no of edges in the network/total no of edges=7/5c2=7/10

$p_B$=no of edges in the network/total no of edges=9/6c2=9/15