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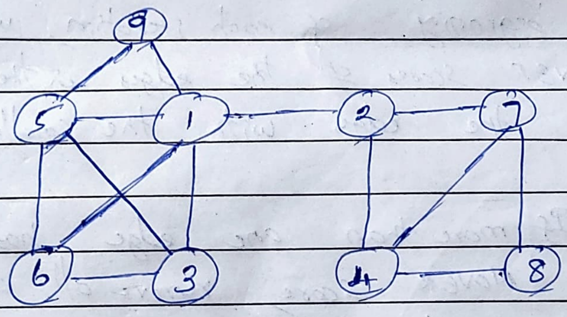
Neighborhood overlap based approach (NOVER)

Neighborhood overlap = number of nodes who are neighbors of both A & B / number of nodes who are neighbors of atleast one of A or B.

Note one should not count neither A nor B as part of the neighbors in the denominator & each node should be counted only once.

Example



1 → {2, 3, 5, 6, 9}
2 → {1, 4, 7}
3 → {1, 5, 6}
4 → {2, 7, 8}
5 → {1, 3, 6, 9}
6 → {1, 3, 5}
7 → {2, 8}
8 → {4, 7}
9 → {1, 5}

Edge	Union of Neighb.	Intersec.	NOVER
1-2	{3, 5, 6, 9, 4, 7}	{ }	0/6 = 0.0
1-3	{2, 5, 6, 9}	{5, 6}	2/4 = 0.5
1-5	{2, 3, 6, 9}	{3, 6, 9}	3/4 = 0.75
1-6	{2, 3, 5, 9}	{3, 5}	2/4 = 0.5
1-9	{2, 3, 5, 6}	{5}	1/4 = 0.25
2-4	{1, 7, 8}	{7}	1/3 = 0.33
2-7	{1, 4, 8}	{4}	1/3 = 0.33

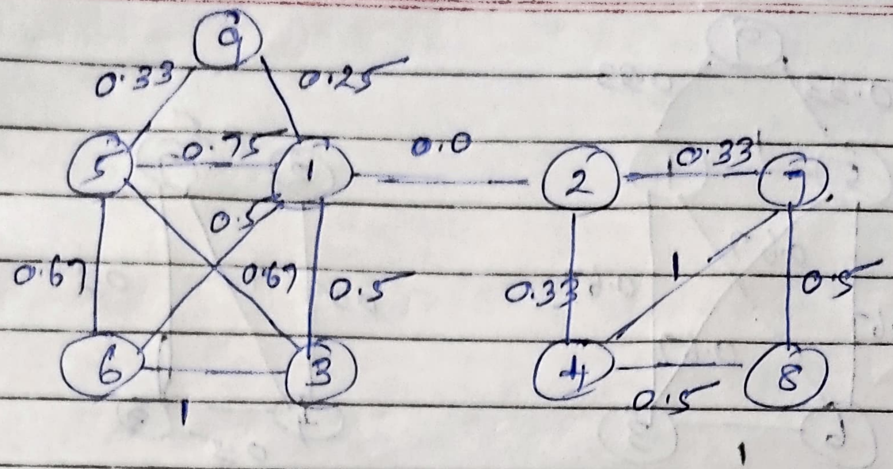
Edge	Union of Neighb.	Interse.	NOVER
3-5	{1,6,9}	{1,6}	2/3 = 0.67
3-6	{1,5}	{1,5}	2/2 = 1.0
4-7	{2,8}	{2,8}	2/2 = 1.0
4-8	{2,7}	{7}	1/2 = 0.5
5-6	{1,3,9}	{1,3}	2/3 = 0.67
5-9	{1,3,6}	{1}	1/3 = 0.33
7-8	{2,4}	{4}	1/2 = 0.5

Nover based GN algorithm

* At the beginning of each iteration, we compute the NOVER scores of the edges in the graph & remove the edges with the smallest NOVER score.
  - If more than one edge has the smallest NOVER score, remove all such competing edges at the same time.
  - If the graph gets disconnected to two or more communities (components), we compute the total modularity score of the resulting communities.

* Repeat the iterations until there are no more edges.

* The partition (set of communities) with the total modularity score is the optimal partition.



Modularity (1, 3, 5, 6, 9)

$Mod(1,3) = 1 - (5*3)/(2*14) = 0.46$

$Mod(1,5) = 1 - (5*4)/(2*14) = 0.28$

$Mod(1,6) = 1 - (5*3)/(2*14) = 0.46$

$Mod(1,9) = 1 - (5*2)/(2*14) = 0.64$

$Mod(3,5) = 1 - (3*4)/(2*14) = 0.57$

$Mod(3,6) = 1 - (3*3)/(2*14) = 0.68$

$Mod(3,9) = 0 - (3*2)/(2*14) = -0.21$

$Mod(5,6) = 1 - (4*3)/(2*14) = 0.57$

$Mod(5,9) = 1 - (4*2)/(2*14) = 0.71$

$Mod(6,9) = 0 - (3*2)/(2*14) = -0.21$

Modularity (1, 3, 5, 6, 9) = 3.95

Modularity (2, 4, 7, 8)

$Mod(2,4) = 1 - (3*3)/(2*14) = 0.68$

$Mod(2,7) = 1 - (3*3)/(2*14) = 0.68$

$Mod(2,8) = 0 - (3*2)/(2*14) = -0.21$

$Mod(4,7) = 1 - (3*3)/(2*14) = 0.68$

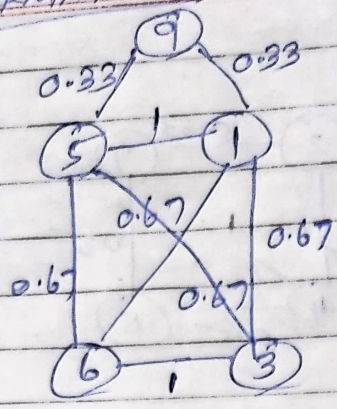
$Mod(4,8) = 1 - (3*2)/(2*14) = 0.78$

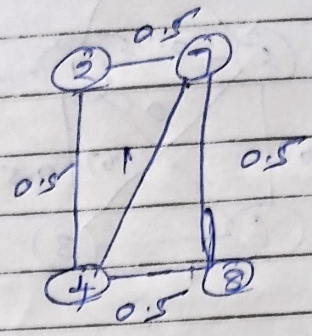
$Mod(7,8) = 1 - (3*2)/(2*14) = 0.78$

Modularity (2, 4, 7, 8) = 3.39

Total Modularity Score = 7.34

Iteration-1





Union $\{5,6,9\}$ Intersection $\{5,6\}$ Never $2/3 = 0.67$

1-3

1-5

1-6

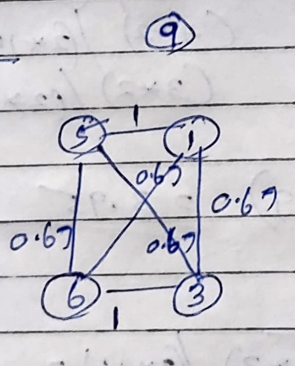
1-9

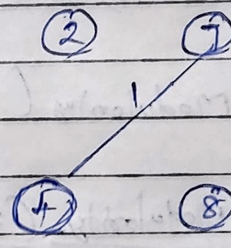
⋮

$1 \leftarrow \{3,5,6,9\}$

$3 \leftarrow \{1,5,6\}$

Iteration-2





Modularity (1,3,5,6)

$Mod(1,3) = 1 - (5*3)/(2*14) = 0.46$

$Mod(1,5) = 1 - (5*4)/(2*14) = 0.28$

$Mod(1,6) = 1 - (5*3)/(2*14) = 0.46$

$Mod(3,5) = 1 - (3*4)/(2*14) = 0.57$

$Mod(3,6) = 1 - (3*3)/(2*14) = 0.68$

$Mod(5,6) = 1 - (4*3)/(2*14) = 0.57$

Modularity $(1,3,5,6) = 3.02$

Modularity (4, 7)

$$Mod (4,7) = 1 - (3 * 3) / (2 * 14) = 0.68$$

Modularity $(4,7) = 0.68$

Total Modularity Score = 3.70