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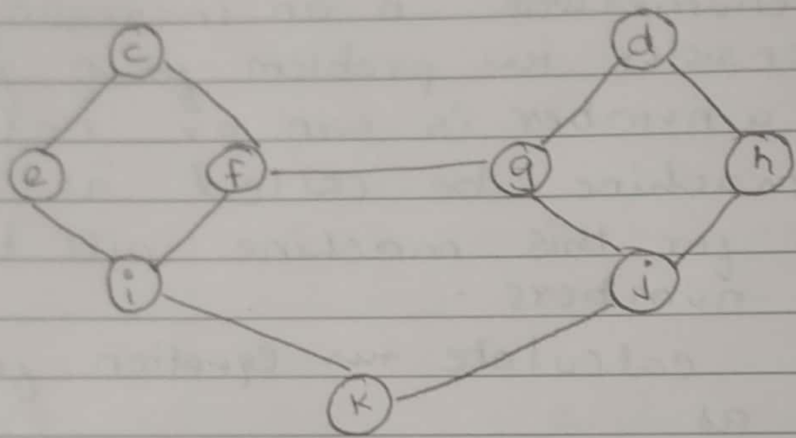
Q.1

a $q = 1/2$

$P_x = \dfrac{\text{number of ~~nodes~~ neighbour nodes adopting A}}{\text{total number of nodes}}$



set S is set of initial adopters
$S = \{e, f\}$
neighbours of e and f are : c, i, g.
if $P_x \geq q$, then node x will adopt behaviour A.

$P_c = \frac{2}{2} = 1$

$P_i = \frac{2}{3}$

$P_g = \frac{1}{3}$

Node c and i will adopt behaviour A, ~~ad~~
Nodes adopting behaviour A = {e, f, c, i}

Neighbours of nodes who have adopted behaviour A are :- k and g.
$P_k = 1/2$.
$P_g = 1/3$.
Node k will adopt behaviour A

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Nodes that have adopted behaviour A = S

$S = \{e, f, c, i, k\}$

Neighbours of nodes who have adopted behaviour A are : g and j

$P_g = 1/3$

$P_j = 1/3$.

Therefore, behaviour A will not spread further.

S = Nodes adopted behaviour A = $\{e, f, c, i, k\}$

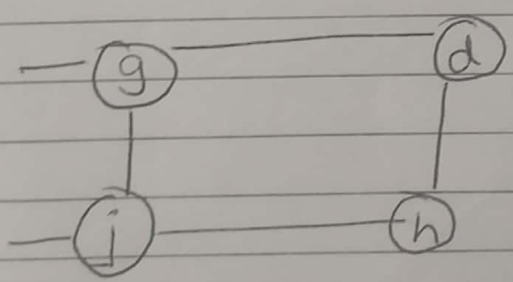
b Let S set has all the elements who have adopted to behaviour A which was early adopted by e and f

S was calculated in previous ~~exam~~ problem.

$S = \{e, f, c, i, k\}$

We have to find cluster density greater than $1-q = 1/2$ in the part of the graph outside S.

The part of graph outside S is below.



Let this graph be one cluster and find out its cluster density.

$$\text{cluster density of node } x = \frac{\text{edges of } \cancel{gr} \text{ nodes in cluster}}{\text{total no. of edges of node.}}$$

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cluster density of node g $= \frac{2}{3}$

cluster density of node j $= \frac{2}{3}$

cluster density of node d $= \frac{2}{2} = 1$

cluster density of node h $= \frac{2}{2} = 1$

since every node in cluster has ~~clusteri~~ cluster density greater than $2/3$.
Therefore cluster density of entire cluster is $2/3$ which is greater than $1/2$.
$\therefore$ Cluster (g, d, h, j) have a cluster density of greater than $1/2$ and are not part of S.

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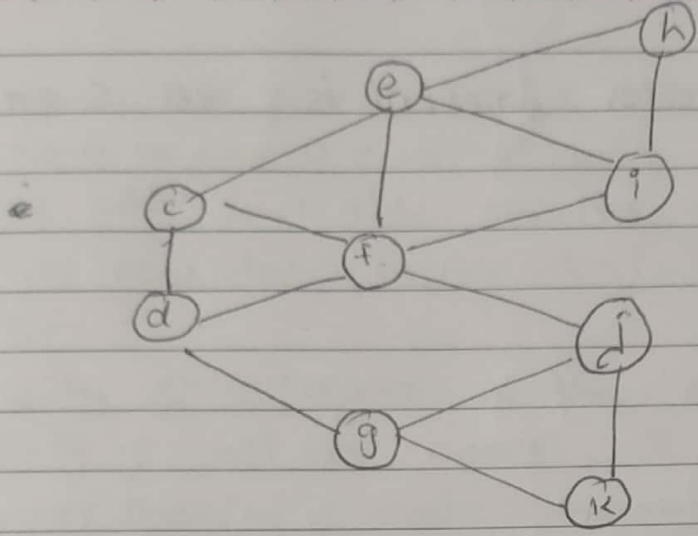
2.

a



$q = 2/5$

Let s is the set of node who have adopted ~~behaviour~~ behaviour A. c and d are early adopters

$S = \{c, d\}$

If $P_x \geq q$ then node x will adopt to behaviour A.

Neighbour of node c and d are :- e, f, g.

~~$P_e = 1$~~ $P_x = \dfrac{\text{Number of neighbour nodes adopting A}}{\text{Total number of ~~nodes~~ neighbour nodes}}$

$P_e = \dfrac{1}{4}$

$P_f = \dfrac{2}{5}$

$P_g = \dfrac{1}{3}.$

Only node f out of the given pair will adopt behaviour A. as ~~$P_f \geq 2/5$~~ $P_f \geq 2/5$.

~~&~~ $S = \{c, d, f\}$

Neighbour of nodes present is set S are: e, i, j, g

$P_e = \frac{2}{4} = \frac{1}{2}$

$P_i = \frac{1}{3}$

$P_j = \frac{1}{3}$

$P_g = \frac{1}{3}$.

$P_e \geq q$, Therefore node e will adopt behaviour A.

$S = \{c, d, f, e\}$

The neighbour nodes of set 's' are:- h, i, g, j

$P_h = \frac{1}{2}$

$P_i = \frac{2}{3}$.

$P_j = \frac{1}{3}$

$P_g = \frac{1}{3}$

P_h and P_i is greater than q.

∴ Node h and i will adopt behaviour A.

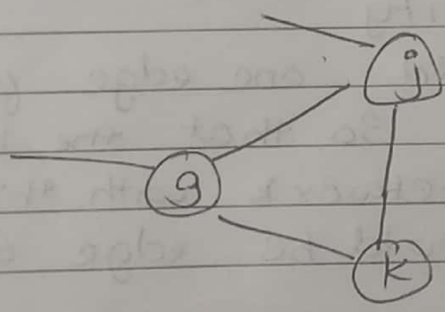
$S = \{c, d, f, e, h, i\}$

Here the spread of behaviour A stops as ~~cluster g, j, k~~ node g and j are not likely to adopt A.

b. In previous part, $S = \{c, d, f, e, h, i\}$
we have to find a cluster with density greater than $1 - q = 3/5$ outside cluster S.
Let us consider cluster $g-j-k$ as they are not part of S.
Density of cluster is the minimum cluster density of all its nodes.
Cluster Density of node x ~~= number of edges of x in clust~~

$$= \frac{\text{number of edges (or neighbour nodes) of } x \text{ in cluster}}{\text{Total number of edges (or neighbour nodes) of } x}$$

Let us draw cluster $g-j-k$.



cluster density of node $j = \frac{2}{3}$.

cluster density of node $g = 2/3$
cluster density of node $k = 2/2 = 1$
As the minimum cluster density of all nodes is atleast $2/3$
Therefore cluster density of cluster $g-j-k$ is $2/3$
And cluster $g-j-k$ has a cluster density greater than $3/5$

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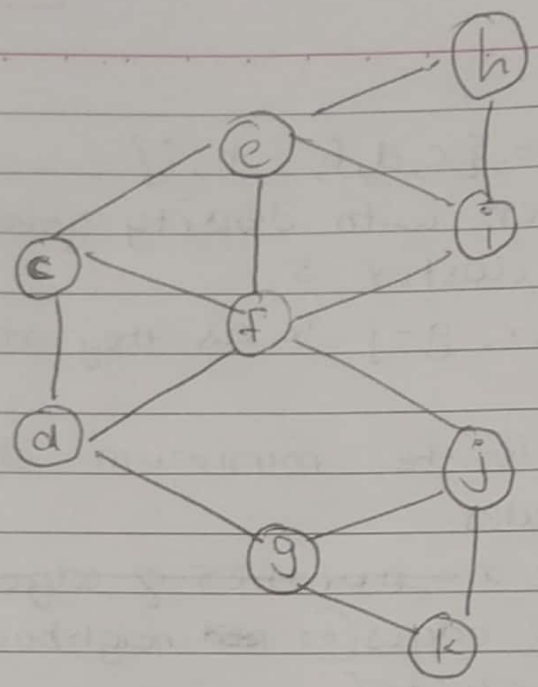
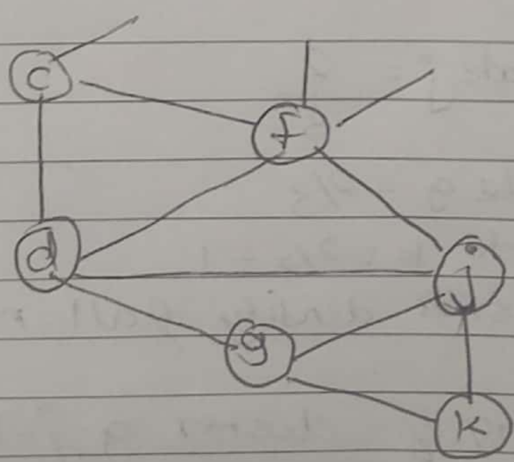
c.



In the above graph, behaviour A spreads in all the nodes except in the cluster of g-j-k. This happens because cluster g-j-k has a high inter connectivity and minimum expernal connectivity.

If we want to add one edge from either node C or node D so that the behaviour A spreads in the network with threshold of 2/5 Then the edge could be edge dj.



with edge dj

$P_j = \frac{2}{4}$

and $P_j \geq 2/5$ so node j will be added in set S.

Similarly Now,

$$P_g = 2/3$$

and P_g becomes greater than $2/5$. hence even node g will be added in set S.

Now lets calculate for node k.

$$P_k = \frac{2}{2} = 1$$

So node k will also be added to set S.

The whole network will adapt behaviour At threshold of $2/5$.