

Homework - III

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Subject: OSNA (Social Network)

SID: A20502846.

FO = LIV

FO = IMV

Solution ①

Independent Cascade Model (ICM) is a sender centric model of cascade. Each node has one chance to activate its neighbors.

In ICM, nodes ~~are~~ that are active are senders & nodes that are being activated are receivers.

As per ICM Algorithm

↳ Node activated at time t , has one chance, at time step $t+1$, to activate its neighbors.

↳ if v is activated at time t

↳ for any neighbor w of v , there's a probability P_{vw} that node w gets activated at time $t+1$.

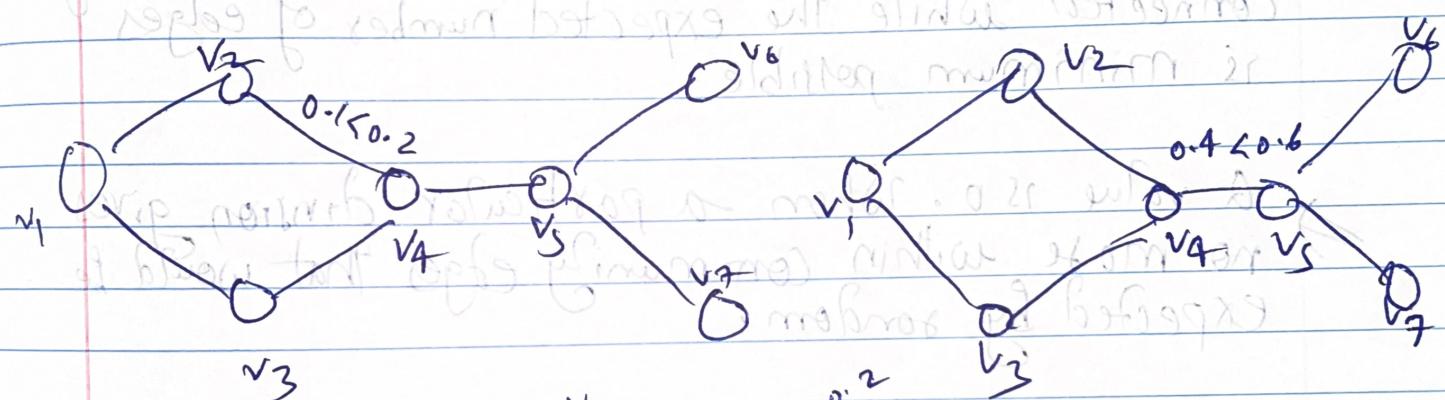
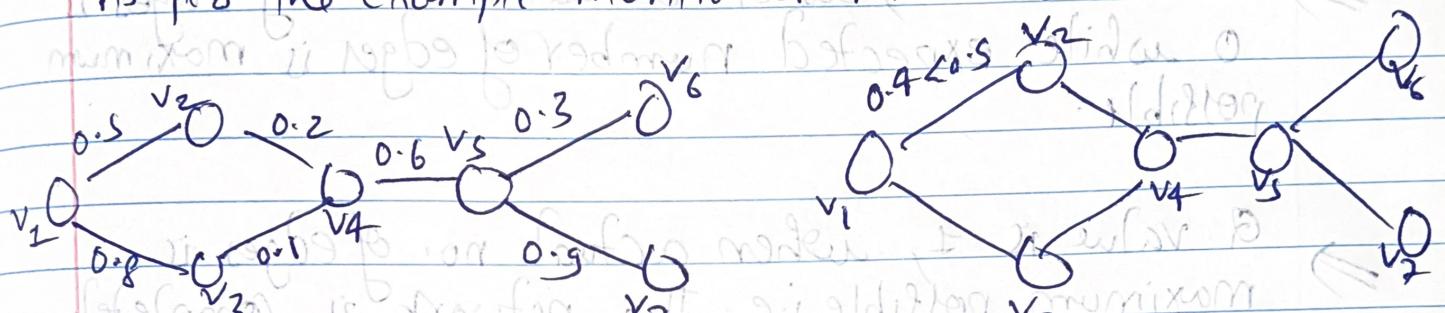
↳ Node v activated at time t has a single chance of activating its neighbors.

↳ activation can only happen at $t+1$.

So, when the ICM stops running the algorithm can be considered as "Converged".

In ICM, activation is a progressive process when nodes are changed from inactive state to active state but not in reverse order. It means the algorithm stops when there are no further activation of nodes.

As per the example mentioned in the class content:



$$\cdot r_{1,2} = 0.4$$

$$\cdot r_{1,3} = 0.9$$

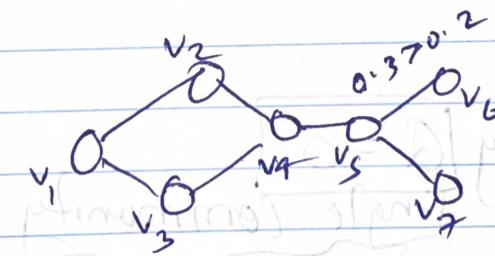
$$\cdot r_{2,4} = 0.1$$

$$\cdot r_{3,4} = 0.9$$

$$\cdot r_{4,5} = 0.4$$

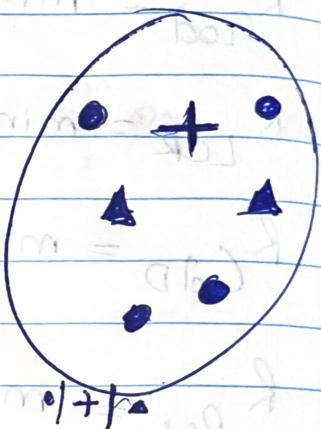
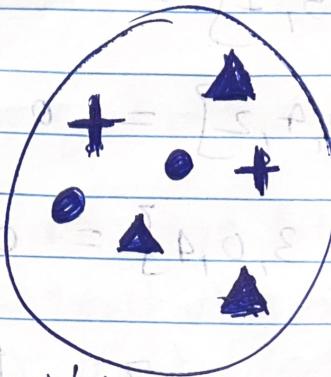
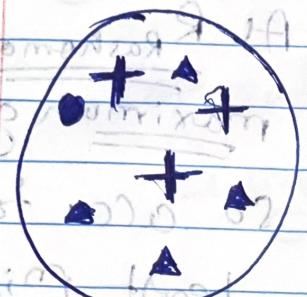
$$\cdot r_{5,6} = 0.2$$

$$\cdot r_{5,7} = 1.0$$



In the above process, ICM stops at node 6 no further nodes. Hence, converged.

② [Community Analysis]



+• Communities

$$TP = 3C_2 + 4C_2 + 3C_2 + 2C_2 + 2C_2 + 4C_2 \\ + 2C_2 \\ = [21]$$

$$FN = (3 \times 2) + (3 \times 1) + (4 \times 3) + (4 \times 2) + (1 \times 2) + \\ (1 \times 4) + (2 \times 1) + (2 \times 4) + (3 \times 2) \\ = [51]$$

$$FP = (4 \times 3) + (4 \times 1) + (3 \times 1) + (2 \times 3) + (2 \times 2) \\ + (3 \times 2) + (4 \times 2) + (4 \times 1) + (2 \times 2) \\ = [49]$$

$$TN = (3 \times 5) + (3 \times 6) + (4 \times 4) + (4 \times 5) + (1 \times 5) + \\ (1 \times 3) + (2 \times 6) + (3 \times 5) + (2 \times 3) \\ TN = [110]$$

Precision

(IM Basformal) IMU A

① Förmig & Recall

IM = IMU

$$\text{Precision} = \frac{21}{21+49} = 0.3$$

$$\text{Recall} = \frac{21}{21+51} = 0.29$$

② F-measure

$$F\text{-measure} = \frac{2PR}{P+R} = \frac{2 \times (0.3) \times (0.29)}{(0.3 + 0.29)}$$

$$= 0.295$$

③ Purity

(wegen 6 von 11) sc=1

$$\text{Purity} = \frac{1}{N} \sum_{i=1}^k \max_j |C_i \cap L_j|$$

$$\text{Purity} = \frac{1}{22} (4+3+4) = 0.27$$

$$\text{Purity} = \frac{1}{22} (4+3+4) = 0.27$$

$$\text{Purity} = \frac{11}{22} = 0.5$$

④ NMI (Normalized MI)

$$NMI = \frac{MI}{\sqrt{H(L)} \sqrt{H(H)}}$$

$$NMI = \sum_{h \in H} \sum_{l \in L} n_{h,l} \log \frac{n \cdot n_{h,l}}{n_h \cdot n_l}$$

$$\sqrt{\left(\sum_{h \in H} n_h \log \frac{n_h}{n} \right) \left(\sum_{l \in L} n_l \log \frac{n_l}{n} \right)}$$

where L & H are labels & found communities.

↳ n_h & n_l are the no. of data pts in conn. h & with label l resp.

$$\& n=22 \text{ (no. of nodes)}$$

$$NMI = \frac{4 \log \left(\frac{22 \times 4}{8 \times 9} \right) + 3 \log \left(\frac{22 \times 3}{8 \times 6} \right) + 1 \log \left(\frac{22 \times 1}{8 \times 7} \right)}{\sqrt{(8 \log(8/22) + 7 \log(7/22) + 7 \log(7/22)) (9 \log(9/22) + 6 \log(6/22) + 7 \log(7/22))}}$$

$$NMI = \frac{\sqrt{(8\log(\delta_{12}) + 7\log(\gamma_{12}) + 7\log(\gamma_{22})) (9\log(\delta_{12}) + 6\log(\delta_{12}) + 7\log(\gamma_{22}))}}{15}$$

~~NMI = 0.11~~

NMI = 0.07 (with log base 2)

~~Solution ③~~

[Influ. & Homophily]

$$Q = \frac{1}{2m} \sum_{ij} [A_{ij} - \frac{d_i d_j}{2m}] \delta(c_i, c_j)$$

the range for modularity Q is $[-1, 1]$

⇒ Q value is -1 , when actual number of edges is 0 while expected number of edges is maximum possible.

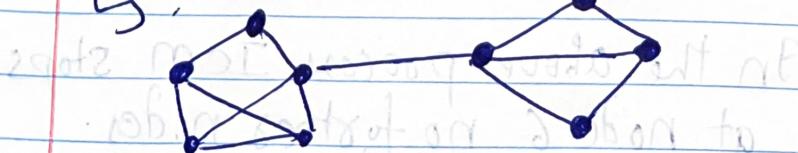
⇒ Q value is 1 , when actual no. of edges is maximum possible i.e. the network is completely connected while the expected number of edges is minimum possible.

⇒ Q value is 0 . When a particular division gives no more within community edges than would be expected by random.

Example

When modularity $[Q = 0]$
example can be single community

↳



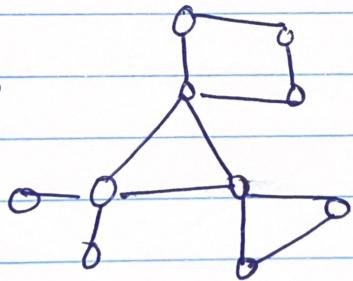
$\rightarrow \cancel{\text{Q}} = -1$ (no edge)

Example

$$\begin{matrix} & 0 & 0 \\ 0 & & 0 \\ & 0 & 0 \end{matrix}$$

$\rightarrow \underline{\text{Q}} = 1$ or modularity = 1 (modular network)

Example



Ans (A)

Solution (B)

Recommendation

(5)

$$G = [Newton, \Sigma in, Gauss]$$

Compute aggregated rating of all products.

using

1) Average Satisf.

2) Least Misery

3) Most Pleasure.

Averag. Satisf.

$$R_{Grod} = \frac{3+5+1}{3} = \boxed{3}, R_{LCR} = \frac{0+4+2}{3} = \boxed{2}$$

$$R_{CAD} = \boxed{\frac{7}{3}}, R_{Rash} = \boxed{\frac{7}{3}},$$

$$R_{Lreb} = \boxed{\frac{8}{3}}$$

As the Aver. Satisf. of Grod $R_{Grod} = 3$ is maximum it will be the first recommended product.

Least Misery

$$R_{God} = \min \{3, 5, 1\} = 1$$

$$R_{LCR} = \min \{0, 4, 2\} = +0$$

$$R_{CoD} = \min \{3, 0, 4\} = 0$$

$$R_{Ros} = \min \{2, 2, 3\} = 2$$

$$R_{Lverb} = \min \{4, 3, 1\} = 1$$

As $R_{Rashomon}$ is
maximum of all

so acc to

Least misery
it will be
recommended
first.

Most Pleasure

$$R_{God} = \max \{3, 5, 1\} = 5$$

$$R_{LCR} = \max \{0, 4, 2\} = 4$$

$$R_{CoD} = \max \{3, 0, 4\} = 4$$

$$R_{Ros} = \max \{2, 2, 3\} = 3$$

$$R_{Lverb} = \max \{4, 3, 1\} = 4$$

As R_{God} is

maximum
using Most
Pleasure
strategy it will
be recommended

$$+ (2xE) + (2xH) + (HxH) + (JxS) + (2xS) = NTP$$

$$(2xG + (2xS) + (2xS) + (2xI))$$

$$(0xE) = NTP$$

④ Recommendation

	Grd	Lec. R.	Cid. el. D.	Rash.	Lav. 3	\bar{r}_u
Newton	3	0	3	2	4	
Einstein	5	4	0	2	3	
Gauss	1	2	4	3	1	
Aristotle	3	?	4	2	2	
Euclid	2	2	0	1	5	2.75

Solution (a)

Table - I User - Item Matrix

User
Item based CF is given by :]

$$r_{u,i} = \bar{r}_{iu} + \frac{\sum_{j \in N(u)} \text{sim}(u, i) (r_{ui} - \bar{r}_{ui})}{\sum_{j \in N(u)} \text{sim}(u, j)}$$

Predicted rating of user u for item i (User u 's mean rating)

(i are 2 items observed rating of user u for item i)

$$r_{u,i} = \bar{r}_{iu} + \sum_j \text{sim}(u, j)$$

Aristotle Lec. R.

$$\begin{array}{r} g+g+4+16 \\ 2s+13 \\ \hline 38 \end{array} \quad \left(\begin{array}{r} 3^2+4^2+2^2+2^2 \\ 8+16+9 \\ \hline 2s+8 \end{array} \right)$$

Calculate avg. ratings

$$\bar{r}_{\text{Newton}} = \frac{3+3+2+4+0}{5} = 12/5$$

$$\bar{r}_{\text{Eini}} = \frac{5+4+0+5}{5} = 14/5$$

$$\bar{r}_{\text{Graw}} = \frac{1+2+4+3+1}{5} = 11/5$$

$$\bar{r}_{\text{Ari}} = \frac{(3+4+4)}{4} = 11/4$$

$$\bar{r}_{\text{Eu}} = 10/5 = 2$$

Calculate user-user Sim.

(Using Cosine Similarity)

$$\text{Sim}(\text{Aristotle}, \text{Newton}) = \frac{9+12+4+8}{\sqrt{33} \sqrt{38}}$$

$$\begin{aligned} &= \frac{0.9318}{\sqrt{33} \sqrt{38}} \\ &\approx 0.5922 \end{aligned}$$

$$\begin{aligned} \text{Sim}(\text{Aristotle}, \text{Graw}) &= \frac{3+16+6+2}{\sqrt{33} \sqrt{27}} \\ &= 0.844 \end{aligned}$$

$$\text{Sim}(\text{Aristotle}, \text{Eu}) = \frac{1+0+2+10}{\sqrt{33} \sqrt{30}}$$

6) Using User-based CF

Assume neighbourhood size = 2

As user-user similarity of Newton & Graw is highest:

$$\begin{aligned} \bar{r}_{\text{Ari. - LCR}} &= \frac{\text{sim}(\text{Ari}, \text{Newton}) (\bar{r}_{\text{Newton}} - \bar{r}_{\text{Ari}}) + \bar{r}_{\text{Ari}}}{\text{sim}(\text{Ari}, \text{Newton}) + \text{sim}(\text{Ari}, \text{Graw})} \\ &\quad + \text{sim}(\text{Ari}, \text{Graw}) (\bar{r}_{\text{Graw}} - \bar{r}_{\text{Ari}}) \\ &= 2.75 + \frac{(0.9318)(0 - 12/5)}{0.9318 + 0.9045} + \frac{0.9045(2 - 11/5)}{0.9318 + 0.9045} \\ &= 2.75 - 1.176 - (0.6188 / 1.7758) - (0.348) \\ &= \boxed{1.225} \end{aligned}$$

$$= \boxed{1.44}$$