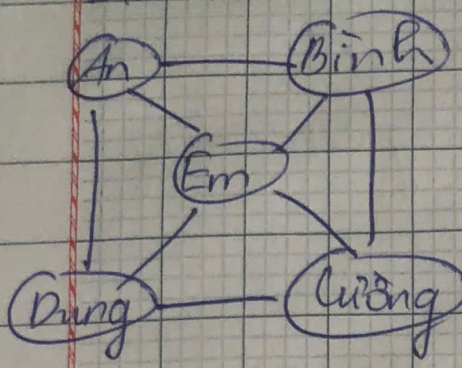
Exercise:



① Calculate desity network.

$n = 5$, $k = 8$.

$$\text{Density} = \frac{k}{n(n-1)/2} = \frac{8}{5.4/2} = 0,8$$

⇒ High Density ⇒ Network tends to connectivity strongly, information easy transmitted between actors.

② Identify:

- Degree centrality.

$$C_D(v) = \frac{\deg(v)}{n-1}$$

$$C_D(An) = \frac{3}{5-1} = \frac{3}{4} = 0.75 \quad CD(Dung) = \frac{3}{4} = 0,75$$

$$C_D(Bình) = \frac{3}{4} = 0,75 \qquad C_D(Em) = \frac{4}{4} = 1$$

$$C_D(Cường) = \frac{3}{4} = 0,75$$

⇒ Actor "Em" have highest degree centrality

⇒ Em is the most important actor in network, ~~direct connection to other actors, bridge for transfer ability, effect network~~

- Closeness centrality.

$$C_c(v) = \frac{1}{\sum_{t \in V, v} d_G(v,t)}$$

$$CC(v) = (n-1)\, C_c(v)$$

An	Binh	Em	Cường	Dung
0	1	1	2	1
1	0	1	1	2
1	1	0	1	1
2	1	1	0	1
1	2	1	1	0

~~$C_c(A) = \frac{1}{5}$~~

$C_c(An) = C_c(Binh) = C_c(Cường) = C_c(Dung) = \frac{1}{5}$.

$C_c(Em) = \frac{1}{4}$.

$CC(An) = CC(Binh) = CC(Cường) = CC(Dung)$

$= (n-1)\, C_c(v) = (5-1) \cdot \frac{1}{5} = \frac{4}{5} = 0,8$.

$CC(Em) = 4 \cdot \frac{1}{4} = 1$.

Comments: ⇒ Vertex "Em" has highest closeness centrality ~~than~~

~~to~~ ⇒ ~~Ver~~ "Em" has highest level.

• Between centrality:

$$C_B(v) = \sum \frac{\delta_{st}(v)}{\delta_{st}}$$

$$C'_B = \frac{C_B(v)}{(n-1)(n-2)/2}$$

An → Cường (Em) ⇒ $\delta_{st} = 1$, $\delta_{st}(Em) = 1$

Dung → Bình (Em) ⇒ $\delta_{st} = 1$, $\delta_{st}(Em) = 1$

$$C_B(Em) = \sum \frac{\delta_{st}(Em)}{\delta_{st}} = \frac{1}{1} + \frac{1}{1} = 2$$

Normalization coef:

$$(n-1)(n-2)/2 = (5-1)(5-2)/2 = 6.$$

$$C'_B(Em) = \frac{C_B(Em)}{(n-1)(n-2)/2} = \frac{2}{6} = 0,33$$

- Comments:

- "Em" occupies 33,3% of the possible mediating roles in the graph.

- "Em" is moderate important not the only intermediate vertex but plays an important connecting role in the network

- Clustering Centrality

$$C_i = \frac{2|\{e_{jk}\}|}{d_i(k_i - 1)}$$

$$C_i(An) = \frac{2.2}{3(3-1)} = 0,67.$$

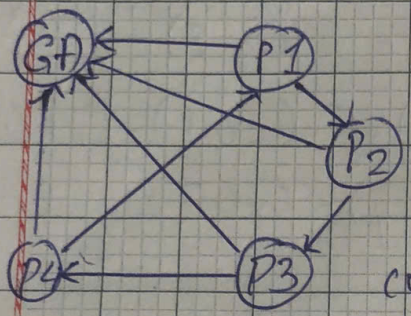
$$\bar{C} = \frac{1}{n}\sum_{i=1}^{n} C_i$$

$C_i(An) = C_i(Binh) = C_i(Wong) = C_i(Dung) = 0,67$

$$C_i(Em) = \frac{2.4}{4(4-1)} = 0,67.$$

⇒ Comments:

- The clustering coefficient (0,67) for each vertex indicates that the degree of connectivity between neighbors is similar.



⑥. Density network:

$n = 5$; $h = 8$.

$$\text{Density} = \frac{h}{n(n-1)/2} = 0,8.$$

⇒ High density, ⇒ Network tends to connectivity strongly, information easy to transmitted between actors.

② - Identify input level & output level each vertex.

- ~~Input level~~ : ~~GĐ = 4~~.

	GĐ	P1	P2	P3	P4
- Input level	4	1	1	1	1
- Output level	0	2	2	2	2

- Closeness centrality:

- Input edge:

- ~~GĐ~~

$$C_c(GĐ) = \frac{1}{\sum_{t \in V,\, t} d_G(v,t)} = \frac{1}{4}.$$

$$CC(GĐ) = (n-1)\, C_c(GĐ) = 4 \cdot \frac{1}{4} = 1.$$

$$C_c(P_1) = \frac{1}{3 + 2 + 1} = \frac{1}{6}$$

$$CC(P_1) = 4 \cdot \frac{1}{6} = \frac{4}{6} \approx 0,67.$$

$C_c(P_2) = \frac{1}{1+3+2} = \frac{1}{6}$

$CC(P_2) = 4 \cdot \frac{1}{6} = \frac{4}{6} = 0,67$.

$C_c(P_3) = \frac{1}{2+1+3} = \frac{1}{6} \Rightarrow CC(P_3) = 4 \cdot \frac{1}{6} = \frac{4}{6}$.

$C_c(P_4) = \frac{1}{3+2+1} = \frac{1}{6} \Rightarrow CC(P_4) = 4 \cdot \frac{1}{6} = \frac{4}{6}$.

- Output edge:

$C_c(P_1) = \frac{1}{1+1+2+3} = \frac{1}{7}$.

$CC(P_1) = 4 \cdot \frac{1}{7} = \frac{4}{7} = 0,57$.

$C_c(P_2) = \frac{1}{3+1+2+1} = \frac{1}{7}$.

$CC(P_2) = 4 \cdot \frac{1}{7} = \frac{4}{7}$.

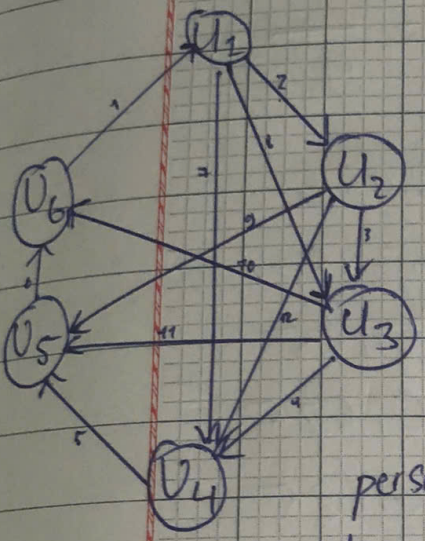
$C_c(P_3) = \frac{1}{2+3+1+1} = \frac{1}{7}$.

$CC(P_3) = 4 \cdot \frac{1}{7} = \frac{4}{7}$.

$C_c(P_4) = \frac{1}{1+1+2+3} = \frac{1}{7}$.

$CC(P_4) = 4 \cdot \frac{1}{7} = \frac{4}{7}$.

③



① Caculate density network.

$n = 6$, $h = 12$

$- \text{Density} = \frac{h}{n(n-1)/2} = \frac{12}{15} = 0,8$

⇒ high density ⇒ Network tends to connectivity strongly, information easy to transmitted between actors.

② Identify input, output level & find person who have the most influential

	U_1	U_2	U_3	U_4	U_5	U_6
Input level	1	1	2	3	3	2
Output level	3	3	3	1	1	1

~~- Person who have the most influence~~

- The most influential person: U_1, U_2, U_3
- The most concerned person: U_4, U_5.

③ Calculate

- Closeness Centrality:

Input:

$C_c(U_1) = \frac{1}{3+2+3+2+1} = \frac{1}{11}$

$C_c(U_2) = \frac{1}{1+3+4+3+2} = \frac{1}{13}$

$C_c(U_3) = \frac{1}{1+1+4+3+2} = \frac{1}{11}$

$C_c(u_4) = \frac{1}{2+2+1+3+2} = \frac{1}{8}$

$C_c(u_5) = \frac{1}{2+1+1+1+3} = \frac{1}{8}$

$C_c(u_6) = \frac{1}{3+2+1+2+1} = \frac{1}{9}$

$CC(u_1) = 5 \cdot \frac{1}{11} = \frac{5}{11} = 0,455$

$CC(u_2) = 5 \cdot \frac{1}{13} = \frac{5}{13} = 0,385$

$CC(u_3) = 5 \cdot \frac{1}{11} = \frac{5}{11} = 0,455$

$CC(u_4) = 5 \cdot \frac{1}{8} = \frac{5}{8} = 0,625$

$CC(u_5) = 5 \cdot \frac{1}{8} = \frac{5}{8} = 0,625$

$CC(u_6) = 5 \cdot \frac{1}{9} = \frac{5}{9} = 0,56$.

Out put:

$C_c(u_1) = \frac{1}{1+1+1+2+3} = \frac{1}{8}$

$C_c(u_2) = \frac{1}{3+1+1+1+2} = \frac{1}{8}$

$C_c(u_3) = \frac{1}{2+3+1+1+1} = \frac{1}{8}$

$C_c(u_4) = \frac{1}{3+4+4+1+2} = \frac{1}{14}$

$C_c(u_5) = \frac{1}{2+3+3+3+1} = \frac{1}{12}$

$C_c(u_6) = \frac{1}{1+2+2+2+3} = \frac{1}{10}$

~~$CC(u_1) = 5 \cdot \frac{1}{8}$~~

$CC(u_1) = CC(u_2) = CC(u_3) = 5 \cdot \frac{1}{8} = \frac{5}{8} = 0,625$

$$cc(u_4) = 5 \cdot \frac{1}{14} = \frac{5}{14} = 0,357.$$

$$cc(u_5) = 5 \cdot \frac{1}{12} = \frac{5}{12} = 0,4166\overline{7}.$$

$$cc(u_6) = 5 \cdot \frac{1}{10} = \frac{5}{10} = 0,5$$

comments :

- Input level : $cc(u_3)$ has smallest distance so it has largest transmission capacity.
- Output level : $cc(u_4)$ has smallest distance so it has largest transmission capacity.