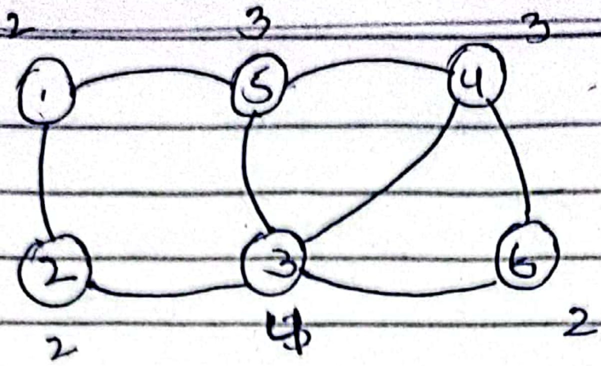
# DM




= 16

**DATA MINING**

$$2+2+3+4+3+2 = \underline{16}$$

Size = edges = 8

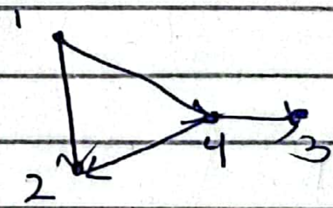
$\Sigma d = 2|\text{size}|$ (only for un-directed)

$16 = 2(8)$

$16 = 16$

un-directed

$$\text{Adj} = \begin{pmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$$




directed

$$\text{Adj} = \begin{pmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \end{pmatrix}$$

# DM

**Trace:**

$$Tr(A) = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

Trace = Sum of diagonal

$$\begin{bmatrix} 1 & 0 & 3 \\ 11 & 5 & 2 \\ 6 & 12 & -5 \end{bmatrix} = 1+5-5 = 1$$

$$\frac{Tr(A^2)}{2} = \text{No. of edges}$$

$$A^2 = \cancel{\begin{bmatrix} 1 & 0 & 3 \\ 11 & 5 & 2 \\ 6 & 12 & -5 \end{bmatrix} \begin{bmatrix} 1 & 0 & 3 \\ 11 & 5 & 2 \\ 6 & 12 & -5 \end{bmatrix}}$$

$$A^2 = \cancel{\begin{bmatrix} 19 & 36 & -12 \\ & & \\ & & \end{bmatrix}}$$

$$A^2 = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 2 & 1 & 1 & 1 \\ 1 & 2 & 1 & 1 \\ 1 & 1 & 1 & 0 \\ 1 & 1 & 0 & 3 \end{bmatrix} = Tr(A^2) = 2+2+1+3 = 8$$

$$\frac{tr(A^2)}{2} = \text{No. of edges } (Ne)$$

$$\frac{8}{2} = 4$$

$4 = 4$ (Hence Proved)

→ Data Minning
→ Natural Language Processing

→ ~~$tr(A^2) = \sum dv$~~ $\frac{tr(A^3)}{6}$ = No. of triangles.

→ $\frac{tr(A^2)}{2}$ = No. of edges

→ Graph is regular or not.

$AI = dI$

Eigen Vector equation

$A - \lambda I$

$$\begin{array}{c} A \\ \begin{pmatrix} 2 & 1 \\ 4 & 5 \end{pmatrix} \end{array} - \lambda \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 2-\lambda & 1 \\ 4 & 5-\lambda \end{pmatrix}$$

$$= (2-\lambda)(5-\lambda) - 4$$

$$= 10 - 2\lambda - 5\lambda + \lambda^2 - 4$$

$$10 - 7\lambda + \lambda^2 - 4$$

$$= \lambda^2 - 7\lambda + 6$$

$$= \lambda^2 - 6\lambda - \lambda + 6$$

$$= \lambda(\lambda - 6) - (\lambda - 6)$$

$$= (\lambda - 6)(\lambda - 1)$$

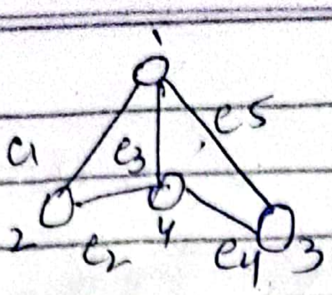
$\lambda - 6 = 0$

$\lambda = 6$

$\lambda - 1 = 0$

$\lambda = 1.$

Data Minning

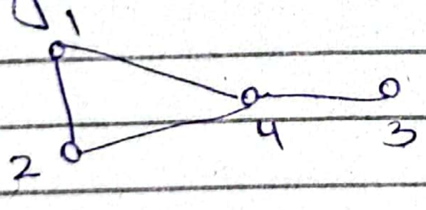
→ 


$N_v \times N_e = 4 \times 5 =$
(for un-directed)

$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 \end{pmatrix} \end{array}$$

directed graph → start : 1, end : -1

→ Degree Matrix



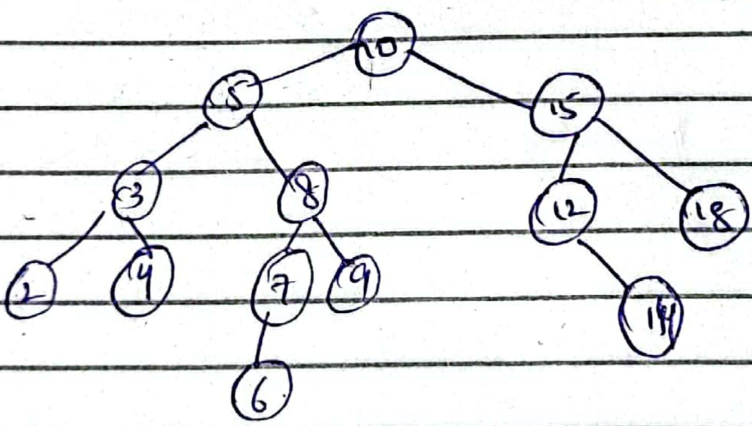

$$D = \begin{pmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 3 \end{pmatrix}$$

→ Laplacian Matrix:

$$L = D - A$$

$$L = \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 3 \end{bmatrix} - \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

$$L = \begin{bmatrix} 2 & -1 & 0 & -1 \\ -1 & 2 & 0 & -1 \\ 0 & 0 & 1 & -1 \\ -1 & -1 & -1 & 3 \end{bmatrix}$$




DFS

10, 5, 3, 2, 4, 8, 7, 6, 9, 15, 12, 14, 18

BFS

10, 5, 15, 3, 8, 12, 18, 2, 4, 7, 9, ~~6, 14~~ 14, 6

DM.

$$\text{Precision} = \frac{a}{a+C}$$

$$F_1 = \frac{2*a*b}{a+b}.$$

↓

$F_1$-score high ↑ → better

$$\text{Recall} = \frac{a}{a+b}$$

| | 1 | 0 |
|---|---|---|
| 1 | 40 TP | 10 FN |
| 0 | 1000 FP | 4000 TN |

$$\text{Acc} = \frac{40+40{,}000}{40+40{,}000+10+10{,}000} = \cancel{0.97}\ 0.8$$

Pre

$$\cancel{\text{Pre}} = \frac{40}{40+100} = 0.038$$

$$\text{Recall} = \frac{40}{40+10} = \frac{40}{50} = 0.8$$

$$F_1\text{-score} = \frac{2\times 0.038\times 0.8}{0.038+0.8} = 0.8$$

2-6 = 4
= 8
4+4

# K-Means

(2,10), (6,6), (1.5, 3.5)

| | Cluster 1 | Cluster 2 | Cluster 3 | |
|---|---|---|---|---|
| A1(2,10) | 0 | 8 | ~~9~~ 7 | C1 |
| A2(2,5) | 5 | 5 | 2 | C3 |
| A3(8,4) | 12 | 4 | 7 | C2 |
| A4(5,8) | 5 | 3 | 8 | C2 |
| A5(7,5) | 10 | 2 | 7 | C2 |
| A6(6,4) | 10 | 2 | 5 | C2 |
| A7(1,2) | 9 | 9 | 2 | C3 |
| A8(4,9) | 3 | 5 | 8 | C1 |

C1 (A1(2,10), A8(4,9)) = (3, 9.5)

C2 (A3(8,4), A4(5,8), A5(7,5), A6(6,4))
= (6.5, 5.25)

C3 (A2(2,5), A7(1,2)) = (1.5, 5.5)

~~P1~~
~~P2~~
~~P3, P6~~
~~P4, P6~~
~~P5~~

| | P1 | P2 | P3, P4, P6 | P5 |
|---|---|---|---|---|
| P1 | 0 | | | |
| P2 | 0.23 | 0 | | |
| P3, P4, P6 | 0.22 | 0.14 | 0 | |
| P5 | 0.34 | 0.14 | 0.23 | 0 |

| | P1 | P2, P3, P4, P6 | P5 |
|---|---|---|---|
| P1 | 0 | | |
| P2, P3, P4, P6 | 0.22 | 0 | |
| P5 | 0.34 | 0.14 | 0 |

Single Linkage

D

| | P1 | P2,P3,P4,P6,P5 |
|---|---|---|
| P1 | 0 | |
| P2,P3,P4,P6,P5 | 0.22 | 0 |

Dendogram