Name: Kishan Kumar Zalavadia EUID: 11685261 ①

③ Given $Q = \{q_1, q_2, q_3, q_4, q_5\}$ ⇒ Queries

$A = \{A_1, A_2, A_3, A_4, A_5\}$ ⇒ Attributes

$S = \{S_1, S_2, S_3\}$ ⇒ Sites

Usage: $use(q_i, A_j) =$

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline Q_1 & 1 & 0 & 0 & 1 & 0 \\ Q_2 & 1 & 1 & 1 & 0 & 0 \\ Q_3 & 0 & 0 & 0 & 1 & 1 \\ Q_4 & 1 & 0 & 1 & 0 & 0 \\ Q_5 & 0 & 1 & 0 & 1 & 1 \end{array}$$

Access Frequencies: $acc_s(q_k) =$

$$\begin{array}{c|ccc} & S_1 & S_2 & S_3 \\ \hline Q_1 & 20 & 30 & 0 \\ Q_2 & 10 & 0 & 15 \\ Q_3 & 0 & 45 & 15 \\ Q_4 & 0 & 20 & 0 \\ Q_5 & 0 & 25 & 0 \end{array}$$

Also given, $ref_s(q_k) = 1$ for all q_k and S_i.

① To find AA (Attribute Affinity) matrix.

We know, $\boxed{aff(A_i, A_j) = \sum\sum ref_s(q_k) * acc_s(q_k)}$

$aff(A_1, A_1) = (1\times20 + 1\times30 + 1\times0) + (1\times10 + 1\times0 + 1\times15) + (1\times0 + 1\times20 + 1\times0)$
$= 50 + 25 + 20$
$= 95$

Since A_1 occurs in query Q_1, Q_2, and Q_4

$aff(A_1, A_2) = (1\times10 + 1\times0 + 1\times15)$
$= 10 + 15$
$= 25$

Since A_1 and A_2 together occurs in query Q_2.

$aff(A_1, A_3) = (1\times10 + 1\times0 + 1\times15) + (1\times0 + 1\times20 + 1\times0)$
$= 25 + 20$
$= 45$

Since A_1 and A_3 together occurs in query Q_2 and Q_4

$aff(A_1, A_4) = (1\times20 + 1\times30 + 1\times0)$

$\{Q_1\}$ $= 20+30$

$= 50$

$aff(A_1, A_5) = 0$

Since, no query is accessing A_1 & A_5 together, so it is 0.

$aff(A_2, A_1) = aff(A_1, A_2) = 25$

$aff(A_2, A_2) = (1\times10 + 1\times0 + 1\times15) + (1\times0 + 1\times25 + 1\times0)$

$\{Q_2, Q_5\}$ $= 25 + 25$

$= 50$

$aff(A_2, A_3) = (1\times10 + 1\times0 + 1\times15)$

$\{Q_2\}$ $= 10+15$

$= 25$

$aff(A_2, A_4) = (1\times0 + 1\times25 + 1\times0)$

$\{Q_5\}$ $= 25$

$aff(A_2, A_5) = (1\times0 + 1\times25 + 1\times0)$

$\{Q_5\}$ $= 25$

$aff(A_3, A_1) = aff(A_1, A_3) = 45$

$aff(A_3, A_2) = aff(A_2, A_3) = 25$

$aff(A_3, A_3) = (1\times10 + 1\times0 + 1\times15) + (1\times0 + 1\times20 + 1\times0)$

$\{Q_2, Q_4\}$ $= 25 + 20$

$= 45$

$aff(A_3, A_4) = 0$

$aff(A_3, A_5) = 0$

} No query accessing both together

$aff(A_4, A_1) = aff(A_1, A_4) = 50$

$aff(A_4, A_2) = aff(A_2, A_4) = 25$

$aff(A_4, A_3) = aff(A_3, A_4) = 0$

$aff(A_4, A_4) = (1\times20 + 1\times30 + 1\times0) + (1\times0 + 1\times45 + 1\times15) + (1\times0 + 1\times25 + 1\times0)$

$\{Q_1, Q_3, Q_5\}$ $= 50 + 60 + 25$

$= 135$

$aff(A_4, A_5) = (1\times0 + 1\times45 + 1\times15) + (1\times0 + 1\times25 + 1\times0)$

$\{Q_3, Q_5\}$ $= 60 + 25$

$= 85$

$aff(A_5, A_1) = aff(A_1, A_5) = 0$

$aff(A_5, A_2) = aff(A_2, A_5) = 25$

$aff(A_5, A_3) = aff(A_3, A_5) = 0$

$aff(A_5, A_4) = aff(A_4, A_5) = 85$

$aff(A_5, A_5) = (1\times 0 + 1\times 45 + 1\times 15) + (1\times 0 + 1\times 25 + 1\times 0)$

$\{Q_3, Q_5\}$ $= 60 + 25$

$= 85$

AA matrix (Attribute Affinity) =

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 95 & 25 & 45 & 50 & 0 \\ A_2 & 25 & 50 & 25 & 25 & 25 \\ A_3 & 45 & 25 & 45 & 0 & 0 \\ A_4 & 50 & 25 & 0 & 135 & 85 \\ A_5 & 0 & 25 & 0 & 85 & 85 \end{array}$$

② The goal is to derive CA (Clustered Affinity) matrix using bond energy algorithm.

Bond Energy Algorithm

The input for bond energy algorithm is AA matrix that we derived from previous step.

As we know

$$\boxed{bond(A_x, A_y) = \sum_{z=1}^{n} aff(A_z, A_x)\, aff(A_z, A_y)}$$, where $n=5$

Now, let us find the bond values.

$bond(A_0, A_3) = aff(A_1, A_0)\, aff(A_1, A_3) + aff(A_2, A_0)\, aff(A_2, A_3) + aff(A_3, A_0)\, aff(A_3, A_3) + aff(A_4, A_0)\, aff(A_4, A_3) + aff(A_5, A_0)\, aff(A_5, A_3)$

$= 0$

Because $aff(A_1, A_0), aff(A_2, A_0), --- aff(A_5, A_0) = 0$

Since A_0 doesnot exist so all values related to A_0 are 0.

$$bond(A_3, A_1) = aff(A_1, A_3)\,aff(A_1, A_1) + aff(A_2, A_3)\,aff(A_2, A_1) + aff(A_3, A_3)\,aff(A_3, A_1) + aff(A_4, A_3)\,aff(A_4, A_1) + aff(A_5, A_3)\,aff(A_5, A_1)$$

$$= (45 * 95) + (25 * 25) + (45 * 45) + (0 * 50) + (0 * 0)$$

$$= 4275 + 625 + 2025 + 0$$

$$= 6925$$

$bond(A_0, A_1) = 0$ because all values associated with A_0 are 0

$bond(A_1, A_3) = bond(A_3, A_1) = 6925$

$$bond(A_3, A_2) = aff(A_1, A_3)\,aff(A_1, A_2) + aff(A_2, A_3)\,aff(A_2, A_2) + aff(A_3, A_3)\,aff(A_3, A_2) + aff(A_4, A_3)\,aff(A_4, A_2) + aff(A_5, A_3)\,aff(A_5, A_2)$$

$$= (45 \times 25) + (25 \times 50) + (45 \times 25) + (0 \times 25) + (0 \times 25)$$

$$= 1125 + 1250 + 1125 + 0$$

$$= 3500$$

$$bond(A_1, A_2) = aff(A_1, A_1)\,aff(A_1, A_2) + aff(A_2, A_1)\,aff(A_2, A_2) + aff(A_3, A_1)\,aff(A_3, A_2) + aff(A_4, A_1)\,aff(A_4, A_2) + aff(A_5, A_1)\,aff(A_5, A_2)$$

$$= (95 \times 25) + (25 \times 50) + (45 \times 25) + (50 \times 25) + (0 \times 25)$$

$$= 2375 + 1250 + 1125 + 1250$$

$$= 6000$$

$bond(A_2, A_3) = bond(A_3, A_2) = 3500$

$$bond(A_3, A_4) = aff(A_1, A_3)\,aff(A_1, A_4) + aff(A_2, A_3)\,aff(A_2, A_4) + aff(A_3, A_3)\,aff(A_3, A_4) + aff(A_4, A_3)\,aff(A_4, A_4) + aff(A_5, A_3)\,aff(A_5, A_4)$$

$$= (45 \times 50) + (25 * 25) + (0 \times 45) + (0 \times 135) + (0 \times 85)$$

$$= 2250 + 625 = 2875$$

$$bond(A_2,A_4) = aff(A_1,A_2)\,aff(A_1,A_4) + aff(A_2,A_2)\,aff(A_2,A_4) + aff(A_3,A_2)\,aff(A_3,A_4) + aff(A_4,A_2)\,aff(A_4,A_4) + aff(A_5,A_2)\,aff(A_5,A_4)$$

$$= (25\times 50) + (50\times 25) + (25\times 0) + (25\times 135) + (25\times 85)$$

$$= 1250 + 1250 + 3375 + 2125$$

$$= 8000$$

$bond(A_0,A_4) = 0$

$bond(A_4,A_3) = bond(A_3,A_4) = 2875$

$bond(A_0,A_3) = 0$

$$bond(A_4,A_1) = aff(A_1,A_4)\,aff(A_1,A_1) + aff(A_2,A_4)\,aff(A_2A_1) + aff(A_3,A_4)\,aff(A_3,A_1) + aff(A_4,A_4)\,aff(A_4,A_1) + aff(A_5,A_4)\,aff(A_5,A_1)$$

$$= (50\times 95) + (25\times 25) + (0\times 45) + (135\times 50) + (85\times 0)$$

$$= 4750 + 625 + 6750$$

$$= 12125$$

$bond(A_3,A_1) = bond(A_1,A_3) = 6925$

$bond(A_1,A_4) = bond(A_4,A_1) = 12125$

$$bond(A_5,A_3) = aff(A_1,A_5)\,aff(A_1,A_3) + aff(A_2,A_5)\,aff(A_2,A_3) + aff(A_3,A_5)\,aff(A_3,A_3) + aff(A_4,A_5)\,aff(A_4,A_3) + aff(A_5,A_5)\,aff(A_5,A_3)$$

$$= (0\times 45) + (25\times 25) + (0\times 45) + (85\times 0) + (85\times 0)$$

$$= 625$$

$$bond(A_5,A_1) = aff(A_1,A_5)\,aff(A_1,A_1) + aff(A_2,A_5)\,aff(A_2,A_1) + aff(A_3,A_5)\,aff(A_3,A_1) + aff(A_4,A_5)\,aff(A_4,A_1) + aff(A_5,A_5)\,aff(A_5,A_1)$$

$$\cancel{= (0 \times 50) + (25 \times 25) + (0 \times 0) + (85 \times 135) + (85 \times 85)}$$

$$= (0 \times 95) + (25 \times 25) + (0 \times 45) + (85 \times 50) + (85 \times 0)$$

$$= 4875$$

$$\text{bond}(A_5, A_4) = \text{aff}(A_1, A_5)\,\text{aff}(A_1, A_4) + \text{aff}(A_2, A_5)\,\text{aff}(A_2, A_4) + \text{aff}(A_3, A_5)\,\text{aff}(A_3, A_4) + \text{aff}(A_4, A_5)\,\text{aff}(A_4, A_4) + \text{aff}(A_5, A_5)\,\text{aff}(A_5, A_4)$$

$$= (0 \times 50) + (25 \times 25) + (0 \times 0) + (85 \times 135) + (85 \times 85)$$

$$= 625 + 11475 + 7225$$

$$= 19325$$

$$\text{bond}(A_5, A_2) = \text{aff}(A_1, A_5)\,\text{aff}(A_1, A_2) + \text{aff}(A_2, A_5)\,\text{aff}(A_2, A_2) + \text{aff}(A_3, A_5)\,\text{aff}(A_3 A_2) + \text{aff}(A_4, A_5)\,\text{aff}(A_4, A_2) + \text{aff}(A_5, A_5)\,\text{aff}(A_5, A_2)$$

$$= (0 \times 25) + (25 \times 50) + (0 \times 25) + (85 \times 25) + (85 \times 25)$$

$$= 1250 + 2125 + 2125$$

$$= 5500$$

We know,

$$\boxed{\text{cont}(A_i, A_k, A_j) = 2\,\text{bond}(A_i, A_k) + 2\,\text{bond}(A_k, A_j) - 2\,\text{bond}(A_i, A_j)}$$

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 95 & 25 & 45 & 50 & 0 \\ A_2 & 25 & 50 & 25 & 25 & 25 \\ A_3 & 45 & 25 & 45 & 0 & 0 \\ A_4 & 50 & 25 & 0 & 135 & 85 \\ A_5 & 0 & 25 & 0 & 85 & 85 \end{array}$$

Aff.
Attribute Affinity matrix (AA)

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_5 & A_6 \\ \hline A_1 & 95 & 25 & & & \\ A_2 & 25 & 50 & & & \\ A_3 & 45 & 25 & & & \\ A_4 & 50 & 25 & & & \\ A_5 & 0 & 25 & & & \end{array}$$

Clustered Affinity Matrix (CA)

Copy first 2 column's

$$\begin{array}{ccccccc} A_0 & A_1 & A_2 & A_3 & A_4 & A_5 & A_6 \end{array}$$

$$\begin{bmatrix} 95 & 25 \\ 25 & 50 \\ 45 & 25 \\ 50 & 25 \\ 0 & 25 \end{bmatrix}$$

$A_0 A_3 A_1$

$A_1 A_3 A_2$

$A_2 A_3 A_4$

3 positions for A_3

Ordering (0-3-1)

$cont(A_0, A_3, A_1) = 2bond(A_0, A_3) + 2bond(A_3, A_1) - 2bond(A_0, A_1)$

$= (2 \times 0) + (2 \times 6925) - (2 \times 0)$

$= 13850$

we have already calculated the bond values.

Ordering (1-3-2)

$cont(A_1, A_3, A_2) = 2bond(A_1, A_3) + 2bond(A_3, A_2) - 2bond(A_1, A_2)$

$= (2 \times 6925) + (2 \times 3500) - (2 \times 6000)$

$= 8850$

Ordering (2-3-4)

$cont(A_2, A_3, A_4) = 2bond(A_2, A_3) + 2bond(A_3, A_4) - 2bond(A_2, A_4)$

$= (2 \times 3500) + (2 \times 2875) - (2 \times 8000)$

$= -3250$

(or)

$cont(A_2, A_3, A_4) = (2 \times 3500) + (2 \times 0) + (2 \times 0)$

$= 7000$

Among all the 3 ordering ordering (0-3-1) has highest value, so $[A_0 A_3 A_1]$ is considered.

$$\begin{array}{ccc} A_3 & A_1 & A_2 \\ \end{array}$$
$$\begin{bmatrix} 45 & 95 & 25 \\ 25 & 25 & 50 \\ 45 & 45 & 25 \\ 0 & 50 & 25 \\ 0 & 0 & 25 \end{bmatrix}$$

$A_0 A_4 A_3$

$A_3 A_4 A_1$

$A_1 A_4 A_2$

$A_2 A_4 A_5$

4 positions for A_4

Ordering (0-4-3)

$$\begin{aligned} cont(A_0, A_4, A_3) &= 2bond(A_0, A_4) + 2bond(A_4, A_3) - 2bond(A_0, A_3) \\ &= (2 \times 0) + (2 \times 2875) - (2 \times 0) \\ &= 5750 \end{aligned}$$

Ordering (3-4-1)

$$\begin{aligned} cont(A_3, A_4, A_1) &= 2bond(A_3, A_4) + 2bond(A_4, A_1) - 2bond(A_3, A_1) \\ &= (2 \times 2875) + (2 \times 12125) - (2 \times 6925) \\ &= 16150 \end{aligned}$$

Ordering (1-4-2)

$$\begin{aligned} cont(A_1, A_4, A_2) &= 2bond(A_1, A_4) + 2bond(A_4, A_2) - 2bond(A_1, A_2) \\ &= (2 \times 12125) + (2 \times 8000) - (2 \times 6000) \\ &= 28250 \end{aligned}$$

Ordering (2-4-5).

$$\begin{aligned} cont(A_2, A_4, A_5) &= 2bond(A_2, A_4) + 2bond(A_4, A_5) - 2bond(A_2, A_5) \\ &= (2 \times 8000) + (2 \times \overset{0}{\cancel{14325}}) - (2 \times \overset{0}{\cancel{5500}}) \\ &= 16000 \end{aligned}$$

(since A_5 does not exit)

Among all the ordering, $[A_1 A_4 A_2]$ has the highest value.

$$\begin{array}{cccc} A_3 & A_1 & A_4 & A_2 \end{array}$$
$$\begin{bmatrix} 45 & 95 & 50 & 25 \\ 25 & 25 & 25 & 50 \\ 45 & 45 & 0 & 25 \\ 0 & 50 & 135 & 25 \\ 0 & 0 & 85 & 25 \end{bmatrix}$$

$A_0\,A_5\,A_3$
$A_3\,A_5\,A_1$
$A_1\,A_5\,A_4$
$A_4\,A_5\,A_2$
$A_2\,A_5\,A_6$

5 positions for A_5

Ordering (0-5-3)

$$cont(A_0, A_5, A_3) = 2bond(A_0, A_5) + 2bond(A_5, A_3) - 2bond(A_0, A_3)$$
$$= (2\times 0) + (2\times 625) + (2\times 0)$$
$$= 1250$$

Ordering (3-5-1)

$$cont(A_3, A_5, A_1) = 2bond(A_3, A_5) + 2bond(A_5, A_1) - 2bond(A_3, A_1)$$
$$= (2\times 625) + (2\times 4875) - (2\times 6925)$$
$$= -2850$$

Ordering (1-5-4)

$$cont(A_1, A_5, A_4) = 2bond(A_1, A_5) + 2bond(A_5, A_4) - 2bond(A_1, A_4)$$
$$= (2\times 4875) + (2\times 19325) - (2\times 12125)$$
$$= 24150$$

Ordering (4-5-2)

$$cont(A_4, A_5, A_2) = 2bond(A_4, A_5) + 2bond(A_5, A_2) - 2bond(A_4, A_2)$$
$$= (2\times 19325) + (2\times 5500) - (2\times 8000)$$
$$= 33650$$

Ordering (2-5-6)

$$cont(A_2, A_5, A_6) = 2bond(A_2, A_5) + 2bond(A_5, A_6) - 2bond(A_2, A_6)$$
$$= (2\times 5500) + (2\times 0) + (2\times 0)$$
$$= 11000$$

Among all the ordering, [A_4, A_5, A_2] has the highest value.

$$
\begin{array}{c|ccccc}
 & A_3 & A_1 & A_4 & A_5 & A_2 \\
\hline
A_1 & 45 & 95 & 50 & 0 & 25 \\
A_2 & 25 & 25 & 25 & 25 & 50 \\
A_3 & 45 & 45 & 0 & 0 & 25 \\
A_4 & 0 & 50 & 135 & 85 & 25 \\
A_5 & 0 & 0 & 85 & 85 & 25
\end{array}
$$

Now, organize the rows in the same order as column's.

$$
\begin{array}{c|ccccc}
 & A_3 & A_1 & A_4 & A_5 & A_2 \\
\hline
A_3 & 45 & 45 & 0 & 0 & 25 \\
A_1 & 45 & 95 & 50 & 0 & 25 \\
A_4 & 0 & 50 & 135 & 85 & 25 \\
A_5 & 0 & 0 & 85 & 85 & 25 \\
A_2 & 25 & 25 & 25 & 25 & 50
\end{array}
$$

Clustered Affinity Matrix (CA)

③ Partitioning

We known,

$$\boxed{Z = CTQ * CBQ - COQ^2}$$

Partition-1:

$$
\begin{array}{c|cccc|c}
 & A_3 & A_1 & A_4 & A_5 & A_2 \\
\hline
A_3 & 45 & 45 & 0 & 0 & 25 \\
A_1 & 45 & 95 & 50 & 0 & 25 \\
A_4 & 0 & 50 & 135 & 85 & 25 \\
A_5 & 0 & 0 & 85 & 85 & 25 \\
\hline
A_2 & 25 & 25 & 25 & 25 & 50
\end{array}
$$

$$Z = CTQ * CBQ - COQ^2$$

$$= (45 + 95 + 135 + 85 + 45 + 95 + 50 + 85) * (50) - (25 + 25 + 25 + 25)^2$$

$$= 540 \times 50 - 10000$$

$$= 27000 - 10000$$

$$= 17000$$

Partition: 2 :

$$\begin{array}{c|ccccc} & A_3 & A_1 & A_4 & A_5 & A_2 \\ \hline A_3 & 45 & 45 & 0 & 0 & 25 \\ A_1 & 45 & 95 & 50 & 0 & 25 \\ A_4 & 0 & 50 & 135 & 85 & 25 \\ A_5 & 0 & 0 & 85 & 85 & 25 \\ A_2 & 25 & 25 & 25 & 25 & 50 \end{array}$$

$Z = CTQ * CBQ - COQ^2$

$= (45 + 95 + 135 + 45 + 50) *$

$(85 + 50 + 25) -$

$(25 + 25 + 25 + 85)$

$= 370 \times 245 - 160^2$

$= 90650 - 25600$

$= 65050$

Partition: 3 :

$$\begin{array}{c|ccccc} & A_3 & A_1 & A_4 & A_5 & A_2 \\ \hline A_3 & 45 & 45 & 0 & 0 & 25 \\ A_1 & 45 & 95 & 50 & 0 & 25 \\ A_4 & 0 & 50 & 135 & 85 & 25 \\ A_5 & 0 & 0 & 85 & 85 & 25 \\ A_2 & 25 & 25 & 25 & 25 & 50 \end{array}$$

$Z = CTQ * CBQ - COQ^2$

$= (45 + 95 + 45) *$

$(135 + 85 + 50 + 85 + 25 + 25) -$

$(50 + 25 + 25)$

$= 84175 - 10000$

$= 74175$

Partition-4 :

$$\begin{array}{c|ccccc} & A_3 & A_1 & A_4 & A_5 & A_2 \\ \hline A_3 & 45 & 45 & 0 & 0 & 25 \\ A_1 & 45 & 95 & 50 & 0 & 25 \\ A_4 & 0 & 50 & 135 & 85 & 25 \\ A_5 & 0 & 0 & 85 & 85 & 25 \\ A_2 & 0 & 25 & 25 & 25 & 50 \end{array}$$

$Z = CTQ * CBQ - COQ^2$

$= (45) * (95 + 135 + 85 + 50 + 50 +$

$25 + 85 + 25 + 25) - (45 + 25)^2$

$= 45 \times 600 - 70^2$

$= 27000 - 4900$

$= 22100$

Partition 3 has the highest value. There fore the below is the partition of CA.

	A_3	A_1	A_4	A_5	A_2
A_3	45	45	0	0	25
A_1	45	95	50	0	25
A_4	0	50	135	85	25
A_5	0	0	85	85	25
A_2	25	25	25	25	50

Two vertical fragments : PROJ1(A_3, A_1) and PROJ2(A_4, A_5, A_2)

1) ① Simple Predicate's for 'TITLE' in PAY.

Simple Predicates are basic conditions that can be applied to a single attribute, 'TITLE' in our case.

The below are simple predicates for 'TITLE' in PAY.

i) TITLE = 'Elect. Eng.'

ii) TITLE = 'Syst. Anal.'

iii) TITLE = 'Mech. Eng.'

iv) TITLE = 'Programmer'

② Primary horizontal Fragmentation (PHF)

Given a relation R (PAY), the set of simple predicates P_0 (from question 1.1)

P_0 is complete and minimal.

$PAY_1 = \sigma_{TITLE = \text{'Elect. Eng.'}}(PAY)$

PAY1

TITLE	SAL
Elect. Eng.	40000

$PAY_2 = \sigma_{TITLE = \text{'Syst. Anal.'}}(PAY)$

PAY2

TITLE	SAL
Syst. Anal.	34000

$PAY_3 = \sigma_{TITLE = \text{'Mech. Eng.'}}(PAY)$

PAY3

TITLE	SAL
Mech. Eng.	27000

$PAY_4 = \sigma_{TITLE = \text{'Programmer'}}(PAY)$

PAY4

TITLE	SAL
Programmer	24000

3 Derived Horizontal Fragmentation (DHF):

Given Link L_1 where $owner(L_1) = PAY$ and $member(L_1) = EMP$

$EMP_1 = EMP \ltimes PAY_1$

where $PAY_1 = \sigma_{TITLE = \text{'Elect. Eng.'}}(PAY)$

EMP1

ENO	ENAME	TITLE
E_1	J. Doe	Elect. Eng.
E_6	L. Chu	Elect. Eng.

$EMP_2 = EMP \ltimes PAY_2$

where $PAY_2 = \sigma_{TITLE = \text{'Syst. Anal.'}}(PAY)$

EMP2

ENO	ENAME	TITLE
E_2	M. Smith	Syst. Anal.
E_5	B. Casey	Syst. Anal.
E_8	J. Jones	Syst. Anal.

$EMP_3 = EMP \ltimes PAY_3$

where $PAY_3 = \sigma_{TITLE = \text{'Mech. Eng.'}}(PAY)$

EMP3

ENO	ENAME	TITLE
E_3	A. Lee	Mech. Eng.
E_7	R. Davis	Mech. Eng.

$EMP_4 = EMP \ltimes PAY_4$

where $PAY_4 = \sigma_{TITLE='Programmer'}(PAY)$

EMP_4

ENO	ENAME	TITLE
E_4	J. Miler	Programmer

4 Derived Horizontal Fragmentation (DHF):

Given Link L_1 where owner(L_1) = ~~PAY~~ EMP and member(L_1) = ASG

$ASG_1 = ASG \ltimes EMP_1$

ASG 1

ENO	PNO	RESP	DUR
E_1	P_1	Manager	12
E_6	P_4	Manager	48

$ASG_2 = ASG \ltimes EMP_2$

ASG2

ENO	PNO	RESP	DUR
E_2	P_1	Analyst	24
E_2	P_2	Analyst	6
E_5	P_2	Manager	24
E_8	P_3	Manager	40

$ASG_3 = ASG \ltimes EMP_3$

ASG 3

ENO	PNO	RESP	DUR
E_3	P_3	Consultant	10
E_3	P_4	Engineer	48
E_7	P_3	Engineer	36

$ASG_4 = ASG \ltimes EMP_4$

ASG4

ENO	PNO	RESP	DUR
E_4	P_2	Programmer	18

2 Given Fragments

$ASG_1 = \sigma_{PNO='P_1'}(ASG)$

ASG1

ENO	PNO	RESP	DUR
E_1	P_1	Manager	12
E_2	P_1	Analyst	24

$ASG_2 = \sigma_{PNO='P_2'}(ASG)$

ASG2

ENO	PNO	RESP	DUR
E_2	P_2	Analyst	6
E_4	P_2	Programmer	18
E_5	P_2	Manager	24

$ASG_3 = \sigma_{PNO='P_3'}(ASG)$

ASG3

ENO	ENO	RESP	DUR
E_3	P_3	Consultant	10
E_7	P_3	Engineer	36
E_8	P_3	Manager	40

$ASG_4 = \sigma_{PNO='P_4'}(ASG)$

ASG4

ENO	PNO	RESP	DUR
E_3	P_4	Engineer	48
E_6	P_4	Manager	48

$PROJ_1 = \sigma_{BUDGET \geq 200000}(PROJ)$

PROJ 1

PNO	PNAME	BUDGET
P_3	CAD/CAM	250000
P_4	Maintenance	310000

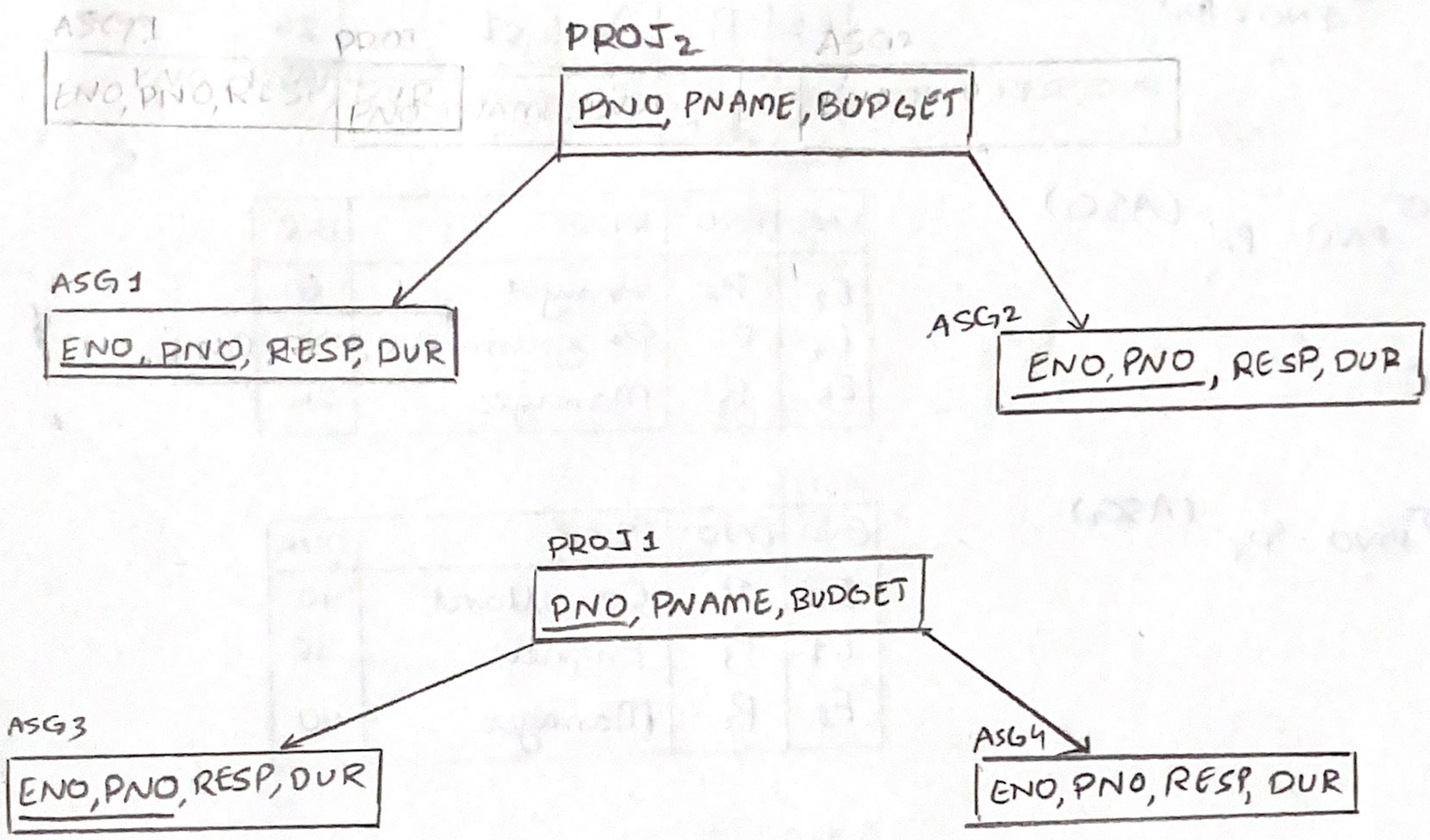
$PROJ_2 = \sigma_{BUDGET < 200000}(PROJ)$

PROJ 2

PNO	PNAME	BUDGET
P_1	Instrumentation	150000
P_2	Database Develop	135000

② Join graph

$ASG \ltimes_{PNO} PROJ$



The Join graph is partitioned. Because there is more than one link going out.

② New fragmentation.

$$ASG_{new-1} = \sigma_{PNO='P_1' \vee PNO='P_2'}(ASG)$$

ASG_{new-1}

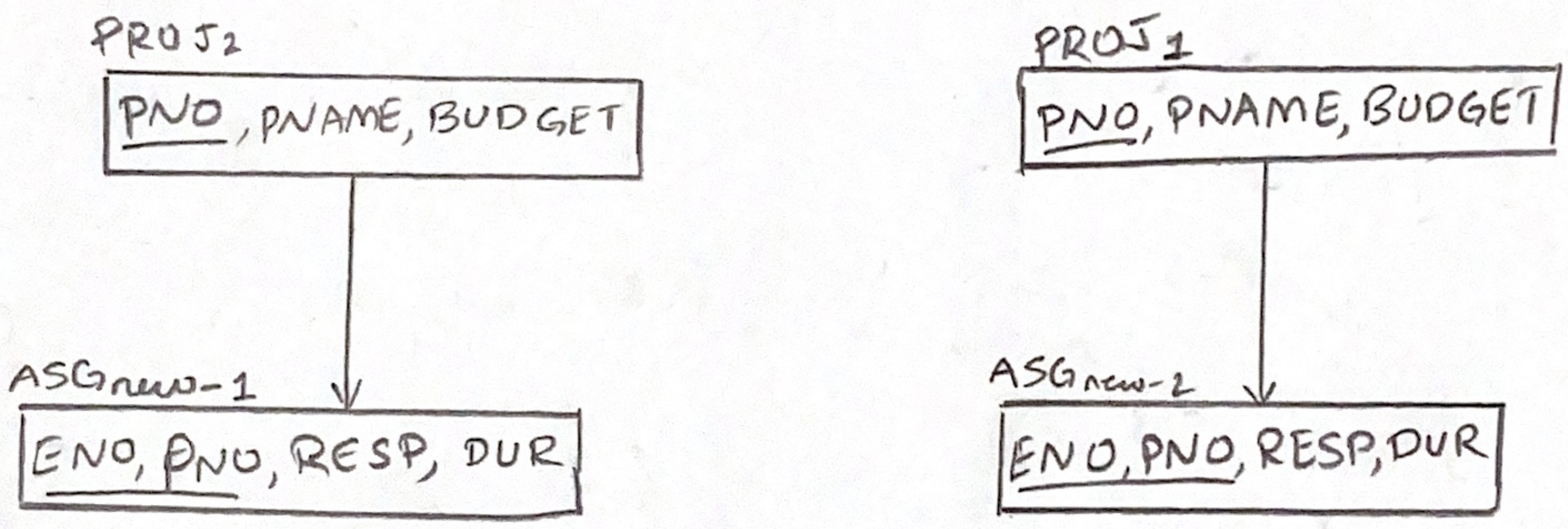
ENO	PNO	RESP	DUR
E_1	P_1	Manager	12
E_2	P_1	Analyst	24
E_2	P_2	Analyst	6
E_4	P_2	Programmer	18
E_5	P_2	Manager	24

$ASG_{new\text{-}2} = \sigma_{PNO='P_3' \vee PNO='P_4'}(ASG)$

$ASG_{new\text{-}2}$

ENO	PNO	RESP	DUR
E_3	P_3	Consultant	10
E_3	P_4	Engineer	48
E_6	P_4	Manager	48
E_7	P_3	Engineer	36
E_8	P_3	Manager	40

③ New Join ~~Diagram~~ Graph



This is Simple Join Graph.