

Banker's Algorithm Example

Formulas to know: $V = R - A \rightarrow R = V + A$
 $Q = C - A$

Given:

$$C = \begin{bmatrix} 2 & 1 & 2 \\ 3 & 3 & 6 \\ 2 & 3 & 5 \\ 1 & 1 & 1 \end{bmatrix}$$

$$A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 3 & 2 \\ 1 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$
$$+ \begin{bmatrix} 3 & 4 & 6 \end{bmatrix}$$

$$V = [0 \ 1 \ 0]$$

a.) Find R Vector

$$R = V + A \text{ (sum of columns)}$$

$$= [0 \ 1 \ 0] + [3 \ 4 \ 6]$$

$$= [3 \ 5 \ 6] //$$

b.) Run Banker's Algorithm

$$Q = C - A$$

$$Q = \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{matrix} \begin{bmatrix} 1 & 1 & 0 \\ 3 & 0 & 4 \\ 1 & 2 & 4 \\ 0 & 1 & 0 \end{bmatrix} \leq \begin{matrix} 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \end{matrix} \begin{matrix} \text{False} \\ \text{False} \\ \text{False} \\ \text{True} \checkmark \end{matrix}$$

ReRun Banker's

$$\begin{matrix} P_1 \\ P_2 \\ P_3 \end{matrix} \begin{bmatrix} 1 & 1 & 0 \\ 3 & 0 & 4 \\ 1 & 2 & 4 \end{bmatrix} \leq \begin{matrix} 1 & 1 & 1 \\ 2 & 1 & 3 \\ 2 & 1 & 3 \end{matrix} \begin{matrix} \text{True} \checkmark \\ \text{False} \\ \text{False} \end{matrix} \left. \vphantom{\begin{matrix} P_1 \\ P_2 \\ P_3 \end{matrix}} \right\} \begin{matrix} P_2 \text{ and } P_3 \text{ in} \\ \text{Deadlock} \end{matrix}$$

$$\text{Finalized } V = [2 \ 1 \ 3] //$$

Not in Safe State //

Banker's Algorithm Example 2

Given:

$$C = \begin{bmatrix} 3 & 1 & 2 \\ 3 & 3 & 2 \\ 2 & 3 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

a.) Find R Vector

$$R = V + A$$

$$= [0 \ 1 \ 0] + [4 \ 4 \ 6]$$

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

$$+ \begin{array}{ccc} 4 & 4 & 6 \end{array}$$

$$V = [0 \ 1 \ 0]$$

$$= [4 \ 5 \ 6] //$$

b.) Run Banker's Algorithm

$$\cdot Q = C - A$$

$$\begin{array}{l} P_1 \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \leq \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \text{ False} \\ P_2 \begin{bmatrix} 3 & 0 & 0 \end{bmatrix} \leq \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \text{ False} \\ P_3 \begin{bmatrix} 1 & 2 & 0 \end{bmatrix} \leq \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \text{ False} \\ P_4 \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \leq \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \text{ True } \checkmark \end{array}$$

ReRun Banker's

$$\begin{array}{l} P_1 \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \leq \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} \text{ True } \checkmark \\ P_2 \begin{bmatrix} 3 & 0 & 0 \end{bmatrix} \leq \begin{bmatrix} 3 & 1 & 3 \end{bmatrix} \text{ True } \checkmark \\ P_3 \begin{bmatrix} 1 & 2 & 0 \end{bmatrix} \leq \begin{bmatrix} 3 & 4 & 5 \end{bmatrix} \text{ True } \checkmark \end{array} \left. \vphantom{\begin{array}{l} P_1 \\ P_2 \\ P_3 \end{array}} \right\} \text{ No deadlocks!}$$

$$\Rightarrow 4 \ 5 \ 6$$

$$\text{Finalized } V = [4 \ 5 \ 6] //$$

Safe State? Yes //