

# Matrix Matrix Multiplication Parallel Implementation

## (A Simple Parallel Algorithm)

e.g.

A=

$$\begin{matrix} 2 & 3 & 4 & 5 \\ 9 & 8 & 7 & 6 \\ 5 & 4 & 2 & 3 \\ 8 & 7 & 3 & 4 \end{matrix}$$

B=

$$\begin{matrix} 3 & 5 & 7 & 6 \\ 2 & 7 & 6 & 3 \\ 7 & 5 & 3 & 2 \\ 4 & 3 & 2 & 5 \end{matrix}$$

Divide A and B among 4 processes(P0, P1, P2, P3):

A=

$$\begin{array}{c|cc|cc} & 2 & 3 & 4 & 5 \\ \hline \text{P0} & 9 & 8 & 7 & 6 & \text{P1} \\ \text{P2} & 5 & 4 & 2 & 3 & \text{P3} \\ & 8 & 7 & 3 & 4 & \end{array}$$

B=

$$\begin{array}{c|cc|cc} & 3 & 5 & 7 & 6 \\ \hline \text{P0} & 2 & 7 & 6 & 3 & \text{P1} \\ \text{P2} & 7 & 5 & 3 & 2 & \text{P3} \\ & 4 & 3 & 2 & 5 & \end{array}$$

**Total number of steps:  $\sqrt{p} = \sqrt{4} = 2$**

**Step 1:**

**Find A1 from A by following process:**

**A=**

2	3	4	5
9	8	7	6
5	4	2	3
8	7	3	4

**← Left Shift**

**A1=**

2	3	4	5
9	8	7	6
2	3	5	4
3	4	8	7

**Find B1 from B by following process:**

**B=**

3	5	7	6
2	7	6	3
7	5	3	2
4	3	2	5



**Up Shift**

B1=

$$\begin{array}{r|rrr} & 3 & 5 & \\ & 2 & 7 & \\ \hline & 7 & 5 & \\ & 4 & 3 & \end{array} \quad \begin{array}{rr} & 3 & 2 \\ & 2 & 5 \\ \hline & 7 & 6 \\ & 6 & 3 \end{array}$$

P0 Process:

$$\begin{array}{rr} 2 & 3 \\ 9 & 8 \end{array} * \begin{array}{rr} 3 & 5 \\ 2 & 7 \end{array} = \begin{array}{rr} 12 & 31 \\ 43 & 101 \end{array}$$

P1 Process:

$$\begin{array}{rr} 4 & 5 \\ 7 & 6 \end{array} * \begin{array}{rr} 3 & 2 \\ 2 & 5 \end{array} = \begin{array}{rr} 22 & 33 \\ 33 & 44 \end{array}$$

P2 Process:

$$\begin{array}{rr} 2 & 3 \\ 3 & 4 \end{array} * \begin{array}{rr} 7 & 5 \\ 4 & 3 \end{array} = \begin{array}{rr} 26 & 19 \\ 37 & 27 \end{array}$$

P3 Process:

$$\begin{array}{rr} 5 & 4 \\ 8 & 7 \end{array} * \begin{array}{rr} 7 & 6 \\ 6 & 3 \end{array} = \begin{array}{rr} 59 & 42 \\ 98 & 69 \end{array}$$

C1=

12	31	22	33
43	101	33	44
26	19	59	42
37	27	98	69

Step 2:

Find A2 from A1 by following process:

A1=

2	3	4	5	← Left Shift
9	8	7	6	
2	3	5	4	
3	4	8	7	← Left Shift

A2=

4	5	2	3
7	6	9	8
5	4	2	3
8	7	3	4

**Find B2 from B1 by following process:**

**B1=**

$$\begin{array}{cc|cc} 3 & 5 & 3 & 2 \\ 2 & 7 & 2 & 5 \\ \hline 7 & 5 & 7 & 6 \\ 4 & 3 & 6 & 3 \end{array}$$

↑                      ↑  
Up Shift    Up Shift

**B2=**

$$\begin{array}{cc|cc} 7 & 5 & 7 & 6 \\ 4 & 3 & 6 & 3 \\ \hline 3 & 5 & 3 & 2 \\ 2 & 7 & 2 & 5 \end{array}$$

**P0 Process:**

$$\begin{array}{cc} 4 & 5 \\ 7 & 6 \end{array} * \begin{array}{cc} 7 & 5 \\ 4 & 3 \end{array} = \begin{array}{cc} 48 & 35 \\ 73 & 53 \end{array}$$

**P1 Process:**

$$\begin{array}{cc} 2 & 3 \\ 9 & 8 \end{array} * \begin{array}{cc} 7 & 6 \\ 6 & 3 \end{array} = \begin{array}{cc} 32 & 31 \\ 111 & 78 \end{array}$$

## P2 Process:

$$\begin{array}{r} 5 \quad 4 \quad * \quad 3 \quad 5 \quad = \quad 23 \quad 53 \\ 8 \quad 7 \quad \quad 2 \quad 7 \quad \quad 38 \quad 89 \end{array}$$

## P3 Process:

$$\begin{array}{r} 2 \quad 3 \quad * \quad 3 \quad 2 \quad = \quad 12 \quad 19 \\ 3 \quad 4 \quad \quad 2 \quad 5 \quad \quad 17 \quad 26 \end{array}$$

C2=

$$\begin{array}{rrrr} 48 & 35 & 32 & 21 \\ 73 & 53 & 111 & 78 \\ 23 & 53 & 12 & 19 \\ 38 & 89 & 17 & 26 \end{array}$$

## Final Result

$$C = C1 + C2$$

$$\begin{array}{rrrrr} 60 & 66 & 54 & 54 & = \quad 12 \quad 31 \quad 22 \quad 33 \quad + \quad 48 \quad 35 \quad 32 \quad 21 \\ 116 \quad 154 \quad 144 \quad 122 & & 43 \quad 101 \quad 33 \quad 44 & & 73 \quad 53 \quad 111 \quad 78 \\ 49 & 72 & 71 & 61 & \quad 26 \quad 19 \quad 59 \quad 42 & \quad 23 \quad 53 \quad 12 \quad 19 \\ 75 & 116 & 115 & 95 & \quad 37 \quad 27 \quad 98 \quad 69 & \quad 38 \quad 89 \quad 17 \quad 26 \end{array}$$