

# Matrix Matrix Multiplication Parallel Implementation

## (A Simple Parallel Algorithm)

e.g.

A=

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

B=

|   |   |   |   |
|---|---|---|---|
| 3 | 5 | 7 | 6 |
| 2 | 7 | 6 | 3 |
| 7 | 5 | 3 | 2 |
| 4 | 3 | 2 | 5 |

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

A=

|    |   |   |   |   |    |
|----|---|---|---|---|----|
|    | 2 | 3 | 4 | 5 |    |
| P0 | 9 | 8 | 7 | 6 | P1 |
|    | 5 | 4 | 2 | 3 |    |
| P2 | 8 | 7 | 3 | 4 | P3 |

B=

|    |   |   |   |   |    |
|----|---|---|---|---|----|
|    | 3 | 5 | 7 | 6 |    |
| P0 | 2 | 7 | 6 | 3 | P1 |
|    | 7 | 5 | 3 | 2 |    |
| P2 | 4 | 3 | 2 | 5 | P3 |

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

**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=**

|   |   |   |   |
|---|---|---|---|
| 3 | 5 | 3 | 2 |
| 2 | 7 | 2 | 5 |
| 7 | 5 | 7 | 6 |
| 4 | 3 | 6 | 3 |

**P0 Process:**

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

**P1 Process:**

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

**P2 Process:**

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

**P3 Process:**

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

**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 |
| 9     | 8 | 7 | 6 |
| <hr/> |   |   |   |
| 2     | 3 | 5 | 4 |
| 3     | 4 | 8 | 7 |

← Left Shift

← Left Shift

**A2=**

|       |   |   |   |
|-------|---|---|---|
| 4     | 5 | 2 | 3 |
| 7     | 6 | 9 | 8 |
| <hr/> |   |   |   |
| 5     | 4 | 2 | 3 |
| 8     | 7 | 3 | 4 |

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

**B1=**

|   |   |   |   |
|---|---|---|---|
| 3 | 5 | 3 | 2 |
| 2 | 7 | 2 | 5 |
| 7 | 5 | 7 | 6 |
| 4 | 3 | 6 | 3 |

↑
↑

Up Shift
Up Shift

**B2=**

|   |   |   |   |
|---|---|---|---|
| 7 | 5 | 7 | 6 |
| 4 | 3 | 6 | 3 |
| 3 | 5 | 3 | 2 |
| 2 | 7 | 2 | 5 |

**P0 Process:**

|   |   |   |   |   |   |    |    |
|---|---|---|---|---|---|----|----|
| 4 | 5 | * | 7 | 5 | = | 48 | 35 |
| 7 | 6 |   | 4 | 3 |   | 73 | 53 |

**P1 Process:**

|   |   |   |   |   |   |     |    |
|---|---|---|---|---|---|-----|----|
| 2 | 3 | * | 7 | 6 | = | 32  | 31 |
| 9 | 8 |   | 6 | 3 |   | 111 | 78 |

## P2 Process:

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

## P3 Process:

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

C2=

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

## Final Result

C= C1 + C2

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