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7B Quiz 4 (Solution)

Parallel and Distributed Computing - CS 3006

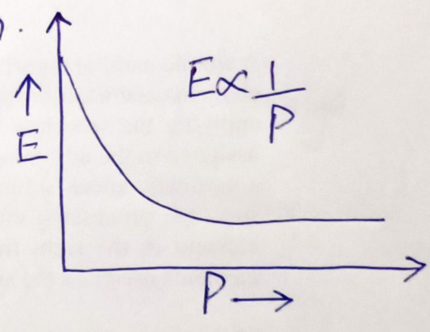
Q1: Define the following. Give appropriate example where possible.

- Scaled Speedup:

Speedup obtained when the problem size is increased linearly with number of processing elements
if scaled-speedup curve is close to linear with respect to no of processing elements, then parallel system is considered scalable.

- Relationship of efficiency with number of processors provided problem size is fixed:

As we increase number of processors elements, the overall efficiency of parallel system goes down.



- Speedup:

Ratio of time taken to solve a problem on a single processing element to time required to solve the same problem on a parallel computer with p identical processing elements.

$$S = \frac{W}{T_P} = \frac{W}{W + T_o(W,P)}$$

How Parallel System Solves this:

From fig (c) we see that N/p columns are given to each process.

Note: You will have a matrix or image stored in a file and each process will execute a code to read P(n/p)Th portion of the image or matrix.

process 0 will read first 2 colums [C0, C1]

process 1 will read columns from [C(1)(2) to C(1+2)(2)-1]

process 2 will read columns from [C(2)(2) to C(2+1)(2)-1]

process 3 will read columns from [C(3)(2) to C(3+1)(2)-1]

Now that each process has loaded portion of image in their personal address-space, you will perform communication.

P0
Receive (first col of P1)

P1
Send (first col to P0)
Receive (first col from P2)

P2
Send (first col to P1)
Receive (first col from P3)

P3
Send (first col to P2)
Receive (first col from P4) ---> invalid boundary comm operation as there is no P4. So need to use if condition with last process and use padding instead.

Q2
FAST Quiz 4 : Bonus Task Image processing.

Matrix

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

Filter: $\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$, Stride $= \underline{1}$ (how much shift after each step)

Output size:

$$\left[\frac{n+2p-f}{s} + 1\right], \quad n = 8 \text{ (matrix size)}, \ p = 0 \text{ (padding)}, \ f = 3 \text{ (filter size)}, \ s = \underline{1}$$

$$= \frac{8+2(0)-3}{1} + 1$$

$$= 5 + 1 = 6 \Rightarrow \text{so, output matrix size is } 6\times6$$

Output Matrix:

2nd step 3rd step

1st step ← 3 0 3

7th step ← 0

6x6

FAST

Date:

2 steps involved in single step:
1) Multiply element by element
2) Add all elements into single

1st step:

$$\begin{bmatrix} 1 & 2 & -1 \\ 2 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$= -1 + 0 - 1 - 4 + 0 + 2 + 0 + 0 + 1 = -3$

2nd step:

$$\begin{bmatrix} 2 & -1 & 0 \\ 0 & 1 & 2 \\ 1 & 1 & -1 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$-2 + 0 + 0 + 0 + 0 + 4 - 1 + 0 - 1 = 0$

3rd step:

$$\begin{bmatrix} -1 & 0 & 0 \\ 1 & 2 & 2 \\ 1 & -1 & 1 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$1 + 0 + 0 - 2 + 0 + 4 - 1 + 0 + 1 = 3$

$\vdots$

6th step:

$$\begin{bmatrix} 1 & 3 & \cancel{8}\ 1 \\ 1 & 1 & 0 \\ -2 & 2 & -2 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Similarly ...

Date:

7^{th} Step:

$$\begin{bmatrix} 2 & 0 & 1 \\ 0 & 1 & 1 \\ 2 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$$-2 + 0 + 1 + 0 + 0 + 2 - 2 + 0 + 1 = 0$$

Now, do this till all elements of matrix iterates

Similarly all remaing elements of 6x6 matrix will be calulated.