

# ADVANCED DATA ENGINEERING: ASSIGN. 10

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## Problem

- Estimate the execution time for the join operation specified in the lecture under the assumption of:
  - Having enough memory.
  - Having 8MB/s bandwidth disks.
  - Ignoring seek time and rotational latency.
- Estimate the execution time for increasing the number of PEs from 8 to 16.

## Question 1: Execution time for the join operation.

*Roughly estimate the execution time using 8 processors and the assumptions above.*

**Answer:** Since we have enough memory for storing the data in each PE, the number of communication is reduced to the number of PEs, and also the network setup time is negligible ( $50\mu s \times 8 = 0.4\ ms$ ) compare to communication time or disk I/O time. According to the given information about the database, we have the relation size in each PE:

$$\mathcal{X} = \frac{64\text{MB}}{8} = 8\text{MB}$$

In each communication phrase, each PE sends:

$$\mathcal{Y} = \frac{\mathcal{X}}{8} = \frac{8\text{MB}}{8} = 1\text{MB}$$

Transfer time in the network:

$$\mathcal{Z} = \frac{\mathcal{Y}}{10\text{MB/s}} = \frac{1\text{MB}}{10\text{MB/s}} = 100\text{ms}$$

We have 8 phrases for the communication, therefore the cost for communication time is:

$$\mathcal{T}_{comm} = 8 \times 2 \times \mathcal{Z} = 1.6s$$

We also have the disk I/O in each PE, assuming there is no skew:

$$\mathcal{W} = 3 \times \frac{|R| + |S|}{8} = 48MB$$

Disk I/O time:

$$\mathcal{T}_{disk} = \frac{\mathcal{W}}{8MB} = 6s$$

Total cost for Parallel Grace Hash Join with 8 PEs is:

$$\mathcal{T} = \mathcal{T}_{comm} + \mathcal{T}_{disk} = 1.6 + 6 = 7.6s$$

## Question 2: Execution time for the join operation.

*Roughly estimate the execution time using 16 processors and the assumptions above.*

**Answer:** Since we have enough memory for storing the data in each PE, the number of communication is reduced to the number of PEs, and also the network setup time is negligible ( $50\mu s \times 16 = 0.8 \text{ ms}$ ) compare to communication time or disk I/O time. According to the given information about the database, we have the relation size in each PE:

$$\mathcal{X} = \frac{64MB}{16} = 4MB$$

In each communication phrase, each PE sends:

$$\mathcal{Y} = \frac{\mathcal{X}}{8} = \frac{4MB}{16} = 250KB$$

Transfer time in the network:

$$\mathcal{Z} = \frac{\mathcal{Y}}{10MB/s} = \frac{0.25MB}{10MB/s} = 25ms$$

We have 8 phrases for the communication, therefore the cost for communication time is:

$$\mathcal{T}_{comm} = 16 \times 2 \times \mathcal{Z} = 0.8s$$

We also have the disk I/O in each PE, assuming there is no skew:

$$\mathcal{W} = 3 \times \frac{|R| + |S|}{16} = 24MB$$

Disk I/O time:

$$\mathcal{T}_{disk} = \frac{\mathcal{W}}{8MB} = 3s$$

Total cost for Parallel Grace Hash Join with 8 PEs is:

$$\mathcal{T} = \mathcal{T}_{comm} + \mathcal{T}_{disk} = 0.8 + 3 = 3.8s$$