Advanced Data Engineering: Assign. 11

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Problem

- In actual situations, it is hard to make the load distribution completely even by the LPT First Strategy.
  - Consider the condition of α for the case in which the Fine Bucket Method with the Spreading Bucket Method is effective for $N_p = 100$, when we assume that the maximum skew remains β % (difference between the longest and shortest execution time is β % of the sequential execution time) after applying the Fine Bucket Method.
  - Consider approaches to make β smaller.

Question 1: Condition of α for $N_p = 100$

Roughly estimate the execution time using 8 processors and the assumtions 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:

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

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

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

Disk I/O time:

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

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

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

Question 2: Execution time for the join operation.

Roughly estimate the execution time using 16 processors and the assumtions 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 ($50\mu s \times 16 = 0.8\ ms$) 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:

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

In each communication phrase, each PE sends:

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

Transfer time in the network:

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

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

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

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

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

Disk I/O time:

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

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

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