Simulation and Scientific Computing
Assignment 3

The Conjugate Gradient Method and MPI Parallelization

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1 Task 2a

Latency is α
No. of Elements is k
BW of the transfer is β
So the time required to transfer k elements $T_k = \frac{k}{\beta}$

So the total time required for communication adding the latency of transfer is,

$T_t = \alpha + \frac{k}{\beta}$

As k elements are transferred, total no. of k iterations are possiblle with one transfer.
And number of updates = $\sum_{i=1}^{k-1} i$ and X is rhe time required for each update.

So total no. of updates in k iteration = X . $\sum_{i=1}^{k-1} i$ = X. $\frac{k(k-1)}{2}$

So total time for k iteration = α + $\frac{k}{\beta}$ + X. $\frac{k(k-1)}{2}$
Hence parallel overhead/process/iteration = $\frac{1}{k}$ (α + $\frac{k}{\beta}$ + X. $\frac{k(k-1)}{2}$)

So $T_{tot} = \frac{\alpha}{k} + \frac{X(k-1)}{2} + \frac{1}{\beta}$ (Answer.)

2 Task 2b

As from 2a we have,

$T_{tot} = \frac{\alpha}{k} + \frac{X(k-1)}{2} + \frac{1}{\beta}$

To get the best value of k we have to take the differentiation of above equation and equate to 0.

$\frac{dT_{tot}}{dk}$ = -$\frac{\alpha}{k^2} + \frac{X}{2} = 0$

As $k \geq 0, k = \sqrt{\frac{2\alpha}{X}}$

So putting α = 2 ms, X = 0.2 ms here, k = $\sqrt{\frac{4}{0.2}} = \sqrt{20} \approx 4.472$

Let's take k = 5, $T_{tot} = \frac{2}{5} + \frac{0.2 \times 4}{2} + \frac{1}{30}$
$= 0.4 + 0.4 + -.0333 \approx 0.833ms.$

So Answer is best value of k = 5, and $T_{tot} = 0.833ms.$