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Set 9 - MPI

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Question 1: Quadratic Form

We want to compute the quadratic form

$$Q = \vec{v}^T \cdot A \cdot \vec{w} = \sum_{ij} v_i A_{ij} w_j \quad (1)$$

in parallel employing shared and distributed memory parallelism with OpenMP and MPI.

Given the $n \times n$ matrix A and the vectors v , w , the provided sequential code `main_seq.c` computes the quadratic form of Equation 1.

- Put your OpenMP solution in `main_omp.c`.
- Parallelize the code for a distributed memory architecture. Using a block-row distribution every process must initialize only the needed portion of the objects `v`; `w`; `A`. Assume that n is a multiple of the number of processes. Put your solution in `main_mpi.c` and extend the Makefile accordingly.

Hints:

- Block-row distribution: distribute the rows of the matrix to the available processes (ranks), as performed in the MPI diffusion code.
- Allocate and initialize only the portion of data needed by each rank.
- Take care of the different range of loop indices when you perform data initialization.
- Optimize MPI communication whenever this is possible.
- The application must produce the same output messages regardless of the implementation approach (i.e. only one rank prints).