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Set 6 - MPI Communicators
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Question 1: MPI Communicators

The $N \times N$ Lehmer matrix A is defined by $A_{i,j} = \min(i,j)/\max(i,j)$, where $i, j = 1, 2, \ldots, N$. We will here compute the L_∞ norm

$$L_\infty = \max_i \left\{ \sum_j |a_{ij}| \right\} \tag{1}$$

of this matrix distributed across a **two dimensional** grid of MPI processes.

A serial implementation can be found in `mpi_communicators_serial.cpp`.

a) On each process allocate an array of appropriate size for the local tile of the matrix such that the number of processes along both dimensions is as close as possible.

   Assume perfect tiling and make use of the MPI helper function `MPI_Dims_create`. For example, if we have 12 MPI processes, assume that N is divisible by 12. We should then have a grid with 4 processes along one dimension and 3 processes along the other. If we have 13 MPI processes, then 1 along one dimension and 13 along the other.

b) Fill the local sub-matrix on each process with appropriate values.

c) Compute the L_∞ norm of the distributed matrix using row and column communicators.

d) Once your code works for small matrix sizes, analyze the scaling for $N = 2^{20} = 1'048'576$.

Summary

Summarize your answers, results and plots into a short PDF document. Furthermore, elucidate the main structure of the code and report possible code details that are relevant in terms of accuracy or performance. Send the PDF document and source code to your assigned teaching assistant.