March 14, 2022

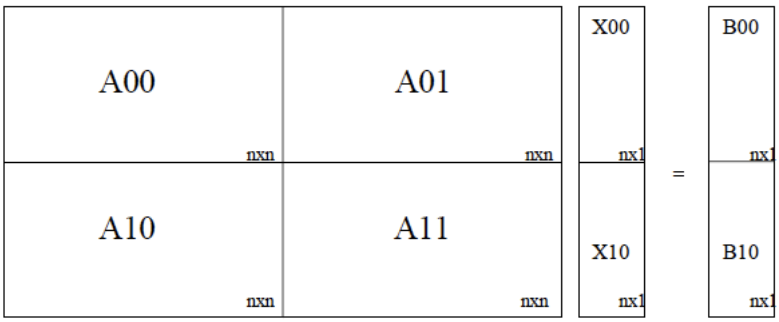
HOMEWORK 1

Dense Matrix-Vector Multiplication
Virtual Topology Implementation with MPI

Suppose that we have an *mxm* square matrix and *mx1* vector. We divide our matrix and vector into sub-matrices and sub-vectors as shown in figure below. Each node of Cartesian topology has an ownership of *nxn* sub-matrices and *nx1* sub-vectors, which should be created and filled locally. Use *2x2*, *4x4*, *8x8 and 12x12* Cartesian topologies to compute the matrix-vector product, and then, each node sends its own result to the master processor.
Write a parallel program (in C/C++ or FORTRAN) based on MPI (Message Passing Interface) using the following instructions.

Steps to follow:

1. Use **derived data type** for the data to be transferred.
2. Use *mxm* synthetic test matrices (their sizes range from 3200, 6400, 12800, 25600, 51200, 102400). (*Hint:* Create sub-matrices locally).
3. Explain how to map the processes into a Cartesian virtual topology.
4. Create **row and column-based sub-topologies** for broadcasting the data.
5. Plot effective speedup and efficiency graphs (Gustafson's Law).
6. Plot speedup and efficiency graphs (Amdahl's Law) for a matrix size (*mxm*) where *m*=51200.
7. Specify and consider the basic metrics of hardware architecture. Discuss the results obtained and explain the potential reason(s) for weak scalability on the processors in term of hardware and software perspectives.
8. Submit your homework report and program's soft copy.



Matrix vector multiplication for 2x2 Cartesian Topology (mxm) where m=2n.

DUE DATE: April 4, 2022

Prof. Dr. M. Serdar ÇELEBİ
ITU, Informatics Institute