

Your Special Challenge

Develop a parallel application that does multiply two Matrices C and MPI

The multiplication of matrices is often done to solve challenges in applied mathematics, physics, and engineering. And it is a frequently used example in courses which focus on parallel and distributed systems [1][2][3][4][5][6].

The individual steps of your task

1. **Investigate** how to implement with the programming language C and with MPI an application that is able to calculate the matrix product from two matrices in parallel. Literature provides many helpful sources, covering the matrix multiplication and how to implement it in C with MPI [7][8][9][10][11][12][13][14].
2. **Deploy** a MPI environment for testing and development on physical hardware, inside virtual machines [15][16] or inside a public cloud infrastructure service like EC2 [17][18][19].
3. **Develop** your application with C and MPI.
4. **Test** your application on your own MPI cluster and test it on our 128 node cluster with the 512 CPU cores. Test your application...
 - with sufficient large problem sizes (matrices) and
 - with different numbers of cores (1, 2, 4, 8, 16...512) andcalculate the speedup. Your outcomes may prove some of the laws and limitations we already discussed during class in slide set 1.
5. **Create** a presentation (max. 30 Minutes) with maximum 15 slides and additionally a live demonstration. Give your presentation during class or during an exercise session.

Some final words to motivate you

In real life, one or two weeks is a typical amount of time to do such a task in parallel to your daily tasks. In this course you have several weeks and you are not alone.

Last but not least, questions of the exam will cover this special task!

References

- [1] “Lecture 6: Parallel Matrix Algorithms (part 1).” <https://www3.nd.edu/~z xu2/acms60212-40212-S12/Lec-07-1.pdf>.
- [2] “Lecture 6: Parallel Matrix Algorithms (part 2).” <https://www3.nd.edu/~z xu2/acms60212-40212-S12/Lec-07-2.pdf>.
- [3] “Lecture 6: Parallel Matrix Algorithms (part 3).” <https://www3.nd.edu/~z xu2/acms60212-40212-S12/Lec-07-3.pdf>.
- [4] D. V. Pankratius and D. J. Meder, “Parallele Algorithmen II,” tech. rep. <http://www.ipd.uka.de/Tichy/uploads/fohlen/166/Cluster15ParalleleAlgos2.pdf>.
- [5] “Matrix Multiplication on a Distributed Memory Machine.” <http://www.phy.ornl.gov/csep/1a/node6.html>.
- [6] “Cannon’s algorithm.” https://en.wikipedia.org/wiki/Matrix_multiplication_algorithm.
- [7] T. Bräunl, *Parallele Programmierung: Eine Einführung*. Vieweg, 1993.
- [8] D. an Mey, “Matrix Multiplication using Matrix Multiplication using MPI,” tech. rep. https://doc.itc.rwth-aachen.de/download/attachments/3475015/04_DaM_MPI_CaseStudy_Matmul.pdf.
- [9] “Matrix-vector Multiplication.” <http://acc6.its.brooklyn.cuny.edu/~cisc7340/examples/mpimatrixmult.pdf>.
- [10] “Matrix Multiplication using MPI Parallel Programming Approach.” <https://www.daniweb.com/programming/software-development/code/334470/matrix-multiplication-using-mpi-parallel-programming-approach>.
- [11] “MPI Matrix Multiply.” https://computing.llnl.gov/tutorials/mpi/samples/C/mpi_mm.c.
- [12] “Matrix multiplication using MPI.” <http://www.eecg.toronto.edu/~amza/ece1747h/homeworks/examples/MPI/other-examples/mmult.c>.
- [13] “Matrix multiplication using Mpi_Scatter and Mpi_Gather.” <https://stackoverflow.com/questions/41575243/matrix-multiplication-using-mpi-scatter-and-mpi-gather>.
- [14] “A very simple implementation of matrix multiplication using open-mpi.” <https://github.com/liyanghua/open-mpi-matrix-multiplication>.

- [15] “MPI Tutorials 01.” <https://www.youtube.com/watch?v=2rpWEZY0aPo>.
- [16] “Create test MPI cluster using VirtualBox images.” <http://www.zamaudio.com/?p=837>.
- [17] “Launching an Amazon EC2 MPI Cluster.” <http://mpitutorial.com/tutorials/launching-an-amazon-ec2-mpi-cluster/>.
- [18] “Using MPICH in Amazon EC2.” https://wiki.mpich.org/mpich/index.php/Using_MPICH_in_Amazon_EC2.
- [19] “MPI on EC2.” <https://www.youtube.com/watch?v=049CVTGH01k>.