Parallel Becnhmarking Practice

1. Aim of the Practice

The main aim of this practice is to learn how to execute a parallel benchmark (application) written in both most extended used parallel languages, MPI and OpenMP in the *moore.udl.cat* cluster. In addition, you will learn to use the main commands of the SGE system queue management to submit, monitor and delete parallel jobs [4].

According to this, you can use any one of the NAS parallel benchmark suite (NPB3.3.1) (https://www.nas.nasa.gov/publications/npb.html) excluding the EP benchmark that we have studied in class. Although this suite is composed by 12 benchmarks with different characteristics each one, not all of them are implemented in the three versions: serial, OpenMP and MPI. So, previously to choose benchmarks, ensure that chosen benchmarks are implemented into the three versions.

You must install, execute and analyze the chosen benchmarks following the rules given in [5]. All executions will be carried out in the cluster "moore.udl.cat ", which is the educational cluster of the Polytechnic School.

2. Contents of the work:

I.- Analysis of the chosen benchmark: Main characteristics of the two benchmarks. Their characteristics can be obtained from [1], [2] and [3] reports listed in the Bibliography. You should highlight what they do, his communication and memory pattern.

II.- Description of the machine to compare: Main characteristics of the evaluated machine (http://moore.udl.cat/wordpress/) and [4] According to its characteristics, you must justify which kind of architecture is the Moore cluster (Shared memory, Distributed memory or Hybrid).

III. Serial, OpenMP and MPI Results: You must fill out the following Tables for each benchmark. From these results, you must calculate and plot the Speedup and Efficiency metrics in relation to the class of the benchmark (A, B, C) and the number of threads/tasks. Note that it is possible that when you execute any specific benchmark, it is not possible to obtain all executions due to lack of computational resources. In those cases, you should do an estimation and explain how you have done this estimation. Likewise, there are some benchmarks that the number of tasks must be square numbers (eg: 1, 4, 9, 16, …. In these cases, the below Table should be changed accordingly.

	BENCHMARK EXECUTION TIME (s)								
	SERIAL	OPENMP (THREADS)			MPI (TASKS)				
Class		2	4	8	2	4	8	16	32
A									
B									
C									

IV.-Analysis of benchmarking results in relation to main characteristics of the benchmarks. In this section, you must explain the obtained results according to the benchmark's characteristics and the *Moore* cluster. You must answer at least to the following questions: Why the SpeedUp is different in relation to different benchmarks? Is Efficiency equal for any benchmark? How is the benchmark's scalability? Why scalability is so different for both programming models (OpenMP and MPI)?

V.-Bibliography

[1] NAS parallel benchmarks. **https://www.nas.nasa.gov/software/npb.html**

[2] Bailey, D. H.; Barszcz, E.; Barton, J. T.; Browning, D. S.; Carter, R. L.; Dagum, L.; Fatoohi, R. A.; Frederickson, P. O.; Lasinski, T. A.; Schreiber, R. S.; Simon, H. D.; Venkatakrishnam, V.; and Weeratunga, S. K.: The NAS Parallel Benchmarks, International Journal of Supercomputer Applications, Vol. 5, No. 3, (Fall 1991), pp. 63-73.

[3] F. C. Wong, R. P. Martin, R. H. Arpaci-Dusseau and D. E. Culler, "Architectural Requirements and Scalability of the NAS Parallel Benchmarks," *SC '99: Proceedings of the 1999 ACM/IEEE Conference on Supercomputing*, Portland, OR, USA, 1999, pp. 41-41, doi: 10.1145/331532.331573.

[4] Access & Execution in a real HPC Infraestructure. https://cv.udl.cat/access/content/group/103084-2425/Chapter%202-Parallel%20Processing%20and%20Benchmarking/SGE_System/CH43SGEAccessExecution_v2.pdf

[5] Tutorial to install and execute NPB.

https://cv.udl.cat/access/content/group/103084-2425/Chapter%202-Parallel%20Processing%20and%20Benchmarking/NAS%20PARALLEL%20BENCHMARKS/Tutorial%20to%20Install%20NPB3.3.1.pdf

3.- Maximum Length of the work: 4 pages. Note that the most extended section should be III and IV section.

4.- Work In pairs. The work can be done individually or by groups of two students.

5.- Submission Deadline: 16th of March of 2025.