High Performance Computing Final Assignment

Hiroyuki Takizawa (Nov 27, 2024)

Submission at Google Classroom (both the report and all programs you write)

Deadline: Dec 6, 2024 (JST)

1. Write an MPI program that makes a round trip of data between 2 nodes, draw a chart to show the relationship between the data size and communication time, and calculate the latency and bandwidth.
2. Download the N-body simulation program (n-body.c), and answer the following questions.
   I. Insert OpenMP directives properly into the program for work-sharing of loops, and calculate the parallelization ratio at the multi-thread level based on the measurement by changing the number of threads. It is better to refactor the program to reduce the parallelization overhead if possible.
   II. Modify the OpenMP version of the code above to use MPI functions properly for multi-node parallel processing, and calculate the parallelization ratio of strong scaling at the multi-node level based on the measurement by changing the numbers of threads and processes. You may change the problem size for discussions.
   III. Do necessary experiments and explain what is Amdahl's effect (not Amdahl's law), based on the experimental data and Karp-Flatt metric.
3. Describe the research theme of your graduate study in 1 to 2 paragraphs. Then, if a supercomputer with much higher performance than ever is available, discuss how the supercomputer can contribute to the study.
4. How was this class? Write your comments on this class.

高性能計算論最終レポート

滝沢寛之 (2024/11/27)

提出先： Google Classroom (作成したレポートと C プログラムの両方提出)

提出期限：2024 年 12 月 6 日 (日本標準時)

(正式版は英語ですが、参考資料として日本語版も以下に示します)

1. 2 つのノード間でデータを 1 往復させる MPI プログラムを作成し、データサイズと通信時間との関係をグラフ化し、通信遅延(latency)とバンド幅(bandwidth)を算出してください。

2. N 体問題のプログラム(n-body.c)をダウンロードして、以下の問題に回答してください。
   I. 最も時間がかかるループを特定し、OpenMP 指示文を挿入してそのループをワークシェアリングに基づいて並列化し、スレッド数を変えながら実行時間を計測して並列化率を算出してください。可能であれば、並列化オーバヘッドを削減するようにプログラムを修正してください。
   II. OpenMP 並列化したプログラムをさらに MPI を用いて並列化し、スレッド数とプロセス数だけ変えながら実行時間を計測して強スケーリングの並列化率を算出してください。考察のために問題サイズを変更してもかまいません。
   III. アムダール効果(Amdahl's effect)とは何か(アムダールの法則(Amdahl's law)ではなく)、必要な実験を行ったうえでその実測結果や Karp-Flatt Metric と結び付けて説明してください。

3. 自分の大学院での研究テーマを 1～2 段落で説明してください。また、これまで以上に高性能なスーパーコンピュータが利用できるとしたら、その研究にどのように活かせるのか考察してください。

4. この講義の感想について自由に記述してください。

In the final report, just putting the programs and/or execution results is not enough. You are requested to provide all the results with the compilation and execution conditions such as job scripts, the compiler and compiler option flags used at the compilation. That's impossible that all of them are identical among students. Of course, report plagiarism is very strictly inhibited.
You would need to run many jobs, and the system could be busy as the deadline approaches. It’s recommended to start working on the assignment as early as possible.
For n-body simulation, you can refer to the following site.

https://rosettacode.org/wiki/N-body_problem

You can use a different programming language for the implementation. In such a case, you must first write your own serial version by figuring out the difference between n-body.c and its original version found on the web page above.
If you have any questions about the final report, you must post it onto the Google Classroom page, not email nor direct message. This is because the answer must be seen also for other students for fairness. Also, you are not allowed to submit the report after the deadline for fairness. It’s strongly recommended to submit the report before the deadline even if you can't finish all items. In the final report, some questions require advanced knowledge and programming efforts.

You can write any comments for Problem 4. Frank comments do not have negative impacts on your score. If you don’t write any comments, the answer for Problem 4 is missing, which could be a reason for decreasing your score.