A4 (GEP=3)

Parallel computing for science data analysis

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GPPU Experimental Point (GEP): 3

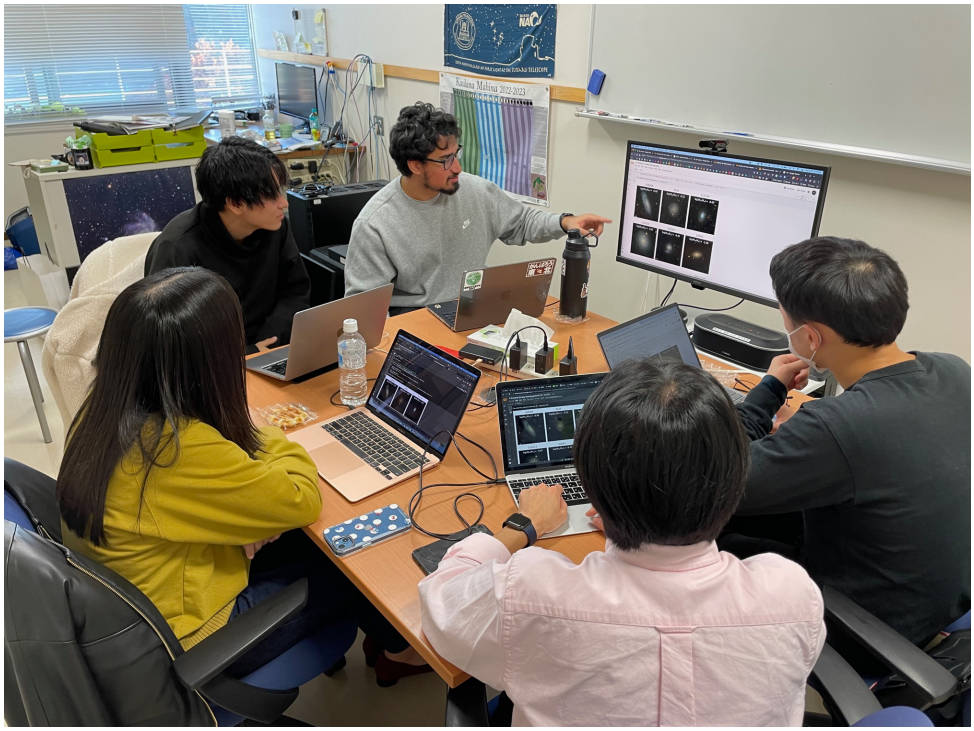
Goal of Study

(1) understand the merit of introducing parallel computing in data reduction.
(2) understand the method to implement the parallel computing using GPGPU/CUDA and multi-core CPU/OpenMP.
(3) master the method to use the parallel computing in imaging data reduction.
(4) master the method to use the parallel computing in solving inverse problems.

Contents

With the spread of CPUs with multi cores and GPUs with many cores, parallel computing has become a popular means of speeding up scientific calculations. With the development of the fast and many elements measurement systems, amount of data necessary to be reduced exponentially growing for various scientific experiments. The increase of the amount of data also enlarge the size of the problem needs to be solved. Furthermore, more complicated calculations are applied to the massive data to reflect the details of the real experiments. In order to reduce such large amount of raw data and apply more sophisticated analysis in a realistic time scale, parallel computing has been a cost effective choice.

In this lecture, the background of the parallel computing is introduced, then the parallel computing methods with multi core CPUs and GPGPUs are discussed. For the parallel computing with multi-core CPU and GPGPU, coding with OpenMP and CUDA environments are explained, respectively. After testing the programming environment, two topics are discussed as the application of the parallel computing: 1) analyzing image data, and 2) solving inverse problem with large number of dataset. In the final part, hands-on session for deep learning application to handle large amount of image data will be made.



Textbook and References

[1] General background reading for the inverse problems: “Discrete Inverse Problems – Insight and Algorithms”, Per Christian Hansen

Progress Schedule

- ✧ Day 1
  - Introduction to parallel computing (Lecture)
  - Parallel computing using multi-core CPUs (Lecture)
  - Parallel computing using GPGPUs (Lecture)
  - Setup necessary environment for the parallel computing (Experiment)
  - Simple example to check the programming and testing environment (Experiment)
- ✧ Day 2
  - Parallel computing for imaging data analysis (Experiment)
  - Parallel computing for solving the inverse problems (Experiment)
  - Parallel computing for deep learning on image data (Experiment)

Other Details

Course Period	2024 Summer
Place	Seminar room (Science Complex C, N502)
Number of Students	<5
Evaluation method	The evaluation will be made based on the participation to the lecture (30%) and quality of the final report made by each participant (70%)

In Addition

Each participant is requested to make his/her own analysis codes and a report.