Parallel Programming

National Tsing Hua University

2025, Fall Semester

Instructor & TA Information

- Instructor: 周志遠教授 (Jerry)
  - Email: jchou@lsalab.cs.nthu.edu.tw
  - Office/phone: 台達602 / 42801
  - Office hour: email for appointment

- TA: Lab & HW
  - Email: pp@lsalab.cs.nthu.edu.tw
  - Office/phone: 資電836 / 33538
  - Office hour: email for appointment

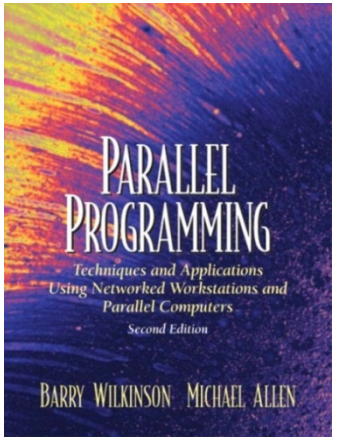
Send all your individual questions to here!!!
Any other contact emails will NOT be replied.

Course Website (EECLASS)

- Website: https://eeclass.nthu.edu.tw/course/27713
  - Announcement
  - Materials (lecture/project slides)
  - Discussion forums

Course Material

- Textbook:
  - "Parallel Programming– Techniques and applications Using Networked Workstations and Parallel Computers", 2nd Edition. Barry Wilkinson and Michael Allen, Prentice Hall.



- Reference:
  - "Parallel Programming in C with MPI and OpenMP". Michael J. Quinn, McGraw Hill.
  - LLNL High-Performance Computing Training https://computing.llnl.gov/?set=training&page=index
  - **Nvidia Tutorial Slides**
  - **Google It!!!!**

Course Contents

- **Part I: Parallel Programming**
  - Intro. to Parallel Computing
  - MPI Programming
  - Pthread Programming
  - OpenMP Programming
- **Part II: Computation Model**
  - Embarrassingly Parallel
  - Divide-and-Conquer Pipelined Computations
  - Synchronous Computations
- **Part III: GPU Programming**
  - Heterogeneous Computing
  - CUDA Programming
  - GPU Architecture & Multi-GPU
  - Optimization
- **Part IV: Advanced Topics**
  - Distributed Training & Inference
  - AI Optimization
  - UCX Communication

Course Expectations

"Parallel/Multi-thread Programming is Essential Programming Skill in Today's World"

- Lecture & textbook
  - Fundamental knowledge, algorithm and theory
- Homework & Project
  - Coding
  - Performance optimization
- Report & Presentation
  - Performance Analysis
  - Writing & Presenting

Grading Information

- Programming homework (78%)---**Individual**
  - 5 Assignments
    - Parallel Odd-Even Transposition Sort (MPI) Due 10/5: 20%
    - Mandelbort Set (MPI & OpenMP) Due 11/2: 20%
    - All-Pairs Shortest Path (GPU) Due 12/7: 20%
    - FlashAttention Implementation (GPU) Due 12/7: 8%
    - Network Benchmark (Ibverbs & UCX) Due 12/21: 10%
  - Grading Items:
    - Code correctness
    - Report (Performance analysis & evaluations)
    - **Code Performance**
  - **Late submission is NOT accepted!**
    - No exception

Grading Information

- Labs (7%) ---Individual
  - Chances to boost & practice your skills
    - 9/11 Lab1: MPI & Slurm Scheduler & IPM Profiler
    - 10/2 Lab2: Pthread & Instruction Vectorization
    - 10/23 Lab3: Basic GPU Programming – CUDA, openACC, HIP
    - 10/30 Lab4: Advanced GPU Programming – Multi-GPU
    - 11/3 Lab5:AMD GPU – Hip&Rocm
    - 11/17 Lab6: Deepspeed & Flash attention
    - 12/1 Lab7: UCX
  - Scheduled on Thr. 7-9pm in the classroom
    - Lecture will be recorded and available
    - Attendance is not mandatory, but highly recommended
    - Simple homework assignments will be given after the lab

Grading Information

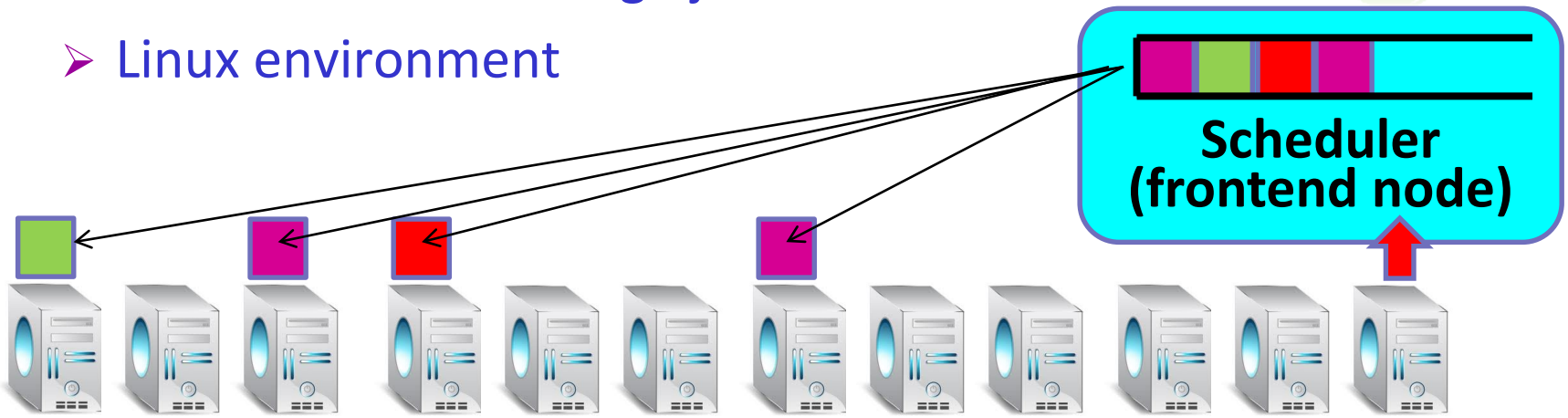
- Final Project(15%) ---Team of 3 persons
  - Select a topic on your own
  - Implement a solution & show how parallel programming is useful
  - 10min. presentation will be scheduled on the final week of 12/15
  - Demo will be scheduled after the presentation

Clarification of Plagiarism

- Homework assignments are individual
  - You may discuss with each other
  - But **NEVER SHOW YOUR CODE** to others & you must write your code by yourself
  - If the codes are similar to other people and you can't questions properly during demo, you will be identified as plagiarism
- 0 points will be given to Plagiarism

Coding Environment

- Separate clusters for CPU and GPU workload
  - Be aware which one is for the homework
  - Batch scheduler though job submission
  - Linux environment



*Don’t wait until the **LAST** day, or you may suffer from **LONG** queuing delay

Recorded Lecture

- Only recommended for review and reference

2021 in Chinese

2022 in English

Extra Enrollment

- Fill in the form before Today 9/1 23:59
  - Decision will be made before **Wednesday night**
  - Submit your e-form sign-up request on 校資系統 after receiving the approval confirmation letter.
  - If you request is rejected, still welcome to attend our lecture.