# MPI Overlapping using Threads Operation / Reinforcement Learning in Job Scheduler

Performance Evaluation of the MPI overlapping method using threads operation
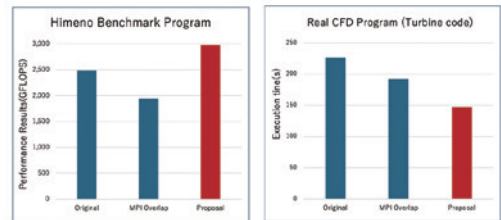
Overview

・Our study focus the calculation of pressure (Poisson equation) at the Computational Fluid Dynamics.
・The communication cost of boundary elements transfer processing for difference calculations of the Poisson equation is increasing.
・Our proposal is overlapping of calculation and communication operations method using threads operation.
・The master thread is in charge communication and calculation operations, and other threads are in charge only calculation operations.
・User assigns calculation quantity each threads. (Not use the schedule function of OpenMP)
・As a result, execution time of simulation is not affected by the overhead at operations of OpenMP.
・We planning to provide the tool that is deciding start and end points of loop for each threads. (Our Web page)

Proposal Method (MPI Overlap using threads operation)


Calculation flow of the Poisson equation

Provide the tool that decides start and end points.
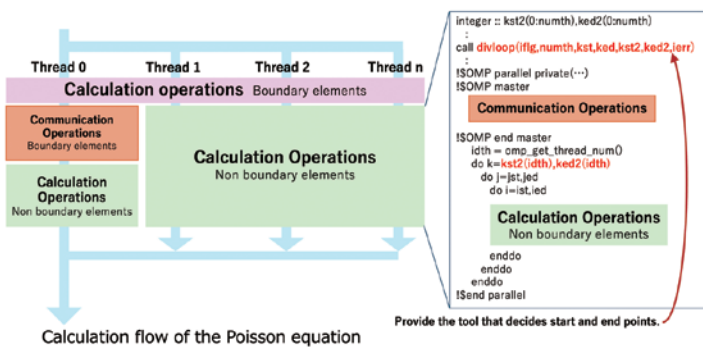
Evaluation Resalts

● Evaluation System : SX-Aurora TSUBASA Type20A

▶ Himeno Benchmark Program : XL size (1024x1024x512), Single Precision
(https://i.riken.jp/en/supercom/documents/himenobmt/)
▶ Real CFD Program : Grid size 3101x211x161, Double Precision

Self-Learning Job Scheduler for Cloud Bursting

Overview

Our study focuses optimizing job scheduling for cloud bursting, with the aim of minimizing both cloud cost and job waiting time.
・ Cloud bursting expands computing capacity of HPC systems by offloading jobs to cloud resources. However, since HPC systems at academic institutions offer affordable usage fees, charging users for additional cloud services is often impractical.
  Therefore, we need to carefully choose which jobs to offload.
・ We are working on designing a machine learning model and have developed a prototype integrating it with a job scheduler.

cloud bursting
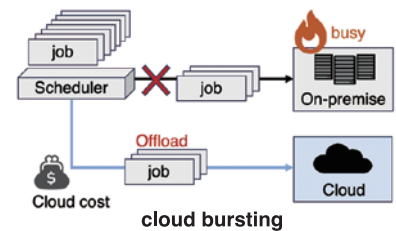
Architecture for Training

・ Slurm plugin provides state of job queue and on-premise and cloud resources to RL when scheduling a job
・ RL returns action that shows the scheduler should assign on-premise or cloud resources to the job.
・ Slurm schedules the job based on the action.
・ Slurm plugin provides reward to RL for evaluating the action based on a waiting time and a cloud cost.
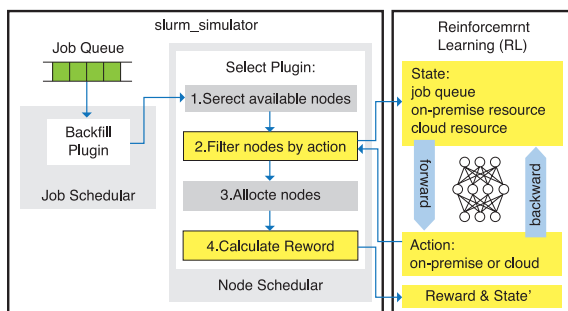
Algorithm > Training Flow

・Jobs are allocated based on job queue and each resource usage.
・ Evaluate allocation by comparing actual results with alternatives, calculating additional cloud cost and waiting time reduction.
・ Obtain a reward from cost-performance analysis and update the model to optimize subsequent decisions.