Introduction to High Performance Computing (IN4049)

Lab exercises directed by Jianbin Fang
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1 Introduction

MPI is undoubtedly the most popular programming model for distributed platforms such as clusters and supercomputers. The lab exercises will be done on the DAS-3 computer. The emphasis will be on designing efficient parallel algorithms and on the necessary optimization of the performance. To pass the lab (50% of this course), you need to code and optimize `a lot`, and finalize a report.

1.1 Option I

We have 5 separate exercises [1] to give you a start-up in MPI programming and then optimize the code in a step-by-step manner.

- ◇ Introduction to MPI (I-required): This exercise will guide you into the MPI world from the scratch. If you are a newbie in MPI, you should not skip it.
- ◇ Poisson solver (II-required): This exercise will teach you program an fairly complex application-Poisson kernel and let you know MPI mechanisms. Thereafter, you are supposed to experiment your parallelized code on DAS3.
- ◇ Finite elements simulation (III-optional):
- ◇ N-body simulation (IV-optional):
- ◇ Matrix Multiplication (V-required): A sequential version of MatMul is given and you need to maximize its performance on four nodes of DAS3.

1.2 Option II

For those highly motivated students, you can focus on Matrix Multiplication only and port it onto Xeon-Phi based clusters on DAS4. For now, I have only one account. Thus, you need to first write and optimize your code on DAS3.

[1] The exercise specifications and the initial code is available here:
`http://www.pds.ewi.tudelft.nl/teaching/courses/in4049/lab/`

2 How to Use the Experimental Platform

- We use DAS3 as our experimental platform. Server Name: fs3.das3.tudelft.nl. For more details about DAS3, please refer to http://www.cs.vu.nl/das3/.
- Use SSH to connect to this server with the provided username and password: *ssh username@fs3.das3.tudelft.nl*
  Note that you can change your password on fs0 of DAS3: *ssh username@fs0.das3.cs.vu.nl*. But it takes around an hour to make your new password work.
- Use the modules prun, default-ethernet, and mpich as follows:
  module load prun
  module load default-ethernet
  module load mpich
  Note that if you do not want to input these command lines each time you log onto the server, please append these lines to your local .bashrc file.
- Use `vi` or `vim` or `pico` for editing: *vi filename.c* or *vim filename.c*.
- Compilation
  mpicc -o filename1 filename1.c
  Note that the source code is in filename1.c, and the result (The executable file) will be in filename1 (indicated by the -o option, 'o' for 'output')
- Run the program
  prun -pbs-script /usr/local/sitedep/reserve.sge/sge-script `pwd`/program x
  program: the name of the program;
  x: the required number of processors;
  `pwd`: the current working directory;
- Follow Steps into the MPI World! in Exercise I.

3 Requirements

- The course work is in the form of `a final report` containing all your answers to all the questions in the exercises.
- Any `figures`, `analysis`, and `tools`, making your answers be intuitive, will be beneficial for your overall grades.
- You are allowed to form groups of **at most** 2 to make the work `easier`.
- Reports should have the following on the front cover: your name(s), student number(s), email address(s), and submission date.
- Please `email` your assignments (including your source code of each step and the final reports) to me; also `print` your reports (no tedious source code) and put it in my mail box labelled as 'Fang J.' (on the 7th floor, EWI HB).
- Submission `Deadline`: one month after the course (February 9th 2014).

4 Assistance

I will be in the lab one hour a week (14:00–15:00 on Friday) to provide live supports. When I am not in the lab or when you have any questions/suggestions about the lab course, you can easily contact me on my email address: j.fang@tudelft.nl or you may drop by my office 07.280 in EWI building.

5 Useful Links

- The exercises and initial source code can be found @ http://www.pds.ewi.tudelft.nl/teaching/courses/in4049/lab/.
- You can also download the electronic instructions copy @ http://www.pds.ewi.tudelft.nl/fang/teaching/

6 FAQ

- Permission Denied
  cd .ssh
  cat id_rsa.pub >> authorized_keys
- to be continued...

7 Grading Rules

I will follow the rules to grade your assignments.

- The base grade starts with 6.0 for (1) the in-time submissions, and (2) satisfying answers of Exercise I and II.
- Multiple 0.5s will be added to your total grades (until 10.0), according to the shining points (e.g., reasonable analysis, nice figures).
- The one obtaining the highest performance of Matrix Multiplication (in GFlops) will earn the 10 points.