Introduction to Programming Laboratory

Lab4 - openmp

2017/7/11

Outline

- Compile and execute openmp program on the platform
- Count prime number with openmp
- Calculate π using MPI + openmp
- Xwindow

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Lab4-1 Compile and run openmp program

Login to server and copy lab4 directory to your home directory

- cp -r /home/ipl2017/shared/lab4 . && cd lab4

[Compile]

```
gcc HelloWorld_omp.c -o HelloWorld_omp –fopenmp
```

[Edit job script]

```
#PBS -l nodes=1:ppn=3
#./HelloWorld_omp 3
```

→ 3 is the number of threads you want

[Run]

```
qsub job.sh
```

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Lab4-2 Count prime number with openmp

prime.c is a sequential program that counts number of prime number in a range.

[Compile]

```
gcc prime.c -o prime -lm
```

[Edit job script]

```
#PBS -l nodes=1:ppn=1
#./prime
```

[Run]

```
qsub job.sh
```

Lab4-2 Count prime number with openmp

1. Modify the sequential prime.c with openmp. Make sure you can get the same result as sequential program.

Think carefully about the data, some may need to be put in private().

2. Measure the time using dynamic, static, different chunk size and different thread number to find the best setting.

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Hybrid program

HelloWorld_hybrid.c is a hybrid version of hello world.

[Compile]

```
mpicc HelloWorld_hybrid.c -o HelloWorld_hybrid -fopenmp
```

[Edit job script] vim **job.sh**:

```
#PBS -q debug
#PBS -l nodes=1:ppn=2
mpirun ./HelloWorld_hybrid 6
```

number of threads

[Run]

```
qsub job.sh
```

NOTE: ppn*number of threads must <= 12, because we only have 12 cores per node

Lab4-3 Calculate the value of π using openmp + MPI (Hybrid)

Each process will be assigned part of the points, and threads in process will do the computing.

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Introduction

The X Window System is a windowing system for bitmap displays, common on UNIX-like computer operating systems.

It provides the basic framework for a GUI environment.

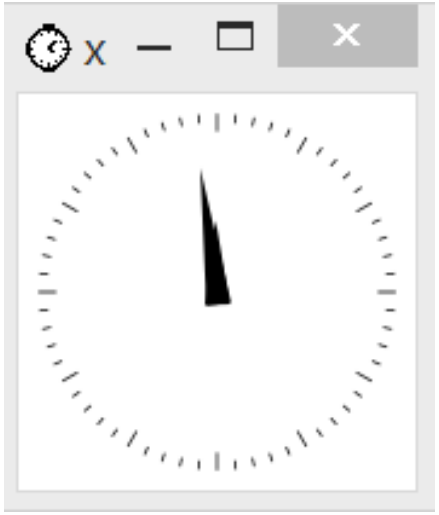
How to use?

- **For mac user**
  - Add -Y after ssh command
  - Example: ssh 100062101@140.114.91.170 **-Y**
  - You may need to install **Xquartz** : https://support.apple.com/zh-tw/HT201341
- **For MobaXterm user**
  - It enables X11 forwarding at default, you don’t have to do anything.

How to use

After you log in to server, type “xclock” at apollo31.

You should see below graph:



Xlib

Xlib is an X Window System protocol client library written in the C programming language.

It contains functions for interacting with an X server.

These functions allow programmers to write programs without knowing the details of the protocol.

Xlib – Basic Datatype

Display – specify the connection to the X server

Window – specify the window

GC – graphic context

Xlib – Basic API

XOpenDisplay – connect to X server

XCreateSimpleWindow – create simple windows

XMapWindow – map windows

XCreateGC – create graphics contexts

XSetBackground – set the background color

XFlush – output buffer or event queue

XDrawString – draw text characters

XDrawPoint – draw points

XFillRectangle – fill rectangles

XFillArc – fill arcs

Mandelbrot Set

Copy hw2 directory under /home/ipl2017/shared to your directory.

You can see how we use these API to draw in the MS_draw.c code we provided.

There are some comments in the code to let you better understand the meaning of each part.

Mandelbrot Set

1. Compile MS_seq.c
2. ./MS_seq 4 -2 2 -2 2 200 200 output_file
3. ./MS_draw output_file

If you want to compile xwindow code:

[Compile]

```
gcc MS_draw.c -o MS_draw –lX11
```

Result

You should be able to see the graph below after the steps.

Lab4-4 Draw using Xwindow

Try to draw line, circle,…by yourself!

Reference

https://www.student.cs.uwaterloo.ca/~cs349/f15/resources/X/xTutorialPart1.html

http://www.halverscience.net/c_programming/c_graphics_xwindows/c_graphics_xwindows.html