Parallel Programming HW2

Single Roller Coaster Car Problem and N-body Problem

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Due: 2014/11/16

Outline

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1. Simulate Single Roller Coaster Car Problem and prevent synchronization by using conditional variable or mutex lock.
2. Parallel N-body's sequential code by using Pthread and OpenMP.
3. Implement Barnes-Hut Algorithm by Pthread.
   - Parallel building tree phase
   - Parallel simulation phase
4. Compare the performance of those N-body versions and sequential code.

Outline

Problem Description

Suppose there are n passengers and one roller coaster car. The passengers repeatedly wait to take rides in the car, which holds C passengers. However, the car can go around the track only when it is full. The car takes the same number of seconds (T) to go around the track each time it fills up. After getting a ride, each passenger wanders around the amusement park for a random amount of time before returning to the roller coaster for another ride.

Problem Description

Write a program using Pthread to simulate this problem. The program should ask for n, C, T and N, then generate n passenger threads and one roller coaster car thread. The program should exit after roller coaster car going around N times.

In the passenger threads, you need to simulate as described below.

1. Passenger wanders around the amusement park for a random amount of time.(use sleep() function to wait for a random time)
2. Then, the passenger will return for another ride.
3. Repeat step 1 and 2 until program exit.

In the roller coaster car, you need to simulate as described below.

1. Repeat to check if there are C passengers in the queue.
2. When there are C passengers in the queue, the car will take T seconds to go around.(use sleep() function too, but wait for T seconds)
3. Then release passengers.
4. Repeat step 1, 2 and 3 N times and exit the program.

Input

./a.out n C T N

- a.out: your execution file
- n: number of passengers ($2 \leq n \leq 10$)
- C: capacity of car
- T: time for car going around the track, represent T millisecond, is a integer.
- N: number of simulation step

Output

- In the passenger threads,
  1. When passenger is going to wander around the amusement park, you should print something like "3rd passenger wander around the par".
  2. When passenger returns for another ride, you should print "3rd passenger return for a ride".
- In the roller coaster car,
  1. When car is going to departure, you should print "car departure at 15 sec. 3rd, 5th and 6th passengers are in the car".
  2. When car arrives, you should print "car arrives at 45 sec. 3rd, 5th and 6th passengers get off".

Outline

Problem Description

Given N celestial bodies with the same mass m. Each body has its initial position (x, y) and velocity (v_x, v_y). Simulate their movement T times by using t seconds between each step.

Input and Output

./a.out *#threads m T t FILE θ enable/disable* x_{min} y_{min} *length Length*

- a.out: your execution file
- *#threads*: number of threads
- *m*: mass, is a float number
- *T*: number of steps
- *t*: time between each step, is a float number
- *FILE*: input file name
- θ: use in Barnes-Hut Algorithm

- *enable*/*disable*: enable or disable Xwindow
- x_{min}, y_{min}: the lower left coordinate of Xwindow
- *length*: the length of the coordinate axis
- *Length*: the Length of Xwindow's side
  Length will be 10^n times of *length*.

If configuration of Xwindow is "enable", show celestial bodies on Xwindow at each step.

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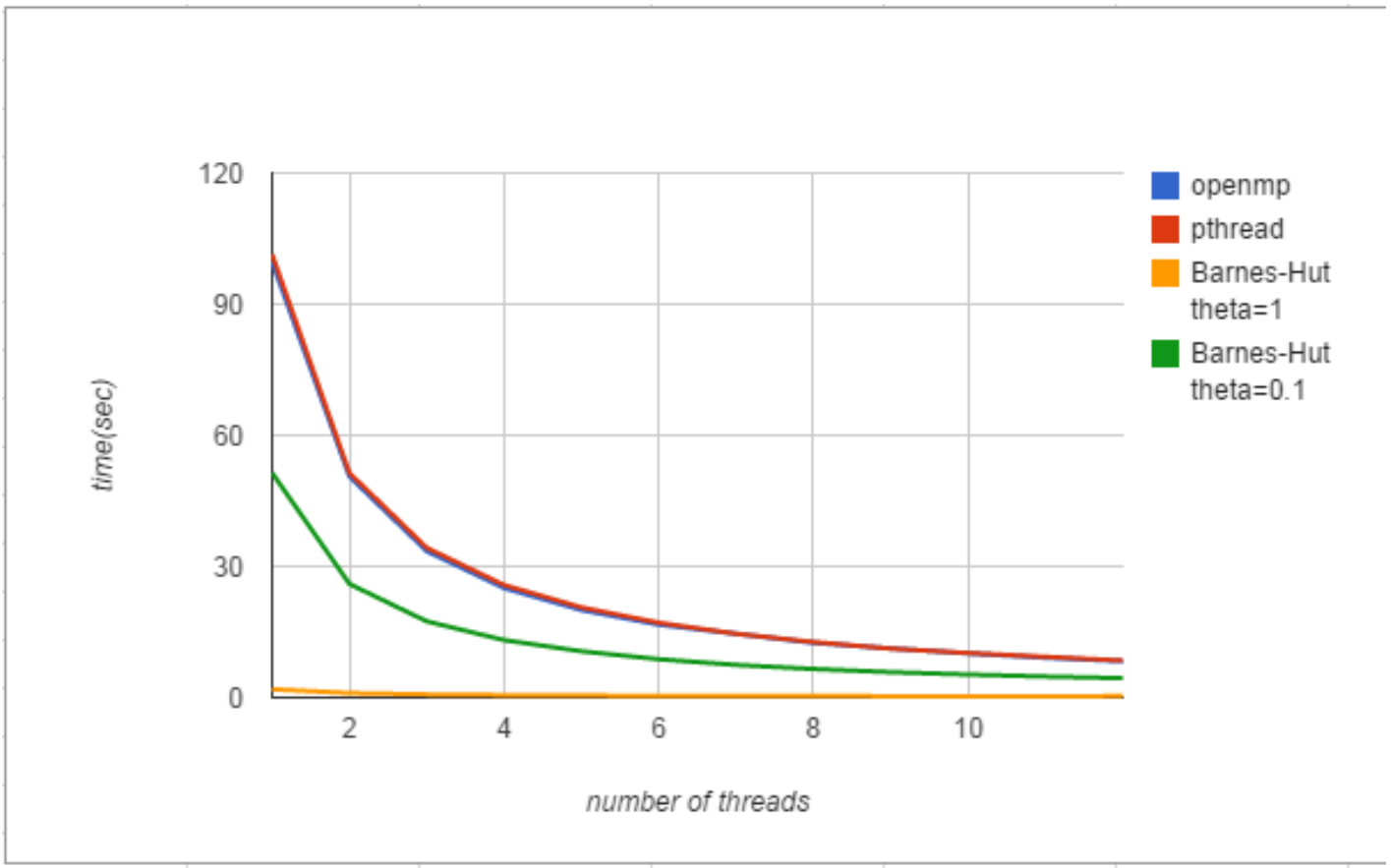
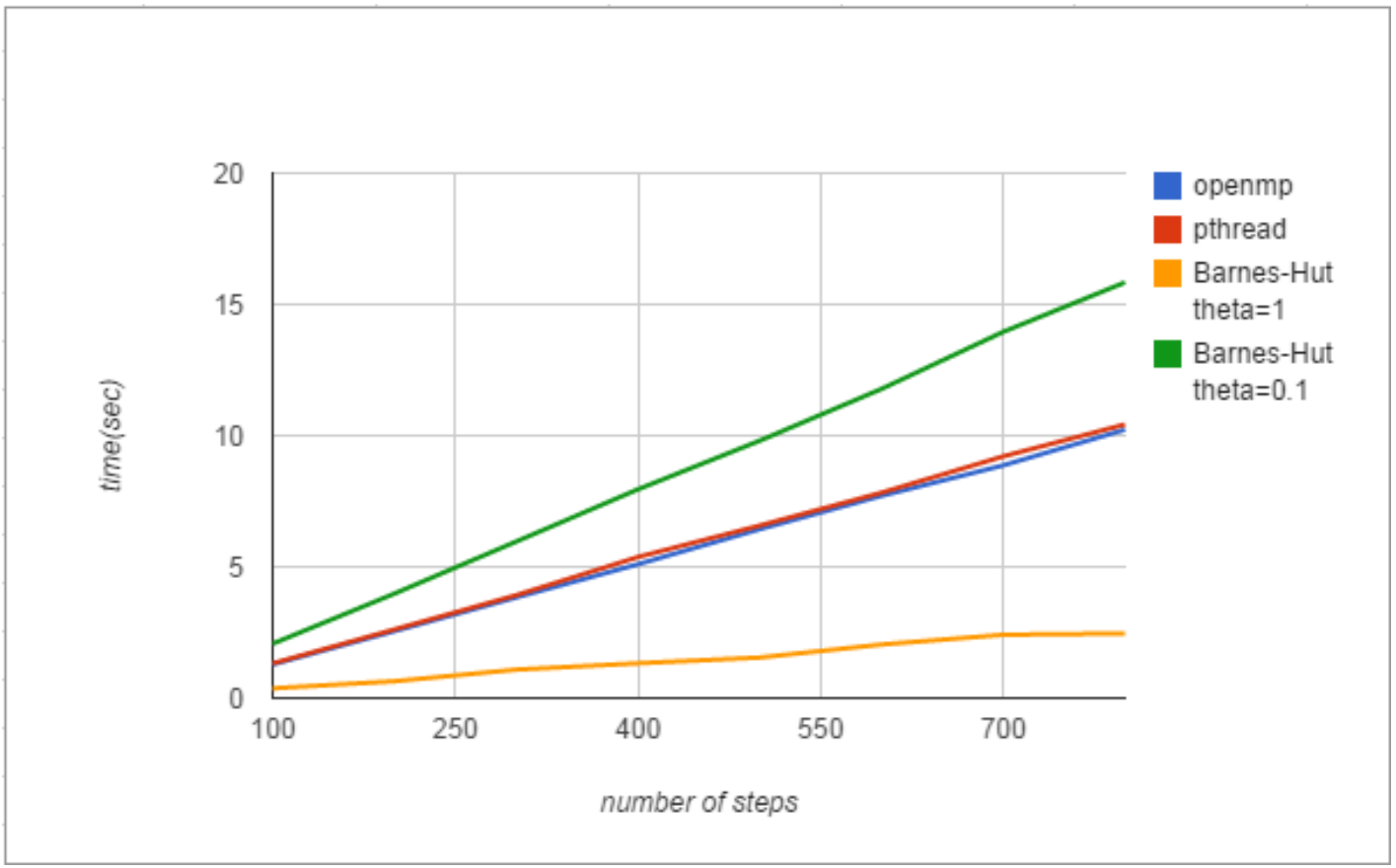
Your grade will be judged by correctness, report and demonstration as described in below:

1. Correctness (50%) During the demo time, TAs will test your program with some testcases to check whether your output is correct.
   - Single Roller Coaster Car Problem(10%)
   - N-body Problem OpenMP version(10%)
   - N-body Problem Pthread version(10%)
   - N-body Problem Barnes-Hut Algorithm version(20%)
2. Report (30%)
3. Demo (20%)

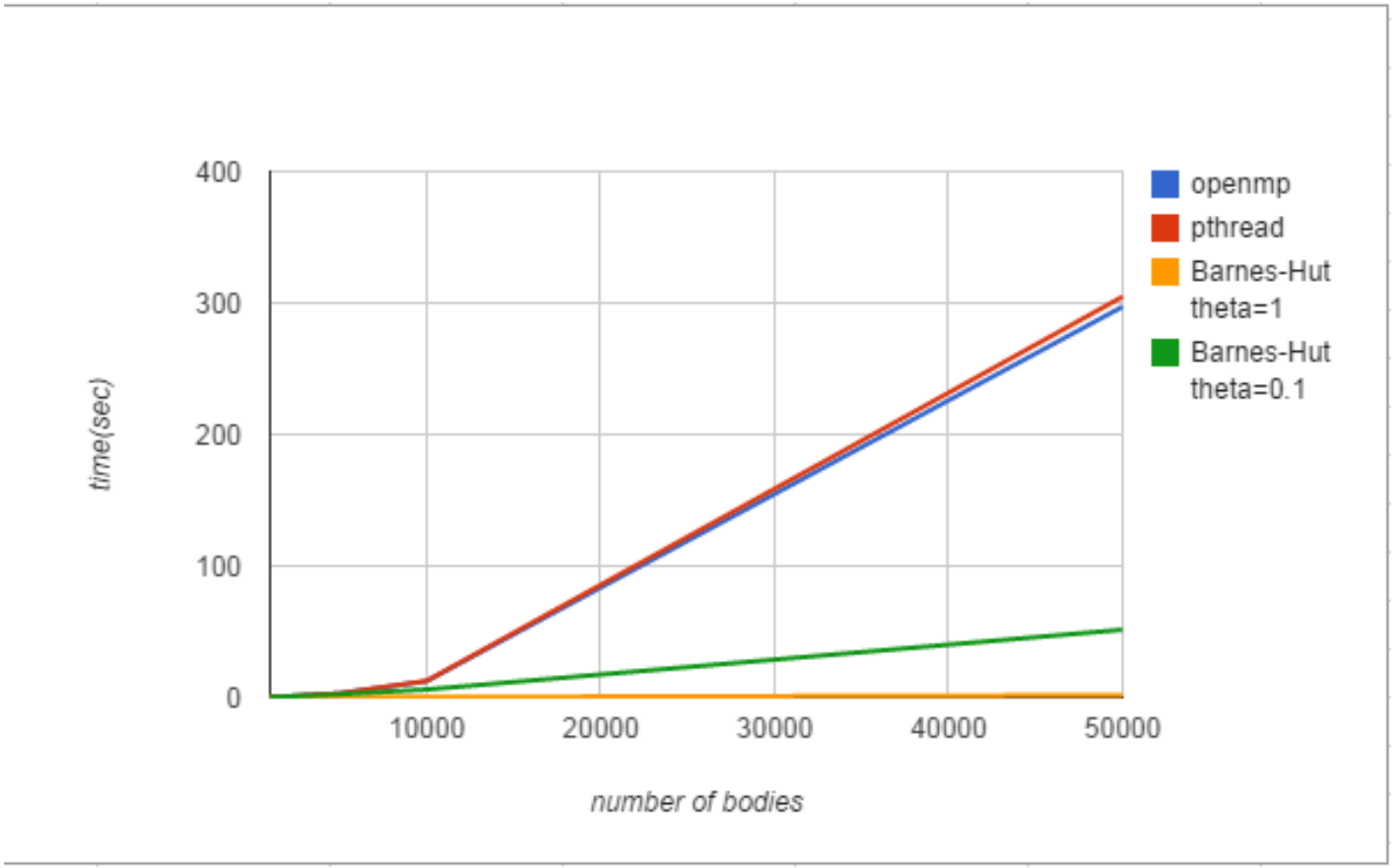
Report


120
90
60
30
0
time(sec)
2
4
6
8
10
number of threads
openmp
pthread
Barnes-Hut theta=1
Barnes-Hut theta=0.1

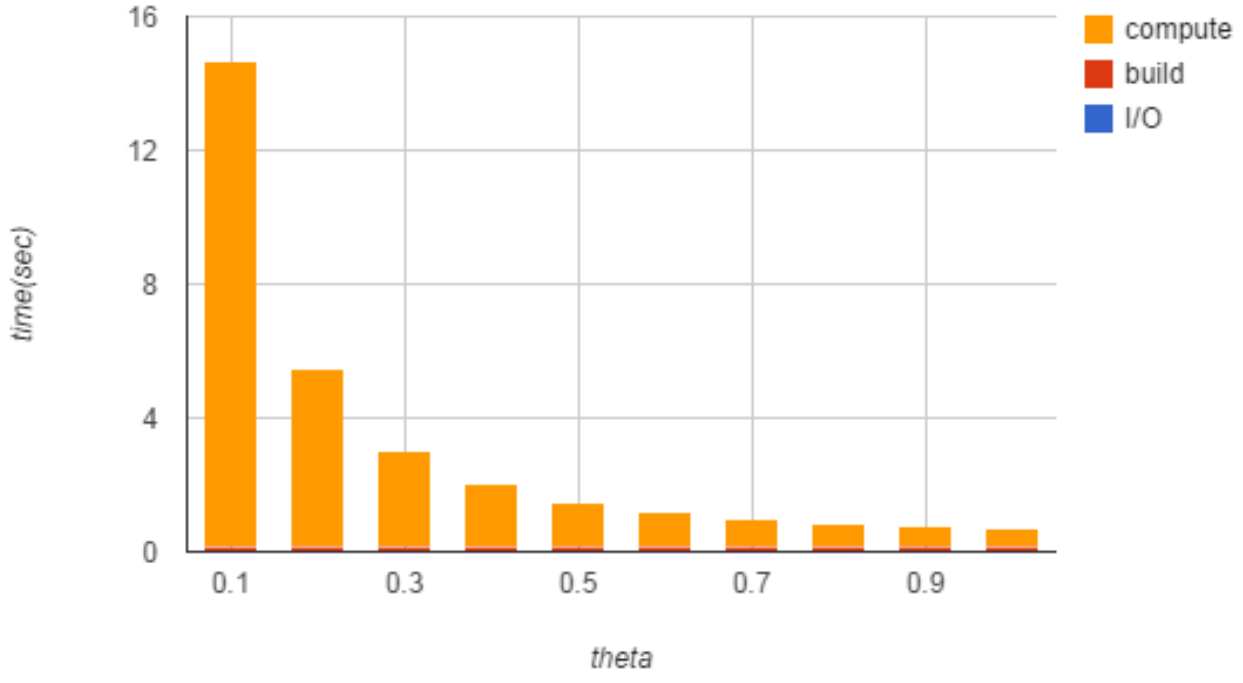
Report


20
15
10
5
0
time(sec)
100
250
400
550
700
number of steps
openmp
pthread
Barnes-Hut
theta=1
Barnes-Hut
theta=0.1

Report


400
300
200
100
0
time(sec)
10000
20000
30000
40000
50000
number of bodies
openmp
pthread
Barnes-Hut theta=1
Barnes-Hut theta=0.1

Report



Outline

1. Late submission penalty policy please refer to syllabus.
2. Please compress all of your codes and report in the file named **${ID}_${name}_HW2.zip** and upload to iLMS before **11/16(Sun.) 23:59 pm**.
3. Name your codes clearly. For example:
   - Single Roller Coaster Car Problem: hw2-SRCC.cpp
   - N-body Problem OpenMP version: hw2-NB-openmp.cpp
   - N-body Problem Pthread version: hw2-NB-pthread.cpp
   - N-body Problem Barnes-Hut Algorithm version: hw2-NB-BHalgo.cpp
4. Because we have limited machines for you guys for tuning. Please start your work ASAP and do not leave it until the last day!

How to complie Pthread(-pthread), OpenMP(-fopenmp) and Xwindow(-lX11)?

- g++ -pthread -lX11 sample.cpp (gcc for XXX.c)
- g++ -fopenmp -lX11 sample.cpp
- execute like ordinary c/c++ programs