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Parallel Computing

Thursday, Nov. 22, KIAA, 7:00 - 8:30 p.m.

Solution for NBODY6++ Tasks:

Here are my time measurements
(taken from output files nbody6.err....):

PE	N	ttot	treg	tirr	tpredtot	tint	tinit	tks	ttcomm	tadj	tmov	tprednb	tsub	tsub2	xtsub1	xtsub2	
1	5000	517.01170	447.73	43.23	0.00	504.89	4.20	0.22	0.00	7.83	1.46	6.85	0.00	0.00	0.00000D+00	0.00000D+00	
2	5000	273.74747	226.19	24.01	0.00	266.98	2.28	0.23	0.00	4.38	3.94	6.86	0.69	1.16	2.35923D+09	3.00958D+09	
4	5000	154.28701	110.07	14.23	0.00	150.33	1.29	0.24	0.00	2.56	8.72	6.82	1.72	2.39	3.53682D+09	4.51333D+09	
6	5000	110.29107	74.53	9.87	0.00	107.22	0.98	0.22	0.00	1.99	8.29	6.70	2.15	1.89	3.92945D+09	5.01460D+09	
12	5000	85.25265	40.48	9.90	0.00	82.62	0.69	0.22	0.00	1.83	14.99	6.74	4.48	3.72	4.32197D+09	5.51592D+09	

Calculate Amdahl's Law:

Let X be the part of my program (in terms of computing time) which can be parallelised. The sequential computing time Tseq is normalized to unity (1), and can be expressed as:

Tseq = 1 = X + (1-X)

The parallel computing time Tpar under ideal conditions (ideal load balancing, ultrafast communication):

Tpar = X/p + (1-X) with processor number (core number) p

Then the speed-up of the program S = Tseq / Tpar :

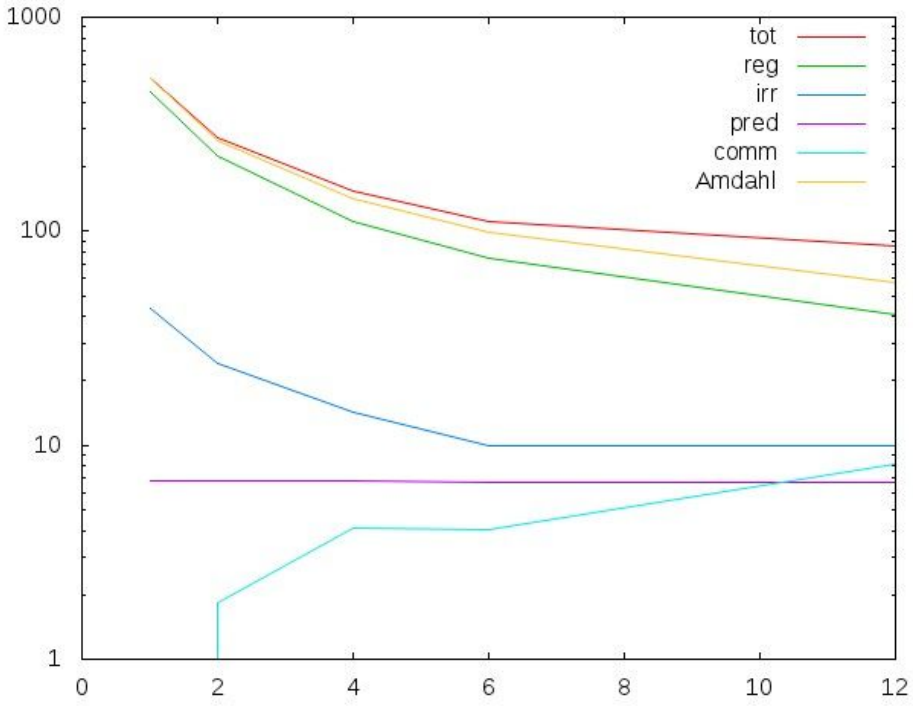
S = 1 / (1-X+X/p)

Note the limit if p is very large: S = 1/(1-X). We find from our measurements with NBODY6++ given above: X = (treg + tirr + tinit + tadj) / ttot = 503 / 517 = 0.97 .
Hence S = 1/(0.03 + 0.97/p), for large p max speed-up: S = 1/0.03 = 33.3333
(Note: this is only for 5000 Particles - for larger N we get MUCH higher X...)

Use gnuplot:

```
set logscale y
plot 'time' u 1:3 w l t'tot', '' u 1:4 w l t 'reg', '' u 1:5 w l t'irr', '' u 1:13 w l t'pred', \
                '' u 1:($14+$15) w l t'comm', '' u 1:(517.*(0.03+0.97/$1)) w l lt 9'Amdahl'
```

Result:



2. Introduction to Many-Core Programming (GPU's for Parallel Computing)

- What is a GPU? Why it can be so fast?
- NBODY6/GPU (Nitadori/Aarseth) versus NBODY6++/GPU or how to use GPU's in a parallel computer for NBODY?
- Hands-on Experiments on 老虎 with GPU.

Notice: After each lecture (not before) I will write up a few more informations and put it on the Internet.