Programming parallel computers: Exercise 2

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1 CP1

Finding the colleration matrix using naive algorithm.

	ny	nx	time(sec)
cp	1	1	0.000
cp	1	10	0.000
cp	1	100	0.000
cp	1	1000	0.000
cp	1	2000	0.000
cp	1	4000	0.000
cp	10	1	0.000
cp	10	10	0.000
cp	10	100	0.000
cp	10	1000	0.000
cp	10	2000	0.000
cp	10	4000	0.001
cp	100	1	0.000
cp	100	10	0.000
cp	100	100	0.001
cp	100	1000	0.010
cp	100	2000	0.017
cp	100	4000	0.018
cp	1000	1	0.001
cp	1000	10	0.004
cp	1000	100	0.037
cp	1000	1000	0.406
cp	1000	2000	0.820
cp	1000	4000	1.659
cp	2000	1	0.002
cp	2000	10	0.016
cp	2000	100	0.147
cp	2000	1000	1.622
cp	2000	2000	3.304
cp	2000	4000	6.641
cp	4000	1	0.009
cp	4000	10	0.065
cp	4000	100	0.588
cp	4000	1000	6.545
cp	4000	2000	13.269
cp	4000	4000	26.612

2 CP2

cp2 is parallelised version of cp1.

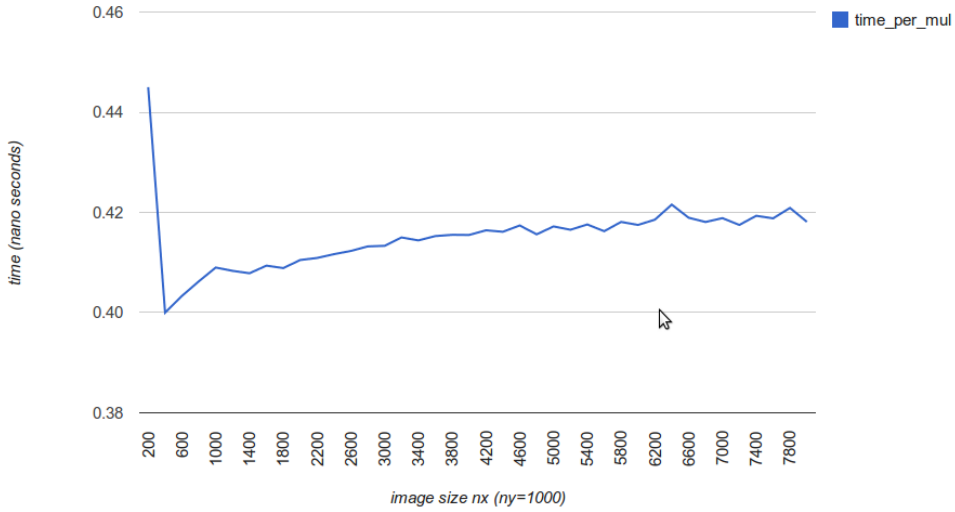

Figure 1: Time taken per multiplication cp1 with ny=1000

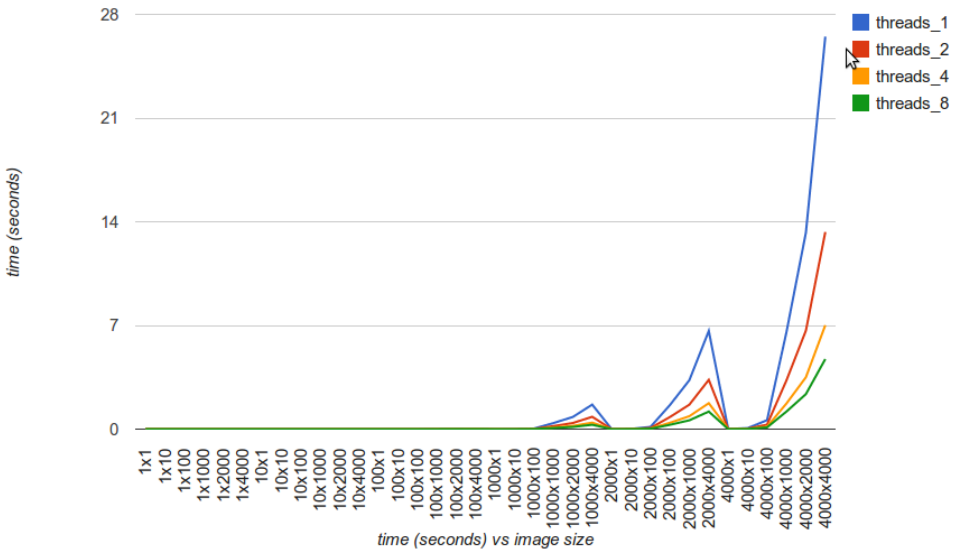

Figure 2: Performance statistics of cp2

	ny	nx	1-thread	2 -threads	4-threads	8-threads
cp	1	1	0	0	0	0
cp	1	10	0	0	0	0
cp	1	100	0	0	0	0
cp	1	1000	0	0	0	0
cp	1	2000	0	0	0	0
cp	1	4000	0	0	0	0
cp	10	1	0	0	0	0
cp	10	10	0	0	0	0
cp	10	100	0	0	0	0
cp	10	1000	0	0	0	0
cp	10	2000	0	0	0	0
cp	10	4000	0.001	0	0	0
cp	100	1	0	0	0	0
cp	100	10	0	0	0	0
cp	100	100	0.001	0.001	0	0
cp	100	1000	0.01	0.005	0.003	0.002
cp	100	2000	0.017	0.01	0.005	0.004
cp	100	4000	0.018	0.012	0.011	0.007
cp	1000	1	0.001	0	0	0
cp	1000	10	0.004	0.002	0.001	0.001
cp	1000	100	0.04	0.019	0.011	0.009
cp	1000	1000	0.408	0.205	0.108	0.074
cp	1000	2000	0.821	0.412	0.218	0.148
cp	1000	4000	1.656	0.832	0.439	0.296
cp	2000	1	0.003	0.002	0.001	0.001
cp	2000	10	0.017	0.009	0.005	0.003
cp	2000	100	0.152	0.076	0.041	0.029
cp	2000	1000	1.627	0.818	0.431	0.292
cp	2000	2000	3.303	1.652	0.873	0.596
cp	2000	4000	6.627	3.329	1.752	1.185
cp	4000	1	0.011	0.006	0.004	0.004
cp	4000	10	0.068	0.034	0.018	0.012
cp	4000	100	0.604	0.304	0.161	0.116
cp	4000	1000	6.553	3.293	1.732	1.187
cp	4000	2000	13.265	6.65	3.5	2.363
cp	4000	4000	26.498	13.307	7.017	4.731

Table 1: CP2 performance statistics

	ny	nx	1-thread	2-threads	4-threads	8-threads
cp	1	1	0	0	0	0
cp	1	10	0	0	0	0
cp	1	100	0	0	0	0
cp	1	1000	0	0	0	0
cp	1	2000	0	0	0	0
cp	1	4000	0	0	0	0
cp	10	1	0	0	0	0
cp	10	10	0	0	0	0
cp	10	100	0	0	0	0
cp	10	1000	0	0	0	0
cp	10	2000	0	0	0	0
cp	10	4000	0	0	0	0
cp	100	1	0	0	0	0
cp	100	10	0	0	0	0
cp	100	100	0	0	0	0
cp	100	1000	0.002	0.001	0.001	0.001
cp	100	2000	0.005	0.003	0.002	0.002
cp	100	4000	0.008	0.006	0.004	0.004
cp	1000	1	0.003	0.004	0.002	0.002
cp	1000	10	0.004	0.004	0.002	0.002
cp	1000	100	0.01	0.011	0.006	0.006
cp	1000	1000	0.085	0.044	0.024	0.023
cp	1000	2000	0.178	0.093	0.053	0.043
cp	1000	4000	0.42	0.235	0.131	0.121
cp	2000	1	0.013	0.006	0.004	0.003
cp	2000	10	0.014	0.007	0.004	0.004
cp	2000	100	0.04	0.02	0.011	0.011
cp	2000	1000	0.357	0.184	0.1	0.077
cp	2000	2000	0.857	0.486	0.25	0.179
cp	2000	4000	1.881	0.96	0.542	0.438
cp	4000	1	0.05	0.026	0.013	0.012
cp	4000	10	0.056	0.028	0.015	0.014
cp	4000	100	0.158	0.08	0.043	0.044
cp	4000	1000	1.655	0.9	0.5	0.351
cp	4000	2000	3.56	2.21	1.053	0.723
cp	4000	4000	7.644	4.924	2.142	1.751

Table 2: CP3 performance statistics

3 CP3

cp3 is vectorised version. The data matrix is converted into vector of float8_t and the all the calculations are dont using vectors.

4 CP4

cp4 is vector multiplication with cache block multiplication with instruction level parallelism. Performance of cp4 with 4 threads is better than 8 threads.

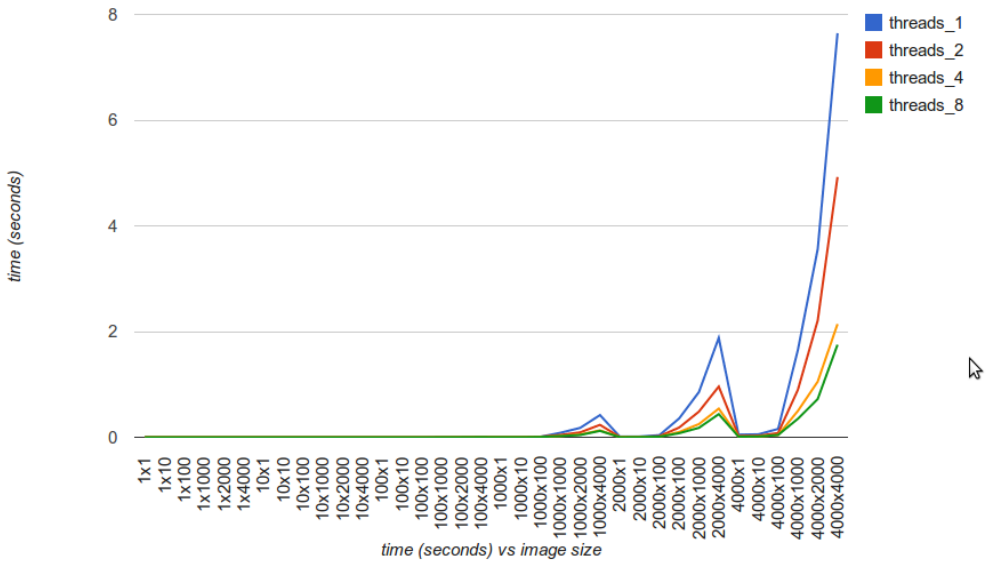

Figure 3: Performance statistics of cp3

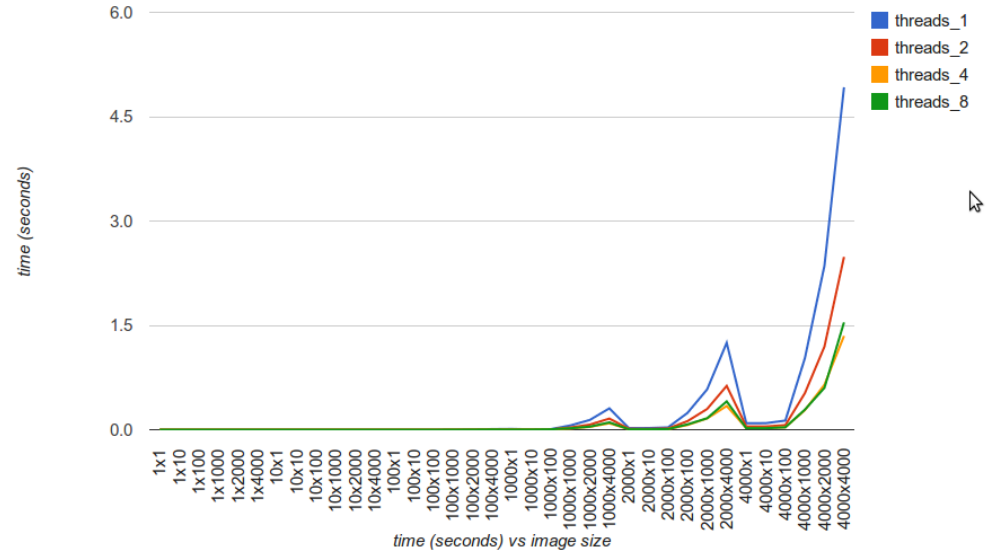

Figure 4: Performance statistics of cp4

	ny	nx	1-thread	2-threads	4-threads	8-threads
cp	1	1	0	0	0	0
cp	1	10	0	0	0	0
cp	1	100	0	0	0	0
cp	1	1000	0	0	0	0
cp	1	2000	0	0	0	0
cp	1	4000	0	0	0	0
cp	10	1	0	0	0	0
cp	10	10	0	0	0	0
cp	10	100	0	0	0	0
cp	10	1000	0	0	0	0
cp	10	2000	0	0	0	0
cp	10	4000	0	0	0	0
cp	100	1	0	0	0	0
cp	100	10	0	0	0	0
cp	100	100	0	0	0	0
cp	100	1000	0.002	0.001	0.001	0.001
cp	100	2000	0.004	0.003	0.002	0.002
cp	100	4000	0.009	0.006	0.004	0.004
cp	1000	1	0.011	0.007	0.004	0.003
cp	1000	10	0.006	0.003	0.004	0.003
cp	1000	100	0.008	0.004	0.006	0.006
cp	1000	1000	0.061	0.032	0.018	0.021
cp	1000	2000	0.14	0.073	0.041	0.044
cp	1000	4000	0.307	0.16	0.092	0.105
cp	2000	1	0.023	0.013	0.007	0.006
cp	2000	10	0.024	0.012	0.007	0.006
cp	2000	100	0.033	0.017	0.01	0.009
cp	2000	1000	0.243	0.124	0.068	0.077
cp	2000	2000	0.58	0.298	0.162	0.165
cp	2000	4000	1.249	0.63	0.341	0.407
cp	4000	1	0.093	0.047	0.025	0.022
cp	4000	10	0.094	0.047	0.025	0.022
cp	4000	100	0.131	0.066	0.035	0.035
cp	4000	1000	1.029	0.526	0.281	0.289
cp	4000	2000	2.358	1.195	0.647	0.602
cp	4000	4000	4.923	2.484	1.347	1.543

Table 3: CP4 performance statistics

ny	nx	time_cp1	time_cp4_8	time_cp4_4	time_cp4_2	time_cp4_1
1000	200	0.089	0.009	0.009	0.013	0.014
1000	400	0.16	0.008	0.007	0.012	0.023
1000	600	0.242	0.013	0.01	0.017	0.032
1000	800	0.325	0.017	0.015	0.026	0.049
1000	1000	0.409	0.021	0.018	0.032	0.061
1000	1200	0.49	0.025	0.024	0.042	0.081
1000	1400	0.571	0.031	0.028	0.05	0.095
1000	1600	0.655	0.034	0.032	0.057	0.109
1000	1800	0.736	0.04	0.038	0.068	0.129
1000	2000	0.821	0.043	0.041	0.073	0.141
1000	2200	0.904	0.053	0.046	0.084	0.161
1000	2400	0.988	0.06	0.05	0.091	0.174
1000	2600	1.072	0.07	0.055	0.099	0.191
1000	2800	1.157	0.072	0.059	0.108	0.207
1000	3000	1.24	0.077	0.063	0.116	0.222
1000	3200	1.328	0.082	0.068	0.124	0.242
1000	3400	1.409	0.089	0.074	0.136	0.259
1000	3600	1.495	0.094	0.079	0.145	0.284
1000	3800	1.579	0.099	0.083	0.153	0.292
1000	4000	1.662	0.104	0.088	0.163	0.321
1000	4200	1.749	0.112	0.097	0.18	0.347
1000	4400	1.831	0.115	0.108	0.201	0.392
1000	4600	1.92	0.121	0.116	0.217	0.416
1000	4800	1.995	0.126	0.126	0.239	0.45
1000	5000	2.086	0.133	0.135	0.256	0.498
1000	5200	2.166	0.139	0.14	0.268	0.501
1000	5400	2.255	0.144	0.145	0.278	0.53
1000	5600	2.331	0.149	0.151	0.291	0.542
1000	5800	2.425	0.155	0.156	0.3	0.582
1000	6000	2.505	0.161	0.161	0.309	0.58
1000	6200	2.595	0.165	0.167	0.319	0.601
1000	6400	2.698	0.171	0.172	0.33	0.624
1000	6600	2.765	0.177	0.18	0.346	0.649
1000	6800	2.843	0.184	0.185	0.356	0.669
1000	7000	2.932	0.189	0.191	0.364	0.686
1000	7200	3.006	0.193	0.196	0.378	0.71
1000	7400	3.103	0.2	0.202	0.387	0.726
1000	7600	3.183	0.204	0.207	0.396	0.748
1000	7800	3.283	0.21	0.213	0.407	0.765
1000	8000	3.345	0.215	0.219	0.421	0.789

Table 4: Performance measurements of cp1 and cp4 with ny=1000

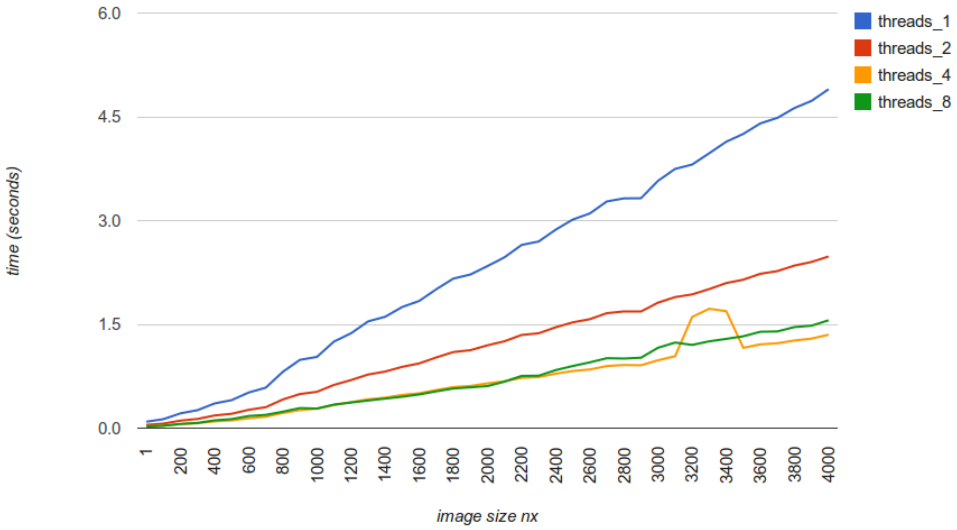

Figure 5: Performance statistics of cp4 with ny=4000

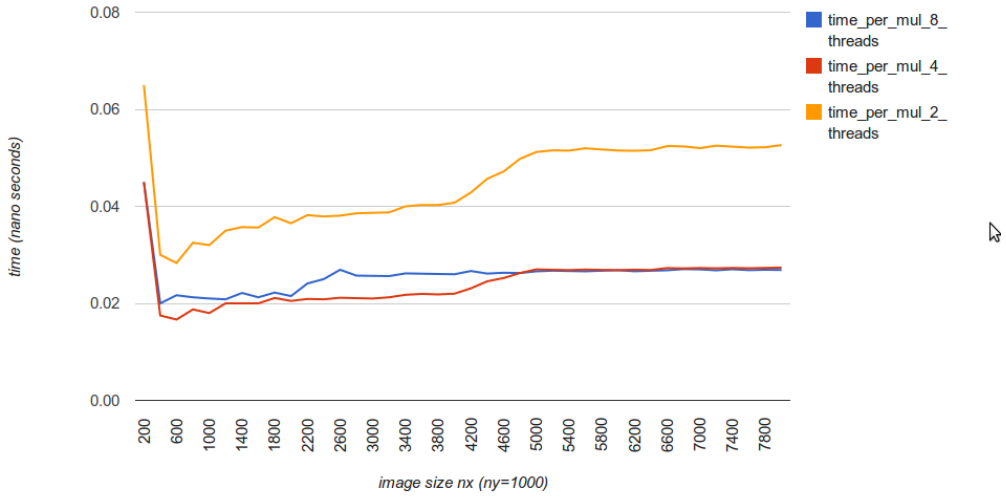

Figure 6: Time per multiplication cp4 with ny=1000