Q1:

The first N is 10 and the last N is 100000.

For N = 10, output is:

There are 10 points on each processor.

Theta is 1

I am rank0. My ntMax Level = 2

I am rank0. My ntN = 10

I am rank0. My ntNode Count = 33

I am rank 0. Tree Center of Mass = (0.468399, 0.365653, 0.367525) with mass 3487.31

I am rank 0. The Fxmin is 3.86413e-05. The Fxmax is 0.000197258. The Fymin is 4.33418e-06. The Fymax is 0.000122654. The Fzmin is 2.94968e-06. The Fzmax is 0.000209789

Overall Time : 0.03

For N=100000, output is:

There are 100000 points on each processor.

Theta is 1

I am rank0. My ntMax Level = 11

I am rank0. My ntN = 100000

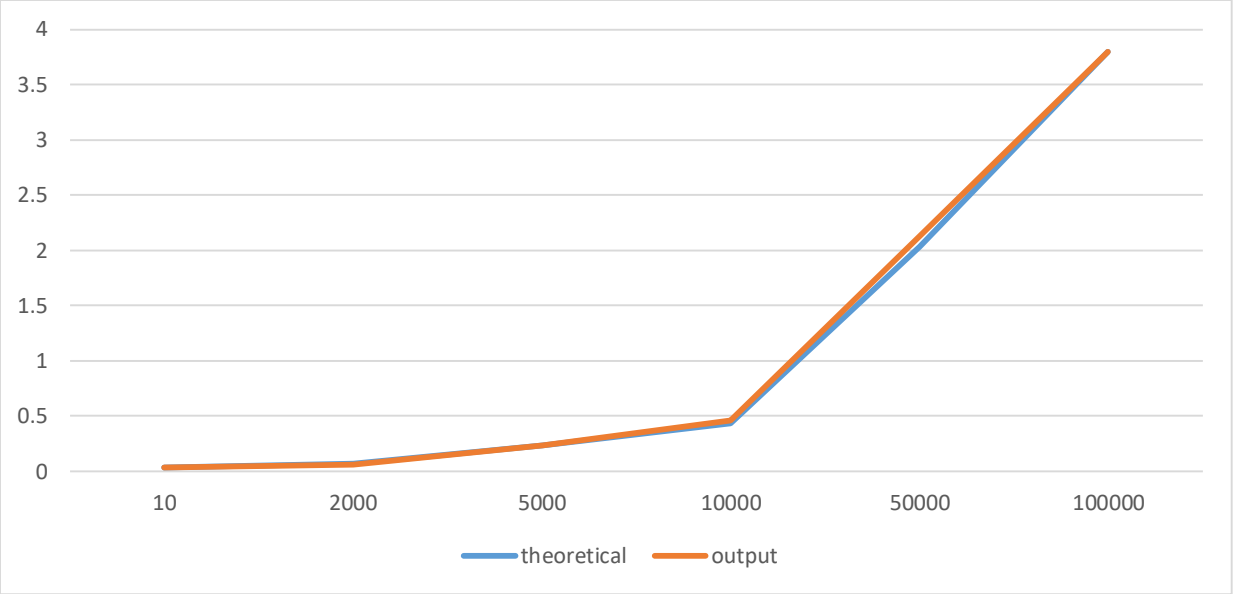
I am rank0. My ntNode Count = 388737

I am rank 0. Tree Center of Mass = (0.499319, 0.50067, 0.499521) with mass 5.00444e+07

I am rank 0. The Fxmin is 3.6569e-06. The Fxmax is 35.0039. The Fymin is 1.20229e-05. The Fymax is 40.4538. The Fzmin is 3.20448e-06. The Fzmax is 73.6928

Overall Time : 3.799

The plots shown below:



I took the first and last overall time as the theoretical performance and compute the theoretical time between them as the time is proportional to N.

As we can see, there is no significant difference when theta equals 1.

Q2.

I chose 5000 points as N.

The output for theta = 1 shown below:

There are 5000 points on each processor.

Theta is 1

I am rank0. My ntMax Level = 9

I am rank0. My ntN = 5000

I am rank0. My ntNode Count = 19257

I am rank 0. Tree Center of Mass = (0.500498, 0.500646, 0.495967) with mass 2.50696e+06

I am rank 0. The Fxmin is 3.45919e-07. The Fxmax is 2.96984. The Fymin is 1.93724e-05. The Fymax is 2.96815. The Fzmin is 2.52664e-06. The Fzmax is 1.48154

Overall Time : 0.233

The output for theta = 0 shown below:

There are 5000 points on each processor.

Theta is 0

I am rank0. My ntMax Level = 8

I am rank0. My ntN = 5000

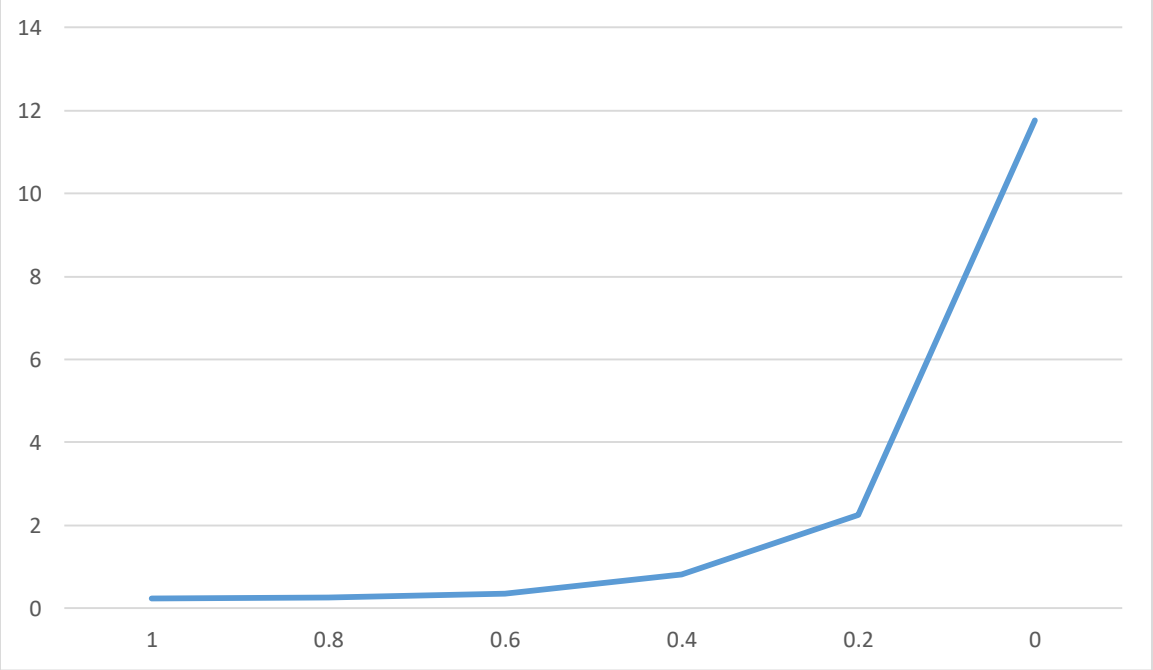
I am rank0. My ntNode Count = 19097

I am rank 0. Tree Center of Mass = (0.499538, 0.498516, 0.501265) with mass 2.49772e+06

I am rank 0. The Fxmin is 6.72577e-06. The Fxmax is 1.97961. The Fymin is 7.07015e-06. The Fymax is 1.97397. The Fzmin is 1.34864e-05. The Fzmax is 2.70017

Overall Time : 11.759

The plots shown below:



As I can see from the plot, the theta is smaller, the time we need is longer, which is make sense.

The theta is lager, which means there are more CoMs we can use because the condition (D/R<=theta). Therefore, when the theta equals to 0, no other CoMs from other processors will be used. It means current processor will use all bodies from other processors to update its own CoM. That's the reason why the time is longer.

Q3.

I chose 50000 points as N and theta = 1.

Output for P=1 shown below:

There are 50000 points on each processor.

Theta is 0.5

I am rank0. My ntMax Level = 10

I am rank0. My ntN = 50000

I am rank0. My ntNode Count = 194801

I am rank 0. Tree Center of Mass = (0.497513, 0.500435, 0.498096) with mass 2.49878e+07

I am rank 0. The Fxmin is 7.79399e-06. The Fxmax is 13.1764. The Fymin is 9.85818e-08. The Fymax is 11.4315. The Fzmin is 2.03868e-06. The Fzmax is 22.7916

Overall Time : 5.226

Output for P=2 shown below:

There are 50000 points on each processor.

Theta is 0.5

Rank 0 initial point size

Rank 1 initial point size

Total points across all procs at this ORB level = 100000

I am rank0. My ntMax Level = 11

I am rank1. My ntMax Level = 10

I am rank0. My ntN = 50002

I am rank1. My ntN = 49998

I am rank0. My ntNode Count = 194385

I am rank1. My ntNode Count = 194705

I am rank 0. Tree Center of Mass = (0.502172, 0.498345, 0.499797) with mass 5.01361e+07

I am rank 1. Tree Center of Mass = (0.502172, 0.498345, 0.499797) with mass 5.01361e+07

I am rank 1. The Fxmin is 3.12503e-05. The Fxmax is 37.912. The Fymin is 1.59548e-05. The Fymax is 45.903. The Fzmin is 1.76286e-06. The Fzmax is 69.032

I am rank 0. The Fxmin is 3.12503e-05. The Fxmax is 37.912. The Fymin is 1.59548e-05. The Fymax is 45.903. The Fzmin is 1.76286e-06. The Fzmax is 69.032

Overall Time : 9.503

Output for P=3 shown below:

There are 50000 points on each processor.

Theta is 0.5

Rank 2 initial point size

Rank 0 initial point size

Rank 1 initial point size

Total points across all procs at this ORB level = 150000

Total points across all procs at this ORB level = 99999

I am rank0. My ntMax Level = 11

I am rank0. My ntN = 50001

I am rank0. My ntNode Count = 192241

I am rank1. My ntMax Level = 11

I am rank1. My ntN = 50002

I am rank1. My ntNode Count = 190833

I am rank2. My ntMax Level = 11

I am rank2. My ntN = 49997

I am rank2. My ntNode Count = 190745

I am rank 2. Tree Center of Mass = (0.498544, 0.500374, 0.499692) with mass 7.50808e+07

I am rank 1. Tree Center of Mass = (0.498544, 0.500374, 0.499692) with mass 7.50808e+07

I am rank 0. Tree Center of Mass = (0.498544, 0.500374, 0.499692) with mass 7.50808e+07

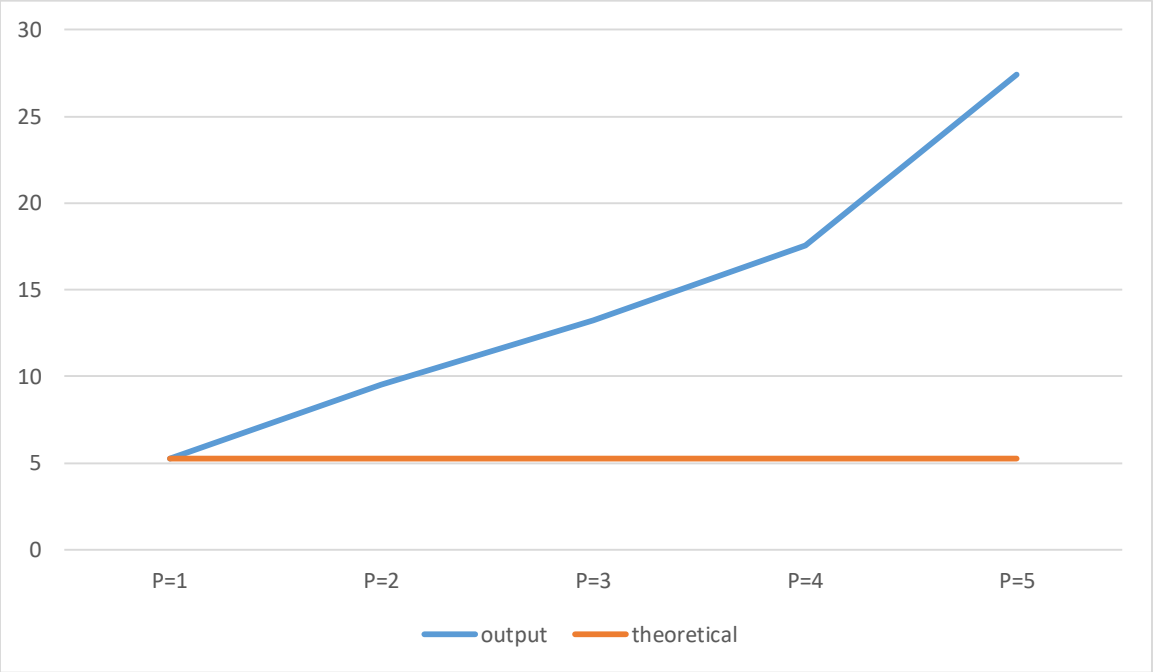
I am rank 1. The Fxmin is 3.78747e-07. The Fxmax is 76.4714. The Fymin is 6.27847e-06. The Fymax is 47.5847. The Fzmin is 1.11546e-05. The Fzmax is 78.1549

I am rank 0. The Fxmin is 3.78747e-07. The Fxmax is 76.4714. The Fymin is 6.27847e-06. The Fymax is 47.5847. The Fzmin is 1.11546e-05. The Fzmax is 78.1549

I am rank 2. The Fxmin is 3.78747e-07. The Fxmax is 76.4714. The Fymin is 6.27847e-06. The Fymax is 47.5847. The Fzmin is 1.11546e-05. The Fzmax is 78.1549

Overall Time : 13.224

The plot shown below:



The theoretical time should be the same no matter there are how many processors. However, this is a N-body problem, which need essential communication. Therefore, the more processors we have (the more points we have), the time we need is longer.