Fri Feb 16 21:31:36 2018   timeStats.profile

    326007706 function calls in 134.143 seconds

 Ordered by: cumulative time

```
 ncalls  tottime  percall  cumtime  percall filename:lineno(function)
      1    0.000    0.000  134.143  134.143 {built-in method builtins.exec}
      1    0.000    0.000  134.143  134.143 nbody.py:3(<module>)
      1    0.607    0.607  134.143  134.143 nbody.py:125(nbody)
2000000   28.036    0.000  133.528    0.000 nbody.py:67(advance)
20000000   35.140    0.000   95.084    0.000 nbody.py:54(update_vs)
120000000   30.784    0.000   59.944    0.000 nbody.py:47(compute_b)
120000000   29.160    0.000   29.160    0.000 nbody.py:51(compute_mag)
10000000    4.023    0.000    4.023    0.000 nbody.py:62(update_rs)
20002000    3.228    0.000    3.228    0.000 nbody.py:44(compute_deltas)
20002000    1.784    0.000    1.784    0.000 {method 'append' of 'list' objects}
14001401    1.375    0.000    1.375    0.000 {method 'keys' of 'dict' objects}
    200    0.003    0.000    0.004    0.000 nbody.py:88(report_energy)
    100    0.003    0.000    0.003    0.000 {built-in method builtins.print}
   2000    0.001    0.000    0.001    0.000 nbody.py:85(compute_energy)
      1    0.000    0.000    0.000    0.000 nbody.py:108(offset_momentum)
      1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

Fri Feb 16 21:35:15 2018   timeStats.profile

    294007806 function calls in 125.330 seconds

 Ordered by: cumulative time

```
 ncalls  tottime  percall  cumtime  percall filename:lineno(function)
      1    0.000    0.000  125.330  125.330 {built-in method builtins.exec}
      1    0.000    0.000  125.330  125.330 nbody_1.py:3(<module>)
      1    0.000    0.000  125.330  125.330 nbody_1.py:138(nbody)
    100   59.510    0.595  125.322    1.253 nbody_1.py:68(advance)
120000000   30.479    0.000   59.410    0.000 nbody_1.py:47(compute_b)
120000000   28.931    0.000   28.931    0.000 nbody_1.py:51(compute_mag)
20002000    3.319    0.000    3.319    0.000 nbody_1.py:44(compute_deltas)
20002000    1.760    0.000    1.760    0.000 {method 'append' of 'list' objects}
14001401    1.325    0.000    1.325    0.000 {method 'keys' of 'dict' objects}
```

```
 200   0.003   0.000   0.004   0.000 nbody_1.py:101(report_energy)
 100   0.003   0.000   0.003   0.000 {built-in method builtins.print}
2000   0.001   0.000   0.001   0.000 nbody_1.py:98(compute_energy)
   1   0.000   0.000   0.000   0.000 nbody_1.py:121(offset_momentum)
   1   0.000   0.000   0.000   0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

Fri Feb 16 21:38:52 2018   timeStats.profile

    306005706 function calls in 127.237 seconds

Ordered by: cumulative time

```
  ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1   0.000    0.000  127.237  127.237 {built-in method builtins.exec}
        1   0.000    0.000  127.237  127.237 nbody_2.py:3(<module>)
        1   0.554    0.554  127.237  127.237 nbody_2.py:127(nbody)
  2000000  23.761    0.000  126.677    0.000 nbody_2.py:67(advance)
 20000000  34.736    0.000   94.508    0.000 nbody_2.py:54(update_vs)
120000000  30.891    0.000   59.771    0.000 nbody_2.py:47(compute_b)
120000000  28.880    0.000   28.880    0.000 nbody_2.py:51(compute_mag)
 10000000   4.027    0.000    4.027    0.000 nbody_2.py:62(update_rs)
 20002000   3.160    0.000    3.160    0.000 nbody_2.py:44(compute_deltas)
 14001401   1.222    0.000    1.222    0.000 {method 'keys' of 'dict' objects}
      200   0.003    0.000    0.004    0.000 nbody_2.py:89(report_energy)
      100   0.003    0.000    0.003    0.000 {built-in method builtins.print}
     2000   0.001    0.000    0.001    0.000 nbody_2.py:86(compute_energy)
        1   0.000    0.000    0.000    0.000 nbody_2.py:110(offset_momentum)
        1   0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

    326007706 function calls in 134.096 seconds

Ordered by: cumulative time

```
ncalls  tottime  percall  cumtime  percall filename:lineno(function)
      1    0.000    0.000  134.096  134.096 {built-in method builtins.exec}
      1    0.000    0.000  134.096  134.096 nbody_3.py:3(<module>)
      1    0.608    0.608  134.096  134.096 nbody_3.py:126(nbody)
2000000   28.545    0.000  133.481    0.000 nbody_3.py:67(advance)
20000000   35.115    0.000   94.522    0.000 nbody_3.py:54(update_vs)
120000000   30.463    0.000   59.408    0.000 nbody_3.py:47(compute_b)
120000000   28.944    0.000   28.944    0.000 nbody_3.py:51(compute_mag)
10000000    3.966    0.000    3.966    0.000 nbody_3.py:62(update_rs)
20002000    3.262    0.000    3.262    0.000 nbody_3.py:44(compute_deltas)
20002000    1.800    0.000    1.800    0.000 {method 'append' of 'list' objects}
14001401    1.386    0.000    1.386    0.000 {method 'keys' of 'dict' objects}
    200    0.003    0.000    0.004    0.000 nbody_3.py:89(report_energy)
    100    0.003    0.000    0.003    0.000 {built-in method builtins.print}
   2000    0.001    0.000    0.001    0.000 nbody_3.py:86(compute_energy)
      1    0.000    0.000    0.000    0.000 nbody_3.py:109(offset_momentum)
      1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}



         314006506 function calls in 129.362 seconds

   Ordered by: cumulative time

 ncalls  tottime  percall  cumtime  percall filename:lineno(function)
      1    0.000    0.000  129.362  129.362 {built-in method builtins.exec}
      1    0.000    0.000  129.362  129.362 nbody_4.py:3(<module>)
      1    0.595    0.595  129.362  129.362 nbody_4.py:129(nbody)
2000000   25.182    0.000  128.761    0.000 nbody_4.py:67(advance)
20000000   35.231    0.000   94.425    0.000 nbody_4.py:54(update_vs)
120000000   30.344    0.000   59.194    0.000 nbody_4.py:47(compute_b)
120000000   28.850    0.000   28.850    0.000 nbody_4.py:51(compute_mag)
10000000    4.000    0.000    4.000    0.000 nbody_4.py:62(update_rs)
20002000    3.193    0.000    3.193    0.000 nbody_4.py:44(compute_deltas)
20002000    1.733    0.000    1.733    0.000 {method 'append' of 'list' objects}
2000201    0.229    0.000    0.229    0.000 {method 'keys' of 'dict' objects}
    200    0.003    0.000    0.004    0.000 nbody_4.py:90(report_energy)
    100    0.003    0.000    0.003    0.000 {built-in method builtins.print}
   2000    0.001    0.000    0.001    0.000 nbody_4.py:87(compute_energy)
      1    0.000    0.000    0.000    0.000 nbody_4.py:112(offset_momentum)
```

```
     1   0.000   0.000   0.000   0.000 {method 'disable' of '_lsprof.Profiler' objects}




     290004706 function calls in 132.152 seconds

   Ordered by: cumulative time

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000  132.152  132.152 {built-in method builtins.exec}
        1    0.000    0.000  132.152  132.152 nbody_opt.py:3(<module>)
        1    0.000    0.000  132.152  132.152 nbody_opt.py:129(nbody)
      100   22.818    0.228  132.144    1.321 nbody_opt.py:67(advance)
 20000000   38.363    0.000  101.617    0.000 nbody_opt.py:54(update_vs)
120000000   32.283    0.000   63.255    0.000 nbody_opt.py:47(compute_b)
120000000   30.971    0.000   30.971    0.000 nbody_opt.py:51(compute_mag)
 10000000    4.299    0.000    4.299    0.000 nbody_opt.py:62(update_rs)
 20002000    3.411    0.000    3.411    0.000 nbody_opt.py:44(compute_deltas)
      200    0.003    0.000    0.004    0.000 nbody_opt.py:91(report_energy)
      100    0.003    0.000    0.003    0.000 {built-in method builtins.print}
     2000    0.001    0.000    0.001    0.000 nbody_opt.py:88(compute_energy)
      301    0.000    0.000    0.000    0.000 {method 'keys' of 'dict' objects}
        1    0.000    0.000    0.000    0.000 nbody_opt.py:112(offset_momentum)
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

I did not save that much time. My speedup was 134.143/132.152 = 1.015065984. There was probably some interference with the techniques used in the speedup.