IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

GALAX Project

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CONTENTS

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CHAPTER 1
Results

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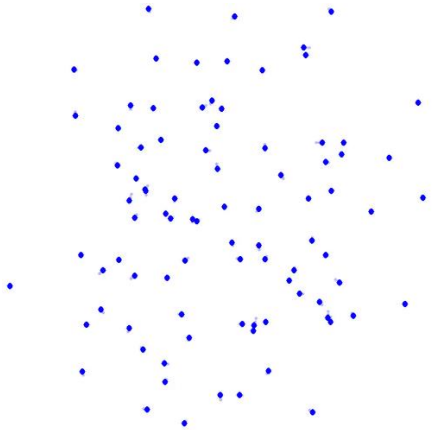

n-body problem

CPU Model

FPS: ~50

omp+xsimd+algorithm

```
average distance vs reference: 0.00101288; min error : 0; max error : 0.00745216
average distance vs reference: 0.00296431; min error : 0; max error : 0.0221624
average distance vs reference: 0.00526584; min error : 0; max error : 0.0437569
average distance vs reference: 0.00661514; min error : 0; max error : 0.052601
average distance vs reference: 0.00721774; min error : 0; max error : 0.0594342
average distance vs reference: 0.00809052; min error : 0; max error : 0.0716785
average distance vs reference: 0.00893563; min error : 0; max error : 0.0706503
average distance vs reference: 0.00966297; min error : 4.76837e-07; max error : 0.0601539
average distance vs reference: 0.0107886; min error : 9.53674e-07; max error : 0.076121
average distance vs reference: 0.0116452; min error : 9.53674e-07; max error : 0.107231
average distance vs reference: 0.0125096; min error : 9.53674e-07; max error : 0.187115
average distance vs reference: 0.0136752; min error : 2.13248e-06; max error : 0.246346
average distance vs reference: 0.0151134; min error : 2.38419e-06; max error : 0.201754
average distance vs reference: 0.0156335; min error : 2.05095e-06; max error : 0.182085
average distance vs reference: 0.0166952; min error : 2.4314e-06; max error : 0.21645
average distance vs reference: 0.0193012; min error : 4.26496e-06; max error : 0.326813
average distance vs reference: 0.0217572; min error : 4.26496e-06; max error : 0.421306
average distance vs reference: 0.0233909; min error : 5.37897e-06; max error : 0.623463
average distance vs reference: 0.0249607; min error : 5.76658e-06; max error : 0.746107
average distance vs reference: 0.0281325; min error : 6.48569e-06; max error : 0.506702
average distance vs reference: 0.0307454; min error : 7.26688e-06; max error : 0.494735
```

Method	**N=10000**
Naive	0
OMP PARFOR	4.5
XSIMD-v1	30
XSIMD-v2	50

CHAPTER 2
Method

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Goal: find acceleration aij between every 2 particles i,j

= a symmetrical matrix whose diagonal line is all zero

```
for (int i = 0; i < n_particles; i++)
        {
                for (int j = 0; j < n_particles; j++)
                {
                        if (i != j)
                        {
                                …
                        }
                }
        }
```

```
#pragma omp parallel for
    for (int i = 0; i < n_particles; i++)
    {
        for (int j = i+1; j < n_particles; j++)
                …
    }
```

Reduce half of the calculations:
change the square to the triangle

Use “omp parrallel for”

Use “Xsimd” to make vectorised calculation

```
for (int i = 0; i < n_particles; i++)
    {
        b_type rposx_i = b_type::load_unaligned(&particles.x[i]);
                …
        auto not_zero =1 if batch > threshold;
        dij = xs::select(not_zero, dij, 0);
                …
                raccx_i.store_unaligned(&accelerationsx[i]);
    }
```

Optimization of “if”:

```
b_type c = xs::rsqrt(dij);
dij = xs::fmin(10, 10.0 * dij * dij * dij);
```

In version 1, check if the position of j is 0 for every batch.
for (int j = 0; j < n_particles; j += 1)

In version 2:
split the loop in version 1 to 2 loops:

first loop:
All the batches of j are complete
for (int j = 0; j < n_particles -inc + 1; j += 1)

second loop:
The previous value is the real value, the latter value does not exist, so it is filled with 0.
for (int j = n_particles -inc + 1; j < n_particles; j += 1)

Idea: Use multiple computer to multiply the calculation.
Core problem: data load/save conflit

We explain you…

CHAPTER 3
Other tricks

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IF or MIN ?

```
# IF LOOP
real    0m0,202s
user    0m0,194s
sys     0m0,000s
# MIN
real    0m0,308s
user    0m0,291s
sys     0m0,004s
#FMIN
real    0m0,370s
user    0m0,360s
sys     0m0,000s
```

Vscode Liveshare :(-> Any other program:(

“-O3” during compilation -> did’t change anything

Barnes-Hut Algorithm -> Octree ??

https://www.cs.princeton.edu/~appel/papers/nbody.pdf

CHAPTER 4
Demo

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Thanks for listening

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