Computational Experiments on Task-Based Parallel Applications

Salão de Iniciação Científica UFRGS 2019

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CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL UFRGS

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Applications running on them can no longer rely on homogeneous hardware if they seek *high performance*

Reality

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Some sort of middle layer capable of partitioning applications workloads into these hybrid systems!

Agenda

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Most popular

There are several popular parallel programming models

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In any of those models, their implementation is a manual, complex, time-consuming and, therefore, error-prone process

Implementations

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Attention!

If only utilizing the previously cited APIs, the domain decomposition is normally fixed to the number of resources you'll be victim to dynamic load imbalances

StarPU

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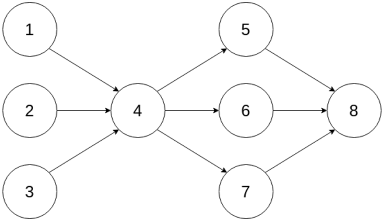
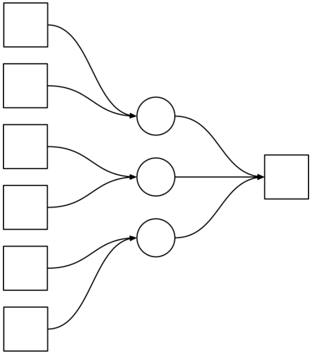
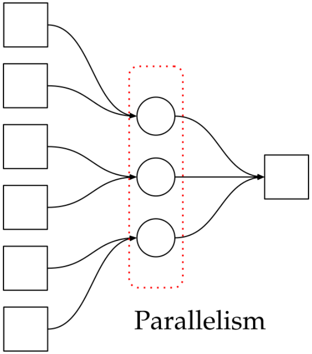


Task-based



Task-based



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2. Learn the StarPU API

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1. Use the task-based approach
2. Learn the StarPU API
3. Analyze its behavior while executing the application

Object of study

A simple vector accumulation

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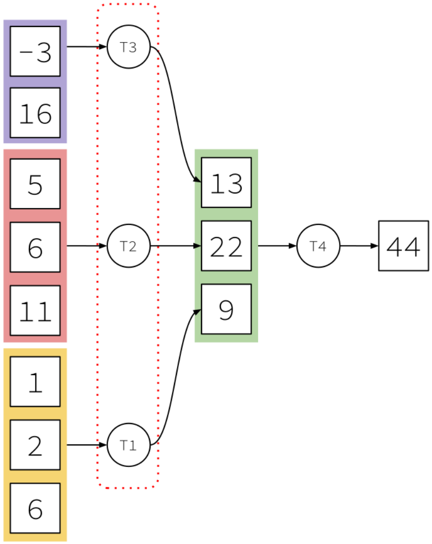

Example kernel

```c
void reduc_sum(void** buffers, void* cl_arg)
{
    ullint* vec_input = (ullint*)STARPU_VECTOR_GET_PTR(buffers[0]);
    ullint* output = (ullint*)STARPU_VARIABLE_GET_PTR(buffers[1]);
    uint nx_input = STARPU_VECTOR_GET_NX(buffers[0]);

    double t0 = get_time();

    // do the job
    for (uint i = 0; i < nx_input; i++)
        *output += vec_input[i];

    double t1 = get_time();

    V_PRINTF("SUM = %d\n"
             "Task finished work with elapsed time %f\n",
        *output, t1 - t0);
}
```

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Basis of comparison

Other simple implementations of vector accumulations

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1. Naive
2. C++ STL
3. OpenMP

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Not intended as a goal to beat, but as a basis

Methodological approach

A full factorial, randomly ordered experiment design

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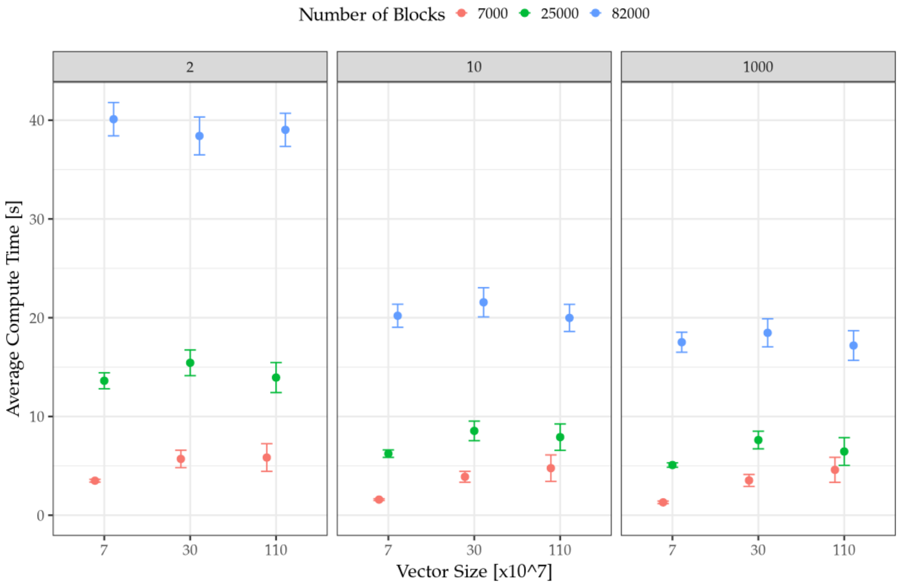
Parameters:

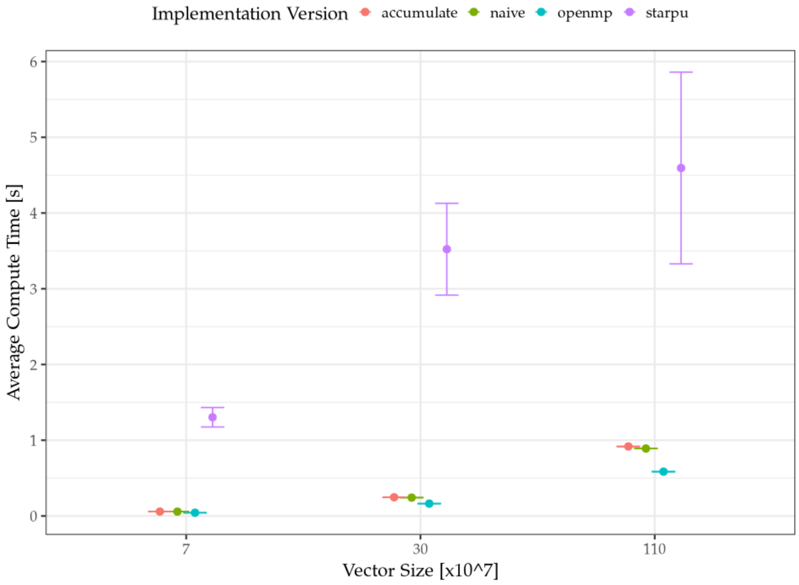
- *Vector size*: `7*10^7, 3*10^8 and 1.1*10^9`
- *Number of blocks*: `7000, 25000 and 82000`
- *Reduction factor*: `2, 10 and 1000`

Agenda

StarPU


Number of Blocks
7000
25000
82000
2
10
1000
Average Compute Time [s]
0
10
20
30
40
7
30
110
Vector Size [x10^7]

Combined graph



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OpenMP	therefore, utilizing *parallel tasks*
OpenMPI	distribute the execution graph across a whole cluster

Questions?

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