Intel Threading Building Blocks (TBB)

Qingzhao Zhu
UTK CS462 project
What is TBB?

- TBB is a library that supports scalable parallel programming using standard C++ code.
  - Specify logical parallelism instead of threads
  - Target threading for robust performance
  - Emphasize on scalable, data-parallel programming
  - Shared memory
  - Portable and open source
Overview

Intel TBB

Parallel Algorithms

Generic Parallel Algorithms

Concurrent Containers

Flow Graph

parallel_for

Task Scheduler

Memory Allocation

Synchronization Primitives
# Code Example

## Sequential code:

```cpp
void SerialApplyFoo(float a[], size_t n) {
    for (size_t i=0; i!=n; ++i)
        Foo(a[i]);
}
```

## Parallel code:

```cpp
#include "tbb/tbb.h"
using namespace tbb;

class ApplyFoo {
    float *const my_a;

public:
    void operator() ( const blocked_range<size_t>& range ) const {
        float *a = my_a;
        for (size_t i = range.begin(); i!= range.end(); ++i )
            Foo(a[i]);
    }

    ApplyFoo( float a[] ) : my_a(a) {}
};

void ParallelApplyFoo( float a[], size_t n ) {
    parallel_for ( blocked_range<size_t>(0,n), ApplyFoo(a) );
}
```

Sample node from: https://software.intel.com/en-us/node/506057
Dynamic Task Scheduler – *Task Stealing*

(Kim and Voss, 2011)
Is TBB right for you?

- Distributed Memory
  - MPI / OpenSHMEM
- Parallel Programming
  - Direct Programming
    - PThreads
- Shared Memory
  - Fortran / C
    - OpenMP
- Abstraction
- C++
  - Bounded Loops
  - Balanced tasks
  - Nested and Recursive Parallelism
  - Unbalanced tasks
  - Object-oriented / templated C++ code
  - Concurrent data structure
  - C++ user-defined types

TBB

OpenMP
TBB vs. OpenMP Performance

Matrix Multiplication (8 cores) (Ali et al., 2012)

- Fixed number of loop iterations
- Equally distributed tasks

Fibonacci 47 (cutoff 2048) (Tousimojarad and Vanderbauwhede, 2014)

- Nested and Recursive Parallelism
- Unbalanced tasks

OpenMP

TBB
More information:

- **Tutorial:**
  - https://www.threadingbuildingblocks.org/intel-tbb-tutorial

- **Concise introduction:**

- **Performance test:**

- **Task Scheduling optimization:**