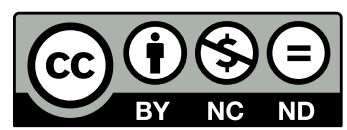
Math 4997-3

Lecture 13: Futurization of the 1D heat equation

https://www.cct.lsu.edu/~pdiehl/teaching/2019/4977/



Reminder

HPX features

Scaling results

Summary

Reminder

Lecture X

What you should know from last lecture

- One-dimensional heat equation
- Serial implementation of the one-dimensional heat equation

HPX features

A ready future

Some times, we need a future, which is already ready, since there is no computation needed.

```
hpx::lcos::future<double> f
    = hpx::make_ready_future(1);
```

Example

```
auto f = hpx::make_ready_future(1);
/*
 * Since the future is ready the output will happen
 * and there will be no barrier.
 */
std::cout << f.get() << std::endl;
```

Data flow I

```
std::vector<hpx::lcos::future<int>> futures;
futures.push_back(hpx::async(square,10));
futures.push_back(hpx::async(square,100));

// When all returns a future containing the vector
// of futures
hpx::when_all(futures).then([](auto&& f){
    // We need to unwrap this future to get
    // the content of it
    auto futures = f.get();
    int result = 0;
    for(size_t i = 0; i < futures.size();i++)
        result += futures[i].get();
    std::cout << result << std::endl;
});
```

Data flow II

```
hpx::dataflow(hpx::launch::sync,[](auto f){
    int result = 0;
    for(size_t i = 0; i < f.size();i++)
        result += f[i].get();
    std::cout << result << std::endl;
},futures);
```

Parameters

1. `hpx::launch::async` or `hpx::launch::sync`
2. The function to call
3. Futures to the arguments to the arguments of the function

Passing futures

```
void sum(int first, int second){

std:: cout << first + second << std::endl;

}

auto f1 = hpx::async(square,10);
auto f2 = hpx::async(square,100);

// We have to call .get() to pass
// the values of the future
sum(f1.get(),f2.get());
```

Unwrapping futures

```
void sum(int first, int second){

std:: cout << first + second << std::endl;

}

// We can unwrapp the function
auto fp = hpx::util::unwrapping(sum);

// After unwrapping, we can pass the future
// directly to the function
hpx::dataflow(hpx::launch::sync,fp,f1,f2);
```

Shared future

`hpx::lcos::future`

- Exclusive ownership model
- If the future is out of the scope, it will be not available anymore.

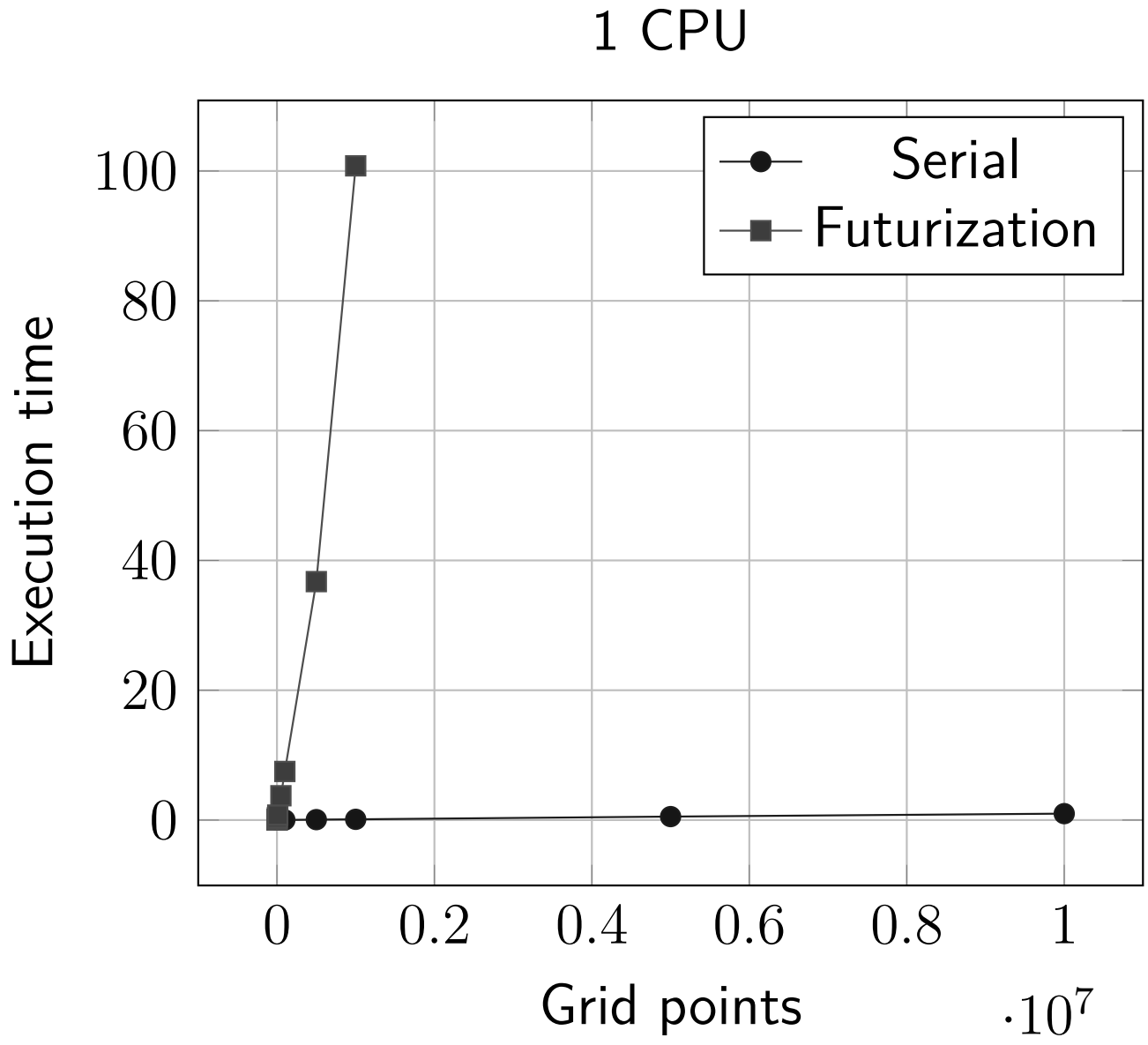
`hpx::shared_future`

- Reference counting ownership model
- All references to the object are counted and the object is only destroyed if there are zero references.

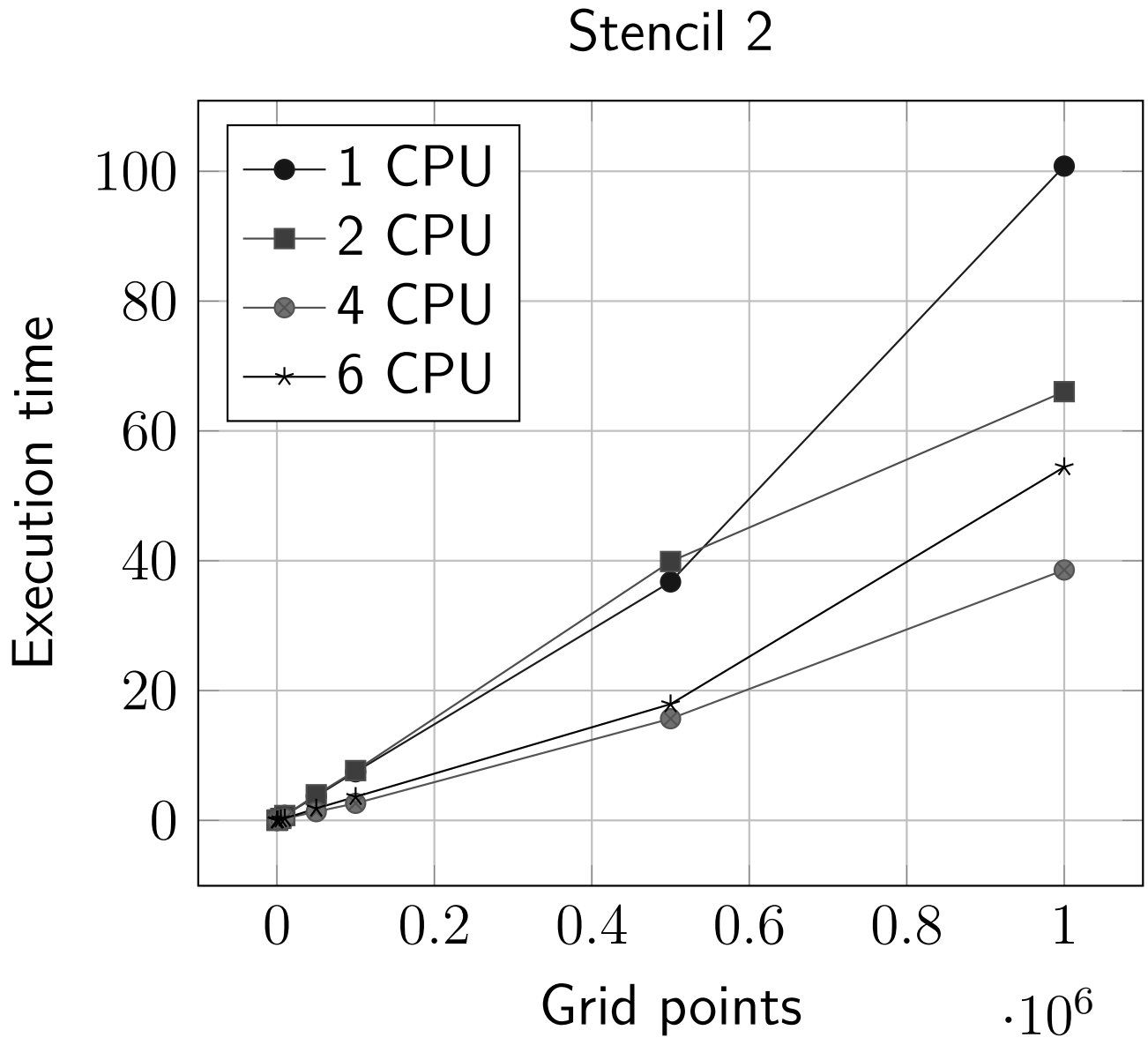
Can be seen to be equal to `std::unique_ptr` and `std::shared_ptr`.

Scaling results

Overhead


1 CPU
Serial
Futurization
Execution time
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
Grid points
$\cdot 10^7$

Scaling


Stencil 2
1 CPU
2 CPU
4 CPU
6 CPU
Execution time
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
Grid points
$\cdot 10^6$

Summary

Summary

After this lecture, you should know

- `hpx::make_ready_future`
- `hpx::dataflow`
- `hpx::util::unwrapping`
- `hpx::shared_future`