- Examples

Let's take a look at examples for creating threads, thread lifetimes, and thread methods.

WE'LL COVER THE FOLLOWING ^ Example 1 Explanation Example 2 Explanation Example 3 Explanation

Example 1

```
#include <iostream> //threadCreate.cpp
                                                                                            G
#include <thread>
void helloFunction(){
  std::cout << "Hello C++11 from a function." << std::endl;</pre>
class HelloFunctionObject {
  public:
    void operator()() const {
      std::cout << "Hello C++11 from a function object." << std::endl;</pre>
};
int main(){
  std::cout << std::endl;</pre>
  // thread executing helloFunction
  std::thread t1(helloFunction);
  // thread executing helloFunctionObject
  HelloFunctionObject helloFunctionObject;
  std::thread t2(helloFunctionObject);
  // thread executing lambda function
  std::thread t3([]{std::cout << "Hello C++11 from lambda function." << std::endl;});</pre>
```

```
// ensure that t1, t2 and t3 have finished before main thread terminates
t1.join();
t2.join();
t3.join();
std::cout << std::endl;
};</pre>
```







[]

Explanation

- All three threads (t1, t2, and t3) write their messages to the console.
 The work package of thread t2 is a function object (lines 8 13). The work package of thread t3 is a lambda function (line 27).
- In lines 30 32, the main thread is waiting until its children are done.

Let's take a look at the output.

- The three threads are executed in an arbitrary order. Even the three output operations can interleave.
- The creator of the child is responsible for the lifetime of the child. In this case, this occurred in the main thread.

Example 2

```
// threadLifetime.cpp
#include <iostream>
#include <thread>

void helloFunction(){
   std::cout << "Hello C++11 from a function." << std::endl;
}

class HelloFunctionObject {
   public:
     void operator()() const {
        std::cout << "Hello C++11 from a function object." << std::endl;
     }
};

int main(){
   std::cout << std::endl;
}</pre>
```

```
// thread executing helloFunction
std::thread t1(helloFunction);

// thread executing helloFunctionObject
HelloFunctionObject helloFunctionObject;
std::thread t2(helloFunctionObject);

// thread executing lambda function
std::thread t3([]{std::cout << "Hello C++11 from lambda function." << std::endl;});

// ensure that t1, t2 and t3 have finished before main thread terminates
t1.join();
t2.detach();
t3.join();
std::cout << std::endl;
};</pre>
```







[]

Explanation

- This program has a race condition.
- The thread t2 is detached, meaning that the function
 helloFunctionObject cannot be performed if thread t1 and t2 are faster than thread t3.

Example 3

```
// threadMethods.cpp
#include <iostream>
#include <thread>
using namespace std;
int main(){
  cout << boolalpha << endl;
  cout << "hardware_concurrency()= "<< thread::hardware_concurrency() << endl;
  thread t1([]{cout << "t1 with id= " << this_thread::get_id() << endl;});
  thread t2([]{cout << "t2 with id= " << this_thread::get_id() << endl;});
  cout << endl;
  cout << "FROM MAIN: id of t1 " << t1.get_id() << endl;
  cout << "FROM MAIN: id of t2 " << t2.get_id() << endl;
  cout << endl;</pre>
```

```
cout << "FROM MAIN: id of t1 " << t1.get_id() << endl;
cout << "FROM MAIN: id of t2 " << t2.get_id() << endl;
cout << endl;

cout << "FROM MAIN: id of main= " << this_thread::get_id() << endl;

cout << endl;

cout << endl;

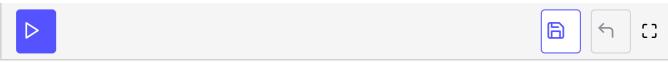
cout << "t1.joinable(): " << t1.joinable() << endl;

cout << endl;

t1.join();
t2.join();
cout << endl;

cout << "t1.joinable(): " << t1.joinable() << endl;

cout << endl;
</pre>
```



Explanation

- In combination with the output, the program should be easy to follow.
- Maybe it looks a little weird that threads t1 and t2 (lines 14 and 15) run at different points in time of the program execution.
- You have no guarantee when each thread runs. It is only guaranteed that both threads will run before t1.join() and t2.join() in lines 38 and 39.
- The more mutable (non-const) variables the threads share, the more challenging multithreading becomes.

Level up your understanding of threads with a few exercises in the next lesson.