

Introduction to Promises and Futures

This lesson gives an introduction to `std::promise` and `std::future`, which are used in C++ for multithreading.

WE'LL COVER THE FOLLOWING ^

- `std::promise`
- `std::future`

Promise and future make a mighty pair. A promise can put a value, an exception, or simply a notification into the shared data channel. One promise can serve many `std::shared_future` futures. With C++20, we may get extended futures that are composable.

Here is an introductory example of the usage of `std::promise` and `std::future`. Both communication endpoints can be moved to separate threads, so the communication takes place between threads.

```
// promiseFuture.cpp

#include <future>
#include <iostream>
#include <thread>
#include <utility>

void product(std::promise<int>&& intPromise, int a, int b){
    intPromise.set_value(a*b);
}

struct Div{

    void operator() (std::promise<int>&& intPromise, int a, int b) const {
        intPromise.set_value(a/b);
    }

};

int main(){

    int a = 20;
    int b = 10;
```

```

std::cout << std::endl;

// define the promises

std::promise<int> prodPromise;
std::promise<int> divPromise;

// get the futures
std::future<int> prodResult = prodPromise.get_future();
std::future<int> divResult = divPromise.get_future();

// calculate the result in a separate thread
std::thread prodThread(product, std::move(prodPromise), a, b);
Div div;
std::thread divThread(div, std::move(divPromise), a, b);

// get the result
std::cout << "20*10 = " << prodResult.get() << std::endl;
std::cout << "20/10 = " << divResult.get() << std::endl;

prodThread.join();

divThread.join();

std::cout << std::endl;
}

```



Thread `prodThread` (line 36) gets the function `product` (lines 8 -10), the `prodPromise` (line 32) and the numbers `a` and `b`. To understand the arguments of `prodThread`, we have to look at the signature of the function. `prodThread` needs, as its first argument, a [callable](#); this is the previously mentioned function `product`. The function `product` requires a promise of the kind [rvalue reference](#) (`std::promise<int>&& intPromise`) and two numbers. These are the last three arguments of `prodThread`. `std::move` in line 36 creates an rvalue reference - and the rest is a piece of cake. `divThread` (line 38) divides the two numbers `a` and `b`. For its job, it uses the instance `div` of the struct `Div` (lines 12 - 18). `div` is an instance of a function object.

The future picks up the results by calling `prodResult.get()` and `divResult.get()`.

`std::promise`

`std::promise` enables us to set a value, a notification, or an exception. In

addition, the promise can provide its result in a delayed fashion.

Method	Description
<code>prom.swap(prom2)</code> and <code>std::swap(prom, prom2)</code>	Swaps the promises.
<code>prom.get_future()</code>	Returns the future.
<code>prom.set_value(val)</code>	Sets the value.
<code>prom.set_exception(ex)</code>	Sets the exception.
<code>prom.set_value_at_thread_exit(val)</code> <code>)</code>	Stores the value and makes it ready if the promise exits.
<code>prom.set_exception_at_thread_exit</code> <code>(ex)</code>	Stores the exception and makes it ready if the promise exits.

If the value or the exception is set by the promise more than once, an `std::future_error` exception is thrown.

`std::future`

An `std::future` enables us to:

- pick up the value from the promise.
- ask the promise if the value is available.
- wait for the notification of the promise. This waiting can be done with a relative time duration or an absolute time point.
- create a shared future (`std::shared_future`).

Method	Description
<code>fut.share()</code>	Returns an <code>std::shared_future</code> . Afterwards, the result is not available anymore.
<code>fut.get()</code>	Returns the result which can be a value or an exception.
<code>fut.valid()</code>	Checks if the result is available. After calling <code>fut.get()</code> , it returns false.
<code>fut.wait()</code>	Waits for the result.
<code>fut.wait_for(relTime)</code>	Waits for the result, but not longer than <code>relTime</code> .
<code>fut.wait_until(absTime)</code>	Waits for the result, but not longer than <code>abstime</code> .

If a future `fut` asks for the result more than once, an `std::future_error` exception is thrown.

There is a one-to-one relationship between a promise and a future. In contrast, `std::shared_future` supports one-to-many relation between a promise and many futures.

To build upon our understanding of this topic, let's solve an exercise in the next lesson.