

ThreadPool

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# Chapter 1

## Data Structure Index

### 1.1 Data Structures

Here are the data structures with brief descriptions:

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# Chapter 2

## File Index

### 2.1 File List

Here is a list of all files with brief descriptions:

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## Chapter 3

# Data Structure Documentation

### 3.1 ThreadPool Class Reference

Manages a pool of worker threads to execute tasks concurrently.

```
#include <ThreadPool.hpp>
```

#### Public Member Functions

- `ThreadPool ()=delete`  
*Deleted default constructor.*
- `ThreadPool (unsigned int num_threads)`  
*Constructs a `ThreadPool` with a fixed number of threads.*
- template<class Func , class... Args>  
`void submit (Func &&f, Args &&... args)`  
*Submits a task to the thread pool.*
- `void finish (bool secure=true)`  
*Stops the thread pool.*
- `bool status ()`  
*Returns the current state of the thread pool.*
- `void wait ()`  
*Waits until the task queue becomes empty.*
- `~ThreadPool ()`  
*Destructor.*

#### Private Attributes

- `thread * th`
- `mutex mtx`
- `queue< function< void()> > q`
- `unsigned int num_threads`
- `bool exit_flag`
- `bool state`
- `int cont = 0`
- `condition_variable cv`

### 3.1.1 Detailed Description

Manages a pool of worker threads to execute tasks concurrently.

The [ThreadPool](#) maintains a queue of tasks. Worker threads continuously fetch and execute tasks from this queue until the pool is stopped.

#### Note

Tasks have no return value.

#### Warning

This implementation uses busy waiting and does not use condition variables.

Definition at line 35 of file [ThreadPool.hpp](#).

### 3.1.2 Constructor & Destructor Documentation

#### 3.1.2.1 ThreadPool() [1/2]

```
ThreadPool::ThreadPool ( ) [delete]
```

Deleted default constructor.

Forces the user to specify the number of threads.

#### 3.1.2.2 ThreadPool() [2/2]

```
ThreadPool::ThreadPool ( unsigned int num_threads ) [explicit]
```

Constructs a [ThreadPool](#) with a fixed number of threads.

Constructs and starts the worker threads.

#### Parameters

<code>num_threads</code>	Number of worker threads to create.
--------------------------	-------------------------------------

Each worker thread runs a loop that retrieves tasks from the queue and executes them until termination is requested. Worker thread function.

Continuously checks the task queue and executes tasks while the pool is active and the exit flag is not set.

Definition at line 15 of file [ThreadPool.cpp](#).

```

00016     : num_threads(num_threads) {
00017
00018     /**
00019      * @brief Worker thread function.
00020      *
00021      * Continuously checks the task queue and executes tasks
00022      * while the pool is active and the exit flag is not set.
00023     */
00024     function<void(void)> f = [&] () {
00025
00026         function<void()> task;
00027
00028         unique_lock<mutex> lock(this->mtx);
00029
00030         while (!this->exit_flag && this->state) {
00031             cv.wait(lock, [&] () {return !this->q.empty();});
00032
00033             if (!this->q.empty()) {
00034                 task = move(this->q.front());
00035                 this->q.pop();
00036
00037                 this->mtx.unlock();
00038
00039                 task();
00040             }
00041         }
00042     };
00043
00044     exit_flag = false;
00045
00046     this->th = new (nothrow) thread[num_threads];
00047
00048     if (this->th != nullptr) {
00049         this->state = true;
00050
00051         try {
00052             for (unsigned int i = 0; i < this->num_threads; i++) {
00053                 this->th[i] = thread(f);
00054             }
00055         } catch (exception&) {
00056             this->state = false;
00057             cout << "The system is unable to start a new thread" << endl;
00058         }
00059     } else {
00060         this->state = false;
00061     }
00062 }
```

### 3.1.2.3 ~ThreadPool()

ThreadPool::~ThreadPool ( )

Destructor.

Stops the pool and releases all allocated resources.

Ensures that the pool is stopped and memory is released.

Definition at line 100 of file [ThreadPool.cpp](#).

```

00100
00101     this->finish();
00102     try{
00103         delete[] this->th;
00104     }catch(...){
00105
00106     }
00107 }
```

Here is the call graph for this function:



### 3.1.3 Member Function Documentation

#### 3.1.3.1 finish()

```
void ThreadPool::finish (
    bool secure = true )
```

Stops the thread pool.

Stops the thread pool and optionally joins threads.

Sets the exit flag and optionally waits for all threads to finish.

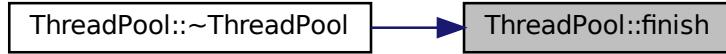
##### Parameters

<code>secure</code>	If true, joins all worker threads.
<code>secure</code>	If true, waits for all threads to finish execution.

Definition at line 78 of file [ThreadPool.cpp](#).

```
00078     {
00079         this->exit_flag = true;
00080
00081         if (secure && this->state) {
00082             for (unsigned int i = 0; i < this->num_threads; i++) {
00083                 if (this->th[i].joinable()) {
00084                     try {
00085                         this->th[i].join();
00086                     } catch (...) {
00087                         cout << "Error joining thread " << i << endl;
00088                     }
00089                 }
00090             }
00091         this->state = false;
00092     }
00093 }
```

Here is the caller graph for this function:



### 3.1.3.2 status()

```
bool ThreadPool::status ( )
```

Returns the current state of the thread pool.

Checks whether the thread pool is running.

#### Returns

True if the pool is running, false otherwise.

True if the pool is active, false otherwise.

Definition at line 69 of file [ThreadPool.cpp](#).

```
00069
00070     return this->state;
00071 }
```

### 3.1.3.3 submit()

```
template<class Func , class... Args>
void ThreadPool::submit (
    Func && f,
    Args &&... args )
```

Submits a task to the thread pool.

Adds a new task to the task queue.

The task is stored in the internal queue and will be executed by one of the worker threads.

#### Template Parameters

<i>Func</i>	Callable object type.
<i>Args</i>	Argument types for the callable.

### Parameters

<i>f</i>	Function to execute.
<i>args</i>	Arguments passed to the function.

Locks the mutex, pushes the task into the queue, and then unlocks the mutex.

Definition at line 132 of file [ThreadPool.hpp](#).

```
00132
00133
00134     {
00135         lock_guard<mutex> lock(this->mtx);
00136
00137
00138         this->q.push(
00139             move(
00140                 [&] () {
00141                     f(args...);
00142                 }
00143             );
00144     }
00145
00146     this->cv.notify_one();
00147 }
```

Here is the caller graph for this function:



### 3.1.3.4 wait()

```
void ThreadPool::wait ( )
```

Waits until the task queue becomes empty.

Waits until all queued tasks have been processed.

#### Note

This function performs a busy wait.

#### Warning

This function uses busy waiting and may waste CPU time.

Definition at line 114 of file [ThreadPool.cpp](#).

```
00114
00115     while (!this->q.empty()) {
00116         // Busy wait
00117     }
00118 }
```

### 3.1.4 Field Documentation

#### 3.1.4.1 cont

```
int ThreadPool::cont = 0 [private]
```

Auxiliary counter (currently unused)

Definition at line 58 of file [ThreadPool.hpp](#).

#### 3.1.4.2 cv

```
condition_variable ThreadPool::cv [private]
```

Condition variable used to stop the threads until a new process is pushed

Definition at line 61 of file [ThreadPool.hpp](#).

#### 3.1.4.3 exit\_flag

```
bool ThreadPool::exit_flag [private]
```

Flag indicating when threads should terminate

Definition at line 52 of file [ThreadPool.hpp](#).

#### 3.1.4.4 mtx

```
mutex ThreadPool::mtx [private]
```

Mutex protecting access to the task queue

Definition at line 43 of file [ThreadPool.hpp](#).

#### 3.1.4.5 num\_threads

```
unsigned int ThreadPool::num_threads [private]
```

Number of threads managed by the pool

Definition at line 49 of file [ThreadPool.hpp](#).

### 3.1.4.6 q

```
queue<function<void()> > ThreadPool::q [private]
```

Queue containing pending tasks

Definition at line 46 of file [ThreadPool.hpp](#).

### 3.1.4.7 state

```
bool ThreadPool::state [private]
```

Indicates whether the thread pool is active

Definition at line 55 of file [ThreadPool.hpp](#).

### 3.1.4.8 th

```
thread* ThreadPool::th [private]
```

Pointer to the array of worker threads

Definition at line 40 of file [ThreadPool.hpp](#).

The documentation for this class was generated from the following files:

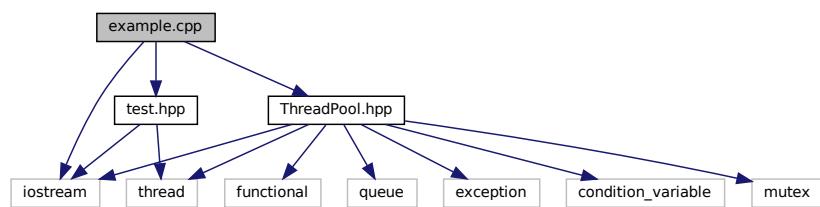
- [ThreadPool.hpp](#)
- [ThreadPool.cpp](#)

# Chapter 4

## File Documentation

### 4.1 example.cpp File Reference

```
#include <iostream>
#include "ThreadPool.hpp"
#include "test.hpp"
Include dependency graph for example.cpp:
```



### Functions

- int [main](#) (int argc, char \*argv[ ])

#### 4.1.1 Function Documentation

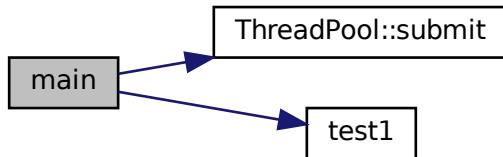
#### 4.1.1.1 main()

```
int main (
    int argc,
    char * argv[] )
```

Definition at line 9 of file example.cpp.

```
00009     {
00010
00011
00012     ThreadPool thp{10};
00013
00014     for(int i=0;i<20;i++){
00015         thp.submit(test1);
00016     }
00017
00018
00019     // thp.wait();
00020
00021     if(thp.status()) {
00022         thp.finish();
00023     }
00024
00025     if(!thp.status()){
00026         cout<<"Cerrado correctamente"\;
00027     }
00028
00029     return 0;
00030 }
```

Here is the call graph for this function:



## 4.2 example.cpp

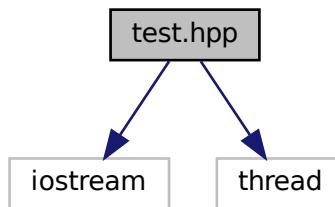
[Go to the documentation of this file.](#)

```
00001 #include <iostream>
00002 #include "ThreadPool.hpp"
00003 #include "test.hpp"
00004
00005
00006 using namespace std;
00007
00008
00009 int main(int argc, char * argv[]){
00010
00011
00012     ThreadPool thp{10};
00013
00014     for(int i=0;i<20;i++){
00015         thp.submit(test1);
00016     }
00017
00018
00019     // thp.wait();
00020
00021     if(thp.status()) {
```

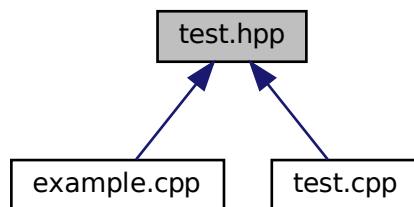
```
00022     thp.finish();  
00023 }  
00024  
00025 if (!thp.status()) {  
00026     cout<<"Cerrado correctamente" << endl;  
00027 }  
00028  
00029 return 0;  
00030 }
```

## 4.3 test.hpp File Reference

```
#include <iostream>  
#include <thread>  
Include dependency graph for test.hpp:
```



This graph shows which files directly or indirectly include this file:



## Functions

- void **test1** ()
- void **test2** (int, int)
- template<class T >  
void **test3** (T x, T y)
- template<class... Args>  
void **test4** (int x, Args... args)

- void **test4** ()
- void **function1** (int x, int y, int z)
- template<class... Args>  
void **function2** (void(\*funcion)(int, int, int), Args... args)

### 4.3.1 Function Documentation

#### 4.3.1.1 **function1()**

```
void function1 (
    int x,
    int y,
    int z )
```

Definition at line 27 of file [test.cpp](#).

```
00027           {
00028     cout<<x+y+z<<endl;
00029
00030 }
```

#### 4.3.1.2 **function2()**

```
template<class... Args>
void function2 (
    void(*)(int, int, int) funcion,
    Args... args )
```

Definition at line 33 of file [test.cpp](#).

```
00033           {
00034
00035   cout<<"function2 "<<endl;
00036   funcion(2,3,4);
00037   funcion(args...);
00038 }
```

#### 4.3.1.3 **test1()**

```
void test1 ( )
```

Definition at line 7 of file [test.cpp](#).

```
00007           {
00008   cout<<this_thread::get_id()<<" Proceso dentro de test1"<<endl;
00009 }
```

Here is the caller graph for this function:



#### 4.3.1.4 test2()

```
void test2 (
    int x,
    int y )
```

Definition at line 12 of file [test.cpp](#).

```
00012     {
00013         cout<<this_thread::get_id()<<" Proceso dentro de test2 con suma "<<x+y<<endl;
00014     }
```

#### 4.3.1.5 test3()

```
template<class T >
void test3 (
    T x,
    T y )
```

Definition at line 13 of file [test.hpp](#).

```
00013     {
00014         cout<<this_thread::get_id()<<" Proceso dentro de test3 con suma "<<x+y<<endl;
00015     }
```

#### 4.3.1.6 test4() [1/2]

```
void test4 ( )
```

Definition at line 22 of file [test.cpp](#).

```
00022     {
00023         cout<<this_thread::get_id()<<" Proceso dentro de test4 sin argumentos"<<endl;
00024     }
```

#### 4.3.1.7 test4() [2/2]

```
template<class... Args>
void test4 (
    int x,
    Args... args )
```

Definition at line 18 of file [test.hpp](#).

```
00018     {
00019         cout<<this_thread::get_id()<<" Proceso dentro de test4 con argumento "<<x<<endl;
00020     }
```

## 4.4 test.hpp

[Go to the documentation of this file.](#)

```

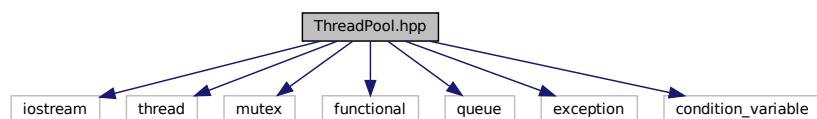
00001 #ifndef TEST_HPP
00002 #define TEST_HPP
00003
00004 #include <iostream>
00005 #include <thread>
00006
00007 using namespace std;
00008
00009 void test1();
00010 void test2(int,int);
00011
00012 template <class T>
00013 void test3(T x,T y){
00014     cout<<this_thread::get_id()<<" Proceso dentro de test3 con suma "<<x+y<<endl;
00015 }
00016
00017 template <class... Args>
00018 void test4(int x,Args... args){
00019     cout<<this_thread::get_id()<<" Proceso dentro de test4 con argumento "<<x<<endl;
00020 }
00021
00022 void test4();
00023
00024
00025 void function1(int x,int y,int z);
00026
00027 template <class... Args>
00028 void function2(void (*funcion)(int,int,int),Args... args);
00029
00030
00031 #endif

```

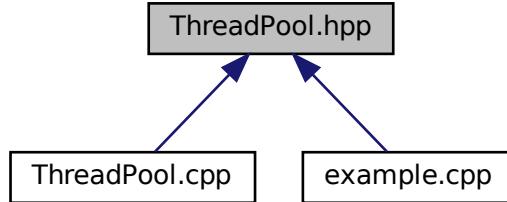
## 4.5 ThreadPool.hpp File Reference

Declaration of a simple [ThreadPool](#) class.

```
#include <iostream>
#include <thread>
#include <mutex>
#include <functional>
#include <queue>
#include <exception>
#include <condition_variable>
Include dependency graph for ThreadPool.hpp:
```



This graph shows which files directly or indirectly include this file:



## Data Structures

- class [ThreadPool](#)  
*Manages a pool of worker threads to execute tasks concurrently.*

### 4.5.1 Detailed Description

Declaration of a simple [ThreadPool](#) class.

#### Author

qwert-asci

This file contains the declaration of a basic thread pool that executes tasks using a fixed number of worker threads.

Definition in file [ThreadPool.hpp](#).

## 4.6 ThreadPool.hpp

[Go to the documentation of this file.](#)

```
00001
00002 /**
00003 * @file ThreadPool.hpp
00004 * @author qwert-asci
00005 * @brief Declaration of a simple ThreadPool class.
00006 *
00007 * This file contains the declaration of a basic thread pool
00008 * that executes tasks using a fixed number of worker threads.
00009 */
00010
00011 #ifndef THREADPOOL_HPP
00012 #define THREADPOOL_HPP
00013
00014 #include <iostream>
00015 #include <thread>
00016 #include <mutex>
00017 #include <functional>
00018 #include <queue>
00019 #include <exception>
00020 #include <condition_variable>
00021
00022 using namespace std;
```

```
00023 /**
00024 * @class ThreadPool
00025 * @brief Manages a pool of worker threads to execute tasks concurrently.
00026 *
00027 *
00028 * The ThreadPool maintains a queue of tasks. Worker threads continuously
00029 * fetch and execute tasks from this queue until the pool is stopped.
00030 *
00031 * @note Tasks have no return value.
00032 * @warning This implementation uses busy waiting and does not use
00033 *           condition variables.
00034 */
00035 class ThreadPool {
00036
00037     private:
00038
00039     /** Pointer to the array of worker threads */
00040     thread* th;
00041
00042     /** Mutex protecting access to the task queue */
00043     mutex mtx;
00044
00045     /** Queue containing pending tasks */
00046     queue<function<void()> q;
00047
00048     /** Number of threads managed by the pool */
00049     unsigned int num_threads;
00050
00051     /** Flag indicating when threads should terminate */
00052     bool exit_flag;
00053
00054     /** Indicates whether the thread pool is active */
00055     bool state;
00056
00057     /** Auxiliary counter (currently unused) */
00058     int cont = 0;
00059
00060     /** Condition variable used to stop the threads until a new process is pushed */
00061     condition_variable cv;
00062
00063 public:
00064
00065 /**
00066 * @brief Deleted default constructor.
00067 *
00068 * Forces the user to specify the number of threads.
00069 */
00070     ThreadPool() = delete;
00071
00072 /**
00073 * @brief Constructs a ThreadPool with a fixed number of threads.
00074 *
00075 * @param num_threads Number of worker threads to create.
00076 */
00077     explicit ThreadPool(unsigned int num_threads);
00078
00079 /**
00080 * @brief Submits a task to the thread pool.
00081 *
00082 * The task is stored in the internal queue and will be executed
00083 * by one of the worker threads.
00084 *
00085 * @tparam Func Callable object type.
00086 * @tparam Args Argument types for the callable.
00087 * @param f Function to execute.
00088 * @param args Arguments passed to the function.
00089 *
00090 */
00091     template <class Func, class... Args>
00092     void submit(Func&& f, Args&&... args);
00093
00094 /**
00095 * @brief Stops the thread pool.
00096 *
00097 * Sets the exit flag and optionally waits for all threads to finish.
00098 *
00099 * @param secure If true, joins all worker threads.
00100 */
00101     void finish(bool secure = true);
00102
00103 /**
00104 * @brief Returns the current state of the thread pool.
00105 *
00106 * @return True if the pool is running, false otherwise.
00107 */
00108     bool status();
00109
```

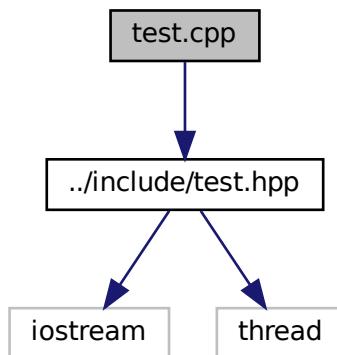
```

00110 /**
00111 * @brief Waits until the task queue becomes empty.
00112 *
00113 * @note This function performs a busy wait.
00114 */
00115     void wait();
00116
00117 /**
00118 * @brief Destructor.
00119 *
00120 * Stops the pool and releases all allocated resources.
00121 */
00122     ~ThreadPool();
00123 };
00124
00125 /**
00126 * @brief Adds a new task to the task queue.
00127 *
00128 * Locks the mutex, pushes the task into the queue,
00129 * and then unlocks the mutex.
00130 */
00131 template <class Func, class... Args>
00132 void ThreadPool::submit(Func&& f, Args&&... args) {
00133
00134     {
00135         lock_guard<mutex> lock(this->mtx);
00136
00137         this->q.push(
00138             move(
00139                 [&] () {
00140                     f(args...);
00141                 }
00142             )
00143         );
00144     }
00145
00146     this->cv.notify_one();
00147 }
00148
00149 #endif

```

## 4.7 test.cpp File Reference

#include "../include/test.hpp"  
 Include dependency graph for test.cpp:



## Functions

- void [test1 \(\)](#)

- void **test2** (int x, int y)
- void **test4** ()
- void **function1** (int x, int y, int z)
- template<class... Args>  
void **function2** (void(\*funcion)(int, int, int), Args... args)

## 4.7.1 Function Documentation

### 4.7.1.1 **function1()**

```
void function1 (
    int x,
    int y,
    int z )
Definition at line 27 of file test.cpp.
00027
00028     cout<<x+y+z<<endl;
00029
00030 }
```

### 4.7.1.2 **function2()**

```
template<class... Args>
void function2 (
    void(*)(int, int, int) funcion,
    Args... args )
Definition at line 33 of file test.cpp.
00033
00034
00035     cout<<"function2 "<<endl;
00036     funcion(2,3,4);
00037     funcion(args...);
00038 }
```

### 4.7.1.3 **test1()**

```
void test1 ( )
Definition at line 7 of file test.cpp.
00007
00008     cout<<this_thread::get_id() << " Proceso dentro de test1" << endl;
00009 }
```

Here is the caller graph for this function:



#### 4.7.1.4 test2()

```
void test2 (
    int x,
    int y )
```

Definition at line 12 of file [test.cpp](#).

```
00012     {
00013         cout<<this_thread::get_id()<<" Proceso dentro de test2 con suma "<<x+y<<endl;
00014     }
```

#### 4.7.1.5 test4()

```
void test4 ( )
```

Definition at line 22 of file [test.cpp](#).

```
00022     {
00023         cout<<this_thread::get_id()<<" Proceso dentro de test4 sin argumentos"<<endl;
00024     }
```

## 4.8 test.cpp

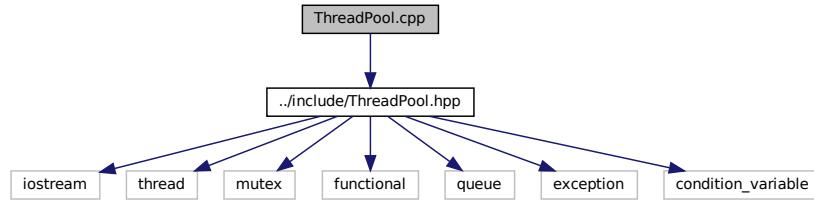
[Go to the documentation of this file.](#)

```
00001 #include "../include/test.hpp"
00002
00003
00004
00005 using namespace std;
00006
00007 void test1(){
00008     cout<<this_thread::get_id()<<" Proceso dentro de test1"<<endl;
00009 }
00010
00011
00012 void test2(int x,int y){
00013     cout<<this_thread::get_id()<<" Proceso dentro de test2 con suma "<<x+y<<endl;
00014 }
00015
00016
00017
00018
00019
00020
00021
00022 void test4(){
00023     cout<<this_thread::get_id()<<" Proceso dentro de test4 sin argumentos"<<endl;
00024 }
00025
00026
00027 void function1(int x,int y,int z){
00028     cout<<x+y+z<<endl;
00029 }
00030
00031
00032 template <class... Args>
00033 void function2(void (*funcion)(int,int,int),Args... args){
00034
00035     cout<<"function2 "<<endl;
00036     funcion(2,3,4);
00037     funcion(args...);
00038 }
```

## 4.9 ThreadPool.cpp File Reference

Implementation of the [ThreadPool](#) class.

```
#include "../include/ThreadPool.hpp"
Include dependency graph for ThreadPool.cpp:
```



### 4.9.1 Detailed Description

Implementation of the [ThreadPool](#) class.

Definition in file [ThreadPool.cpp](#).

## 4.10 ThreadPool.cpp

[Go to the documentation of this file.](#)

```

00001 /**
00002 * @file ThreadPool.cpp
00003 * @brief Implementation of the ThreadPool class.
00004 */
00005
00006 #include "../include/ThreadPool.hpp"
00007
00008 /**
00009 * @brief Constructs and starts the worker threads.
00010 *
00011 * Each worker thread runs a loop that retrieves tasks
00012 * from the queue and executes them until termination
00013 * is requested.
00014 */
00015 ThreadPool::ThreadPool(unsigned int num_threads)
00016     : num_threads(num_threads) {
00017
00018 /**
00019 * @brief Worker thread function.
00020 *
00021 * Continuously checks the task queue and executes tasks
00022 * while the pool is active and the exit flag is not set.
00023 */
00024     function<void(void)> f = [&]() {
00025
00026         function<void()> task;
00027
00028         unique_lock<mutex> lock(this->mtx);
00029
00030         while (!this->exit_flag && this->state) {
00031             cv.wait(lock, [&](){return !this->q.empty();});
00032
00033             if (!this->q.empty()) {
00034                 task = move(this->q.front());
00035                 this->q.pop();
00036
00037                 this->mtx.unlock();
00038             }
00039         }
00040     }
00041 }
```

```
00039         task();
00040     }
00041 }
00042 };
00043
00044 exit_flag = false;
00045
00046 this->th = new (nothrow) thread[num_threads];
00047
00048 if (this->th != nullptr) {
00049     this->state = true;
00050
00051     try {
00052         for (unsigned int i = 0; i < this->num_threads; i++) {
00053             this->th[i] = thread(f);
00054         }
00055     } catch (exception& e) {
00056         this->state = false;
00057         cout << "The system is unable to start a new thread" << endl;
00058     }
00059 } else {
00060     this->state = false;
00061 }
00062 }
00063
00064 /**
00065 * @brief Checks whether the thread pool is running.
00066 *
00067 * @return True if the pool is active, false otherwise.
00068 */
00069 bool ThreadPool::status() {
00070     return this->state;
00071 }
00072
00073 /**
00074 * @brief Stops the thread pool and optionally joins threads.
00075 *
00076 * @param secure If true, waits for all threads to finish execution.
00077 */
00078 void ThreadPool::finish(bool secure) {
00079     this->exit_flag = true;
00080
00081     if (secure && this->state) {
00082         for (unsigned int i = 0; i < this->num_threads; i++) {
00083             if (this->th[i].joinable()) {
00084                 try {
00085                     this->th[i].join();
00086                 } catch (...) {
00087                     cout << "Error joining thread " << i << endl;
00088                 }
00089             }
00090         }
00091     this->state = false;
00092 }
00093 }
00094
00095 /**
00096 * @brief Destructor.
00097 *
00098 * Ensures that the pool is stopped and memory is released.
00099 */
00100 ThreadPool::~ThreadPool() {
00101     this->finish();
00102     try {
00103         delete[] this->th;
00104     } catch (...) {
00105
00106     }
00107 }
00108
00109 /**
00110 * @brief Waits until all queued tasks have been processed.
00111 *
00112 * @warning This function uses busy waiting and may waste CPU time.
00113 */
00114 void ThreadPool::wait() {
00115     while (!this->q.empty()) {
00116         // Busy wait
00117     }
00118 }
```



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