ThreadPool

Chapter 1

Data Structure Index

1.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 2

File Index

2.1 File List

Here is a list of all files with brief descriptions:

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.
- unsigned int length ()

  Returns the number of process in queue.
- void wait ()

  Waits until the task queue becomes empty.
- ∼ThreadPool ()

  Destructor.

Data Fields

- atomic< bool > error =false

Private Attributes

- thread ∗ th
- mutex mtx
- queue< function< void()> > q
- unsigned int num_threads
- atomic< bool > exit_flag
- atomic< bool > ∗ process_flag
- atomic< bool > state
- atomic< bool > waiting
- condition_variable cv
- condition_variable cv2

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.

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

num_threads	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.

```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(unsigned int)> f = [&](unsigned int process_number) {
00025
00026         function<void()> task;
00027
00028         unique_lock<mutex> lock(this->mtx);
00029
00030         while (!this->exit_flag.load() && this->state.load()) {
00031
00032
00033             cv.wait(lock,[&](){
00034                     return !this->q.empty() || (this->exit_flag.load() || !this->state.load());
00035                 }
00036             );
00037
00038
00039
00040             if(this->exit_flag.load() || !this->state.load()){
00041                 lock.unlock();
00042                 break;
00043             }
00044
00045             task = move(this->q.front());
00046             this->q.pop();
00047
00048             lock.unlock();
00049
00050
00051             this->process_flag[process_number]=true;
00052             try{
00053                 task();
00054             }catch(...){
00055                 this->error=true;
00056             }
00057             this->process_flag[process_number]=false;
00058             if(this->waiting.load()==true){
00059                 this->cv2.notify_one();
00060             }
00061             lock.lock();
00062         }
00063     };
00064
00065     this->exit_flag = false;
00066     this->waiting=false;
00067
00068     this->th = new (nothrow) thread[num_threads];
00069     this->process_flag = new (nothrow) atomic<bool>[num_threads];
00070
00071     if (this->th != nullptr && this->process_flag != nullptr) {
00072         this->state = true;
00073
00074         try {
00075             for (unsigned int i = 0; i < this->num_threads; i++) {
00076                 this->th[i] = thread(f,i);
00077                 this->process_flag[i]=false;
00078             }
00079         } catch (exception&) {
00080             this->state = false;
00081             // cout « "The system is unable to start a new thread" « endl;
00082         }
00083     } else {
00084         this->state = false;
00085     }
00086 }
```

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 141 of file ThreadPool.cpp.

```
00141                              {
00142       this->finish();
00143       try{
00144           delete[] this->th;
00145           delete[] this->process_flag;
00146       }catch(...){
00147
00148       }
00149 }
```

Here is the call graph for this function:
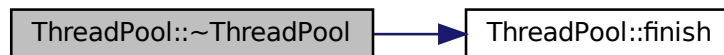
3.1.3 Member Function Documentation

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

secure	If true, joins all worker threads.
secure	If true, waits for all threads to finish execution.

Definition at line 116 of file ThreadPool.cpp.

```
00116                                      {
```

```
00117       this->exit_flag = true;
00118
00119       this->cv.notify_all();
00120
00121       if (secure && this->state.load()) {
00122           for (unsigned int i = 0; i < this->num_threads; i++) {
00123               if (this->th[i].joinable()) {
00124                   try {
00125                       this->th[i].join();
00126                   } catch (...)   {
00127                       // cout « "Error joining thread " « i « endl;
00128                   }
00129               }
00130
00131           }
00132           this->state = false;
00133       }
00134 }
```
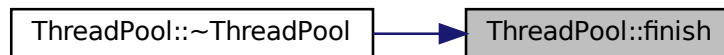
Here is the caller graph for this function:

3.1.3.2 length()

```
unsigned int ThreadPool::length ( )
```

Returns the number of process in queue.

Provides the number of process in queue.

Returns

>   integer with the length of the queue.

Definition at line 105 of file ThreadPool.cpp.
```
00105                                               {
00106       return this->q.size();
00107 }
```

3.1.3.3 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 93 of file ThreadPool.cpp.
```
00093                                               {
00094       return this->state;
00095 }
```

3.1.3.4 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

Func	Callable object type.
Args	Argument types for the callable.

Parameters

f	Function to execute.
args	Arguments passed to the function.

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

Definition at line 153 of file ThreadPool.hpp.

```
00153                                                  {
00154
00155
00156      {
00157          lock_guard<mutex> lock(this->mtx);
00158
00159
00160          this->q.push(
00161              move(
00162                  [&]() {
00163                      f(args...);
00164                  }
00165              )
00166          );
00167      }
00168
00169      this->cv.notify_one();
00170 }
```

Here is the caller graph for this function:

```
main ──────▶ ThreadPool::submit
```
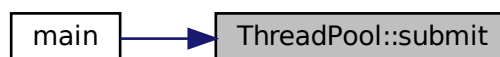
3.1.3.5 wait()

```
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.

Definition at line 154 of file ThreadPool.cpp.

```
00154                          {
00155     unique_lock<mutex> lock(this->mtx);
00156
00157     this->waiting=true;
00158
00159     this->cv2.wait(lock,[&](){
00160
00161             bool flag=true;
00162
00163             if(this->q.empty()){
00164
00165                 for(unsigned int i=0;i<this->num_threads;i++){
00166                     if(this->process_flag[i].load()){
00167                         flag=false;
00168                         break;
00169                     }
00170                 }
00171
00172                 return flag?true:false;
00173             }else{
00174                 return false;
00175             }
00176         }
00177     );
00178
00179     this->waiting=false;
00180
00181 }
```

3.1.4 Field Documentation

3.1.4.1 cv

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

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

Definition at line 64 of file ThreadPool.hpp.

3.1.4.2 cv2

```
condition_variable ThreadPool::cv2  [private]
```

Condition variable used to wait until all the queue finish

Definition at line 67 of file ThreadPool.hpp.

3.1.4.3 error

```
atomic<bool> ThreadPool::error =false
```

Parameters

Flag	that idicates if any thread has thrown an exception

Definition at line 143 of file ThreadPool.hpp.

3.1.4.4 exit_flag

```
atomic<bool> ThreadPool::exit_flag  [private]
```

Flag indicating when threads should terminate

Definition at line 52 of file ThreadPool.hpp.

3.1.4.5 mtx

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

Mutex protecting access to the task queue

Definition at line 43 of file ThreadPool.hpp.

3.1.4.6 num_threads

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

Number of threads managed by the pool

Definition at line 49 of file ThreadPool.hpp.

3.1.4.7 process_flag

```
atomic<bool>* ThreadPool::process_flag  [private]
```

Array of flags indicating if a thread is running a process or not

Definition at line 55 of file ThreadPool.hpp.

3.1.4.8 q

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

Queue containing pending tasks

Definition at line 46 of file ThreadPool.hpp.

3.1.4.9 state

`atomic<bool> ThreadPool::state  [private]`

Indicates whether the thread pool is active

Definition at line 58 of file ThreadPool.hpp.

3.1.4.10 th

`thread* ThreadPool::th  [private]`

Pointer to the array of worker threads

Definition at line 40 of file ThreadPool.hpp.

3.1.4.11 waiting

`atomic<bool> ThreadPool::waiting  [private]`

Indicates whether the thread pool is waiting to finish all the tasks or not

Definition at line 61 of file ThreadPool.hpp.

The documentation for this class was generated from the following files:
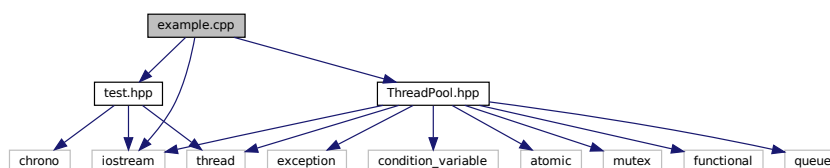
- ThreadPool.hpp
- ThreadPool.cpp

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{4};
```
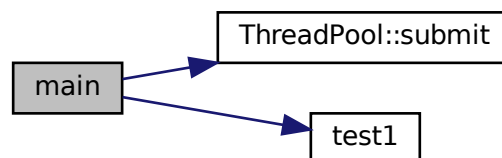
```
00013
00014     for(int i=0;i<20;i++){
00015         thp.submit(test1,i);
00016         this_thread::sleep_for(20ms);
00017     }
00018
00019     // cout«"En proceso"«endl;
00020
00021     thp.wait();
00022
00023     if(thp.status()){
00024         thp.finish();
00025     }
00026
00027     if(!thp.status()){
00028         cout«"Cerrado correctamente"«endl;
00029     }
00030
00031     return 0;
00032 }
```

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{4};
00013
00014   for(int i=0;i<20;i++){
00015   thp.submit(test1,i);
00016   this_thread::sleep_for(20ms);
00017   }
00018
00019   // cout«"En proceso"«endl;
00020
00021   thp.wait();
00022
00023   if(thp.status()){
00024   thp.finish();
00025   }
00026
00027   if(!thp.status()){
00028   cout«"Cerrado correctamente"«endl;
00029   }
00030
00031   return 0;
00032 }
```
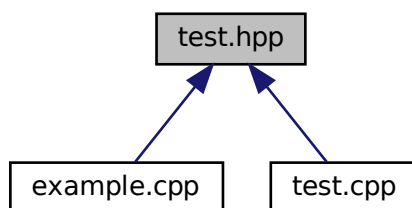
## 4.3 test.hpp File Reference

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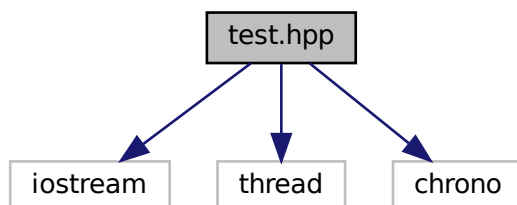


This graph shows which files directly or indirectly include this file:



### Functions

- void test1 (int)
- 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 28 of file test.cpp.

```
00028                                       {
00029     cout«x+y+x«endl;
00030
00031 }
```

4.3.1.2 function2()

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

Definition at line 34 of file test.cpp.

```
00034                                                 {
00035
00036     cout«"function2 "«endl;
00037     funcion(2,3,4);
00038     funcion(args...);
00039 }
```

4.3.1.3 test1()

```
void test1 (
            int x )
```

Definition at line 7 of file test.cpp.

```
00007                     {
00008     // this_thread::sleep_for(1000ms);
00009     cout«this_thread::get_id()«" Proceso dentro de test1 "«x«endl;
00010 }
```

Here is the caller graph for this function:

4.3.1.4 test2()

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

Definition at line 13 of file test.cpp.

```
00013                    {
00014     cout«this_thread::get_id()«" Proceso dentro de test2 con suma "«x+y«endl;
00015 }
```

4.3.1.5 test3()

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

Definition at line 14 of file test.hpp.

```
00014                    {
00015     cout«this_thread::get_id()«" Proceso dentro de test3 con suma "«x+y«endl;
00016 }
```

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

```
void test4 ( )
```

Definition at line 23 of file test.cpp.

```
00023                    {
00024     cout«this_thread::get_id()«" Proceso dentro de test4 sin argumentos"«endl;
00025 }
```

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

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

Definition at line 19 of file test.hpp.

```
00019                         {
00020     cout«this_thread::get_id()«" Proceso dentro de test4 con argumento "«x«endl;
00021 }
```

4.4　test.hpp

```
00001 #ifndef TEST_HPP
00002 #define TEST_HPP
00003
00004 #include <iostream>
00005 #include <thread>
00006 #include <chrono>
00007
00008 using namespace std;
00009
00010 void test1(int);
00011 void test2(int,int);
00012
00013 template <class T>
00014 void test3(T x,T y){
00015     cout«this_thread::get_id()«" Proceso dentro de test3 con suma "«x+y«endl;
00016 }
00017
00018 template <class...  Args>
00019 void test4(int x,Args...  args){
00020     cout«this_thread::get_id()«" Proceso dentro de test4 con argumento "«x«endl;
00021 }
00022
00023 void test4();
00024
00025
00026 void function1(int x,int y,int z);
00027
00028 template <class...  Args>
00029 void function2(void (*funcion)(int,int,int),Args...  args);
00030
00031
00032 #endif
```
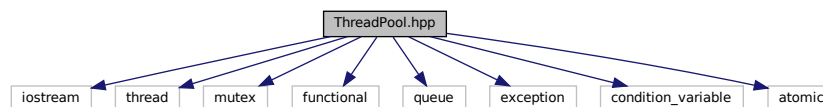
4.5　ThreadPool.hpp File Reference

Declaration of a simple ThreadPool class.

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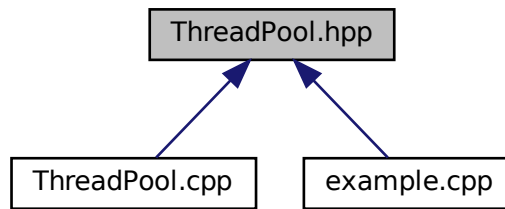Include dependency graph for ThreadPool.hpp:

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 #include <atomic>
00022
```

```
00023
00024 using namespace std;
00025
00026 /**
00027 * @class ThreadPool
00028 * @brief Manages a pool of worker threads to execute tasks concurrently.
00029 *
00030 * The ThreadPool maintains a queue of tasks.  Worker threads continuously
00031 * fetch and execute tasks from this queue until the pool is stopped.
00032 *
00033 * @note Tasks have no return value.
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     atomic<bool> exit_flag;
00053
00054 /** Array of flags indicating if a thread is running a process or not */
00055     atomic<bool> * process_flag;
00056
00057 /** Indicates whether the thread pool is active */
00058     atomic<bool> state;
00059
00060 /** Indicates whether the thread pool is waiting to finish all the tasks or not*/
00061     atomic<bool> waiting;
00062
00063 /** Condition variable used to stop the threads until a new process is pushed */
00064     condition_variable cv;
00065
00066 /** Condition variable used to wait until all the queue finish */
00067     condition_variable cv2;
00068
00069 public:
00070
00071 /**
00072 * @brief Deleted default constructor.
00073 *
00074 * Forces the user to specify the number of threads.
00075 */
00076     ThreadPool() = delete;
00077
00078 /**
00079 * @brief Constructs a ThreadPool with a fixed number of threads.
00080 *
00081 * @param num_threads Number of worker threads to create.
00082 */
00083     explicit ThreadPool(unsigned int num_threads);
00084
00085 /**
00086 * @brief Submits a task to the thread pool.
00087 *
00088 * The task is stored in the internal queue and will be executed
00089 * by one of the worker threads.
00090 *
00091 * @tparam Func Callable object type.
00092 * @tparam Args Argument types for the callable.
00093 * @param f Function to execute.
00094 * @param args Arguments passed to the function.
00095 *
00096 */
00097     template <class Func, class... Args>
00098     void submit(Func&& f, Args&&... args);
00099
00100 /**
00101 * @brief Stops the thread pool.
00102 *
00103 * Sets the exit flag and optionally waits for all threads to finish.
00104 *
00105 * @param secure If true, joins all worker threads.
00106 */
00107     void finish(bool secure = true);
00108
00109 /**
```

```
00110 * @brief Returns the current state of the thread pool.
00111 *
00112 * @return True if the pool is running, false otherwise.
00113 */
00114     bool status();
00115
00116
00117 /**
00118 * @brief Returns the number of process in queue.
00119 *
00120 * @return integer with the length of the queue.
00121 */
00122     unsigned int length();
00123
00124 /**
00125 * @brief Waits until the task queue becomes empty.
00126 *
00127 * @note This function performs a busy wait.
00128 */
00129     void wait();
00130
00131 /**
00132 * @brief Destructor.
00133 *
00134 * Stops the pool and releases all allocated resources.
00135 */
00136     ~ThreadPool();
00137
00138
00139 /**
00140 * @param Flag that idicates if any thread has thrown an exception
00141 *
00142 */
00143     atomic<bool> error=false;
00144 };
00145
00146 /**
00147 * @brief Adds a new task to the task queue.
00148 *
00149 * Locks the mutex, pushes the task into the queue,
00150 * and then unlocks the mutex.
00151 */
00152 template <class Func, class...  Args>
00153 void ThreadPool::submit(Func&& f, Args&&...  args) {
00154
00155
00156     {
00157         lock_guard<mutex> lock(this->mtx);
00158
00159
00160         this->q.push(
00161             move(
00162                 [&]() {
00163                     f(args...);
00164                 }
00165             )
00166         );
00167     }
00168
00169     this->cv.notify_one();
00170 }
00171
00172 #endif
```

4.7 test.cpp File Reference

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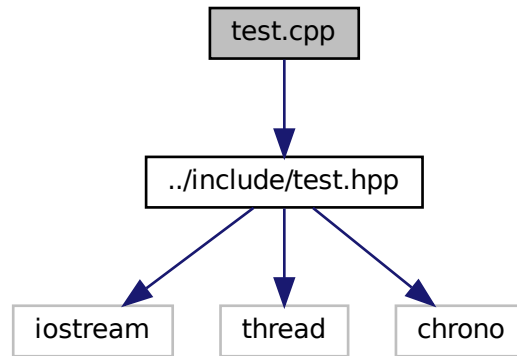
Functions

- void test1 (int x)
- 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 28 of file test.cpp.
```
00028                                   {
00029     cout«x+y+x«endl;
00030
00031 }
```

4.7.1.2 function2()

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

Definition at line 34 of file test.cpp.
```
00034                                                  {
00035
00036     cout«"function2 "«endl;
00037     funcion(2,3,4);
00038     funcion(args...);
00039 }
```

4.7.1.3 test1()

```
void test1 (
            int x )
```

Definition at line 7 of file test.cpp.
```
00007                {
00008     // this_thread::sleep_for(1000ms);
00009     cout«this_thread::get_id()«" Proceso dentro de test1 "«x«endl;
00010 }
```

Here is the caller graph for this function:

4.7.1.4 test2()

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

Definition at line 13 of file test.cpp.
```
00013                        {
00014     cout«this_thread::get_id()«" Proceso dentro de test2 con suma "«x+y«endl;
00015 }
```

4.7.1.5 test4()

```
void test4 ( )
```

Definition at line 23 of file test.cpp.

```
00023         {
00024     cout«this_thread::get_id()«" Proceso dentro de test4 sin argumentos"«endl;
00025 }
```

4.8 test.cpp
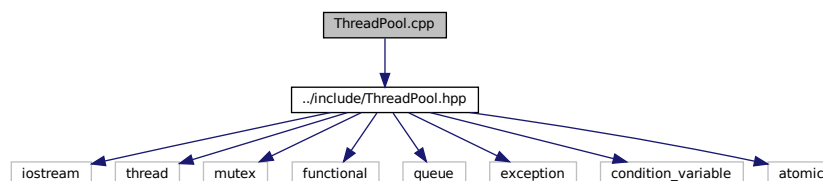
Go to the documentation of this file.
```
00001 #include "../include/test.hpp"
00002
00003
00004
00005 using namespace std;
00006
00007 void test1(int x){
00008     // this_thread::sleep_for(1000ms);
00009     cout«this_thread::get_id()«" Proceso dentro de test1 "«x«endl;
00010 }
00011
00012
00013 void test2(int x,int y){
00014     cout«this_thread::get_id()«" Proceso dentro de test2 con suma "«x+y«endl;
00015 }
00016
00017
00018
00019
00020
00021
00022
00023 void test4(){
00024     cout«this_thread::get_id()«" Proceso dentro de test4 sin argumentos"«endl;
00025 }
00026
00027
00028 void function1(int x,int y,int z){
00029     cout«x+y+x«endl;
00030
00031 }
00032
00033 template <class...  Args>
00034 void function2(void (*funcion)(int,int,int),Args...  args){
00035
00036     cout«"function2 "«endl;
00037     funcion(2,3,4);
00038     funcion(args...);
00039 }
```

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(unsigned int)> f = [&](unsigned int process_number) {
00025
00026         function<void()> task;
00027
00028         unique_lock<mutex> lock(this->mtx);
00029
00030         while (!this->exit_flag.load() && this->state.load()) {
00031
00032
00033             cv.wait(lock,[&](){
00034                 return !this->q.empty() || (this->exit_flag.load() || !this->state.load());
00035             }
00036             );
00037
00038
00039
00040             if(this->exit_flag.load() || !this->state.load()){
00041                 lock.unlock();
00042                 break;
00043             }
00044
00045             task = move(this->q.front());
00046             this->q.pop();
00047
00048             lock.unlock();
00049
00050
00051             this->process_flag[process_number]=true;
00052             try{
00053                 task();
00054             }catch(...){
00055                 this->error=true;
00056             }
00057             this->process_flag[process_number]=false;
00058             if(this->waiting.load()==true){
00059                 this->cv2.notify_one();
00060             }
00061             lock.lock();
00062         }
00063     };
00064
00065     this->exit_flag = false;
00066     this->waiting=false;
00067
00068     this->th = new (nothrow) thread[num_threads];
00069     this->process_flag = new (nothrow) atomic<bool>[num_threads];
```

```
00070
00071     if (this->th != nullptr && this->process_flag != nullptr) {
00072         this->state = true;
00073
00074         try {
00075             for (unsigned int i = 0; i < this->num_threads; i++) {
00076                 this->th[i] = thread(f,i);
00077                 this->process_flag[i]=false;
00078             }
00079         } catch (exception&) {
00080             this->state = false;
00081             // cout « "The system is unable to start a new thread" « endl;
00082         }
00083     } else {
00084         this->state = false;
00085     }
00086 }
00087
00088 /**
00089 * @brief Checks whether the thread pool is running.
00090 *
00091 * @return True if the pool is active, false otherwise.
00092 */
00093 bool ThreadPool::status() {
00094     return this->state;
00095 }
00096
00097
00098
00099
00100 /**
00101 * @brief Provides the number of process in queue.
00102 *
00103 * @return integer with the length of the queue.
00104 */
00105 unsigned int ThreadPool::length() {
00106     return this->q.size();
00107 }
00108
00109
00110
00111 /**
00112 * @brief Stops the thread pool and optionally joins threads.
00113 *
00114 * @param secure If true, waits for all threads to finish execution.
00115 */
00116 void ThreadPool::finish(bool secure) {
00117     this->exit_flag = true;
00118
00119     this->cv.notify_all();
00120
00121     if (secure && this->state.load()) {
00122         for (unsigned int i = 0; i < this->num_threads; i++) {
00123             if (this->th[i].joinable()) {
00124                 try {
00125                     this->th[i].join();
00126                 } catch (...)  {
00127                     // cout « "Error joining thread " « i « endl;
00128                 }
00129             }
00130
00131         }
00132         this->state = false;
00133     }
00134 }
00135
00136 /**
00137 * @brief Destructor.
00138 *
00139 * Ensures that the pool is stopped and memory is released.
00140 */
00141 ThreadPool::~ThreadPool() {
00142     this->finish();
00143     try{
00144         delete[] this->th;
00145         delete[] this->process_flag;
00146     }catch(...){
00147
00148     }
00149 }
00150
00151 /**
00152 * @brief Waits until all queued tasks have been processed.
00153 */
00154 void ThreadPool::wait() {
00155     unique_lock<mutex> lock(this->mtx);
00156
```

```
00157       this->waiting=true;
00158
00159       this->cv2.wait(lock,[&](){
00160
00161               bool flag=true;
00162
00163               if(this->q.empty()){
00164
00165                   for(unsigned int i=0;i<this->num_threads;i++){
00166                       if(this->process_flag[i].load()){
00167                           flag=false;
00168                           break;
00169                       }
00170                   }
00171
00172                   return flag?true:false;
00173               }else{
00174                   return false;
00175               }
00176           }
00177       );
00178
00179       this->waiting=false;
00180
00181 }
```

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