

CSE344 HW4 & HW5

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1 Introduction

This report details the design and implementation of a multi-threaded file copying system using producer-consumer patterns and inter-thread communication through shared buffers. The system consists of multiple components, each encapsulated in specific header and source files. The goal is to facilitate efficient file copying from a source directory to a destination directory, utilizing a manager thread to read and distribute files and multiple worker threads to perform the copying.

2 Design Structure

The design of the system is modular, with each component responsible for a specific aspect of the file copying process. This modularity is achieved through the use of separate header and source files for each component. Below, the design and rationale for each defined structure are explained.

2.1 Buffer Management

The buffer management system is defined in `buffer.h` and `buffer.c`. The buffer acts as a bounded queue to hold file descriptors for files that need to be copied. The buffer structure includes several key fields:

- **data**: An array to hold the transactions (file descriptors).
- **size**: The maximum size of the buffer.
- **count**: The current number of items in the buffer.
- **head**: The index of the next item to be read.
- **tail**: The index of the next item to be written.
- **closed**: A flag indicating whether the buffer is closed.
- **mutex**: A mutex to synchronize access to the buffer.
- **not_empty**: A condition variable to signal when the buffer is not empty.
- **not_full**: A condition variable to signal when the buffer is not full.

The buffer is designed to handle concurrent access by multiple threads safely. The mutex ensures mutual exclusion, while the condition variables manage synchronization between producers (manager thread) and consumers (worker threads). The buffer provides functions for initialization, destruction, closing, putting items into the buffer, and getting items from the buffer.

2.2 Statistics Collection

Statistics collection is handled in `stats.h` and `stats.c`. This module tracks various statistics during the file copying process. The statistics structure includes:

- **execution_time**: Total execution time of the file copying process.
- **regular_files**: Number of regular files copied.
- **directories**: Number of directories created.
- **bytes**: Total number of bytes copied.
- **mutex**: A mutex to synchronize access to the statistics.

The use of a mutex ensures that updates to the statistics are thread-safe. Functions are provided to initialize the statistics, print them, and increment the counters for regular files, directories, and bytes.

2.3 Thread Arguments

The thread arguments are defined in `thread_args.h`. These structures encapsulate the arguments passed to the manager and worker threads.

- **ManagerThreadArgs**: Contains pointers to the buffer, source directory, destination directory, and statistics.
- **WorkerThreadArgs**: Contains pointers to the buffer and statistics.

By encapsulating these arguments into structures, the design ensures that all necessary data is passed to the threads in an organized manner, reducing the risk of errors and improving code readability.

2.4 Transaction Management

Transaction management is defined in `transaction.h` and `transaction.c`. A transaction represents a pair of file descriptors for the source and destination files.

- **source_fd**: The file descriptor of the source file.
- **dest_fd**: The file descriptor of the destination file.

The transaction structure is simple but essential for passing file descriptors between the manager and worker threads. This encapsulation simplifies the code and makes it clear what data is being transferred.

If the file descriptors were to be put into the buffer without such structure encapsulating them, a potential race condition would exist, where a worker thread gets the source file descriptor and just before it gets the destination file descriptor (which is to be assumed to be put right after the source file descriptor in the buffer) another worker thread may get a file descriptor from the buffer thinking they got a source file descriptor.

3 Main Program Flow

The main program is implemented in `1901042656_main.c`. It initializes the buffer, statistics, and threads, then starts the manager and worker threads. The program handles signals to ensure graceful termination.

The main steps are as follows:

1. Parse command-line arguments for buffer size, number of worker threads, source directory, and destination directory.
2. Set up signal handling for graceful termination.
3. Initialize the buffer and statistics.
4. Create and start the manager thread.
5. Create and start the worker threads.

6. Wait for the manager thread to finish.
7. Close the buffer and wait for worker threads to finish.
8. Print the collected statistics.

4 Thread Functions

The manager and worker functions are implemented in separate files (`manager.c` and `worker.c`).

4.1 Manager Thread

The manager thread reads the source directory and enqueues file descriptors for files and directories. It recursively handles directories, ensuring all files are processed. When a regular file is encountered, it opens the source and destination file descriptors and enqueues a transaction in the buffer. For directories, it ensures they are created in the destination and increments the directory counter in the statistics.

4.2 Worker Threads

Each worker thread dequeues transactions from the buffer and copies the content from the source file descriptor to the destination file descriptor. It increments the counters for regular files and bytes copied in the statistics. Workers also handle synchronization using a barrier to ensure all threads start and finish copying simultaneously.

5 Synchronization

Synchronization is a critical aspect of the multi-threaded file copying system to ensure correct and efficient operation. The system uses mutexes, condition variables, and barriers to manage synchronization between threads.

5.1 Mutexes

A mutex (mutual exclusion) is used to protect shared resources from concurrent access, ensuring that only one thread can access the resource at a time. In this system, mutexes are used in the following contexts:

- **Buffer Access:** The buffer's `mutex` ensures that only one thread can modify the buffer at a time. This prevents race conditions when multiple threads attempt to put or get transactions from the buffer. For instance, when a thread wants to add a transaction to the buffer, it locks the mutex, performs the addition, and then unlocks the mutex.
- **Statistics Updates:** The statistics' `mutex` ensures that updates to the statistics (such as incrementing the count of files or bytes copied) are thread-safe. This prevents race conditions when multiple threads attempt to update the statistics simultaneously.

The use of mutexes ensures that critical sections of the code, where shared resources are accessed, are protected, maintaining data consistency and preventing unexpected behavior.

5.2 Condition Variables

Condition variables are used in conjunction with mutexes to synchronize the execution of threads based on the state of shared resources. In this system, condition variables are used for the following purposes:

- **Buffer Not Empty:** The `not_empty` condition variable is used to signal worker threads when the buffer is not empty. When a worker thread tries to get a transaction from an empty buffer, it waits on this condition variable. When the manager thread adds a transaction to the buffer, it signals the `not_empty` condition variable, waking up one of the waiting worker threads.

- **Buffer Not Full:** The `not_full` condition variable is used to signal the manager thread when the buffer is not full. When the manager thread tries to add a transaction to a full buffer, it waits on this condition variable. When a worker thread removes a transaction from the buffer, it signals the `not_full` condition variable, waking up the waiting manager thread.

Condition variables provide a mechanism for threads to wait for certain conditions to be met before proceeding, thereby coordinating the execution flow and ensuring efficient resource usage.

5.3 Barriers

A barrier is a synchronization primitive that ensures that multiple threads reach a certain point of execution before any of them can proceed. In this system, a barrier is used to synchronize the initialization of worker threads:

- **Worker Initialization:** The barrier is initialized to the number of worker threads. Each worker thread calls `pthread_barrier_wait` after its initialization. This ensures that all worker threads are initialized and ready to start copying files simultaneously. Once all threads have reached the barrier, they are released to proceed with their tasks. The worker threads also wait at the barrier after they are stopped or there's no more files to be copied. Which enables simultaneous exit from all worker threads.

Using a barrier ensures that the worker threads start copying files only after all of them are initialized, preventing any premature execution that could lead to inconsistent states or inefficient operation.

6 Signal Handling and Global Variable Usage

6.1 SIGINT Signal Handler

The system includes a signal handler to manage graceful termination upon receiving a SIGINT signal (typically generated by pressing Ctrl+C). The signal handler is defined in the `1901042656_main.c` file and is responsible for setting a global variable and signaling all threads to stop their operations.

6.1.1 Handler Function

The signal handler function, `handle_sigint`, is designed to handle the SIGINT signal. Its main responsibilities include:

- **Set the Stop Flag:** The global variable `stop` is set to 1, indicating that the system should stop processing.
- **Close the Buffer:** The buffer is closed using `buffer_close`, which sets the `closed` flag and broadcasts the condition variables `not_empty` and `not_full` to wake up any waiting threads.
- **Immediate Exit on Second Signal:** If the signal handler is invoked again while the system is already in the process of shutting down, it immediately exits the program to prevent any further delay.

6.2 Global Variable `stop`

The global variable `stop` is used across multiple threads to check whether the system has been signaled to stop. This variable is declared as `volatile sig_atomic_t` to ensure that its updates are atomic and visible across all threads.

6.2.1 Usage in Thread Functions

Both the manager and worker threads regularly check the `stop` variable to determine whether they should terminate their operations:

- **Manager Thread:** The manager thread checks `stop` within its main loop. If `stop` is set, the thread stops reading directories and adding transactions to the buffer.

- **Worker Threads:** Worker threads also check `stop` within their main loop. If `stop` is set, they cease processing transactions and prepare to exit. Additionally, worker threads check the `closed` flag of the buffer to determine if no more items will be added, allowing them to exit gracefully once all current transactions are processed.

By using the `stop` variable and the SIGINT signal handler, the system ensures a controlled and orderly shutdown process, preventing potential data corruption and ensuring that all threads can exit gracefully.

7 Tests

Following test executions are all assumed to be done onto the **empty** `../tocopy` directory.

7.1 `valgrind ./MWCp 10 10 ../testdir/src/libvterm ../tocopy`

7.1.1 Normal Execution

```

erengeren-Lenovo-Ideapad-330-15IKB:~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$ valgrind ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==10988== Memcheck, a memory error detector
==10988== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10988== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10988== Command: ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==10988==
Worker 99206720 initialized. Waiting for other workers to initialize...
Worker 124384832 initialized. Waiting for other workers to initialize...
Worker 166348352 initialized. Waiting for other workers to initialize...
Worker 174741056 initialized. Waiting for other workers to initialize...
Worker 157955648 initialized. Waiting for other workers to initialize...
Worker 141170240 initialized. Waiting for other workers to initialize...
Worker 132777536 initialized. Waiting for other workers to initialize...
Worker 107599424 initialized. Waiting for other workers to initialize...
Worker 115992128 initialized. Waiting for other workers to initialize...
Worker 149562944 initialized. Waiting for other workers to initialize...
Worker 149562944 starting to copy files
Worker 141170240 starting to copy files
Worker 132777536 starting to copy files
Worker 107599424 starting to copy files
Worker 115992128 starting to copy files
Worker 166348352 starting to copy files
Worker 157955648 starting to copy files
Worker 174741056 starting to copy files
Worker 99206720 starting to copy files
Worker 124384832 starting to copy files
Manager thread completed
Worker 107599424 completed copying. Waiting for other workers to complete...
Worker 174741056 completed copying. Waiting for other workers to complete...
Worker 132777536 completed copying. Waiting for other workers to complete...
Worker 115992128 completed copying. Waiting for other workers to complete...
Worker 141170240 completed copying. Waiting for other workers to complete...
Worker 99206720 completed copying. Waiting for other workers to complete...
Worker 166348352 completed copying. Waiting for other workers to complete...
Worker 149562944 completed copying. Waiting for other workers to complete...
Worker 124384832 completed copying. Waiting for other workers to complete...
Worker 157955648 completed copying. Waiting for other workers to complete...
Worker 132777536 exiting
Worker 141170240 exiting
Worker 157955648 exiting
Worker 99206720 exiting
Worker 149562944 exiting
Worker 107599424 exiting
Worker 166348352 exiting
Worker 174741056 exiting
Worker 115992128 exiting
Worker 124384832 exiting
Copy statistics are as follows:
Execution time: 0.629620 seconds
Regular files: 194
Directories: 7
Bytes: 25009680
==10988==
==10988== HEAP SUMMARY:
==10988==   in use at exit: 0 bytes in 0 blocks
==10988==   total heap usage: 22 allocs, 22 frees, 266,704 bytes allocated
==10988==
==10988== All heap blocks were freed -- no leaks are possible
==10988==
==10988== For lists of detected and suppressed errors, rerun with: -s
==10988== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
erengeren-Lenovo-Ideapad-330-15IKB:~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$

```

Figure 1: Normal execution

7.1.2 SIGINT Handling

Below it is shown both user pressing `ctrl+c` at the start of the execution and at the finishing stage, where worker threads are waiting for finishing barrier.

```

eren@eren-Lenovo-ideapad-330-151KB: ~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$ valgrind ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==11167== Memcheck, a memory error detector
==11167== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==11167== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==11167== Command: ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==11167==
^CWorker 99206720 initialized. Waiting for other workers to initialize...
Worker 115992128 initialized. Waiting for other workers to initialize...
Worker 157955648 initialized. Waiting for other workers to initialize...
Manager thread completed
Worker 166348352 initialized. Waiting for other workers to initialize...
Worker 107599424 initialized. Waiting for other workers to initialize...
Worker 124384832 initialized. Waiting for other workers to initialize...
Worker 174741056 initialized. Waiting for other workers to initialize...
Worker 132777536 initialized. Waiting for other workers to initialize...
Worker 141170240 initialized. Waiting for other workers to initialize...
Worker 149562944 initialized. Waiting for other workers to initialize...
Worker 99206720 starting to copy files
Worker 99206720 interrupted
Worker 115992128 starting to copy files
Worker 115992128 interrupted
Worker 157955648 starting to copy files
Worker 157955648 interrupted
Worker 107599424 starting to copy files
Worker 107599424 interrupted
Worker 124384832 starting to copy files
Worker 124384832 interrupted
Worker 141170240 starting to copy files
Worker 141170240 interrupted
Worker 174741056 starting to copy files
Worker 174741056 interrupted
Worker 166348352 starting to copy files
Worker 166348352 interrupted
Worker 149562944 starting to copy files
Worker 149562944 interrupted
Worker 132777536 starting to copy files
Worker 132777536 interrupted
Copy statistics are as follows:
Execution time: 0.312379 seconds
Regular files: 0
Directories: 0
Bytes: 0
==11167==
==11167== HEAP SUMMARY:
==11167==   in use at exit: 0 bytes in 0 blocks
==11167==   total heap usage: 15 allocs, 15 frees, 36,992 bytes allocated
==11167==
==11167== All heap blocks were freed -- no leaks are possible
==11167==
==11167== For lists of detected and suppressed errors, rerun with: -s
==11167== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
eren@eren-Lenovo-ideapad-330-151KB: ~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$

```

Figure 2: SIGINT at the start

```

==11195== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==11195== Command: ./MMCP 10 10 ../testdir/src/libvterm ../tocopy
==11195==
Worker 99206720 initialized. Waiting for other workers to initialize...
Worker 149562944 initialized. Waiting for other workers to initialize...
Worker 124384832 initialized. Waiting for other workers to initialize...
Worker 166348352 initialized. Waiting for other workers to initialize...
Worker 107599424 initialized. Waiting for other workers to initialize...
Worker 132777536 initialized. Waiting for other workers to initialize...
Worker 115992128 initialized. Waiting for other workers to initialize...
Worker 157955648 initialized. Waiting for other workers to initialize...
Worker 174741056 initialized. Waiting for other workers to initialize...
Worker 141170240 initialized. Waiting for other workers to initialize...
Worker 107599424 starting to copy files
Worker 115992128 starting to copy files
Worker 124384832 starting to copy files
Worker 174741056 starting to copy files
Worker 132777536 starting to copy files
Worker 149562944 starting to copy files
Worker 141170240 starting to copy files
Worker 157955648 starting to copy files
Worker 99206720 starting to copy files
Worker 166348352 starting to copy files
Manager thread completed
Worker 166348352 completed copying. Waiting for other workers to complete...
Worker 99206720 completed copying. Waiting for other workers to complete...
Worker 115992128 completed copying. Waiting for other workers to complete...
Worker 124384832 completed copying. Waiting for other workers to complete...
Worker 132777536 completed copying. Waiting for other workers to complete...
Worker 141170240 completed copying. Waiting for other workers to complete...
Worker 174741056 completed copying. Waiting for other workers to complete...
Worker 157955648 completed copying. Waiting for other workers to complete...
Worker 107599424 completed copying. Waiting for other workers to complete...
^CWorker 149562944 interrupted
Worker 166348352 exiting
Worker 174741056 exiting
Worker 99206720 exiting
Worker 132777536 exiting
Worker 115992128 exiting
Worker 124384832 exiting
Worker 107599424 exiting
Worker 141170240 exiting
Worker 157955648 exiting
Copy statistics are as follows:
Execution time: 0.628130 seconds
Regular files: 194
Directories: 7
Bytes: 25009680
==11195==
==11195== HEAP SUMMARY:
==11195==    in use at exit: 0 bytes in 0 blocks
==11195==   total heap usage: 22 allocs, 22 frees, 266,704 bytes allocated
==11195==
==11195== All heap blocks were freed -- no leaks are possible
==11195==
==11195== For lists of detected and suppressed errors, rerun with: -s
==11195== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)

```

Figure 3: SIGINT at the end

These tests prove the barriers do not prevent user from signaling termination.

7.2 `./MWCp 10 4 ../testdir/src/libvterm/src ../tocopy`

```
eren@eren-Lenovo-Ideapad-330-15IKB: ~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$ ./MWCp 10 4 ../testdir/src/libvterm/src ../to
copy
Worker 137607145055808 initialized. Waiting for other workers to initialize...
Worker 137607128270400 initialized. Waiting for other workers to initialize...
Worker 137607136663104 initialized. Waiting for other workers to initialize...
Worker 137607119877696 initialized. Waiting for other workers to initialize...
Worker 137607119877696 starting to copy files
Worker 137607128270400 starting to copy files
Worker 137607136663104 starting to copy files
Worker 137607145055808 starting to copy files
Manager thread completed
Worker 137607119877696 completed copying. Waiting for other workers to complete...
Worker 137607136663104 completed copying. Waiting for other workers to complete...
Worker 137607128270400 completed copying. Waiting for other workers to complete...
Worker 137607145055808 completed copying. Waiting for other workers to complete...
Worker 137607145055808 exiting
Worker 137607119877696 exiting
Worker 137607136663104 exiting
Worker 137607128270400 exiting
Copy statistics are as follows:
Execution time: 0.065956 seconds
Regular files: 140
Directories: 2
Bytes: 24873082
eren@eren-Lenovo-Ideapad-330-15IKB: ~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$
```

Figure 4: Normal execution

7.3 `./MWCp 10 100 ../testdir ../tocopy`

The cursor markings in the screenshots below are to ensure that screenshots do indeed overlap and no output is overlooked.

7.3.1 Normal Execution

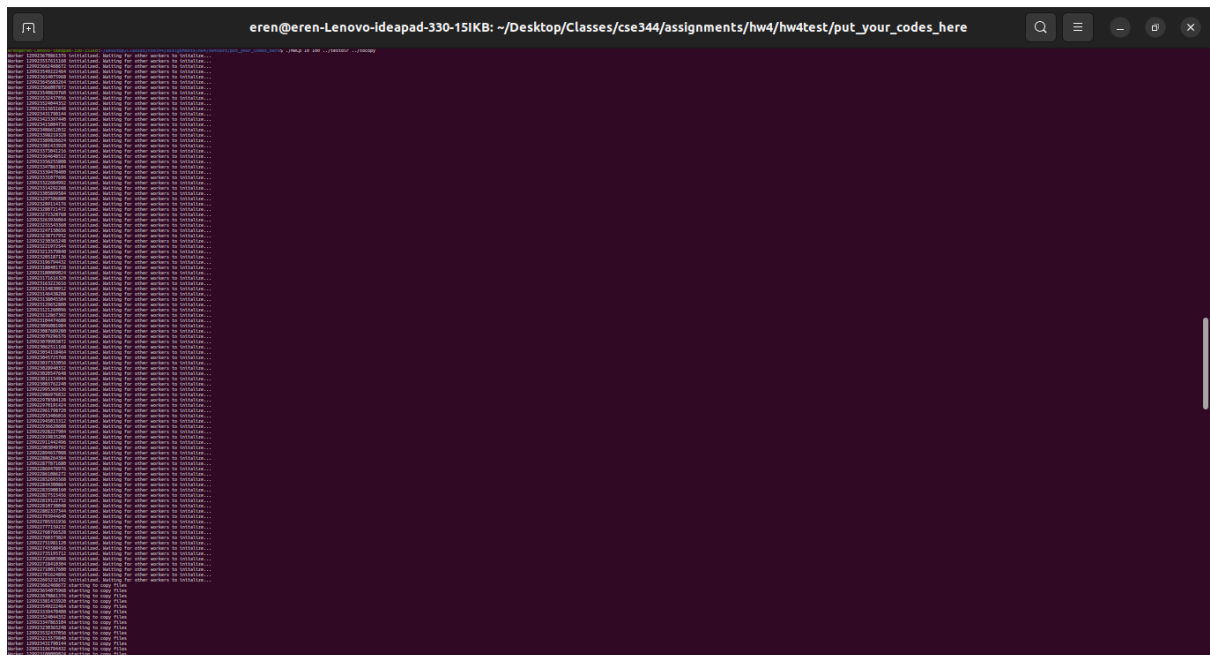


Figure 5: Normal execution part 1

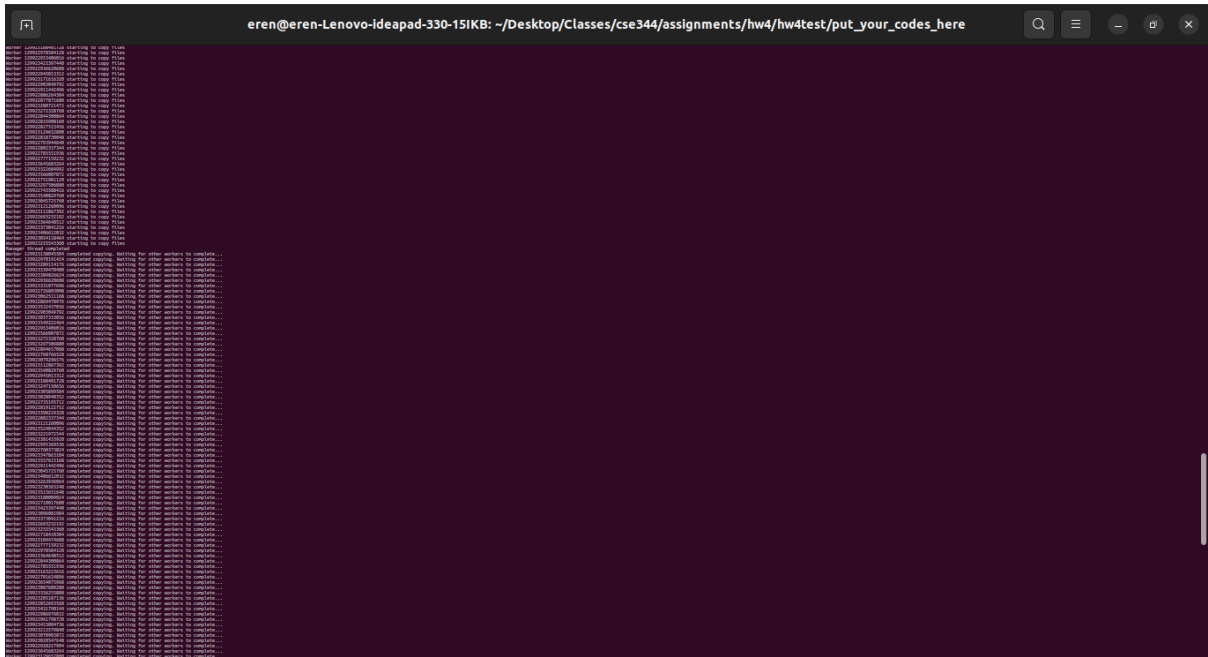


Figure 6: Normal execution part 2

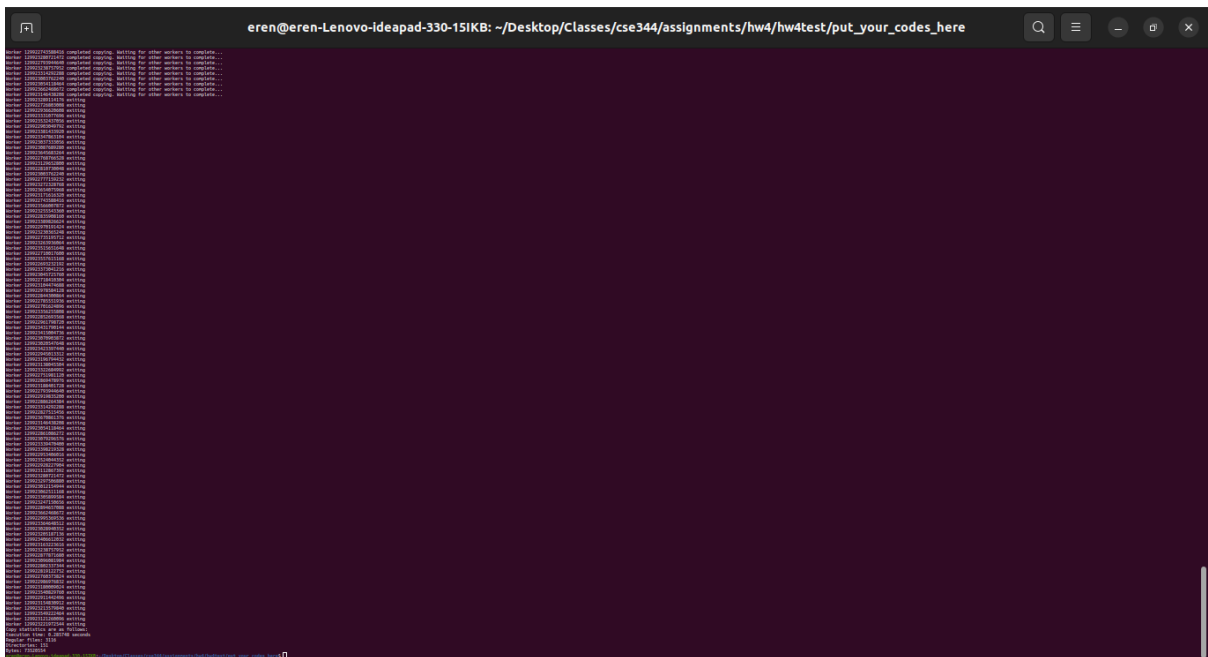


Figure 7: Normal execution part 3

Due to the great length of the output of this execution, it is rather hard to see on the screenshots. It is therefore copied below:

```
Worker 129923670861376 initialized. Waiting for other workers to initalize...
Worker 129923557615168 initialized. Waiting for other workers to initalize...
Worker 129923662468672 initialized. Waiting for other workers to initalize...
Worker 129923549222464 initialized. Waiting for other workers to initalize...
Worker 129923654075968 initialized. Waiting for other workers to initalize...
Worker 129923645683264 initialized. Waiting for other workers to initalize...
```

[illegible]

Worker 129922986976832 initialized. Waiting for other workers to initalize...
Worker 129922978584128 initialized. Waiting for other workers to initalize...
Worker 129922970191424 initialized. Waiting for other workers to initalize...
Worker 129922961798720 initialized. Waiting for other workers to initalize...
Worker 129922953406016 initialized. Waiting for other workers to initalize...
Worker 129922945013312 initialized. Waiting for other workers to initalize...
Worker 129922936620608 initialized. Waiting for other workers to initalize...
Worker 129922928227904 initialized. Waiting for other workers to initalize...
Worker 129922919835200 initialized. Waiting for other workers to initalize...
Worker 129922911442496 initialized. Waiting for other workers to initalize...
Worker 129922903049792 initialized. Waiting for other workers to initalize...
Worker 129922894657088 initialized. Waiting for other workers to initalize...
Worker 129922886264384 initialized. Waiting for other workers to initalize...
Worker 129922877871680 initialized. Waiting for other workers to initalize...
Worker 129922869478976 initialized. Waiting for other workers to initalize...
Worker 129922861086272 initialized. Waiting for other workers to initalize...
Worker 129922852693568 initialized. Waiting for other workers to initalize...
Worker 129922844300864 initialized. Waiting for other workers to initalize...
Worker 129922835908160 initialized. Waiting for other workers to initalize...
Worker 129922827515456 initialized. Waiting for other workers to initalize...
Worker 129922819122752 initialized. Waiting for other workers to initalize...
Worker 129922810730048 initialized. Waiting for other workers to initalize...
Worker 129922802337344 initialized. Waiting for other workers to initalize...
Worker 129922793944640 initialized. Waiting for other workers to initalize...
Worker 129922785551936 initialized. Waiting for other workers to initalize...
Worker 129922777159232 initialized. Waiting for other workers to initalize...
Worker 129922768766528 initialized. Waiting for other workers to initalize...
Worker 129922760373824 initialized. Waiting for other workers to initalize...
Worker 129922751981120 initialized. Waiting for other workers to initalize...
Worker 129922743588416 initialized. Waiting for other workers to initalize...
Worker 129922735195712 initialized. Waiting for other workers to initalize...
Worker 129922726803008 initialized. Waiting for other workers to initalize...
Worker 129922718410304 initialized. Waiting for other workers to initalize...
Worker 129922710017600 initialized. Waiting for other workers to initalize...
Worker 129922701624896 initialized. Waiting for other workers to initalize...
Worker 129922693232192 initialized. Waiting for other workers to initalize...
Worker 129923662468672 starting to copy files
Worker 129923654075968 starting to copy files
Worker 129923670861376 starting to copy files
Worker 129923381433920 starting to copy files
Worker 129923549222464 starting to copy files
Worker 129923339470400 starting to copy files
Worker 129923524044352 starting to copy files
Worker 129923347863104 starting to copy files
Worker 129923230365248 starting to copy files
Worker 129923532437056 starting to copy files
Worker 129923213579840 starting to copy files
Worker 129923431790144 starting to copy files
Worker 129923196794432 starting to copy files
Worker 129923180009024 starting to copy files
Worker 129923389826624 starting to copy files
Worker 129923163223616 starting to copy files
Worker 129923146438208 starting to copy files
Worker 129923557615168 starting to copy files
Worker 129923138045504 starting to copy files
Worker 129923104474688 starting to copy files
Worker 129923079296576 starting to copy files
Worker 129923356255808 starting to copy files

Worker 129923070903872 starting to copy files
Worker 129923037333056 starting to copy files
Worker 129923028940352 starting to copy files
Worker 129923012154944 starting to copy files
Worker 129923020547648 starting to copy files
Worker 129922986976832 starting to copy files
Worker 129923205187136 starting to copy files
Worker 129922970191424 starting to copy files
Worker 129922961798720 starting to copy files
Worker 129922928227904 starting to copy files
Worker 129922919835200 starting to copy files
Worker 129922894657088 starting to copy files
Worker 129923154830912 starting to copy files
Worker 129922869478976 starting to copy files
Worker 129922861086272 starting to copy files
Worker 129922852693568 starting to copy files
Worker 129922819122752 starting to copy files
Worker 129923263936064 starting to copy files
Worker 129922768766528 starting to copy files
Worker 129922760373824 starting to copy files
Worker 129923247150656 starting to copy files
Worker 129923096081984 starting to copy files
Worker 129923314292288 starting to copy files
Worker 129923305899584 starting to copy files
Worker 129923238757952 starting to copy files
Worker 129923087689280 starting to copy files
Worker 129923289114176 starting to copy files
Worker 129923062511168 starting to copy files
Worker 129923515651648 starting to copy files
Worker 129922735195712 starting to copy files
Worker 129922726803008 starting to copy files
Worker 129922718410304 starting to copy files
Worker 129922710017600 starting to copy files
Worker 129922701624896 starting to copy files
Worker 129923398219328 starting to copy files
Worker 129923331077696 starting to copy files
Worker 129923221972544 starting to copy files
Worker 129922995369536 starting to copy files
Worker 129923003762240 starting to copy files
Worker 129923415004736 starting to copy files
Worker 129923188401728 starting to copy files
Worker 129922978584128 starting to copy files
Worker 129922953406016 starting to copy files
Worker 129923423397440 starting to copy files
Worker 129922936620608 starting to copy files
Worker 129922945013312 starting to copy files
Worker 129923171616320 starting to copy files
Worker 129922903049792 starting to copy files
Worker 129922911442496 starting to copy files
Worker 129922886264384 starting to copy files
Worker 129922877871680 starting to copy files
Worker 129923280721472 starting to copy files
Worker 129923272328768 starting to copy files
Worker 129922844300864 starting to copy files
Worker 129922835908160 starting to copy files
Worker 129922827515456 starting to copy files
Worker 129923129652800 starting to copy files
Worker 129922810730048 starting to copy files

Worker 129922793944640 starting to copy files
Worker 129922802337344 starting to copy files
Worker 129922785551936 starting to copy files
Worker 129922777159232 starting to copy files
Worker 129923645683264 starting to copy files
Worker 129923322684992 starting to copy files
Worker 129923566007872 starting to copy files
Worker 129922751981120 starting to copy files
Worker 129923297506880 starting to copy files
Worker 129922743588416 starting to copy files
Worker 129923540829760 starting to copy files
Worker 129923045725760 starting to copy files
Worker 129923121260096 starting to copy files
Worker 129923112867392 starting to copy files
Worker 129922693232192 starting to copy files
Worker 129923364648512 starting to copy files
Worker 129923373041216 starting to copy files
Worker 129923406612032 starting to copy files
Worker 129923054118464 starting to copy files
Worker 129923255543360 starting to copy files
Manager thread completed
Worker 129923138045504 completed copying. Waiting for other workers to complete...
Worker 129922970191424 completed copying. Waiting for other workers to complete...
Worker 129923289114176 completed copying. Waiting for other workers to complete...
Worker 129923339470400 completed copying. Waiting for other workers to complete...
Worker 129923389826624 completed copying. Waiting for other workers to complete...
Worker 129922936620608 completed copying. Waiting for other workers to complete...
Worker 129923331077696 completed copying. Waiting for other workers to complete...
Worker 129922726803008 completed copying. Waiting for other workers to complete...
Worker 129923062511168 completed copying. Waiting for other workers to complete...
Worker 129922869478976 completed copying. Waiting for other workers to complete...
Worker 129923532437056 completed copying. Waiting for other workers to complete...
Worker 129922903049792 completed copying. Waiting for other workers to complete...
Worker 129923037333056 completed copying. Waiting for other workers to complete...
Worker 129923549222464 completed copying. Waiting for other workers to complete...
Worker 129922953406016 completed copying. Waiting for other workers to complete...
Worker 129923566007872 completed copying. Waiting for other workers to complete...
Worker 129923272328768 completed copying. Waiting for other workers to complete...
Worker 129923297506880 completed copying. Waiting for other workers to complete...
Worker 129922894657088 completed copying. Waiting for other workers to complete...
Worker 129922768766528 completed copying. Waiting for other workers to complete...
Worker 129923079296576 completed copying. Waiting for other workers to complete...
Worker 129923112867392 completed copying. Waiting for other workers to complete...
Worker 129923540829760 completed copying. Waiting for other workers to complete...
Worker 129922945013312 completed copying. Waiting for other workers to complete...
Worker 129923188401728 completed copying. Waiting for other workers to complete...
Worker 129923247150656 completed copying. Waiting for other workers to complete...
Worker 129923305899584 completed copying. Waiting for other workers to complete...
Worker 129923028940352 completed copying. Waiting for other workers to complete...
Worker 129922735195712 completed copying. Waiting for other workers to complete...
Worker 129922819122752 completed copying. Waiting for other workers to complete...
Worker 129923398219328 completed copying. Waiting for other workers to complete...
Worker 129922802337344 completed copying. Waiting for other workers to complete...
Worker 129923121260096 completed copying. Waiting for other workers to complete...
Worker 129923524044352 completed copying. Waiting for other workers to complete...
Worker 129923221972544 completed copying. Waiting for other workers to complete...
Worker 129923381433920 completed copying. Waiting for other workers to complete...
Worker 129922995369536 completed copying. Waiting for other workers to complete...

Worker 129922760373824 completed copying. Waiting for other workers to complete...
Worker 129923347863104 completed copying. Waiting for other workers to complete...
Worker 129923557615168 completed copying. Waiting for other workers to complete...
Worker 129922911442496 completed copying. Waiting for other workers to complete...
Worker 129923045725760 completed copying. Waiting for other workers to complete...
Worker 129923406612032 completed copying. Waiting for other workers to complete...
Worker 129923263936064 completed copying. Waiting for other workers to complete...
Worker 129923230365248 completed copying. Waiting for other workers to complete...
Worker 129923515651648 completed copying. Waiting for other workers to complete...
Worker 129923180009024 completed copying. Waiting for other workers to complete...
Worker 129922710017600 completed copying. Waiting for other workers to complete...
Worker 129923423397440 completed copying. Waiting for other workers to complete...
Worker 129923096081984 completed copying. Waiting for other workers to complete...
Worker 129923373041216 completed copying. Waiting for other workers to complete...
Worker 129922693232192 completed copying. Waiting for other workers to complete...
Worker 129923255543360 completed copying. Waiting for other workers to complete...
Worker 129922718410304 completed copying. Waiting for other workers to complete...
Worker 129923104474688 completed copying. Waiting for other workers to complete...
Worker 129922777159232 completed copying. Waiting for other workers to complete...
Worker 129922978584128 completed copying. Waiting for other workers to complete...
Worker 129923364648512 completed copying. Waiting for other workers to complete...
Worker 129922844300864 completed copying. Waiting for other workers to complete...
Worker 129922785551936 completed copying. Waiting for other workers to complete...
Worker 129923163223616 completed copying. Waiting for other workers to complete...
Worker 129922701624896 completed copying. Waiting for other workers to complete...
Worker 129923654075968 completed copying. Waiting for other workers to complete...
Worker 129923087689280 completed copying. Waiting for other workers to complete...
Worker 129923356255808 completed copying. Waiting for other workers to complete...
Worker 129923205187136 completed copying. Waiting for other workers to complete...
Worker 129922852693568 completed copying. Waiting for other workers to complete...
Worker 129923431790144 completed copying. Waiting for other workers to complete...
Worker 129922986976832 completed copying. Waiting for other workers to complete...
Worker 129922961798720 completed copying. Waiting for other workers to complete...
Worker 129923415004736 completed copying. Waiting for other workers to complete...
Worker 129923213579840 completed copying. Waiting for other workers to complete...
Worker 129923070903872 completed copying. Waiting for other workers to complete...
Worker 129923020547648 completed copying. Waiting for other workers to complete...
Worker 129922928227904 completed copying. Waiting for other workers to complete...
Worker 129923645683264 completed copying. Waiting for other workers to complete...
Worker 129923129652800 completed copying. Waiting for other workers to complete...
Worker 129922835908160 completed copying. Waiting for other workers to complete...
Worker 129922919835200 completed copying. Waiting for other workers to complete...
Worker 129923196794432 completed copying. Waiting for other workers to complete...
Worker 129923012154944 completed copying. Waiting for other workers to complete...
Worker 129923154830912 completed copying. Waiting for other workers to complete...
Worker 129923171616320 completed copying. Waiting for other workers to complete...
Worker 129922810730048 completed copying. Waiting for other workers to complete...
Worker 129923322684992 completed copying. Waiting for other workers to complete...
Worker 129922751981120 completed copying. Waiting for other workers to complete...
Worker 129922861086272 completed copying. Waiting for other workers to complete...
Worker 129922886264384 completed copying. Waiting for other workers to complete...
Worker 129922877871680 completed copying. Waiting for other workers to complete...
Worker 129923670861376 completed copying. Waiting for other workers to complete...
Worker 129922827515456 completed copying. Waiting for other workers to complete...
Worker 129922743588416 completed copying. Waiting for other workers to complete...
Worker 129923280721472 completed copying. Waiting for other workers to complete...
Worker 129922793944640 completed copying. Waiting for other workers to complete...
Worker 129923238757952 completed copying. Waiting for other workers to complete...

Worker 129923314292288 completed copying. Waiting for other workers to complete...
Worker 129923003762240 completed copying. Waiting for other workers to complete...
Worker 129923054118464 completed copying. Waiting for other workers to complete...
Worker 129923662468672 completed copying. Waiting for other workers to complete...
Worker 129923146438208 completed copying. Waiting for other workers to complete...
Worker 129923289114176 exiting
Worker 129922726803008 exiting
Worker 129922936620608 exiting
Worker 129923331077696 exiting
Worker 129923532437056 exiting
Worker 129922903049792 exiting
Worker 129923381433920 exiting
Worker 129923347863104 exiting
Worker 129923037333056 exiting
Worker 129923087689280 exiting
Worker 129923645683264 exiting
Worker 129922768766528 exiting
Worker 129923129652800 exiting
Worker 129922810730048 exiting
Worker 129923003762240 exiting
Worker 129922777159232 exiting
Worker 129923272328768 exiting
Worker 129923654075968 exiting
Worker 129923171616320 exiting
Worker 129922743588416 exiting
Worker 129923566007872 exiting
Worker 129923255543360 exiting
Worker 129922835908160 exiting
Worker 129923389826624 exiting
Worker 129922970191424 exiting
Worker 129923230365248 exiting
Worker 129922735195712 exiting
Worker 129923263936064 exiting
Worker 129923515651648 exiting
Worker 129922710017600 exiting
Worker 129923557615168 exiting
Worker 129922693232192 exiting
Worker 129923373041216 exiting
Worker 129923045725760 exiting
Worker 129922718410304 exiting
Worker 129923104474688 exiting
Worker 129922978584128 exiting
Worker 129922844300864 exiting
Worker 129922785551936 exiting
Worker 129922701624896 exiting
Worker 129923356255808 exiting
Worker 129922852693568 exiting
Worker 129922961798720 exiting
Worker 129923431790144 exiting
Worker 129923415004736 exiting
Worker 129923070903872 exiting
Worker 129923020547648 exiting
Worker 129923423397440 exiting
Worker 129922945013312 exiting
Worker 129923196794432 exiting
Worker 129923138045504 exiting
Worker 129923322684992 exiting
Worker 129922751981120 exiting

Worker 129922869478976 exiting
Worker 129923188401728 exiting
Worker 129922793944640 exiting
Worker 129922919835200 exiting
Worker 129922886264384 exiting
Worker 129923314292288 exiting
Worker 129922827515456 exiting
Worker 129923670861376 exiting
Worker 129923146438208 exiting
Worker 129923054118464 exiting
Worker 129922861086272 exiting
Worker 129923079296576 exiting
Worker 129923339470400 exiting
Worker 129923398219328 exiting
Worker 129922953406016 exiting
Worker 129923524044352 exiting
Worker 129922928227904 exiting
Worker 129923112867392 exiting
Worker 129923280721472 exiting
Worker 129923297506880 exiting
Worker 129923012154944 exiting
Worker 129923062511168 exiting
Worker 129923305899584 exiting
Worker 129923247150656 exiting
Worker 129922894657088 exiting
Worker 129923662468672 exiting
Worker 129922995369536 exiting
Worker 129923364648512 exiting
Worker 129923028940352 exiting
Worker 129923205187136 exiting
Worker 129923406612032 exiting
Worker 129923163223616 exiting
Worker 129923238757952 exiting
Worker 129922877871680 exiting
Worker 129923096081984 exiting
Worker 129922802337344 exiting
Worker 129922819122752 exiting
Worker 129922760373824 exiting
Worker 129922986976832 exiting
Worker 129923180009024 exiting
Worker 129923540829760 exiting
Worker 129922911442496 exiting
Worker 129923154830912 exiting
Worker 129923213579840 exiting
Worker 129923549222464 exiting
Worker 129923121260096 exiting
Worker 129923221972544 exiting
Copy statistics are as follows:
Execution time: 0.285748 seconds
Regular files: 3116
Directories: 151
Bytes: 73520554

7.3.2 SIGINT Handling

In this section the user presses `ctrl+c` in the middle of the process.


```

gcc -Wall -pthread -c buffer.c
gcc -Wall -pthread -o MMCP 1901042656_main.o manager.o worker.o buffer.o transaction.o stats.o
erengeren-Lenovo-Ideapad-330-151KB:~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$ ./MMCP 10 100 ../testdir ../tocopy
Worker 124298566030912 initialized. Waiting for other workers to initialize...
Worker 124298557638208 initialized. Waiting for other workers to initialize...
Worker 124298574423616 initialized. Waiting for other workers to initialize...
Worker 124298549245504 initialized. Waiting for other workers to initialize...
Worker 124298532460096 initialized. Waiting for other workers to initialize...
Worker 124298524067392 initialized. Waiting for other workers to initialize...
Worker 124298540852800 initialized. Waiting for other workers to initialize...
Worker 124298515674688 initialized. Waiting for other workers to initialize...
Worker 124298433918528 initialized. Waiting for other workers to initialize...
Worker 124298425525824 initialized. Waiting for other workers to initialize...
Worker 124298417133120 initialized. Waiting for other workers to initialize...
Worker 124298408740416 initialized. Waiting for other workers to initialize...
Worker 124298400347712 initialized. Waiting for other workers to initialize...
Worker 124298391955008 initialized. Waiting for other workers to initialize...
Worker 124298383562304 initialized. Waiting for other workers to initialize...
Worker 124298299700800 initialized. Waiting for other workers to initialize...
Worker 124298291308096 initialized. Waiting for other workers to initialize...
Worker 124298282915392 initialized. Waiting for other workers to initialize...
Worker 124298274522688 initialized. Waiting for other workers to initialize...
Worker 124298266129984 initialized. Waiting for other workers to initialize...
Worker 124298249344576 initialized. Waiting for other workers to initialize...
Worker 124298240951872 initialized. Waiting for other workers to initialize...
Worker 124298257737280 initialized. Waiting for other workers to initialize...
Worker 124298232559168 initialized. Waiting for other workers to initialize...
Worker 124298224166464 initialized. Waiting for other workers to initialize...
Worker 124298215773760 initialized. Waiting for other workers to initialize...
Worker 124298198988352 initialized. Waiting for other workers to initialize...
Worker 124298190595648 initialized. Waiting for other workers to initialize...
Worker 124298207381056 initialized. Waiting for other workers to initialize...
Worker 124298182202944 initialized. Waiting for other workers to initialize...
Worker 124298173810240 initialized. Waiting for other workers to initialize...
Worker 124298165417536 initialized. Waiting for other workers to initialize...
Worker 124298157024832 initialized. Waiting for other workers to initialize...
Worker 124298148632128 initialized. Waiting for other workers to initialize...
Worker 124298140239424 initialized. Waiting for other workers to initialize...
Worker 124298131846720 initialized. Waiting for other workers to initialize...
Worker 124298123454016 initialized. Waiting for other workers to initialize...
Worker 124298115061312 initialized. Waiting for other workers to initialize...
Worker 124298106668608 initialized. Waiting for other workers to initialize...
Worker 12429809275008 initialized. Waiting for other workers to initialize...

```

Figure 8: SIGINT handling part 1

```

Worker 124298106668608 initialized. Waiting for other workers to initialize...
Worker 124298098275904 initialized. Waiting for other workers to initialize...
Worker 124298089883200 initialized. Waiting for other workers to initialize...
Worker 124298081490496 initialized. Waiting for other workers to initialize...
Worker 124298073097792 initialized. Waiting for other workers to initialize...
Worker 124298064785088 initialized. Waiting for other workers to initialize...
Worker 124298056312384 initialized. Waiting for other workers to initialize...
Worker 124298047919680 initialized. Waiting for other workers to initialize...
Worker 124298039526976 initialized. Waiting for other workers to initialize...
Worker 124298031134272 initialized. Waiting for other workers to initialize...
Worker 124298022741568 initialized. Waiting for other workers to initialize...
Worker 124298014348864 initialized. Waiting for other workers to initialize...
Worker 124298005956160 initialized. Waiting for other workers to initialize...
Worker 124297997563456 initialized. Waiting for other workers to initialize...
Worker 124297989170752 initialized. Waiting for other workers to initialize...
Worker 124297980778048 initialized. Waiting for other workers to initialize...
Worker 124297972385344 initialized. Waiting for other workers to initialize...
Worker 124297963992640 initialized. Waiting for other workers to initialize...
Worker 124297955599936 initialized. Waiting for other workers to initialize...
Worker 124297947207232 initialized. Waiting for other workers to initialize...
Worker 124297938814528 initialized. Waiting for other workers to initialize...
Worker 124297930421824 initialized. Waiting for other workers to initialize...
Worker 124297922029120 initialized. Waiting for other workers to initialize...
Worker 124297913636416 initialized. Waiting for other workers to initialize...
Worker 124297905243712 initialized. Waiting for other workers to initialize...
Worker 124297896851008 initialized. Waiting for other workers to initialize...
Worker 124297888458304 initialized. Waiting for other workers to initialize...
Worker 124297880065600 initialized. Waiting for other workers to initialize...
Worker 124297871672896 initialized. Waiting for other workers to initialize...
Worker 124297863280192 initialized. Waiting for other workers to initialize...
Worker 124297854887488 initialized. Waiting for other workers to initialize...
Worker 124297846494784 initialized. Waiting for other workers to initialize...
Worker 124297838102080 initialized. Waiting for other workers to initialize...
Worker 124297829709376 initialized. Waiting for other workers to initialize...
Worker 124297821316672 initialized. Waiting for other workers to initialize...
Worker 124297812923968 initialized. Waiting for other workers to initialize...
Worker 124297804531264 initialized. Waiting for other workers to initialize...
Worker 124297796138560 initialized. Waiting for other workers to initialize...
Worker 124297787745856 initialized. Waiting for other workers to initialize...
Worker 124297779353152 initialized. Waiting for other workers to initialize...
Worker 124297770960448 initialized. Waiting for other workers to initialize...
Worker 124297762567744 initialized. Waiting for other workers to initialize...
Worker 124297754175040 initialized. Waiting for other workers to initialize...

```

Figure 9: SIGINT handling part 2

```

Worker 124297770960448 initialized. Waiting for other workers to initialize...
Worker 124297762567744 initialized. Waiting for other workers to initialize...
Worker 124297754175040 initialized. Waiting for other workers to initialize...
Worker 124297745782336 initialized. Waiting for other workers to initialize...
Worker 124297737389632 initialized. Waiting for other workers to initialize...
Worker 124297728996928 initialized. Waiting for other workers to initialize...
Worker 124297720604224 initialized. Waiting for other workers to initialize...
Worker 124297712211520 initialized. Waiting for other workers to initialize...
Worker 124297703818816 initialized. Waiting for other workers to initialize...
Worker 124297695426112 initialized. Waiting for other workers to initialize...
Worker 124297687033408 initialized. Waiting for other workers to initialize...
Worker 124297678640704 initialized. Waiting for other workers to initialize...
Worker 124297670248000 initialized. Waiting for other workers to initialize...
Worker 124297661855296 initialized. Waiting for other workers to initialize...
Worker 124297653462592 initialized. Waiting for other workers to initialize...
Worker 124297645069888 initialized. Waiting for other workers to initialize...
Worker 124297636677184 initialized. Waiting for other workers to initialize...
Worker 124297628284480 initialized. Waiting for other workers to initialize...
Worker 124297619891776 initialized. Waiting for other workers to initialize...
Worker 124297611499872 initialized. Waiting for other workers to initialize...
Worker 124297603106368 initialized. Waiting for other workers to initialize...
Worker 124297594713664 initialized. Waiting for other workers to initialize...
Worker 124298574423616 starting to copy files
Worker 124298524067392 starting to copy files
Worker 124298515674688 starting to copy files
Worker 124298224166464 starting to copy files
Worker 124298557638208 starting to copy files
Worker 124298257737280 starting to copy files
Worker 124298433918528 starting to copy files
Worker 124298215773760 starting to copy files
Worker 124298207381056 starting to copy files
Worker 124298182202944 starting to copy files
Worker 124297871672896 starting to copy files
Worker 124298417133120 starting to copy files
Worker 124297779353152 starting to copy files
Worker 124298549245504 starting to copy files
Worker 124298232559168 starting to copy files
Worker 124298566030912 starting to copy files
Worker 124297594713664 starting to copy files
Worker 124298173810240 starting to copy files
Worker 124298391955008 starting to copy files
Worker 124298157024832 starting to copy files
Worker 12429776091328 starting to copy files

```

Figure 10: SIGINT handling part 3

```

Worker 124298391955008 starting to copy files
Worker 124298157024832 starting to copy files
Worker 124297645069888 starting to copy files
Worker 124298115061312 starting to copy files
Worker 124298098275904 starting to copy files
Worker 124298282915392 starting to copy files
Worker 124298056312384 starting to copy files
Worker 124298047919680 starting to copy files
Worker 124298039526976 starting to copy files
Worker 124298031134272 starting to copy files
Worker 124298022741568 starting to copy files
Worker 124298014348864 starting to copy files
Worker 124298005956160 starting to copy files
Worker 124297997563456 starting to copy files
Worker 124297989170752 starting to copy files
Worker 124297980778048 starting to copy files
Worker 124297972385344 starting to copy files
Worker 124298249344576 starting to copy files
Worker 124297947207232 starting to copy files
Worker 124298240951872 starting to copy files
Worker 124297930421824 starting to copy files
Worker 124298190595648 starting to copy files
Worker 124297922029120 starting to copy files
Worker 124297913636416 starting to copy files
Worker 124297905243712 starting to copy files
Worker 124297888458304 starting to copy files
Worker 124297863280192 starting to copy files
Worker 124298165417536 starting to copy files
Worker 124297846494784 starting to copy files
Worker 124297838102080 starting to copy files
Worker 124298408740416 starting to copy files
Worker 124297829709376 starting to copy files
Worker 124298425525824 starting to copy files
Worker 124297762567744 starting to copy files
Worker 124297754175040 starting to copy files
Worker 124297745782336 starting to copy files
Worker 124298123454016 starting to copy files
Worker 124298106668608 starting to copy files
Worker 124298291308096 starting to copy files
Worker 124297712211520 starting to copy files
Worker 124297687033408 starting to copy files
Worker 124297670248000 starting to copy files
Worker 12429766091328 starting to copy files

```

Figure 11: SIGINT handling part 4

```

Worker 124297687033408 starting to copy files
Worker 124297670248000 starting to copy files
Worker 124297619891776 starting to copy files
Worker 124297611499072 starting to copy files
Worker 124297603106368 starting to copy files
Worker 124298274522688 starting to copy files
Worker 124298198988352 starting to copy files
Worker 124297963992640 starting to copy files
Worker 124297955599936 starting to copy files
Worker 124297938814528 starting to copy files
Worker 124297896851008 starting to copy files
Worker 124298540852800 starting to copy files
Worker 124297880065600 starting to copy files
Worker 124298148632128 starting to copy files
Worker 124297854887488 starting to copy files
Worker 124297821316672 starting to copy files
Worker 124297812923968 starting to copy files
Worker 124297804531264 starting to copy files
Worker 124297796138560 starting to copy files
Worker 124297787745856 starting to copy files
Worker 124297770960448 starting to copy files
Worker 124298131846720 starting to copy files
Worker 124298299700800 starting to copy files
Worker 124297737389632 starting to copy files
Worker 124297728996928 starting to copy files
Worker 124297720604224 starting to copy files
Worker 124297703818816 starting to copy files
Worker 124297695426112 starting to copy files
Worker 124298532460096 starting to copy files
Worker 124298089883200 starting to copy files
Worker 124298081490496 starting to copy files
Worker 124297678640704 starting to copy files
Worker 124297653462592 starting to copy files
Worker 124297661855296 starting to copy files
Worker 124297636677184 starting to copy files
Worker 124297628284480 starting to copy files
Worker 124298383562304 starting to copy files
Worker 124298140239424 starting to copy files
Worker 124298073097792 starting to copy files
Worker 124298400347712 starting to copy files
Worker 124298266129984 starting to copy files
Worker 124298064705088 starting to copy files

```

Figure 12: SIGINT handling part 5

```

Worker 124298266129984 starting to copy files
Worker 124298064705088 starting to copy files
^CManager thread completed
Worker 124297871672896 interrupted
Worker 124298232559168 interrupted
Worker 124298515674688 interrupted
Worker 124297963992640 interrupted
Worker 124297812923968 interrupted
Worker 124298148632128 interrupted
Worker 124298549245504 interrupted
Worker 124297821316672 interrupted
Worker 124297787745856 interrupted
Worker 124297796138560 interrupted
Worker 124297804531264 interrupted
Worker 124298198988352 interrupted
Worker 124298574423616 interrupted
Worker 124298022741568 interrupted
Worker 124297880065600 interrupted
Worker 124298433918528 interrupted
Worker 124298274522688 interrupted
Worker 124297779353152 interrupted
Worker 124297611499072 interrupted
Worker 124298566030912 interrupted
Worker 124297896851008 interrupted
Worker 124298165417536 interrupted
Worker 124298131846720 interrupted
Worker 124298224166464 interrupted
Worker 124297703818816 interrupted
Worker 124298557638208 interrupted
Worker 124297955599936 interrupted
Worker 124297712211520 interrupted
Worker 124297989170752 interrupted
Worker 124298299700800 interrupted
Worker 124298098275904 interrupted
Worker 124298089883200 interrupted
Worker 124298047919680 interrupted
Worker 124297737389632 interrupted
Worker 124298257737280 interrupted
Worker 124297770960448 interrupted
Worker 124298173810240 interrupted
Worker 124298532460096 interrupted
Worker 124297636677184 interrupted
Worker 124297653462592 interrupted

```

Figure 13: SIGINT handling part 6

```

Worker 124298532460096 interrupted
Worker 124297636677184 interrupted
Worker 124297854887488 interrupted
Worker 124297997563456 interrupted
Worker 124298383562304 interrupted
Worker 124297670248000 interrupted
Worker 124297653462592 interrupted
Worker 124297678640704 interrupted
Worker 124298391955008 interrupted
Worker 124297628284480 interrupted
Worker 124297720604224 interrupted
Worker 124297846494784 interrupted
Worker 124298417133120 interrupted
Worker 124298073097792 interrupted
Worker 124298524067392 interrupted
Worker 124298400347712 interrupted
Worker 124297863280192 interrupted
Worker 124297972385344 interrupted
Worker 124298064705088 interrupted
Worker 124298115061312 interrupted
Worker 124298081490496 interrupted
Worker 124298157024832 interrupted
Worker 124297745782336 interrupted
Worker 124298425525824 interrupted
Worker 124297888458304 interrupted
Worker 124298190595648 interrupted
Worker 124297695426112 interrupted
Worker 124297645069888 interrupted
Worker 124298266129984 interrupted
Worker 124298056312384 interrupted
Worker 124297594713664 interrupted
Worker 124298005956160 interrupted
Worker 124298140239424 interrupted
Worker 124298240951872 interrupted
Worker 124298215773760 interrupted
Worker 124298039526976 interrupted
Worker 124297905243712 interrupted
Worker 124297980778048 interrupted
Worker 124297754175040 interrupted
Worker 124297947207232 interrupted
Worker 124298282915392 interrupted
Worker 124298182202944 interrupted
Worker 12429822141616 interrupted

```

Figure 14: SIGINT handling part 7

```

Worker 124298282915392 interrupted
Worker 124298182202944 interrupted
Worker 124298123454016 interrupted
Worker 124297661855296 interrupted
Worker 124298249344576 interrupted
Worker 124298014348864 interrupted
Worker 124298408740416 interrupted
Worker 124297762567744 interrupted
Worker 124297829709376 interrupted
Worker 124297619891776 interrupted
Worker 124297687033408 interrupted
Worker 124298031134272 interrupted
Worker 124297922029120 interrupted
Worker 124297930421824 interrupted
Worker 124298106668008 interrupted
Worker 124297838102080 interrupted
Worker 124297913636416 interrupted
Worker 124298540852800 interrupted
Worker 124298207381056 interrupted
Worker 124297938814528 interrupted
Worker 124297603106368 interrupted
Worker 124298291308096 interrupted
Worker 124297728996928 interrupted
Worker 124298515674688 terminated
Worker 124297611499072 terminated
Worker 124298022741568 terminated
Worker 124297880065600 terminated
Worker 124297812923968 terminated
Worker 124297963992640 terminated
Worker 124297896851008 terminated
Worker 124298131846720 terminated
Worker 124298232559168 terminated
Worker 124298148632128 terminated
Worker 124298047919680 terminated
Worker 124298257737280 terminated
Worker 124297997563456 terminated
Worker 124297838102080 terminated
Worker 124298207381056 terminated
Worker 124298198988352 terminated
Worker 124298574423616 terminated
Worker 124298299700800 terminated
Worker 124298173810240 terminated
Worker 124297907345600 terminated

```

Figure 15: SIGINT handling part 8

```

Worker 124298299700800 terminated
Worker 124298173810240 terminated
Worker 1242977787745856 terminated
Worker 124297779353152 terminated
Worker 124298566030912 terminated
Worker 124298165417536 terminated
Worker 124298224166464 terminated
Worker 124297720604224 terminated
Worker 124297796138560 terminated
Worker 124297955599936 terminated
Worker 124298549245504 terminated
Worker 124298524067392 terminated
Worker 124297703818816 terminated
Worker 124297989170752 terminated
Worker 124298073097792 terminated
Worker 124298089883200 terminated
Worker 124298098275904 terminated
Worker 124298157024832 terminated
Worker 124297737389632 terminated
Worker 124297712211520 terminated
Worker 124297770960448 terminated
Worker 124298274522688 terminated
Worker 124298532460096 terminated
Worker 124297846494784 terminated
Worker 124297821316672 terminated
Worker 124297854887488 terminated
Worker 124297636677184 terminated
Worker 124298383562304 terminated
Worker 124297653462592 terminated
Worker 124297670248000 terminated
Worker 124298391955008 terminated
Worker 124297678640704 terminated
Worker 124298056312384 terminated
Worker 124297628284480 terminated
Worker 124298039526976 terminated
Worker 124298417133120 terminated
Worker 124297754175040 terminated
Worker 124297871672896 terminated
Worker 124297863280192 terminated
Worker 124298400347712 terminated
Worker 124298064705088 terminated
Worker 124297661855296 terminated
Worker 12429815061312 terminated

```

Figure 16: SIGINT handling part 9

```

Worker 124298064705088 terminated
Worker 124297661855296 terminated
Worker 124298115061312 terminated
Worker 124298081490496 terminated
Worker 124297745782336 terminated
Worker 124297762567744 terminated
Worker 124298425525824 terminated
Worker 124297888458304 terminated
Worker 124298190595648 terminated
Worker 124297645069888 terminated
Worker 124298266129984 terminated
Worker 124298005956160 terminated
Worker 124298140239424 terminated
Worker 124297594713664 terminated
Worker 124297687033408 terminated
Worker 124298240951872 terminated
Worker 124297930421824 terminated
Worker 124297972385344 terminated
Worker 124298215773760 terminated
Worker 124297980778048 terminated
Worker 124297695426112 terminated
Worker 124297947207232 terminated
Worker 124298182202944 terminated
Worker 124298123454016 terminated
Worker 124298540852800 terminated
Worker 124298249344576 terminated
Worker 124298282915392 terminated
Worker 124297905243712 terminated
Worker 124298408740416 terminated
Worker 124298014348864 terminated
Worker 124297603106368 terminated
Worker 124297829709376 terminated
Worker 124297922029120 terminated
Worker 124298106668608 terminated
Worker 124297913636416 terminated
Worker 124297938814528 terminated
Worker 124298291308096 terminated
Worker 124297619891776 terminated
Worker 124298031134272 terminated
Worker 124297804531264 terminated
Worker 124297728996928 terminated
Worker 124298557638208 terminated
Worker 12429815061312 terminated

```

Figure 17: SIGINT handling part 10

```

Worker 124297888458304 terminated
Worker 124298190595648 terminated
Worker 124297645069888 terminated
Worker 124298266129984 terminated
Worker 124298005956160 terminated
Worker 124298140239424 terminated
Worker 124297594713664 terminated
Worker 124297687033408 terminated
Worker 124298240951872 terminated
Worker 124297930421824 terminated
Worker 124297972385344 terminated
Worker 124298215773760 terminated
Worker 124297980778048 terminated
Worker 124297695426112 terminated
Worker 124297947207232 terminated
Worker 124298182202944 terminated
Worker 124298123454016 terminated
Worker 124298540852800 terminated
Worker 124298249344576 terminated
Worker 124298282915392 terminated
Worker 124297905243712 terminated
Worker 124298408740416 terminated
Worker 124298014348864 terminated
Worker 124297603106368 terminated
Worker 124297829709376 terminated
Worker 124297922029120 terminated
Worker 124298106608008 terminated
Worker 124297913636416 terminated
Worker 124297938814528 terminated
Worker 124298291308096 terminated
Worker 124297619891776 terminated
Worker 124298031134272 terminated
Worker 124297804531264 terminated
Worker 124297728996928 terminated
Worker 124298557638208 terminated
Worker 124298433918528 terminated
Copy statistics are as follows:
Execution time: 0.134106 seconds
Regular files: 462
Directories: 22
Bytes: 39803563
erengeren-Lenovo-Ideapad-330-15IKB:~/Desktop/Classes/cse344/assignments/hw4/hw4test/put_your_codes_here$

```

Figure 18: SIGINT handling part 11

Due to the great length of the output of this execution, it is rather hard to see on the screenshots. It is therefore copied below:

```

Worker 124298566030912 initialized. Waiting for other workers to initalize...
Worker 124298557638208 initialized. Waiting for other workers to initalize...
Worker 124298574423616 initialized. Waiting for other workers to initalize...
Worker 124298549245504 initialized. Waiting for other workers to initalize...
Worker 124298532460096 initialized. Waiting for other workers to initalize...
Worker 124298524067392 initialized. Waiting for other workers to initalize...
Worker 124298540852800 initialized. Waiting for other workers to initalize...
Worker 124298515674688 initialized. Waiting for other workers to initalize...
Worker 124298433918528 initialized. Waiting for other workers to initalize...
Worker 124298425525824 initialized. Waiting for other workers to initalize...
Worker 124298417133120 initialized. Waiting for other workers to initalize...
Worker 124298408740416 initialized. Waiting for other workers to initalize...
Worker 124298400347712 initialized. Waiting for other workers to initalize...
Worker 124298391955008 initialized. Waiting for other workers to initalize...
Worker 124298383562304 initialized. Waiting for other workers to initalize...
Worker 124298299700800 initialized. Waiting for other workers to initalize...
Worker 124298291308096 initialized. Waiting for other workers to initalize...
Worker 124298282915392 initialized. Waiting for other workers to initalize...
Worker 124298274522688 initialized. Waiting for other workers to initalize...
Worker 124298266129984 initialized. Waiting for other workers to initalize...
Worker 124298249344576 initialized. Waiting for other workers to initalize...
Worker 124298240951872 initialized. Waiting for other workers to initalize...
Worker 124298257737280 initialized. Waiting for other workers to initalize...
Worker 124298232559168 initialized. Waiting for other workers to initalize...
Worker 124298224166464 initialized. Waiting for other workers to initalize...
Worker 124298215773760 initialized. Waiting for other workers to initalize...
Worker 124298198988352 initialized. Waiting for other workers to initalize...
Worker 124298190595648 initialized. Waiting for other workers to initalize...
Worker 124298207381056 initialized. Waiting for other workers to initalize...
Worker 124298182202944 initialized. Waiting for other workers to initalize...

```


Worker 124298173810240 initialized. Waiting for other workers to initalize...
Worker 124298165417536 initialized. Waiting for other workers to initalize...
Worker 124298157024832 initialized. Waiting for other workers to initalize...
Worker 124298148632128 initialized. Waiting for other workers to initalize...
Worker 124298140239424 initialized. Waiting for other workers to initalize...
Worker 124298131846720 initialized. Waiting for other workers to initalize...
Worker 124298123454016 initialized. Waiting for other workers to initalize...
Worker 124298115061312 initialized. Waiting for other workers to initalize...
Worker 124298106668608 initialized. Waiting for other workers to initalize...
Worker 124298098275904 initialized. Waiting for other workers to initalize...
Worker 124298089883200 initialized. Waiting for other workers to initalize...
Worker 124298081490496 initialized. Waiting for other workers to initalize...
Worker 124298073097792 initialized. Waiting for other workers to initalize...
Worker 124298064705088 initialized. Waiting for other workers to initalize...
Worker 124298056312384 initialized. Waiting for other workers to initalize...
Worker 124298047919680 initialized. Waiting for other workers to initalize...
Worker 124298039526976 initialized. Waiting for other workers to initalize...
Worker 124298031134272 initialized. Waiting for other workers to initalize...
Worker 124298022741568 initialized. Waiting for other workers to initalize...
Worker 124298014348864 initialized. Waiting for other workers to initalize...
Worker 124298005956160 initialized. Waiting for other workers to initalize...
Worker 124297997563456 initialized. Waiting for other workers to initalize...
Worker 124297989170752 initialized. Waiting for other workers to initalize...
Worker 124297980778048 initialized. Waiting for other workers to initalize...
Worker 124297972385344 initialized. Waiting for other workers to initalize...
Worker 124297963992640 initialized. Waiting for other workers to initalize...
Worker 124297955599936 initialized. Waiting for other workers to initalize...
Worker 124297947207232 initialized. Waiting for other workers to initalize...
Worker 124297938814528 initialized. Waiting for other workers to initalize...
Worker 124297930421824 initialized. Waiting for other workers to initalize...
Worker 124297922029120 initialized. Waiting for other workers to initalize...
Worker 124297913636416 initialized. Waiting for other workers to initalize...
Worker 124297905243712 initialized. Waiting for other workers to initalize...
Worker 124297896851008 initialized. Waiting for other workers to initalize...
Worker 124297888458304 initialized. Waiting for other workers to initalize...
Worker 124297880065600 initialized. Waiting for other workers to initalize...
Worker 124297871672896 initialized. Waiting for other workers to initalize...
Worker 124297863280192 initialized. Waiting for other workers to initalize...
Worker 124297854887488 initialized. Waiting for other workers to initalize...
Worker 124297846494784 initialized. Waiting for other workers to initalize...
Worker 124297838102080 initialized. Waiting for other workers to initalize...
Worker 124297829709376 initialized. Waiting for other workers to initalize...
Worker 124297821316672 initialized. Waiting for other workers to initalize...
Worker 124297812923968 initialized. Waiting for other workers to initalize...
Worker 124297804531264 initialized. Waiting for other workers to initalize...
Worker 124297796138560 initialized. Waiting for other workers to initalize...
Worker 124297787745856 initialized. Waiting for other workers to initalize...
Worker 124297779353152 initialized. Waiting for other workers to initalize...
Worker 124297770960448 initialized. Waiting for other workers to initalize...
Worker 124297762567744 initialized. Waiting for other workers to initalize...
Worker 124297754175040 initialized. Waiting for other workers to initalize...
Worker 124297745782336 initialized. Waiting for other workers to initalize...
Worker 124297737389632 initialized. Waiting for other workers to initalize...
Worker 124297728996928 initialized. Waiting for other workers to initalize...
Worker 124297720604224 initialized. Waiting for other workers to initalize...
Worker 124297712211520 initialized. Waiting for other workers to initalize...
Worker 124297703818816 initialized. Waiting for other workers to initalize...
Worker 124297695426112 initialized. Waiting for other workers to initalize...

Worker 124297687033408 initialized. Waiting for other workers to initalize...
Worker 124297678640704 initialized. Waiting for other workers to initalize...
Worker 124297670248000 initialized. Waiting for other workers to initalize...
Worker 124297661855296 initialized. Waiting for other workers to initalize...
Worker 124297653462592 initialized. Waiting for other workers to initalize...
Worker 124297645069888 initialized. Waiting for other workers to initalize...
Worker 124297636677184 initialized. Waiting for other workers to initalize...
Worker 124297628284480 initialized. Waiting for other workers to initalize...
Worker 124297619891776 initialized. Waiting for other workers to initalize...
Worker 124297611499072 initialized. Waiting for other workers to initalize...
Worker 124297603106368 initialized. Waiting for other workers to initalize...
Worker 124297594713664 initialized. Waiting for other workers to initalize...
Worker 124298574423616 starting to copy files
Worker 124298524067392 starting to copy files
Worker 124298515674688 starting to copy files
Worker 124298224166464 starting to copy files
Worker 124298557638208 starting to copy files
Worker 124298257737280 starting to copy files
Worker 124298433918528 starting to copy files
Worker 124298215773760 starting to copy files
Worker 124298207381056 starting to copy files
Worker 124298182202944 starting to copy files
Worker 124297871672896 starting to copy files
Worker 124298417133120 starting to copy files
Worker 124297779353152 starting to copy files
Worker 124298549245504 starting to copy files
Worker 124298232559168 starting to copy files
Worker 124298566030912 starting to copy files
Worker 124297594713664 starting to copy files
Worker 124298173810240 starting to copy files
Worker 124298391955008 starting to copy files
Worker 124298157024832 starting to copy files
Worker 124297645069888 starting to copy files
Worker 124298115061312 starting to copy files
Worker 124298098275904 starting to copy files
Worker 124298282915392 starting to copy files
Worker 124298056312384 starting to copy files
Worker 124298047919680 starting to copy files
Worker 124298039526976 starting to copy files
Worker 124298031134272 starting to copy files
Worker 124298022741568 starting to copy files
Worker 124298014348864 starting to copy files
Worker 124298005956160 starting to copy files
Worker 124297997563456 starting to copy files
Worker 124297989170752 starting to copy files
Worker 124297980778048 starting to copy files
Worker 124297972385344 starting to copy files
Worker 124298249344576 starting to copy files
Worker 124297947207232 starting to copy files
Worker 124298240951872 starting to copy files
Worker 124297930421824 starting to copy files
Worker 124298190595648 starting to copy files
Worker 124297922029120 starting to copy files
Worker 124297913636416 starting to copy files
Worker 124297905243712 starting to copy files
Worker 124297888458304 starting to copy files
Worker 124297863280192 starting to copy files
Worker 124298165417536 starting to copy files

Worker 124297846494784 starting to copy files
Worker 124297838102080 starting to copy files
Worker 124298408740416 starting to copy files
Worker 124297829709376 starting to copy files
Worker 124298425525824 starting to copy files
Worker 124297762567744 starting to copy files
Worker 124297754175040 starting to copy files
Worker 124297745782336 starting to copy files
Worker 124298123454016 starting to copy files
Worker 124298106668608 starting to copy files
Worker 124298291308096 starting to copy files
Worker 124297712211520 starting to copy files
Worker 124297687033408 starting to copy files
Worker 124297670248000 starting to copy files
Worker 124297619891776 starting to copy files
Worker 124297611499072 starting to copy files
Worker 124297603106368 starting to copy files
Worker 124298274522688 starting to copy files
Worker 124298198988352 starting to copy files
Worker 124297963992640 starting to copy files
Worker 124297955599936 starting to copy files
Worker 124297938814528 starting to copy files
Worker 124297896851008 starting to copy files
Worker 124298540852800 starting to copy files
Worker 124297880065600 starting to copy files
Worker 124298148632128 starting to copy files
Worker 124297854887488 starting to copy files
Worker 124297821316672 starting to copy files
Worker 124297812923968 starting to copy files
Worker 124297804531264 starting to copy files
Worker 124297796138560 starting to copy files
Worker 124297787745856 starting to copy files
Worker 124297770960448 starting to copy files
Worker 124298131846720 starting to copy files
Worker 124298299700800 starting to copy files
Worker 124297737389632 starting to copy files
Worker 124297728996928 starting to copy files
Worker 124297720604224 starting to copy files
Worker 124297703818816 starting to copy files
Worker 124297695426112 starting to copy files
Worker 124298532460096 starting to copy files
Worker 124298089883200 starting to copy files
Worker 124298081490496 starting to copy files
Worker 124297678640704 starting to copy files
Worker 124297653462592 starting to copy files
Worker 124297661855296 starting to copy files
Worker 124297636677184 starting to copy files
Worker 124297628284480 starting to copy files
Worker 124298383562304 starting to copy files
Worker 124298140239424 starting to copy files
Worker 124298073097792 starting to copy files
Worker 124298400347712 starting to copy files
Worker 124298266129984 starting to copy files
Worker 124298064705088 starting to copy files
~CManager thread completed
Worker 124297871672896 interrupted
Worker 124298232559168 interrupted
Worker 124298515674688 interrupted

Worker 124297963992640 interrupted
Worker 124297812923968 interrupted
Worker 124298148632128 interrupted
Worker 124298549245504 interrupted
Worker 124297821316672 interrupted
Worker 124297787745856 interrupted
Worker 124297796138560 interrupted
Worker 124297804531264 interrupted
Worker 124298198988352 interrupted
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Worker 124298022741568 interrupted
Worker 124297880065600 interrupted
Worker 124298433918528 interrupted
Worker 124298274522688 interrupted
Worker 124297779353152 interrupted
Worker 124297611499072 interrupted
Worker 124298566030912 interrupted
Worker 124297896851008 interrupted
Worker 124298165417536 interrupted
Worker 124298131846720 interrupted
Worker 124298224166464 interrupted
Worker 124297703818816 interrupted
Worker 124298557638208 interrupted
Worker 124297955599936 interrupted
Worker 124297712211520 interrupted
Worker 124297989170752 interrupted
Worker 124298299700800 interrupted
Worker 124298098275904 interrupted
Worker 124298089883200 interrupted
Worker 124298047919680 interrupted
Worker 124297737389632 interrupted
Worker 124298257737280 interrupted
Worker 124297770960448 interrupted
Worker 124298173810240 interrupted
Worker 124298532460096 interrupted
Worker 124297636677184 interrupted
Worker 124297854887488 interrupted
Worker 124297997563456 interrupted
Worker 124298383562304 interrupted
Worker 124297670248000 interrupted
Worker 124297653462592 interrupted
Worker 124297678640704 interrupted
Worker 124298391955008 interrupted
Worker 124297628284480 interrupted
Worker 124297720604224 interrupted
Worker 124297846494784 interrupted
Worker 124298417133120 interrupted
Worker 124298073097792 interrupted
Worker 124298524067392 interrupted
Worker 124298400347712 interrupted
Worker 124297863280192 interrupted
Worker 124297972385344 interrupted
Worker 124298064705088 interrupted
Worker 124298115061312 interrupted
Worker 124298081490496 interrupted
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Worker 124297745782336 interrupted
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Worker 124297888458304 interrupted
Worker 124298190595648 interrupted
Worker 124297695426112 interrupted
Worker 124297645069888 interrupted
Worker 124298266129984 interrupted
Worker 124298056312384 interrupted
Worker 124297594713664 interrupted
Worker 124298005956160 interrupted
Worker 124298140239424 interrupted
Worker 124298240951872 interrupted
Worker 124298215773760 interrupted
Worker 124298039526976 interrupted
Worker 124297905243712 interrupted
Worker 124297980778048 interrupted
Worker 124297754175040 interrupted
Worker 124297947207232 interrupted
Worker 124298282915392 interrupted
Worker 124298182202944 interrupted
Worker 124298123454016 interrupted
Worker 124297661855296 interrupted
Worker 124298249344576 interrupted
Worker 124298014348864 interrupted
Worker 124298408740416 interrupted
Worker 124297762567744 interrupted
Worker 124297829709376 interrupted
Worker 124297619891776 interrupted
Worker 124297687033408 interrupted
Worker 124298031134272 interrupted
Worker 124297922029120 interrupted
Worker 124297930421824 interrupted
Worker 124298106668608 interrupted
Worker 124297838102080 interrupted
Worker 124297913636416 interrupted
Worker 124298540852800 interrupted
Worker 124298207381056 interrupted
Worker 124297938814528 interrupted
Worker 124297603106368 interrupted
Worker 124298291308096 interrupted
Worker 124297728996928 interrupted
Worker 124298515674688 terminated
Worker 124297611499072 terminated
Worker 124298022741568 terminated
Worker 124297880065600 terminated
Worker 124297812923968 terminated
Worker 124297963992640 terminated
Worker 124297896851008 terminated
Worker 124298131846720 terminated
Worker 124298232559168 terminated
Worker 124298148632128 terminated
Worker 124298047919680 terminated
Worker 124298257737280 terminated
Worker 124297997563456 terminated
Worker 124297838102080 terminated
Worker 124298207381056 terminated
Worker 124298198988352 terminated
Worker 124298574423616 terminated
Worker 124298299700800 terminated
Worker 124298173810240 terminated

Worker 124297787745856 terminated
Worker 124297779353152 terminated
Worker 124298566030912 terminated
Worker 124298165417536 terminated
Worker 124298224166464 terminated
Worker 124297720604224 terminated
Worker 124297796138560 terminated
Worker 124297955599936 terminated
Worker 124298549245504 terminated
Worker 124298524067392 terminated
Worker 124297703818816 terminated
Worker 124297989170752 terminated
Worker 124298073097792 terminated
Worker 124298089883200 terminated
Worker 124298098275904 terminated
Worker 124298157024832 terminated
Worker 124297737389632 terminated
Worker 124297712211520 terminated
Worker 124297770960448 terminated
Worker 124298274522688 terminated
Worker 124298532460096 terminated
Worker 124297846494784 terminated
Worker 124297821316672 terminated
Worker 124297854887488 terminated
Worker 124297636677184 terminated
Worker 124298383562304 terminated
Worker 124297653462592 terminated
Worker 124297670248000 terminated
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Worker 124297678640704 terminated
Worker 124298056312384 terminated
Worker 124297628284480 terminated
Worker 124298039526976 terminated
Worker 124298417133120 terminated
Worker 124297754175040 terminated
Worker 124297871672896 terminated
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Worker 124298400347712 terminated
Worker 124298064705088 terminated
Worker 124297661855296 terminated
Worker 124298115061312 terminated
Worker 124298081490496 terminated
Worker 124297745782336 terminated
Worker 124297762567744 terminated
Worker 124298425525824 terminated
Worker 124297888458304 terminated
Worker 124298190595648 terminated
Worker 124297645069888 terminated
Worker 124298266129984 terminated
Worker 124298005956160 terminated
Worker 124298140239424 terminated
Worker 124297594713664 terminated
Worker 124297687033408 terminated
Worker 124298240951872 terminated
Worker 124297930421824 terminated
Worker 124297972385344 terminated
Worker 124298215773760 terminated
Worker 124297980778048 terminated

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Worker 124297695426112 terminated
Worker 124297947207232 terminated
Worker 124298182202944 terminated
Worker 124298123454016 terminated
Worker 124298540852800 terminated
Worker 124298249344576 terminated
Worker 124298282915392 terminated
Worker 124297905243712 terminated
Worker 124298408740416 terminated
Worker 124298014348864 terminated
Worker 124297603106368 terminated
Worker 124297829709376 terminated
Worker 124297922029120 terminated
Worker 124298106668608 terminated
Worker 124297913636416 terminated
Worker 124297938814528 terminated
Worker 124298291308096 terminated
Worker 124297619891776 terminated
Worker 124298031134272 terminated
Worker 124297804531264 terminated
Worker 124297728996928 terminated
Worker 124298557638208 terminated
Worker 124298433918528 terminated
Copy statistics are as follows:
Execution time: 0.134106 seconds
Regular files: 462
Directories: 22
Bytes: 39863563
```

8 Conclusion

The multi-threaded file copying system designed in this assignment demonstrates the use of producer-consumer patterns, thread synchronization, and shared resources. The modular design, encapsulated in well-defined structures and functions, ensures clarity, maintainability, and efficient operation. The use of mutexes and condition variables guarantees safe concurrent access to shared resources, and the statistics module provides valuable insights into the performance of the system.

9 Notes

This report encapsulates the final version of the assignment specified in HW5, since HW4 is essentially sub-version of HW5 and HW5 is permitted to be submitted as HW4 too, this report is valid for both of them.