

CSE 344

SYSTEM PROGRAMMING

HW 5 Report

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INTRODUCTION

This project is a multi-threaded file copying utility designed to traverse a source directory and replicate its structure and contents to a destination directory using a buffer and worker threads for efficient file handling. It maintains statistics on the types of files copied and the total bytes transferred.

Mutexes, condition variables and also barriers are used for synchronization of worker threads.

To compile program in shell: \$> make

To run program correctly: \$> ./MWCp <task_buffer_size> <#of workers> <source_folder>
<destination_folder>

To clean unnecessary files: \$> make clean

*In explanation of used variables and structures, I indicated the changes with * at beginning of each line. In pseudo code, I indicated changes with bold and italic text.*

USED MUTEXES, CONDITION VARIABLES, BARRIER

Mutexes

buffer_mutex: Protects access to the task buffer and related variables (buffer_front, buffer_rear, buffer_count).

stats_mutex: Protects access to the statistics variables (num_regular_files, num_fifo_files, num_directories, num_other_files, total_bytes_copied).

stdout_mutex: Synchronizes access to standard output.

*** finished_threads_mutex:** Used for safely updating and checking the count of finished threads.

Condition Variables

buffer_not_empty: Signals worker threads that the buffer has at least one task available.

buffer_not_full: Signals the manager thread that there is space available in the buffer.

* Barrier

pthread_barrier_t: The barrier ensures that all worker threads wait for each other before proceeding when they are idle and there are enough tasks.

USED TYPES AND GLOBAL VARIABLES

Types

file_task_t: A structure representing a file copying task. It holds file descriptors for the source file and destination file.

directory_paths_t: A structure representing the source and destination directories.

Global Variables

task_buffer: A dynamically allocated buffer that holds the file copying tasks to be processed by worker threads.

number_of_workers: Stores the number of worker threads that will process tasks from the task buffer.

buffer_size: Defines the size of the task buffer, determining how many tasks can be queued at any given time.

buffer_front, buffer_rear, buffer_count: Indexes and count for handling buffer.

done_flag: A flag indicating whether the copying process should be terminated, used for handling signals safely.

num_regular_files, num_fifo_files, num_directories, num_other_files: Counters for different types of files and directories processed.

total_bytes_copied: Accumulates the total number of bytes copied across all files.

*** number_finish_threads:** Counters for finished threads when there is signal or there is no task.

PROGRAM STRUCTURE AS PSEUDOCODE

The program is a multi-threaded file copying utility that initializes global variables and sets up necessary signal handlers. The **main function** parses command-line arguments, allocates memory for the task buffer, initializes a barrier for synchronizing worker threads, creates manager and worker threads, and measures the execution time. The **manager_thread** traverses the source directory, adds tasks to the buffer, and signals completion. **Worker threads** process these tasks by copying files and updating statistics.

* In the **worker threads**, after processing each task, the thread checks if there are enough remaining tasks for all threads to participate in the barrier. If there are enough tasks, the thread waits at the barrier using `pthread_barrier_wait`. This ensures that threads do not proceed independently, but rather synchronize with each other when idle. If a thread finishes processing and there are no more tasks, it increments the `number_finish_threads` count safely using the mutex and then breaks out of the loop.

Each function is explained as pseudocode.

Main function

- Parse command line arguments and check them
- Allocate memory for `task_buffer` and initialize it
- Call `setup_signal_handler`
- Initialize barrier**
- Create manager thread
- Create worker threads
- Measure time
- Join manager and worker threads
- Print statistics
- Free resources and destroy mutexes and condition variables
- Destroy barrier**

worker_thread function

- Loop indefinitely
 - Lock `buffer_mutex`
 - Wait for `buffer_not_empty` if `buffer_count` is 0 and `done_flag` is not set
 - Finish loop if `buffer_count` is 0 and `done_flag` is set
 - Update number_finish_threads safely by using finished_threads_mutex**
 - Unlock buffer_mutex**
 - Get task from `task_buffer`
 - Update `buffer_front` and `buffer_count`
 - Signal `buffer_not_full`
 - Unlock `buffer_mutex`
 - Call `copy_file` with current task

Lock finished_threads_mutex

If number_finish_threads is 0 and remaining tasks are enough for all threads

Unlock finished_threads_mutex

Wait at the barrier

Else

Unlock finished_threads_mutex

copy_file function

Read from source_fd and write to destination_fd in chunks

Handle read/write errors

Close source_fd and destination_fd

Lock stats_mutex

Update total_bytes_copied

Unlock stats_mutex

manager_thread function

Call traverse_directory with source_folder and destination_folder

Lock buffer_mutex

Set done_flag

Broadcast buffer_not_empty and buffer_not_full

Unlock buffer_mutex

traverse_directory function

Open source_folder directory

Create destination_folder if it does not exist

For each entry in source_folder

 If entry is a directory and not "." or ".."

 Call handle_directory with source_folder, destination_folder, entry

 Else Call handle_file with source_folder, destination_folder, entry

Close directory

handle_file function

Construct source_file and destination_file paths

Open source_file for reading

Open destination_file for writing

Create file_task_t with file descriptors and file paths

Lock buffer_mutex

Wait for buffer_not_full if buffer_count is buffer_size and done_flag is not set

Break if done_flag is set

Add task to task_buffer

Update buffer_rear and buffer_count

Signal buffer_not_empty

Unlock buffer_mutex

Call update_statistics with entry

handle_directory function

- Construct new_source and new_dest paths
- Call traverse_directory with new_source and new_dest to handle sub directory
- Lock stats_mutex
- Increment num_directories safely by using stats_mutex
- Unlock stats_mutex

update_statistics function

- Lock stats_mutex
- Update file type counters based on entry type
- Unlock stats_mutex

setup_signal_handler function

- Set signal handlers for SIGINT, SIGTERM, SIGQUIT, SIGHUP, SIGUSR1, SIGUSR2

handle_signal function

- Set done_flag
- Broadcast buffer_not_empty and buffer_not_full

destroy_mutexes_and_cond_vars function

- Destroy buffer_mutex, stats_mutex, stdout_mutex
- Destroy buffer_not_empty and buffer_not_full

close_fd function

- Close file descriptor and handle errors

TESTS

NOTE: Printing the completion status of each file is not shown in some test screenshots because it may takes space in report. I have given shown examples below for one short number of folder entries and one CTRL+C example. Done tests are similar to homework 4.

Copying different folders completely (No printing)

```
ties Terminal May 31 16:18 mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here

mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$ make
gcc -Wall -std=gnu99 1901042621_main.c -o MMCP -lpthread -lrt
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$ valgrind ./MMCP 10 10 ../testdir/src/libvterm ../tocopy
==10571== Memcheck, a memory error detector
==10571== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10571== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10571== Command: ./MMCP 10 10 ../testdir/src/libvterm ../tocopy
==10571==

-----STATISTICS-----
Consumers: 10 - Buffer Size: 10
Number of Regular Files: 194
Number of FIFO Files: 0
Number of Directories: 7
Number of Other Files: 0
TOTAL BYTES COPIED: 25009680
TOTAL TIME: 00:00.618 (min:sec.millis)
==10571==
==10571== HEAP SUMMARY:
==10571==    in use at exit: 0 bytes in 0 blocks
==10571==   total heap usage: 22 allocs, 22 frees, 287,184 bytes allocated
==10571==
==10571== All heap blocks were freed -- no leaks are possible
==10571==
==10571== For lists of detected and suppressed errors, rerun with: -s
==10571== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$
```

```
ties Terminal May 31 16:27 mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here

mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$ valgrind ./MMCP 10 5 ../testdir/ ../tocopyDir
==10819== Memcheck, a memory error detector
==10819== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10819== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10819== Command: ./MMCP 10 5 ../testdir/ ../tocopyDir
==10819==

-----STATISTICS-----
Consumers: 5 - Buffer Size: 10
Number of Regular Files: 3116
Number of FIFO Files: 0
Number of Directories: 151
Number of Other Files: 0
TOTAL BYTES COPIED: 73520554
TOTAL TIME: 00:03.2338 (min:sec.millis)
==10819==
==10819== HEAP SUMMARY:
==10819==    in use at exit: 0 bytes in 0 blocks
==10819==   total heap usage: 161 allocs, 161 frees, 5,011,288 bytes allocated
==10819==
==10819== All heap blocks were freed -- no leaks are possible
==10819==
==10819== For lists of detected and suppressed errors, rerun with: -s
==10819== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$
```

```
ties Terminal May 31 16:31 mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here

mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$ valgrind ./MMCP 10 3 ../testdir/src/libvterm/src ../tocopyB
==10860== Memcheck, a memory error detector
==10860== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10860== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10860== Command: ./MMCP 10 3 ../testdir/src/libvterm/src ../tocopyB
==10860==

-----STATISTICS-----
Consumers: 3 - Buffer Size: 10
Number of Regular Files: 140
Number of FIFO Files: 0
Number of Directories: 2
Number of Other Files: 0
TOTAL BYTES COPIED: 24873882
TOTAL TIME: 00:01.645 (min:sec.millis)
==10860==
==10860== HEAP SUMMARY:
==10860==    in use at exit: 0 bytes in 0 blocks
==10860==   total heap usage: 10 allocs, 10 frees, 121,144 bytes allocated
==10860==
==10860== All heap blocks were freed -- no leaks are possible
==10860==
==10860== For lists of detected and suppressed errors, rerun with: -s
==10860== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5test/put_your_codes_here$
```

```
Terminal May 31 16:35
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5Test/put_your_codes_here

mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$ valgrind ./MWCp 5 8 ../testdir/runtime ../tocopyCC
==10901== Memcheck, a memory error detector
==10901== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10901== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10901== Command: ./MWCp 5 8 ../testdir/runtime ../tocopyCC
==10901==

-----STATISTICS-----
Consumers: 8 - Buffer Size: 5
Number of Regular Files: 1899
Number of FIFO Files: 0
Number of Directories: 98
Number of Other Files: 0
TOTAL BYTES COPIED: 24826550
TOTAL TIME: 00:01.1074 (min:sec.millis)
==10901==
==10901== HEAP SUMMARY:
==10901==    in use at exit: 0 bytes in 0 blocks
==10901==    total heap usage: 111 allocs, 111 frees, 3,262,600 bytes allocated
==10901==
==10901== All heap blocks were freed -- no leaks are possible
==10901==
==10901== For lists of detected and suppressed errors, rerun with: -s
==10901== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$
```

Copying folders completely (Printing)

```
Terminal May 31 16:37
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5Test/put_your_codes_here

mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$ make
gcc -Wall -std=gnu99 1901042621_main.c -o MWCp -lpthread -lrt
mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$ valgrind ./MWCp 5 8 ../testdir/src/xdiff ../tocopyF
==10956== Memcheck, a memory error detector
==10956== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==10956== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==10956== Command: ./MWCp 5 8 ../testdir/src/xdiff ../tocopyF
==10956==
Copied ../testdir/src/xdiff/xnacros.h to ../tocopyF/xnacros.h, 1901 bytes
Copied ../testdir/src/xdiff/xtypes.h to ../tocopyF/xtypes.h, 1529 bytes
Copied ../testdir/src/xdiff/xutils.c to ../tocopyF/xutils.c, 9553 bytes
Copied ../testdir/src/xdiff/xenit.h to ../tocopyF/xenit.h, 1204 bytes
Copied ../testdir/src/xdiff/xutils.h to ../tocopyF/xutils.h, 1779 bytes
Copied ../testdir/src/xdiff/xenit.c to ../tocopyF/xenit.c, 7848 bytes
Copied ../testdir/src/xdiff/xhistogram.c to ../tocopyF/xhistogram.c, 9638 bytes
Copied ../testdir/src/xdiff/xprepare.h to ../tocopyF/xprepare.h, 1058 bytes
Copied ../testdir/src/xdiff/xinclude.h to ../tocopyF/xinclude.h, 1641 bytes
Copied ../testdir/src/xdiff/README.txt to ../tocopyF/README.txt, 647 bytes
Copied ../testdir/src/xdiff/xpatience.c to ../tocopyF/xpatience.c, 10920 bytes
Copied ../testdir/src/xdiff/xdiff.h to ../tocopyF/xdiff.h, 3790 bytes
Copied ../testdir/src/xdiff/xdiffi.h to ../tocopyF/xdiffi.h, 1936 bytes
Copied ../testdir/src/xdiff/xprepare.c to ../tocopyF/xprepare.c, 12242 bytes
Copied ../testdir/src/xdiff/COPYING to ../tocopyF/COPYING, 26421 bytes
Copied ../testdir/src/xdiff/xdiffi.c to ../tocopyF/xdiffi.c, 27698 bytes
==10956==
-----STATISTICS-----
Consumers: 8 - Buffer Size: 5
Number of Regular Files: 16
Number of FIFO Files: 0
Number of Directories: 0
Number of Other Files: 0
TOTAL BYTES COPIED: 119805
TOTAL TIME: 00:00.111 (min:sec.millis)
==10956==
==10956== HEAP SUMMARY:
==10956==    in use at exit: 0 bytes in 0 blocks
==10956==    total heap usage: 13 allocs, 13 frees, 46,632 bytes allocated
==10956==
==10956== All heap blocks were freed -- no leaks are possible
==10956==
==10956== For lists of detected and suppressed errors, rerun with: -s
==10956== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$
```


Copying folders CTRL+C (Printing)

```
mrguven@mrguven: ~/Desktop/cse344/hw5/hw5Test/put_your_codes_here
mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$ valgrind ./MwCp 15 8 ../testdir/ ../tocopyEG
==11058== Memcheck, a memory error detector
==11058== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==11058== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright info
==11058== Command: ./MwCp 15 8 ../testdir/ ../tocopyEG
==11058==
Copied ../testdir//lgtn.yml to ../tocopyEG//lgtn.yml, 148 bytes
Copied ../testdir//vintutor.bat to ../tocopyEG//vintutor.bat, 1812 bytes
Copied ../testdir//runtime/vin16x16.gif to ../tocopyEG/runtime/vin16x16.gif, 166 bytes
Copied ../testdir//runtime/spell/en/en_US.diff to ../tocopyEG/runtime/spell/en/en_US.diff, 5718 bytes
Copied ../testdir//runtime/spell/en/en_CA.diff to ../tocopyEG/runtime/spell/en/en_CA.diff, 5544 bytes
Copied ../testdir//runtime/spell/en/en_GB.diff to ../tocopyEG/runtime/spell/en/en_GB.diff, 5195 bytes
Copied ../testdir//runtime/spell/en/en_AU.diff to ../tocopyEG/runtime/spell/en/en_AU.diff, 66901 bytes
Copied ../testdir//runtime/spell/en/main.aap to ../tocopyEG/runtime/spell/en/main.aap, 8650 bytes
Copied ../testdir//runtime/spell/en/en_NZ.diff to ../tocopyEG/runtime/spell/en/en_NZ.diff, 66085 bytes
Copied ../testdir//runtime/spell/nl/nl_NZ.diff to ../tocopyEG/runtime/spell/nl/nl_NZ.diff, 197 bytes
Copied ../testdir//runtime/spell/nl/main.aap to ../tocopyEG/runtime/spell/nl/main.aap, 2471 bytes
Copied ../testdir//runtime/spell/zu/zu_ZA.diff to ../tocopyEG/runtime/spell/zu/zu_ZA.diff, 174 bytes
Copied ../testdir//runtime/spell/zu/main.aap to ../tocopyEG/runtime/spell/zu/main.aap, 2570 bytes
Copied ../testdir//runtime/spell/ca/ca_ES.diff to ../tocopyEG/runtime/spell/ca/ca_ES.diff, 1576 bytes
Copied ../testdir//runtime/spell/ca/main.aap to ../tocopyEG/runtime/spell/ca/main.aap, 2571 bytes
Copied ../testdir//runtime/spell/sk/sk_SK.diff to ../tocopyEG/runtime/spell/sk/sk_SK.diff, 501 bytes
Copied ../testdir//runtime/spell/sk/main.aap to ../tocopyEG/runtime/spell/sk/main.aap, 2598 bytes
Copied ../testdir//runtime/spell/en.ascii.sug to ../tocopyEG/runtime/spell/en.ascii.sug, 597210 bytes
Copied ../testdir//runtime/spell/tn/tn_ZA.diff to ../tocopyEG/runtime/spell/tn/tn_ZA.diff, 381 bytes
Copied ../testdir//runtime/spell/tn/main.aap to ../tocopyEG/runtime/spell/tn/main.aap, 2645 bytes
Copied ../testdir//runtime/spell/en.latin1.spl to ../tocopyEG/runtime/spell/en.latin1.spl, 621179 bytes
Copied ../testdir//runtime/spell/ro/ro_R0.diff to ../tocopyEG/runtime/spell/ro/ro_R0.diff, 828 bytes
Copied ../testdir//runtime/spell/ro/main.aap to ../tocopyEG/runtime/spell/ro/main.aap, 3262 bytes
Copied ../testdir//runtime/spell/ro/main.aap to ../tocopyEG/runtime/spell/ro/main.aap, 2482 bytes
Copied ../testdir//runtime/spell/eo/eo_13.diff to ../tocopyEG/runtime/spell/eo/eo_13.diff, 0 bytes
Copied ../testdir//runtime/spell/lt/lt_LT.diff to ../tocopyEG/runtime/spell/lt/lt_LT.diff, 0 bytes
Copied ../testdir//runtime/spell/lt/main.aap to ../tocopyEG/runtime/spell/lt/main.aap, 2450 bytes
Copied ../testdir//runtime/spell/it/it_IT.diff to ../tocopyEG/runtime/spell/it/it_IT.diff, 7594 bytes
Copied ../testdir//runtime/spell/it/main.aap to ../tocopyEG/runtime/spell/it/main.aap, 2476 bytes
Copied ../testdir//runtime/spell/es/es_MX.diff to ../tocopyEG/runtime/spell/es/es_MX.diff, 168138 bytes
Copied ../testdir//runtime/spell/es/main.aap to ../tocopyEG/runtime/spell/es/main.aap, 3002 bytes
Copied ../testdir//runtime/spell/es/es_ES.diff to ../tocopyEG/runtime/spell/es/es_ES.diff, 770 bytes
Copied ../testdir//runtime/spell/hu/hu_HU.diff to ../tocopyEG/runtime/spell/hu/hu_HU.diff, 3478 bytes
Copied ../testdir//runtime/spell/hu/main.aap to ../tocopyEG/runtime/spell/hu/main.aap, 2628 bytes
Copied ../testdir//runtime/spell/hr/hr_HR.diff to ../tocopyEG/runtime/spell/hr/hr_HR.diff, 341 bytes
Copied ../testdir//runtime/spell/hr/main.aap to ../tocopyEG/runtime/spell/hr/main.aap, 2589 bytes
Copied ../testdir//runtime/spell/check_locales.vin to ../tocopyEG/runtime/spell/check_locales.vin, 463 bytes
Copied ../testdir//runtime/spell/si/si_SI.diff to ../tocopyEG/runtime/spell/si/si_SI.diff, 341 bytes
Copied ../testdir//runtime/doc/vin2html.pl to ../tocopyEG/runtime/doc/vin2html.pl, 4517 bytes
Copied ../testdir//runtime/doc/vindiff.1 to ../tocopyEG/runtime/doc/vindiff.1, 1276 bytes
Copied ../testdir//runtime/doc/vintutor-da.1 to ../tocopyEG/runtime/doc/vintutor-da.1, 1342 bytes
Copied ../testdir//runtime/doc/vintutor-fr.UTF-8.1 to ../tocopyEG/runtime/doc/vintutor-fr.UTF-8.1, 1741 bytes
Copied ../testdir//runtime/doc/os_gnx.txt to ../tocopyEG/runtime/doc/os_gnx.txt, 4871 bytes
Copied ../testdir//runtime/doc/usr_83.txt to ../tocopyEG/runtime/doc/usr_83.txt, 23618 bytes
Copied ../testdir//runtime/doc/evin-ja.UTF-8.1 to ../tocopyEG/runtime/doc/evin-ja.UTF-8.1, 1827 bytes
Copied ../testdir//runtime/doc/vin-it.1 to ../tocopyEG/runtime/doc/vin-it.1, 16613 bytes
^C Copied ../testdir//runtime/doc/pi_netrw.txt to ../tocopyEG/runtime/doc/pi_netrw.txt, 175523 bytes
Copied ../testdir//runtime/doc/vin-fr.UTF-8.1 to ../tocopyEG/runtime/doc/vin-fr.UTF-8.1, 18232 bytes
Copied ../testdir//runtime/doc/vi_diff.txt to ../tocopyEG/runtime/doc/vi_diff.txt, 57263 bytes
Copied ../testdir//runtime/doc/os_os2.txt to ../tocopyEG/runtime/doc/os_os2.txt, 299 bytes
Copied ../testdir//runtime/doc/tabpage.txt to ../tocopyEG/runtime/doc/tabpage.txt, 16897 bytes
Copied ../testdir//runtime/doc/vindiff-fr.UTF-8.1 to ../tocopyEG/runtime/doc/vindiff-fr.UTF-8.1, 1805 bytes
Copied ../testdir//runtime/doc/arabic.txt to ../tocopyEG/runtime/doc/arabic.txt, 11908 bytes
Copied ../testdir//runtime/doc/usr_89.txt to ../tocopyEG/runtime/doc/usr_89.txt, 11582 bytes
Copied ../testdir//runtime/doc/xxd.man to ../tocopyEG/runtime/doc/xxd.man, 11315 bytes
Copied ../testdir//runtime/doc/vintutor-ru.1 to ../tocopyEG/runtime/doc/vintutor-ru.1, 1442 bytes
Copied ../testdir//runtime/doc/vindiff.man to ../tocopyEG/runtime/doc/vindiff.man, 1513 bytes
Copied ../testdir//runtime/doc/uganda.txt to ../tocopyEG/runtime/doc/uganda.txt, 14029 bytes
Copied ../testdir//runtime/doc/pi_zip.txt to ../tocopyEG/runtime/doc/pi_zip.txt, 7040 bytes
Copied ../testdir//runtime/doc/usr_30.txt to ../tocopyEG/runtime/doc/usr_30.txt, 22661 bytes
Copied ../testdir//runtime/doc/filetype.txt to ../tocopyEG/runtime/doc/filetype.txt, 26739 bytes
Copied ../testdir//runtime/doc/xxd-ru.UTF-8.1 to ../tocopyEG/runtime/doc/xxd-ru.UTF-8.1, 28689 bytes
-----STATISTICS-----
Consumers: 0 - Buffer Size: 15
Number of Regular Files: 826
Number of FIFO Files: 0
Number of Directories: 88
Number of Other Files: 0
TOTAL BYTES COPIED: 9929174
TOTAL TIME: 00:00.580 (min:sec.millis)
==11058==
==11058== HEAP SUMMARY:
==11058==    in use at exit: 0 bytes in 0 blocks
==11058==   total heap usage: 101 allocs, 101 frees, 2,955,000 bytes allocated
==11058==
==11058== All heap blocks were freed -- no leaks are possible
==11058==
==11058== For lists of detected and suppressed errors, rerun with: -s
==11058== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
mrguven@mrguven:~/Desktop/cse344/hw5/hw5Test/put_your_codes_here$
```