

# **CSE344 Systems Programming**

## **Homework 4 Report**

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# How to Compile and Run

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ make  
gcc main.c -lrt -lpthread -o MWCp
```

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ make test1  
valgrind --leak-check=full ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
```

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ make test2  
./MWCp 10 4 ../testdir/src/libvterm/src ../tocopy
```

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ make test3  
./MWCp 10 10 ../testdir ../tocopy
```

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ make clean  
rm -f MWCp
```

- make: Compile main.c as MWCp.
- make clean: Remove MWCp.
- make test1 - test2 - test3: These commands were only available while testing. I deleted them from the makefile and then retested the program. The results were the same.

## Functions and Components

1. `void *manager(void *arg);`

- The manager is responsible for traversing the source directory and its subfolders and adding file pair
- It utilizes the processDirectory to do the previous task. So the only thing that it does is setting the done flag and broadcasting bufferNotEmpty when all the files are added to the buffer.

2. `void *worker(void *arg);`

- They continuously check the buffer for files to copy.
- They wait for a signal from bufferNotEmpty.
- The different file types are handled differently. Regular files are copied (truncated if it already exists), folders are created with mkdir and fifos are created with mkfifo.
- After copying a file, it updates the totalByteCounter, and increases either numRegular, numFifo or numDir. Prints an informative message about the file that is copied.
- After the done flag is changed by the manager, it returns.

3. `void processDirectory(const char *src_dir, const char *dest_dir);`

- Starting from the source directory, copies all files, subfolders and their contents recursively.
- For each file, it creates a source and destination paths.
- It gets the type of the file using stat struct and sets the buffer accordingly.
- It utilizes mutex to change the buffer and the counters.
- If the buffer is full, it waits until there is an empty spot

4. `int main(int argc, char *argv[])`
- It checks the command line arguments first.
  - Based on the user's input, it sets the buffer size, number of worker threads, source directory and destination directory.
  - It creates the manager thread and worker threads.
  - It waits for all threads to finish.
  - Before exiting, it prints all statistics

5. `// Signal handler for SIGINT`  
`void SIGINTHandler(int signo)`
- This function handles interrupt signals.
  - It notifies the user by printing a message to the standard output.
  - It sets the done flag and notifies everyone who waits for bufferNotEmpty.
  - It closes file descriptors.
  - Finally terminates the program.

6. `file_pair_t buffer[MAX_BUFFER_SIZE]; // An array of file_pair_t structs that holds information about files to be copied`  
`int bufferSize; // size of the buffer`  
`int bufferCount = 0; // number of items in the buffer`  
`int done = 0; // flag to indicate all files are processed`  
`long totalBytes = 0; // total bytes transferred`  
`int numRegular = 0; // number of regular files transferred`  
`int numFifo = 0; // number of FIFO files transferred`  
`int numDir = 0; // number of directories transferred`

7. `typedef struct // A struct that holds information about files to be copied`  
`{`  
 `int srcFD; // source file descriptor`  
 `int destFD; // destination file descriptor`  
 `char srcName[PATH_MAX]; // source file path`  
 `char destName[PATH_MAX]; // destination file path`  
 `int isFifo; // flag to indicate if the file is a FIFO file`  
 `int isDir; // flag to indicate if the file is a directory`  
`} file_pair_t;`

8. `pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER; // mutex for buffer`  
`pthread_cond_t bufferNotFull = PTHREAD_COND_INITIALIZER; // condition variable for buffer not full`  
`pthread_cond_t bufferNotEmpty = PTHREAD_COND_INITIALIZER; // condition variable for buffer not empty`

# Example Input and Outputs

## 1. Test1

```
test
Copied: ../testdir/src/libvterm/t/44screen_pen.test -> ../tocopy/t/44screen_pen.test
Copied: ../testdir/src/libvterm/t/46screen_extent.test -> ../tocopy/t/46screen_extent.
test
Copied: ../testdir/src/libvterm/t/45screen_protect.test -> ../tocopy/t/45screen_protect.
test
Copied: ../testdir/src/libvterm/t/47screen_dbl_wh.test -> ../tocopy/t/47screen_dbl_wh.
test
Copied: ../testdir/src/libvterm/t/90vttest_01-movement-1.test -> ../tocopy/t/90vttest_
01-movement-1.test
Copied: ../testdir/src/libvterm/t/48screen_termprops.test -> ../tocopy/t/48screen_term
props.test
Copied: ../testdir/src/libvterm/t/90vttest_01-movement-2.test -> ../tocopy/t/90vttest_
01-movement-2.test
Copied: ../testdir/src/libvterm/t/90vttest_01-movement-4.test -> ../tocopy/t/90vttest_
01-movement-4.test
Copied: ../testdir/src/libvterm/t/90vttest_01-movement-3.test -> ../tocopy/t/90vttest_
01-movement-3.test
Copied: ../testdir/src/libvterm/t/90vttest_02-screen-1.test -> ../tocopy/t/90vttest_02
-screen-1.test
Copied: ../testdir/src/libvterm/t/90vttest_02-screen-2.test -> ../tocopy/t/90vttest_02
-screen-2.test
Copied: ../testdir/src/libvterm/t/90vttest_02-screen-3.test -> ../tocopy/t/90vttest_02
-screen-3.test
Copied: ../testdir/src/libvterm/t/92lp1640917.test -> ../tocopy/t/92lp1640917.test
Copied: ../testdir/src/libvterm/t/90vttest_02-screen-4.test -> ../tocopy/t/90vttest_02
-screen-4.test
Copied: ../testdir/src/libvterm/t/run-test.pl -> ../tocopy/t/run-test.pl
Copied: ../testdir/src/libvterm/.bzrignore -> ../tocopy/.bzrignore
Copied: ../testdir/src/libvterm/.gitignore -> ../tocopy/.gitignore
Copied: ../testdir/src/libvterm/t/harness.c -> ../tocopy/t/harness.c
Copied: ../testdir/src/libvterm/LICENSE -> ../tocopy/LICENSE
Copied: ../testdir/src/libvterm/Makefile -> ../tocopy/Makefile
Copied: ../testdir/src/libvterm/tbl2inc_c.pl -> ../tocopy/tbl2inc_c.pl
Copied: ../testdir/src/libvterm/README -> ../tocopy/README
Copied: ../testdir/src/libvterm/vterm.pc.in -> ../tocopy/vterm.pc.in
Copied: ../testdir/src/libvterm/src/MRT10.pdf -> ../tocopy/src/MRT10.pdf
Copied: ../testdir/src/libvterm/src/isl1551098739430.pdf -> ../tocopy/src/isl155109873
9430.pdf
All files copied successfully.
```

```
-----STATISTICS-----
```

```
Consumers: 10 - Buffer Size: 10
Number of Regular File: 194
Number of FIFO File: 0
Number of Directory: 7
TOTAL BYTES COPIED: 25009680
TOTAL TIME: 00:00.258 (min:sec.mili)
==11239==
==11239== HEAP SUMMARY:
==11239==    in use at exit: 0 bytes in 0 blocks
==11239== total heap usage: 214 allocs, 214 frees, 1,064,240 bytes allocated
==11239==
==11239== All heap blocks were freed -- no leaks are possible
==11239==
==11239== For lists of detected and suppressed errors, rerun with: -s
```

## 2. Test2

```
Copied: ../testdir/src/libvterm/src/config.h.in -> ../toCopy/config.h.in
Copied: ../testdir/src/libvterm/src/hangulin.c -> ../toCopy/hangulin.c
Copied: ../testdir/src/libvterm/src/if_mzsch.h -> ../toCopy/if_mzsch.h
Copied: ../testdir/src/libvterm/src/if_lua.c -> ../toCopy/if_lua.c
Copied: ../testdir/src/libvterm/src/if_mzsch.c -> ../toCopy/if_mzsch.c
Copied: ../testdir/src/libvterm/src/if_ole.cpp -> ../toCopy/if_ole.cpp
Copied: ../testdir/src/libvterm/src/if_ole.idl -> ../toCopy/if_ole.idl
Copied: ../testdir/src/libvterm/src/if_cscope.h -> ../toCopy/if_cscope.h
Copied: ../testdir/src/libvterm/src/if_perlsfio.c -> ../toCopy/if_perlsfio.c
Copied: ../testdir/src/libvterm/src/gui_gtk_x11.c -> ../toCopy/gui_gtk_x11.c
Copied: ../testdir/src/libvterm/src/if_ole.h -> ../toCopy/if_ole.h
Copied: ../testdir/src/libvterm/src/if_python.c -> ../toCopy/if_python.c
Copied: ../testdir/src/libvterm/src/if_perl.xs -> ../toCopy/if_perl.xs
Copied: ../testdir/src/libvterm/src/if_ruby.c -> ../toCopy/if_ruby.c
Copied: ../testdir/src/libvterm/src/iid_ole.c -> ../toCopy/iid_ole.c
Copied: ../testdir/src/libvterm/src/if_python3.c -> ../toCopy/if_python3.c
Copied: ../testdir/src/libvterm/src/infplist.xml -> ../toCopy/infplist.xml
Copied: ../testdir/src/libvterm/src/if_tcl.c -> ../toCopy/if_tcl.c
Copied: ../testdir/src/libvterm/src/indent.c -> ../toCopy/indent.c
Copied: ../testdir/src/libvterm/src/insexpand.c -> ../toCopy/insexpand.c
Copied: ../testdir/src/libvterm/src/INSTALL -> ../toCopy/INSTALL
Copied: ../testdir/src/libvterm/src/INSTALLami.txt -> ../toCopy/INSTALLami.txt
Copied: ../testdir/src/libvterm/src/INSTALLmac.txt -> ../toCopy/INSTALLmac.txt
Copied: ../testdir/src/libvterm/src/installman.sh -> ../toCopy/installman.sh
Copied: ../testdir/src/libvterm/src/if_py_both.h -> ../toCopy/if_py_both.h
Copied: ../testdir/src/libvterm/src/install-sh -> ../toCopy/install-sh
Copied: ../testdir/src/libvterm/src/installml.sh -> ../toCopy/installml.sh
Copied: ../testdir/src/libvterm/src/if_xcmdsrv.c -> ../toCopy/if_xcmdsrv.c
Copied: ../testdir/src/libvterm/src/iscygpty.h -> ../toCopy/iscygpty.h
Copied: ../testdir/src/libvterm/src/iscygpty.c -> ../toCopy/iscygpty.c
Copied: ../testdir/src/libvterm/src/INSTALLvms.txt -> ../toCopy/INSTALLvms.txt
Copied: ../testdir/src/libvterm/src/INSTALLx.txt -> ../toCopy/INSTALLx.txt
Copied: ../testdir/src/libvterm/src/json_test.c -> ../toCopy/json_test.c
Copied: ../testdir/src/libvterm/src/json.c -> ../toCopy/json.c
Copied: ../testdir/src/libvterm/src/keyboard.c -> ../toCopy/keyboard.c
Copied: ../testdir/src/libvterm/src/kword_test.c -> ../toCopy/kword_test.c
Copied: ../testdir/src/libvterm/src/mouse.c -> ../toCopy/mouse.c
Copied: ../testdir/src/libvterm/src/keymap.h -> ../toCopy/keymap.h
Copied: ../testdir/src/libvterm/src/pen.c -> ../toCopy/pen.c
Copied: ../testdir/src/libvterm/src/rect.h -> ../toCopy/rect.h
Copied: ../testdir/src/libvterm/src/INSTALLpc.txt -> ../toCopy/INSTALLpc.txt
Copied: ../testdir/src/libvterm/src/state.c -> ../toCopy/state.c
Copied: ../testdir/src/libvterm/src/termscreen.c -> ../toCopy/termscreen.c
Copied: ../testdir/src/libvterm/src/utf8.h -> ../toCopy/utf8.h
Copied: ../testdir/src/libvterm/src/unicode.c -> ../toCopy/unicode.c
Copied: ../testdir/src/libvterm/src/vterm.c -> ../toCopy/vterm.c
Copied: ../testdir/src/libvterm/src/vterm_internal.h -> ../toCopy/vterm_internal.h
Copied: ../testdir/src/libvterm/src/parser.c -> ../toCopy/parser.c
Copied: ../testdir/src/libvterm/src/hashtab.c -> ../toCopy/hashtab.c
Copied: ../testdir/src/libvterm/src/if_cscope.c -> ../toCopy/if_cscope.c
Copied: ../testdir/src/libvterm/src/hardcopy.c -> ../toCopy/hardcopy.c
Copied: ../testdir/src/libvterm/src/charset.c -> ../toCopy/charset.c
Copied: ../testdir/src/libvterm/src/change.c -> ../toCopy/change.c
Copied: ../testdir/src/libvterm/src/channel.c -> ../toCopy/channel.c
Copied: ../testdir/src/libvterm/src/bigvim64.bat -> ../toCopy/bigvim64.bat
Copied: ../testdir/src/libvterm/src/blob.c -> ../toCopy/blob.c
Copied: ../testdir/src/libvterm/src/MRT10.pdf -> ../toCopy/MRT10.pdf
Copied: ../testdir/src/libvterm/src/isl1551098739430.pdf -> ../toCopy/isl1551098739430.pdf
All files copied successfully.
```

### 3. Test3

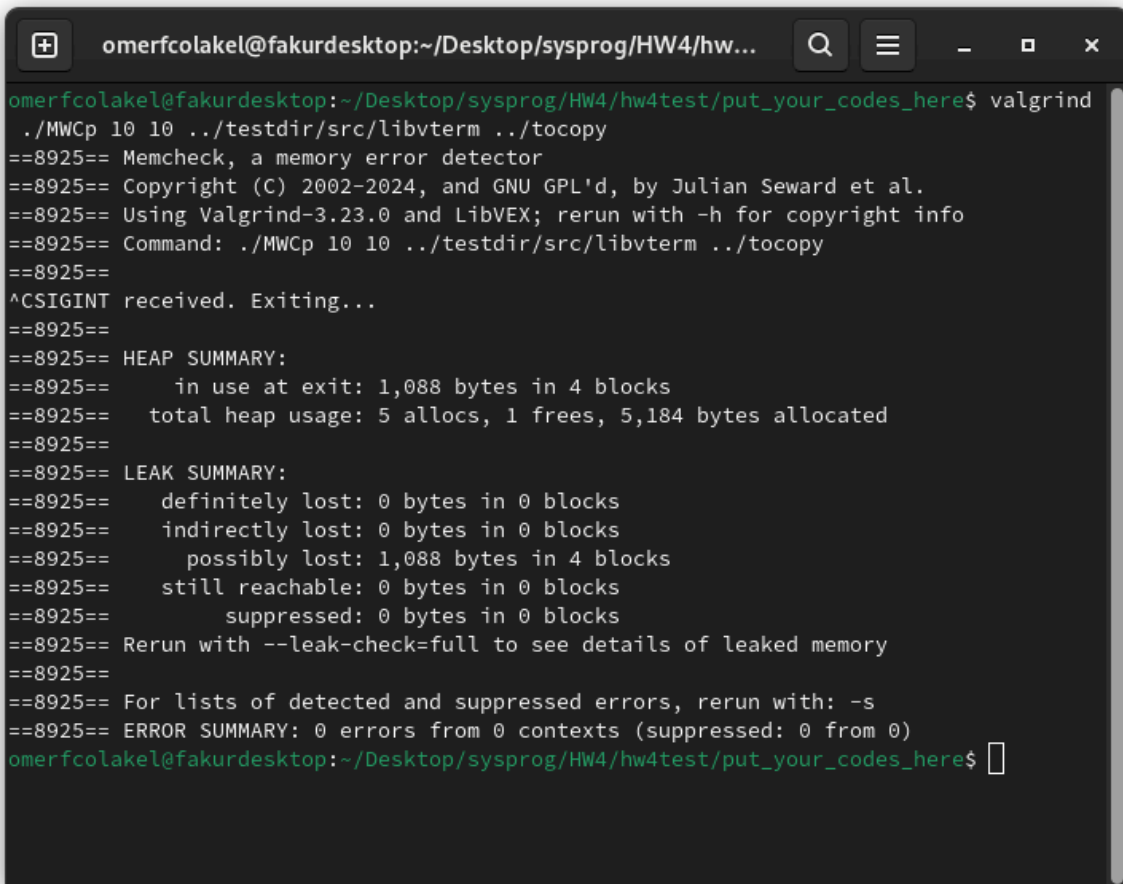
```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw...
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ ./MWCp 10
10 ../testdir ../toCopy
mkdir: File exists
mkdir: File exists
mkdir: File exists
mkdir: File exists
mkdir: File exists
mkdir: File exists
mkdir: File exists
mkdir: File exists
Copied: ../testdir/.gitignore -> ../toCopy/.gitignore
Copied: ../testdir/.lgtn.yml -> ../toCopy/.lgtn.yml
Copied: ../testdir/.hgignore -> ../toCopy/.hgignore
Copied: ../testdir/appveyor.yml -> ../toCopy/appveyor.yml
Copied: ../testdir/configure -> ../toCopy/configure
Copied: ../testdir/CONTRIBUTING.md -> ../toCopy/CONTRIBUTING.md
Copied: ../testdir/uninstal.txt -> ../toCopy/uninstal.txt
Copied: ../testdir/vimtutor.bat -> ../toCopy/vimtutor.bat
Copied: ../testdir/vimtutor.com -> ../toCopy/vimtutor.com
Copied: ../testdir/README.md -> ../toCopy/README.md
Copied: ../testdir/README.txt -> ../toCopy/README.txt
Copied: ../testdir/.travis.yml -> ../toCopy/.travis.yml
Copied: ../testdir/Filelist -> ../toCopy/Filelist
Copied: ../testdir/Makefile -> ../toCopy/Makefile
All files copied successfully.

-----STATISTICS-----
Consumers: 10 - Buffer Size: 10
Number of Regular File: 14
Number of FIFO File: 0
Number of Directory: 0
TOTAL BYTES COPIED: 76446
TOTAL TIME: 00:00.001 (min:sec.mili)
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$
```

### 4. Wrong usage. Printed how to run.

```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw...
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ ./MWCp 10
10 ../testdir ../toCopy aaa
Usage: ./MWCp <buffer_size> <num_workers> <src_dir> <dest_dir>
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ ./MWCp 10
-10 ../testdir ../toCopy
Invalid buffer size or number of workers
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$
```

## 5. Test1 with SIGINT.



```
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw...
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$ valgrind
./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==8925== Memcheck, a memory error detector
==8925== Copyright (C) 2002-2024, and GNU GPL'd, by Julian Seward et al.
==8925== Using Valgrind-3.23.0 and LibVEX; rerun with -h for copyright info
==8925== Command: ./MWCp 10 10 ../testdir/src/libvterm ../tocopy
==8925==
^CSIGINT received. Exiting...
==8925==
==8925== HEAP SUMMARY:
==8925==   in use at exit: 1,088 bytes in 4 blocks
==8925==   total heap usage: 5 allocs, 1 frees, 5,184 bytes allocated
==8925==
==8925== LEAK SUMMARY:
==8925==   definitely lost: 0 bytes in 0 blocks
==8925==   indirectly lost: 0 bytes in 0 blocks
==8925==   possibly lost: 1,088 bytes in 4 blocks
==8925==   still reachable: 0 bytes in 0 blocks
==8925==   suppressed: 0 bytes in 0 blocks
==8925== Rerun with --leak-check=full to see details of leaked memory
==8925==
==8925== For lists of detected and suppressed errors, rerun with: -s
==8925== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
omerfcolakel@fakurdesktop:~/Desktop/sysprog/HW4/hw4test/put_your_codes_here$
```