

CSE 344
SYSTEMS PROGRAMMING

HOMEWORK 04

REPORT

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1. Program Flow

In that part, program starts with initializing the used semaphores and creates necessary threads which are 6 chefs and 1 wholesaler. After creation of these POSIX threads using by ***pthread_create()*** function, threads are going to be joined by ***pthread_join()*** function. While creating threads, passing arguments for wholesaler as ***filePath*** and ***NULL*** for chefs' function. In the main function after these operations, semaphores are going to be destroyed successfully.

In the **wholesaler**, it reads the input file inside a 2D char array. Then it start a loop to count ingredients and wake up the chefs. The global variables, sugar-flour-milk-walnuts, are increased by one which represents the wholesaler delivered ingredient. After deliveration the wholesaler make awake the chefs using a semaphore. And awakes one of the chef to get its ingredients. While it does that, chef makes ready the dessert and the wholesaler leaves to sell it. In the end, it post a semaphore that it finished to deliver and exits.

In the **chefs**, in the beginning of chefs' function, they waits to start to execute function. The wholesaler post the start semaphore and they start to run. In an infinite loop each chef waits in the semaphore to get food. When the wholesaler let one of the chef to get its ingredients if its job is not finished. For each chef has its own critical region to get ingredients and decreases the global variables which that it needs. Then it post the dessert to wholesaler. It goes to wait in the beginning of the infinite loop to wait.

Makefile:

```
Makefile x filePath.txt x program.c x wholesaler.c x
1 CC = gcc
2 CFLAGS = -c
3 VALG = valgrind -v
4 THREAD = -lpthread
5
6 all:main run
7
8 main: program.o wholesaler.o chefs.o semaphore.o
9     $(CC) program.o wholesaler.o chefs.o semaphore.o -o program $(THREAD)
10
11 program.o: program.c
12     $(CC) $(CFLAGS) program.c
13
14 wholesaler.o: wholesaler.c
15     $(CC) $(CFLAGS) wholesaler.c
16
17 chefs.o: chefs.c
18     $(CC) $(CFLAGS) chefs.c
19
20 semaphore.o: semaphore.c
21     $(CC) $(CFLAGS) semaphore.c
22
23 run:
24     ./program -i filePath.txt
25
26 v:main runv
27
28 runv:
29     $(VALG) ./program -i filePath.txt
30
31 clean:
32     rm -rf *.o program
33
```

filePath.txt:

```
filePath.txt x
1 MS
2 MF
3 WS
4 SW
5 MW
6 FW
7 SF
8 MF
9 SM
10 WF
11 FS
12 MW
13
```

Console:

```
omer@omer:~/Desktop/HW04/HW04$ make
gcc -c program.c
gcc -c wholesaler.c
gcc -c chefs.c
gcc -c semaphore.c
gcc program.o wholesaler.o chefs.o semaphore.o -o program -lpthread
./program -i filePath.txt
the wholesaler delivers milk and sugar
the wholesaler is waiting for the dessert
chef1 is waiting for walnuts and sugar
chef6 is waiting for milk and sugar
chef6 has taken the milk
chef5 is waiting for walnuts and milk
chef3 is waiting for sugar and flour
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef2 is waiting for flour and walnuts
chef6 has taken the sugar
chef6 is preparing the dessert
chef6 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers milk and flour
the wholesaler is waiting for the dessert
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef4 has taken the milk
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 has taken the flour
chef4 is preparing the dessert
chef4 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers walnuts and sugar
the wholesaler is waiting for the dessert
chef1 is waiting for walnuts and sugar
chef1 has taken the walnuts
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 has taken the sugar
chef1 is preparing the dessert
chef1 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers sugar and walnuts
the wholesaler is waiting for the dessert
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
```

chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef1 has taken the walnuts
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 has taken the sugar
chef1 is preparing the dessert
chef1 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers milk and walnuts
the wholesaler is waiting for the dessert
chef5 is waiting for walnuts and milk
chef5 has taken the walnuts
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 has taken the milk
chef5 is preparing the dessert
chef5 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers flour and walnuts
the wholesaler is waiting for the dessert
chef2 is waiting for flour and walnuts
chef2 has taken the flour
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 has taken the walnuts
chef2 is preparing the dessert
chef2 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers sugar and flour
chef6 is waiting for milk and sugar
the wholesaler is waiting for the dessert
chef3 is waiting for sugar and flour
chef3 has taken the sugar
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 has taken the flour
chef3 is preparing the dessert
chef3 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers milk and flour
chef4 is waiting for milk and flour
chef4 has taken the milk

chef4 has taken the milk
the wholesaler is waiting for the dessert
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 has taken the flour
chef4 is preparing the dessert
chef4 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers sugar and milk
the wholesaler is waiting for the dessert
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef6 has taken the milk
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 has taken the sugar
chef6 is preparing the dessert
chef6 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers walnuts and flour
chef3 is waiting for sugar and flour
the wholesaler is waiting for the dessert
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef2 has taken the flour
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 has taken the walnuts
chef2 is preparing the dessert
chef2 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers flour and sugar
the wholesaler is waiting for the dessert
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef3 has taken the sugar
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 has taken the flour


```

chef3 has taken the flour
chef3 is preparing the dessert
chef3 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers milk and walnuts
chef4 is waiting for milk and flour
the wholesaler is waiting for the dessert
chef1 is waiting for walnuts and sugar
chef5 is waiting for walnuts and milk
chef5 has taken the walnuts
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef5 has taken the milk
chef5 is preparing the dessert
chef5 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
omer@omer:~/Desktop/HW04/HW04$ _

```

Make with Valgrind:

```

omer@omer:~/Desktop/HW04/HW04$ make v
gcc -c program.c
gcc -c wholesaler.c
gcc -c chefs.c
gcc -c semaphore.c
gcc program.o wholesaler.o chefs.o semaphore.o -o program -lpthread
valgrind -v ./program -i filePath.txt
==15183== Memcheck, a memory error detector
==15183== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==15183== Using Valgrind-3.15.0-608cb11914-20190413 and LibVEX; rerun with -h for copyright info
==15183== Command: ./program -i filePath.txt
==15183==
--15183-- Valgrind options:
--15183-- -v
--15183-- Contents of /proc/version:
--15183-- Linux version 5.4.0-29-generic (buildd@lgw01-amd64-035) (gcc version 9.3.0 (Ubuntu 9.3.0-10ubuntu2)) #33-Ubuntu SMP Wed Apr 29 14:32:27 UTC 2020
--15183--
--15183-- Arch and hwcaps: AMD64, LittleEndian, amd64-cx16-lzcnt-rdtscp-sse3-ssse3-avx-avx2-bmi-f16c-rdrand
--15183-- Page sizes: currently 4096, max supported 4096
--15183-- Valgrind library directory: /usr/lib/x86_64-linux-gnu/valgrind
--15183-- Reading syms from /home/omer/Desktop/HW04/HW04/program
--15183-- Reading syms from /lib/x86_64-linux-gnu/ld-2.31.so
--15183-- Considering /lib/x86_64-linux-gnu/ld-2.31.so ..
--15183-- .. CRC mismatch (computed 387b17ea wanted d28cf5ef)
--15183-- Considering /lib/x86_64-linux-gnu/ld-2.31.so ..
--15183-- .. CRC mismatch (computed 387b17ea wanted d28cf5ef)
--15183-- Considering /usr/lib/debug/lib/x86_64-linux-gnu/ld-2.31.so ..
--15183-- .. CRC is valid
--15183-- Reading syms from /usr/lib/x86_64-linux-gnu/valgrind/memcheck-amd64-linux
--15183-- object doesn't have a symbol table
--15183-- object doesn't have a dynamic symbol table
--15183-- Scheduler: using generic scheduler lock implementation.
--15183-- Reading suppressions file: /usr/lib/x86_64-linux-gnu/valgrind/default.supp
==15183== embedded gdbserver: reading from /tmp/vgdb-pipe-from-vgdb-to-15183-by-omer-on-???
==15183== embedded gdbserver: writing to /tmp/vgdb-pipe-to-vgdb-from-15183-by-omer-on-???
==15183== embedded gdbserver: shared mem /tmp/vgdb-pipe-shared-mem-vgdb-15183-by-omer-on-???
==15183==
==15183== TO CONTROL THIS PROCESS USING vgdb (which you probably
==15183== don't want to do, unless you know exactly what you're doing,
==15183== or are doing some strange experiment):
==15183== /usr/lib/x86_64-linux-gnu/valgrind/../../bin/vgdb --pid=15183 ...command...
==15183==
==15183== TO DEBUG THIS PROCESS USING GDB: start GDB like this
==15183== /path/to/gdb ./program
==15183== and then give GDB the following command
==15183== target remote | /usr/lib/x86_64-linux-gnu/valgrind/../../bin/vgdb --pid=15183
==15183== --pid is optional if only one valgrind process is running
==15183==
--15183-- REDIR: 0x4022d80 (ld-linux-x86-64.so.2:strlen) redirected to 0x580c9ce2 (???)
--15183-- REDIR: 0x4022b50 (ld-linux-x86-64.so.2:index) redirected to 0x580c9cfc (???)
--15183-- Reading syms from /usr/lib/x86_64-linux-gnu/valgrind/vgpreload_core-amd64-linux.so
--15183-- object doesn't have a symbol table
--15183-- Reading syms from /usr/lib/x86_64-linux-gnu/valgrind/vgpreload_memcheck-amd64-linux.so
--15183-- object doesn't have a symbol table
==15183== WARNING: new redirection conflicts with existing -- ignoring it

```

```
the wholesaler delivers walnuts and flour
the wholesaler is waiting for the dessert
chef3 is waiting for sugar and flour
chef5 is waiting for walnuts and milk
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef2 is waiting for flour and walnuts
chef2 has taken the flour
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef5 is waiting for walnuts and milk
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef2 has taken the walnuts
chef2 is preparing the dessert
chef2 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers flour and sugar
the wholesaler is waiting for the dessert
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef3 has taken the sugar
chef5 is waiting for walnuts and milk
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 has taken the flour
chef3 is preparing the dessert
chef3 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
the wholesaler delivers milk and walnuts
the wholesaler is waiting for the dessert
chef5 is waiting for walnuts and milk
chef5 has taken the walnuts
chef4 is waiting for milk and flour
chef1 is waiting for walnuts and sugar
chef2 is waiting for flour and walnuts
chef6 is waiting for milk and sugar
chef3 is waiting for sugar and flour
chef5 has taken the milk
chef5 is preparing the dessert
chef5 has delivered the dessert to the wholesaler
the wholesaler has obtained the dessert and left to sell it
--15183-- REDIR: 0x492a850 (libc.so.6:free) redirected to 0x483c9d0 (free)
==15183==
==15183== HEAP SUMMARY:
==15183==    in use at exit: 0 bytes in 0 blocks
==15183==   total heap usage: 20 allocs, 20 frees, 2,036 bytes allocated
==15183==
==15183== All heap blocks were freed -- no leaks are possible
==15183==
==15183== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
omer@omer:~/Desktop/HW04/HW04$ _
```


Zombie Detection with ps -aux:

```
omer 2240 0.0 0.0 459824 6268 ? Ssl 15:16 0:00 /usr/libexec/gsd-rfkill
omer 2241 0.0 0.0 238236 6028 ? Ssl 15:16 0:00 /usr/libexec/gsd-screensaver-proxy
omer 2242 0.0 0.1 467724 11144 ? Ssl 15:16 0:01 /usr/libexec/gsd-sharing
omer 2243 0.0 0.1 391696 9040 ? Ssl 15:16 0:00 /usr/libexec/gsd-smartcard
omer 2246 0.0 0.1 322052 9312 ? Ssl 15:16 0:00 /usr/libexec/gsd-sound
omer 2247 0.0 0.0 387768 7492 ? Ssl 15:16 0:00 /usr/libexec/gsd-usb-protection
omer 2248 0.0 0.3 343468 24040 ? Ssl 15:16 0:00 /usr/libexec/gsd-wacom
omer 2249 0.0 0.1 316788 8260 ? Ssl 15:16 0:00 /usr/libexec/gsd-wwan
omer 2256 0.0 0.3 345300 26728 ? Ssl 15:16 0:00 /usr/libexec/gsd-xsettings
omer 2274 0.0 0.7 635076 58496 ? Sl 15:16 0:00 /usr/libexec/evolution-data-server/evolution-alarm-notify
omer 2297 0.0 0.0 231792 6268 ? Sl 15:16 0:00 /usr/libexec/gsd-disk-utility-notify
omer 2306 0.0 0.6 739036 50512 ? Sl 15:16 0:06 desktopfolder
omer 2331 0.0 0.3 1251288 31360 ? Ssl 15:16 0:00 /usr/libexec/evolution-calendar-factory
omer 2373 0.0 0.1 344892 15060 ? Sl 15:16 0:00 /usr/libexec/gsd-printer
omer 2417 0.0 4.3 1341696 345304 ? Sl 15:16 0:15 /snap/snap-store/433/usr/bin/snap-store --gapplication-service
omer 2451 0.0 0.3 749940 29808 ? Ssl 15:16 0:00 /usr/libexec/evolution-addressbook-factory
omer 2489 0.0 0.0 165328 6976 ? Ssl 15:16 0:00 /usr/libexec/gvfsd-metadata
root 2597 0.0 0.0 241404 7808 ? Ssl 15:16 0:00 /usr/lib/bolt/boltd
omer 3506 0.0 0.3 420848 31712 ? Sl 15:17 0:01 update-notifier
omer 3537 0.0 1.2 1263316 95528 ? Sl 15:17 0:14 /usr/bin/nautilus --gapplication-service
omer 3660 0.3 0.6 961028 51616 ? Rsl 15:18 1:25 /usr/libexec/gnome-terminal-server
omer 3681 0.0 0.0 13848 5684 pts/0 Ss 15:18 0:00 bash
omer 3693 2.8 3.5 1504260 280968 ? Ssl 15:18 11:41 /opt/sublime_text/sublime_text
omer 3716 0.0 0.8 320744 66436 ? Sl 15:18 0:11 /opt/sublime_text/plugin_host 3693 --auto-shell-env
omer 6009 0.0 0.1 390648 8664 ? Sl 15:39 0:00 /usr/libexec/gvfsd-network --spawner :1.3 /org/gtk/gvfs/exec_spaw/1
omer 6027 0.0 0.1 317700 8548 ? Sl 15:39 0:00 /usr/libexec/gvfsd-dnssd --spawner :1.3 /org/gtk/gvfs/exec_spaw/3
root 6039 0.0 0.0 12056 2444 ? Ss 15:39 0:00 /sbin/mount.ntfs /dev/sda5 /media/omer/A4FC5222FC51EF54 -o rw,nodev,nos
root 7252 0.0 0.0 0 0 ? I 16:34 0:02 [kworker/3:3-events]
omer 7300 0.0 0.5 467104 41060 ? SLL 16:35 0:00 /usr/bin/seahorse --gapplication-service
omer 7301 0.0 0.6 855332 54868 ? Sl 16:35 0:00 /usr/bin/gnome-calendar --gapplication-service
root 10293 0.0 0.0 0 0 ? I 18:32 0:02 [kworker/2:1-events]
omer 10312 9.9 8.7 3567240 694368 ? Sl 18:35 21:18 /usr/lib/firefox/firefox -new-window
omer 10365 0.6 2.3 2474920 184960 ? Sl 18:35 1:20 /usr/lib/firefox/firefox -contentproc -childID 1 -isForBrowser -prefsLe
omer 10417 0.2 4.3 2868236 344120 ? Sl 18:35 0:31 /usr/lib/firefox/firefox -contentproc -childID 2 -isForBrowser -prefsLe
omer 10466 0.0 1.0 2380052 84384 ? Sl 18:35 0:00 /usr/lib/firefox/firefox -contentproc -childID 3 -isForBrowser -prefsLe
root 11337 0.1 0.0 0 0 ? I 18:57 0:18 [kworker/0:1-events]
root 12304 0.0 0.4 396280 39320 ? Ssl 19:26 0:00 /usr/libexec/fwupd/fwupd
root 12335 0.0 0.0 0 0 ? I 19:26 0:00 [kworker/3:0-mm_percpu_wq]
root 13448 0.0 0.0 0 0 ? I 19:49 0:01 [kworker/1:0-events]
root 14449 0.0 0.0 0 0 ? I 20:19 0:00 [kworker/1:1-mm_percpu_wq]
root 14520 0.0 0.0 0 0 ? I 20:21 0:01 [kworker/0:2-events]
root 14536 0.1 0.0 0 0 ? I 22:05 0:00 [kworker/u8:19-i915]
root 14538 0.9 0.0 0 0 ? D 22:05 0:03 [kworker/u8:21+events_unbound]
root 14563 0.0 0.0 0 0 ? I 22:05 0:00 [kworker/u8:46-events_unbound]
root 14570 0.0 0.0 0 0 ? S 22:05 0:00 [irq/128-mei_me]
root 14572 0.0 0.0 0 0 ? I 22:05 0:00 [kworker/0:4-events]
root 14573 0.0 0.0 0 0 ? I 22:05 0:00 [kworker/2:2-cgroup_destroy]
root 14711 0.0 0.0 0 0 ? I< 22:05 0:00 [kworker/u9:2-hci0]
omer 14815 0.4 1.0 987920 86712 ? Sl 22:05 0:01 evince /home/omer/Desktop/HW04/hw4.pdf
omer 14821 0.0 0.0 156048 5456 ? Sl 22:05 0:00 /usr/libexec/evinced
omer 14933 0.2 0.3 437620 27764 ? Ssl 22:08 0:00 /usr/libexec/tracker-store
root 15132 0.0 0.0 0 0 ? I 22:10 0:00 [kworker/1:2]
omer 15133 0.0 0.0 14628 4160 pts/0 R+ 22:10 0:00 ps -aux
omer@omer:~/Desktop/HW04/HW04$ _
```

Notes:

- Program compiles perfectly.
- Program runs perfectly.
- No deadlock, no crash.
- Only POSIX threads are used which are 6 for chefs 1 for wholesaler.
- Chefs used only one function.
- Synchronization between threads is provided by only POSIX unnamed semaphores.
- I am sending my own test file and makefile inside .zip.