CSE344
System Programming

Assignment #3
Semaphores
Report

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Design & Algorithm

As in the cigarette smokers problem mentioned in the lecture's book, there is a need for 1 additional process per each ingredient (4 in this case) to solve this problem with POSIX semaphores since they can't atomically increment/decrement 2 semaphores at the same time. Each of these additional processes which are called pushers waits for 1 ingredient and sets the corresponding value (these values are kept in a shared memory which also contains the current ingredients) to 1. When a pusher receives its ingredient, it first checks if another pusher also received its ingredient and if so, posts the semaphore which corresponds to non-existing 2 ingredients. Then, the chef who has these non-existing ingredients and has been waiting, wakes up, takes the ingredients, and prepares güllaç. When wholesaler doesn't have any ingredients to bring, it sends SIGINT to all chefs and pushers.

In total, I used 12 semaphores:

Ingredient Semaphores (sugar,flour,walnuts,milk): wholesaler posts and pushers waits these.

Multi-Ingredient Semaphores (mf,mw,ms,fw,fs,ws):pushers posts and chefs waits these

Mututal Exclusion semaphore: Used for preventing pushers race condition.

Wholesaler Semaphore: Used for waking up the wholesaler

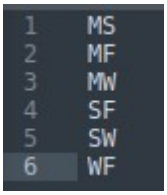
For the unnamed semaphores case, there was a need for sharing the semaphores between processes. I used another shared memory segment for this and kept all 12 semaphores in this shared memory as an array. Each process gets the semaphore it needs from this segment and rest is the same with named case.

Tests

All inputs are tested with both named and unnamed semaphores cases. Outputs are the same with named & unnamed semaphores.

Test Case 1

Sending ingredients 6 times (1 for each chef)



Output

```
gokbey@gokbey-ABRA-A5-V15-3:~/Desktop/sysprog_hw3/hw3named$ ./hw3named -i input -n wsaler
Chef0 (pid 38671) is waiting for Sugar and Walnuts|Ingredients arr:--
the wholesaler (pid 38670) delivers milk and sugar
the wholesaler (pid 38670) is waiting for the dessert
Chef1 (pid 38672) is waiting for Flour and Walnuts|Ingredients arr:MS
Chef3 (pid 38674) is waiting for Milk and Flour|Ingredients arr:MS
Chef4 (pid 38675) is waiting for Milk and Walnuts|Ingredients arr:MS
Chef2 (pid 38673) is waiting for Sugar and Flour|Ingredients arr:MS
Chef5 (pid 38676) is waiting for Milk and Sugar|Ingredients arr:MS
Chef5 (pid 38676) has taken the Milk|Ingredients arr:MS
Chef5 (pid 38676) has taken the Sugar|Ingredients arr:-S
Chef5 (pid 38676) is preparing the dessert|Ingredients arr:--
Chef5 (pid 38676) has delivered the desert|Ingredients arr:--
Chef5 (pid 38676) is waiting for Milk and Sugar|Ingredients arr:--
the wholesaler (pid 38670) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 38670) delivers milk and flour
the wholesaler (pid 38670) is waiting for the dessert
Chef3 (pid 38674) has taken the Milk|Ingredients arr:MF
Chef3 (pid 38674) has taken the Flour|Ingredients arr:-F
Chef3 (pid 38674) is preparing the dessert|Ingredients arr:--
Chef3 (pid 38674) has delivered the desert|Ingredients arr:--
Chef3 (pid 38674) is waiting for Milk and Flour|Ingredients arr:--
the wholesaler (pid 38670) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 38670) delivers milk and walnuts
the wholesaler (pid 38670) is waiting for the dessert
Chef4 (pid 38675) has taken the Milk|Ingredients arr:MW
Chef4 (pid 38675) has taken the Walnuts|Ingredients arr:-W
Chef4 (pid 38675) is preparing the dessert|Ingredients arr:--
Chef4 (pid 38675) has delivered the desert|Ingredients arr:--
Chef4 (pid 38675) is waiting for Milk and Walnuts|Ingredients arr:--
the wholesaler (pid 38670) has obtained the dessert and left
```

.

.

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```
the wholesaler (pid 38670) delivers walnut and flour
the wholesaler (pid 38670) is waiting for the dessert
Chef1 (pid 38672) has taken the Flour|Ingredients arr:WF
Chef1 (pid 38672) has taken the Walnuts|Ingredients arr:W-
Chef1 (pid 38672) is preparing the dessert|Ingredients arr:--
Chef1 (pid 38672) has delivered the desert|Ingredients arr:--
Chef1 (pid 38672) is waiting for Flour and Walnuts|Ingredients arr:--
the wholesaler (pid 38670) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 38670) is done (total desserts: 6)
```

Test Case 2

Sending ingredients randomly (20 times)

Input

```
1   MS
2   MF
3   MW
4   SF
5   SW
6   WF
7   SM
8   FM
9   WM
10  FS
11  WS
12  FW
13  SF
14  WS
15  SW
16  SW
17  FM
18  FS
19  SF
20  MW
```

Output

```
------------------------------------------------------------
the wholesaler (pid 3698) delivers flour and sugar
the wholesaler (pid 3698) is waiting for the dessert
Chef2 (pid 3701) has taken the Sugar|Ingredients arr:SF
Chef2 (pid 3701) has taken the Flour|Ingredients arr:-F
Chef2 (pid 3701) is preparing the dessert|Ingredients arr:--
Chef2 (pid 3701) has delivered the desert|Ingredients arr:--
Chef2 (pid 3701) is waiting for Sugar and Flour|Ingredients arr:--
the wholesaler (pid 3698) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 3698) delivers milk and walnuts
the wholesaler (pid 3698) is waiting for the dessert
Chef4 (pid 3703) has taken the Milk|Ingredients arr:MW
Chef4 (pid 3703) has taken the Walnuts|Ingredients arr:-W
Chef4 (pid 3703) is preparing the dessert|Ingredients arr:--
Chef4 (pid 3703) has delivered the desert|Ingredients arr:--
Chef4 (pid 3703) is waiting for Milk and Walnuts|Ingredients arr:--
the wholesaler (pid 3698) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 3698) is done (total desserts: 20)
```

Test Case 3

Sending ingredients 1296 times (216 for each)

Output

```
------------------------------------------------------------
the wholesaler (pid 7141) delivers walnut and flour
the wholesaler (pid 7141) is waiting for the dessert
Chef1 (pid 7143) has taken the Flour|Ingredients arr:WF
Chef1 (pid 7143) has taken the Walnuts|Ingredients arr:W-
Chef1 (pid 7143) is preparing the dessert|Ingredients arr:--
Chef1 (pid 7143) has delivered the desert|Ingredients arr:--
Chef1 (pid 7143) is waiting for Flour and Walnuts|Ingredients arr:--
the wholesaler (pid 7141) has obtained the dessert and left
------------------------------------------------------------
the wholesaler (pid 7141) is done (total desserts: 1296)
gokbey@gokbey-ABRA-A5-V15-3:~/Desktop/sysprog_hw3/hw3named$
```

Valgrind Memory Leak Check Result

```
HEAP SUMMARY:
    in use at exit: 0 bytes in 0 blocks
  total heap usage: 2,077 allocs, 2,077 frees, 42,497 bytes allocated

All heap blocks were freed -- no leaks are possible

ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

Test Case 4

Sending Milk&Sugar 259 times.

```
the wholesaler (pid 11128) is done (total desserts: 3)
```

Reason: The function used for collecting chef outputs (WEXITSTATUS) gets the least significant 8 bits of the exit value of the child process. So, when a chef sends more than 255 güllaçs, it overflows.

Man Page for waitpid:

```
WEXITSTATUS(wstatus)
       returns  the  exit  status  of  the child.  This consists of the
       least significant 8 bits of the status argument that  the  child
       specified  in  a  call to exit(3) or _exit(2) or as the argument
       for a return statement in main().  This macro should be employed
       only if WIFEXITED returned true.
```

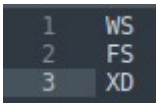
Why didn’t I handle the overflow?

Since WEXITSTATUS has a really small range between 0-255, I had to treat one of these values as an error value and print “a chef cant make more than 254 güllaçs” on wholesaler to handle this.

Example: chef returns 255 when there are more than 254 güllaçs. This would mean losing 1 more value and range is already too limited. So I didn’t handled this and left it as it is.

Error Case

Encountered wrong input (other than W-S-F-M)




```
the wholesaler (pid 15304) delivers flour and sugar
the wholesaler (pid 15304) is waiting for the dessert
Chef2 (pid 15307) has taken the Sugar|Ingredients arr:FS
Chef2 (pid 15307) has taken the Flour|Ingredients arr:F-
Chef2 (pid 15307) is preparing the dessert|Ingredients arr:--
Chef2 (pid 15307) has delivered the desert|Ingredients arr:--
Chef2 (pid 15307) is waiting for Sugar and Flour|Ingredients arr:--
the wholesaler (pid 15304) has obtained the dessert and left
--------------------------------------------------------
WRONG INPUT
Terminating... (total deserts 2)
gokbey@gokbey-ABRA-A5-V15-3:~/Desktop/sysprog_hw3/hw3named$
```