Cmpsc 473- Programming Assignment 4
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Title: Multithreaded Program using Pthreads

Assumptions and Decisions:

(i) Pseudocode of the solution:

Shared variables: sem_t lock
    sem_t m_done (signals empress when the merchants are done trading)
    sem_t m1, m2, m3 (signals the merchants to start the next day)

    (All integers below)
    Day (time)
    Ready (variable that indicates the last merchant to trade)
    Transactions (number of merchants that sold goods)
    Arrive (shared array, each thread accesses their own element)

Thread: Main
    lock = semaphore(1)
    m_done = semaphore(0)
    m1 = semaphore(0)
    m2 = semaphore(0)
    m3 = semaphore(0)
    Day = Ready = Transactions = 0
    Arrive = *FILE*

Thread: Empress
    while(Day < 11):   // Begin While
        wait(&m_done)
        wait(&lock)   // CS BEGIN - Acquire lock
        Ready = 0   // Shared Variable
        If(Arrive == Day)   // check transactions
        If(Arrive == Day+1)   // check missed transactions
        Day++   // Shared Variable
        post(&lock)   // CS END - Release lock
        post(&m1)   // RM
        post(&m2)
        post(&m3)
    Done   // End While
    If(Transactions == 3) print "Canton"
    Else print "USA"

Thread: Merchant (1, 2, or 3)
    while(Day < 11):
        wait(&lock)   // CS BEGIN - Acquire lock
        If(Arrive == day)   // Shared Variable

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                Transactions++
        Ready++                  // Shared Variable
        If( Ready == 3 ) // signal empress
                post( &m_done )
        post( &lock )            // CS END - Release lock
        wait( &m1 )  OR  wait( &m2 )  OR  wait( &m3 )
Done                             // End While
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(ii) Output for all input files:

We created a shell script testAllInputs.sh so that the program checks each of the 20 input files and produces an output for each file. After running the script, ./testAllInputs.sh :

sanyuktabaluni@ubuntu:~/Cmpsc473/pa4-jrd5595-master$ ./testAllInputs.sh
This script will allow you to test multiple input files at once
...Removing old output files...
NOTE: The input folder path is ./inputs/
NOTE: the files must be in this format: input#
Enter the last file number:
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Running: ./inputs/input1
main: begin thread creation
Merchant (1) creation successful!   Arrival Time: 5
Merchant (3) creation successful!   Arrival Time: 7
Merchant (2) creation successful!   Arrival Time: 1
Merchant (2) sold his goods!   Day: 1, Trans: 1
Empress creation successful!
Merchant (1) sold his goods!   Day: 5, Trans: 2
Empress arrived on day 6
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input1 complete!

Running: ./inputs/input2
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 2
Merchant (2) creation successful!   Arrival Time: 6
Merchant (1) creation successful!   Arrival Time: 7
Empress creation successful!
Merchant (3) sold his goods!   Day: 2, Trans: 1
Merchant (2) sold his goods!   Day: 6, Trans: -2

Empress arrived on day 6

Alas, we were too late.. We missed some merchants!

Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!

Time to turn back to the US..

Empress rejoined!

main: exiting

Execution of ./inputs/input2 complete!

Running: ./inputs/input3

main: begin thread creation

Merchant (3) creation successful!   Arrival Time: 9

Merchant (2) creation successful!   Arrival Time: 4

Merchant (1) creation successful!   Arrival Time: 2

Empress creation successful!

Merchant (1) sold his goods!   Day: 2, Trans: 1

Merchant (2) sold his goods!   Day: 4, Trans: -2

Empress arrived on day 4

Alas, we were too late.. We missed some merchants!

Time to turn back to the US..

Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!

Empress rejoined!

main: exiting

Execution of ./inputs/input3 complete!

Running: ./inputs/input4

main: begin thread creation

Merchant (3) creation successful!   Arrival Time: 4

Merchant (2) creation successful!   Arrival Time: 4

Merchant (1) creation successful!   Arrival Time: 2

Empress creation successful!

Merchant (1) sold his goods!   Day: 2, Trans: 1

Empress arrived on day 3

Alas, we were too late.. We missed some merchants!

Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!

Time to turn back to the US..

Empress rejoined!

main: exiting

Execution of ./inputs/input4 complete!

Running: ./inputs/input5

main: begin thread creation

Merchant (3) creation successful!   Arrival Time: 7

Merchant (2) creation successful! *Arrival Time: 6*
Merchant (1) creation successful! *Arrival Time: 9*
Empress creation successful!
Empress arrived on day 4
Merchant (2) sold his goods! *Day: 6, Trans: 1*
We bought some goods!
Merchant (3) sold his goods! *Day: 7, Trans: 2*
We bought some goods!
We bought some goods!
Merchant (1) sold his goods! *Day: 9, Trans: 3*
We met everyone by day 9
Merchant 1 rejoined! *Merchant 2 rejoined!* *Merchant 3 rejoined!*
Good Job! We met everyone, time to go to Canton!
Empress rejoined!
main: exiting
Execution of ./inputs/input5 complete!

Running: ./inputs/input6
main: begin thread creation
Merchant (3) creation successful! *Arrival Time: 6*
Merchant (2) creation successful! *Arrival Time: 6*
Merchant (1) creation successful! *Arrival Time: 1*
Merchant (1) sold his goods! *Day: 1, Trans: 1*
Empress creation successful!
Empress arrived on day 2
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined! *Merchant 2 rejoined!* *Merchant 3 rejoined!*
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input6 complete!

Running: ./inputs/input7
main: begin thread creation
Empress creation successful!
Merchant (3) creation successful! *Arrival Time: 7*
Merchant (2) creation successful! *Arrival Time: 3*
Merchant (1) creation successful! *Arrival Time: 2*
Merchant (1) sold his goods! *Day: 2, Trans: 1*
Merchant (2) sold his goods! *Day: 3, Trans: 2*
Empress arrived on day 4
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..

Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input7 complete!

Running: ./inputs/input8
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 1
Merchant (3) sold his goods!   Day: 1, Trans: 1
Merchant (2) creation successful!   Arrival Time: 9
Merchant (1) creation successful!   Arrival Time: 8
Empress creation successful!
Empress arrived on day 1
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
Merchant (1) sold his goods!   Day: 8, Trans: 2
We bought some goods!
Merchant (2) sold his goods!   Day: 9, Trans: 3
We met everyone by day 9
Good Job! We met everyone, time to go to Canton!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input8 complete!

Running: ./inputs/input9
main: begin thread creation
Empress creation successful!
Merchant (3) creation successful!   Arrival Time: 5
Merchant (2) creation successful!   Arrival Time: 10
Merchant (1) creation successful!   Arrival Time: 3
Merchant (1) sold his goods!   Day: 3, Trans: 1
Merchant (3) sold his goods!   Day: 5, Trans: 2
Empress arrived on day 7
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting

Execution of ./inputs/input9 complete!

Running: ./inputs/input10
main: begin thread creation
Merchant (3) creation successful!   *Arrival Time: 10*
Merchant (2) creation successful!   *Arrival Time: 10*
Merchant (1) creation successful!   *Arrival Time: 5*
Empress creation successful!
Empress arrived on day 3
Merchant (1) sold his goods!   *Day: 5, Trans: 1*
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
We bought some goods!
Merchant (2) sold his goods!   *Day: 10, Trans: 2*
Merchant (3) sold his goods!   *Day: 10, Trans: 3*
We met everyone by day 10
Merchant 1 rejoined!   *Merchant 2 rejoined!*   *Merchant 3 rejoined!*
Good Job! We met everyone, time to go to Canton!
Empress rejoined!
main: exiting
Execution of ./inputs/input10 complete!

Running: ./inputs/input11
main: begin thread creation
Merchant (3) creation successful!   *Arrival Time: 10*
Merchant (2) creation successful!   *Arrival Time: 1*
Merchant (2) sold his goods!   *Day: 1, Trans: 1*
Merchant (1) creation successful!   *Arrival Time: 8*
Empress creation successful!
Empress arrived on day 5
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   *Merchant 2 rejoined!*   *Merchant 3 rejoined!*
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input11 complete!

Running: ./inputs/input12
main: begin thread creation
Merchant (3) creation successful!   *Arrival Time: 9*

Merchant (2) creation successful!   Arrival Time: 7
Merchant (1) creation successful!   Arrival Time: 7
Empress creation successful!
Merchant (2) sold his goods!   Day: 7, Trans: 1
Merchant (1) sold his goods!   Day: 7, Trans: 2
Merchant (3) sold his goods!   Day: 9, Trans: 3
Empress arrived on day 10
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input12 complete!

Running: ./inputs/input13
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 1
Merchant (3) sold his goods!   Day: 1, Trans: 1
Merchant (2) creation successful!   Arrival Time: 7
Merchant (1) creation successful!   Arrival Time: 1
Merchant (1) sold his goods!   Day: 1, Trans: 2
Empress creation successful!
Merchant (2) sold his goods!   Day: 7, Trans: 3
Empress arrived on day 8
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input13 complete!

Running: ./inputs/input14
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 7
Merchant (2) creation successful!   Arrival Time: 3
Merchant (1) creation successful!   Arrival Time: 7
Empress creation successful!
Merchant (2) sold his goods!   Day: 3, Trans: 1
Empress arrived on day 6
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting

Execution of ./inputs/input14 complete!

Running: ./inputs/input15
main: begin thread creation
Empress creation successful!
Merchant (2) creation successful!   Arrival Time: 2
Merchant (3) creation successful!   Arrival Time: 5
Merchant (1) creation successful!   Arrival Time: 5
Merchant (2) sold his goods!   Day: 2, Trans: 1
Empress arrived on day 4
Alas, we were too late.. We missed some merchants!
Time to turn back to the US..
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Empress rejoined!
main: exiting
Execution of ./inputs/input15 complete!

Running: ./inputs/input16
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 2
Merchant (2) creation successful!   Arrival Time: 9
Merchant (1) creation successful!   Arrival Time: 10
Empress creation successful!
Merchant (3) sold his goods!   Day: 2, Trans: 1
Empress arrived on day 5
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input16 complete!

Running: ./inputs/input17
main: begin thread creation
Merchant (3) creation successful!   Arrival Time: 9
Merchant (2) creation successful!   Arrival Time: 1
Merchant (2) sold his goods!   Day: 1, Trans: 1
Merchant (1) creation successful!   Arrival Time: 2
Empress creation successful!
Merchant (1) sold his goods!   Day: 2, Trans: 2
Empress arrived on day 3
Alas, we were too late.. We missed some merchants!

Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input17 complete!

Running: ./inputs/input18
main: begin thread creation
Merchant (3) creation successful!	*Arrival Time: 10*
Merchant (2) creation successful!	*Arrival Time: 5*
Merchant (1) creation successful!	*Arrival Time: 1*
Merchant (1) sold his goods!	*Day: 1, Trans: 1*

Empress creation successful!
Merchant (2) sold his goods!	*Day: 5, Trans: 2*
Merchant (3) sold his goods!	*Day: 10, Trans: -1*

Empress arrived on day 10
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input18 complete!

Running: ./inputs/input19
main: begin thread creation
Merchant (3) creation successful!	*Arrival Time: 2*
Merchant (2) creation successful!	*Arrival Time: 3*
Merchant (1) creation successful!	*Arrival Time: 2*

Empress creation successful!
Merchant (1) sold his goods!	*Day: 2, Trans: 1*
Merchant (3) sold his goods!	*Day: 2, Trans: 2*
Merchant (2) sold his goods!	*Day: 3, Trans: 3*

Empress arrived on day 6
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input19 complete!

Running: ./inputs/input20
main: begin thread creation

Merchant (3) creation successful!   *Arrival Time: 9*
Merchant (2) creation successful!   *Arrival Time: 2*
Merchant (1) creation successful!   *Arrival Time: 5*
Empress creation successful!
Merchant (2) sold his goods!   *Day: 2, Trans: 1*
Merchant (1) sold his goods!   *Day: 5, Trans: 2*
Empress arrived on day 8
Alas, we were too late.. We missed some merchants!
Merchant 1 rejoined!   Merchant 2 rejoined!   Merchant 3 rejoined!
Time to turn back to the US..
Empress rejoined!
main: exiting
Execution of ./inputs/input20 complete!