OPERATING SYSTEMS

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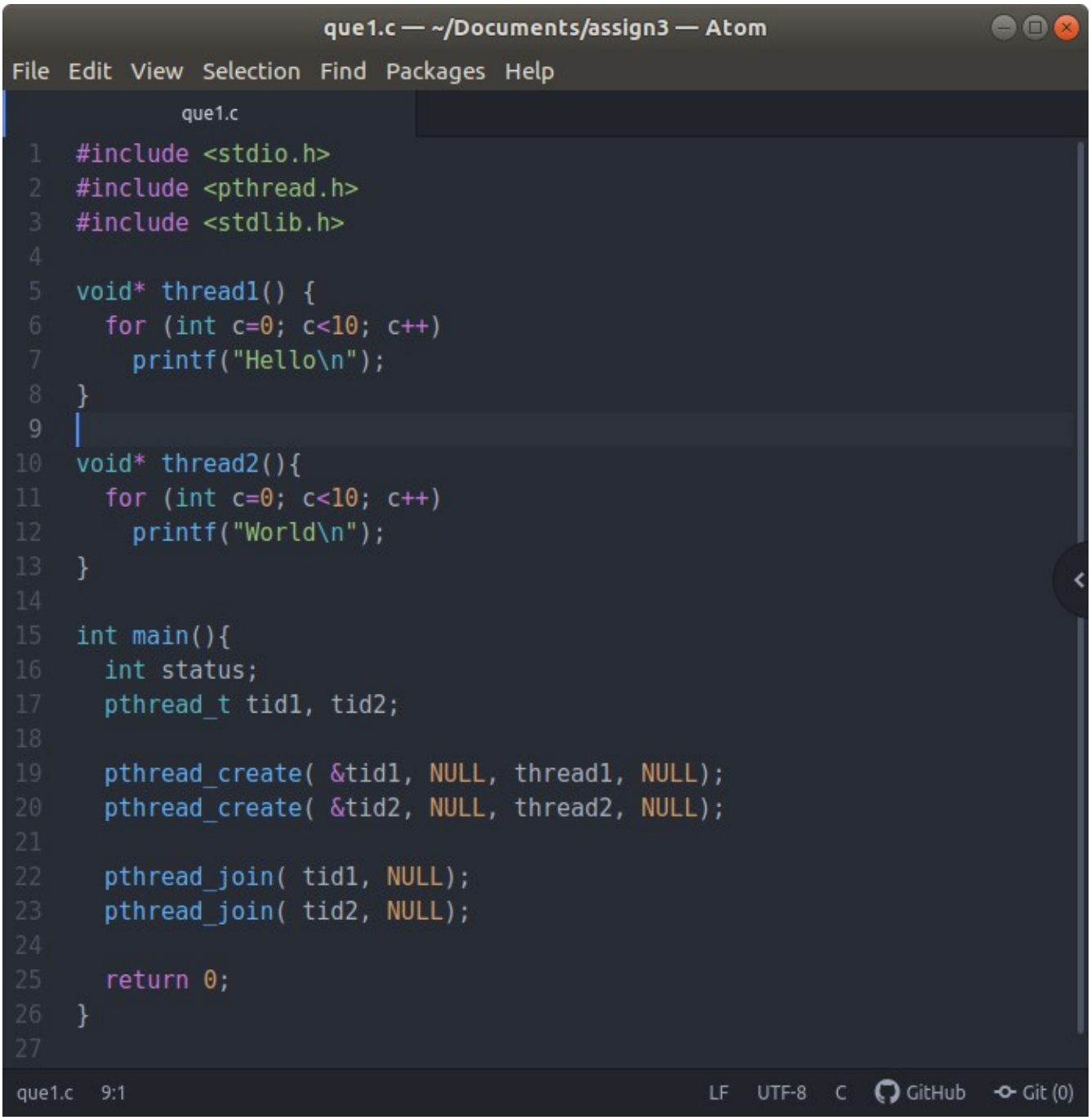
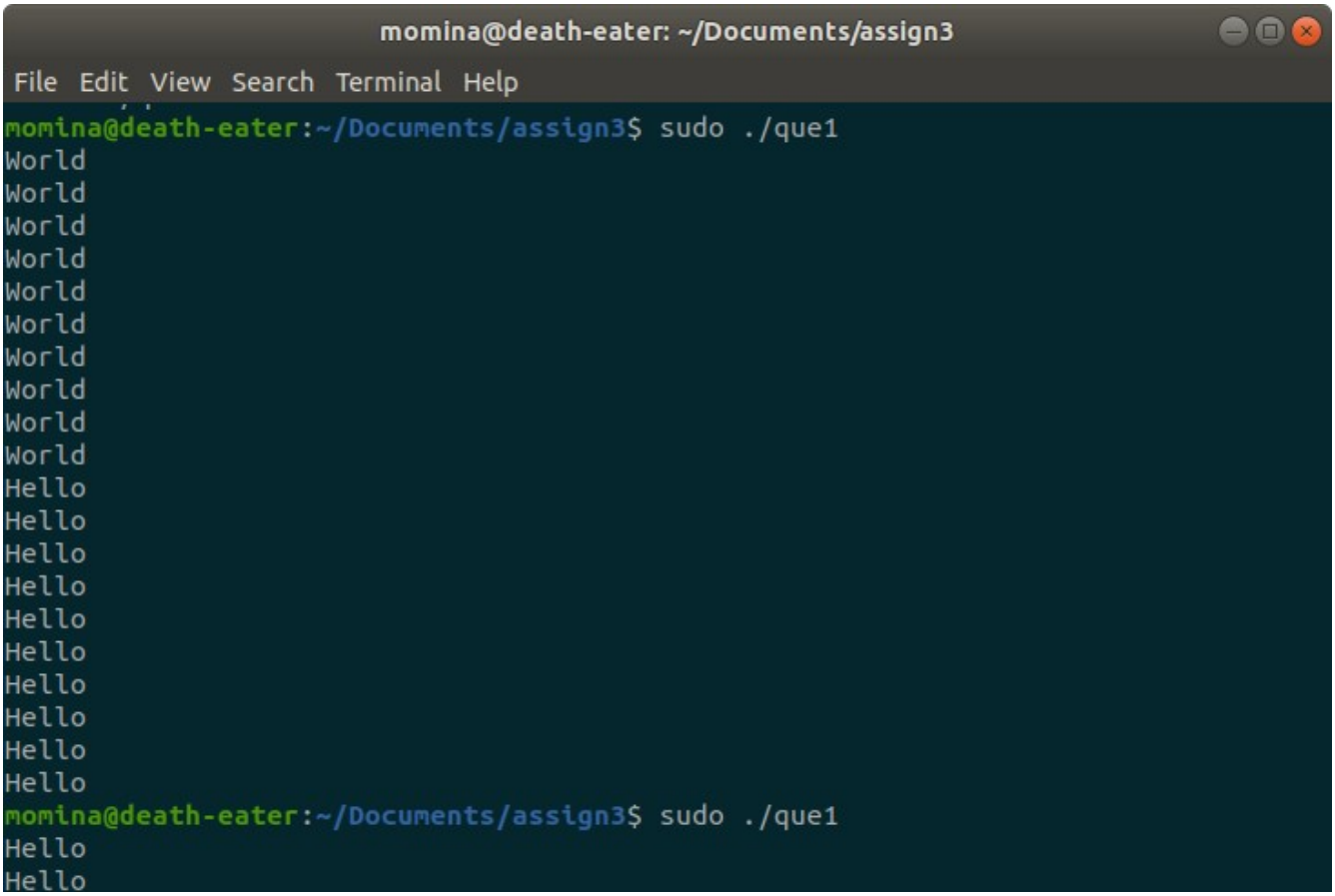
P18-0030
Section: B

Question 1:




momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ sudo ./que1
World
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World
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Hello
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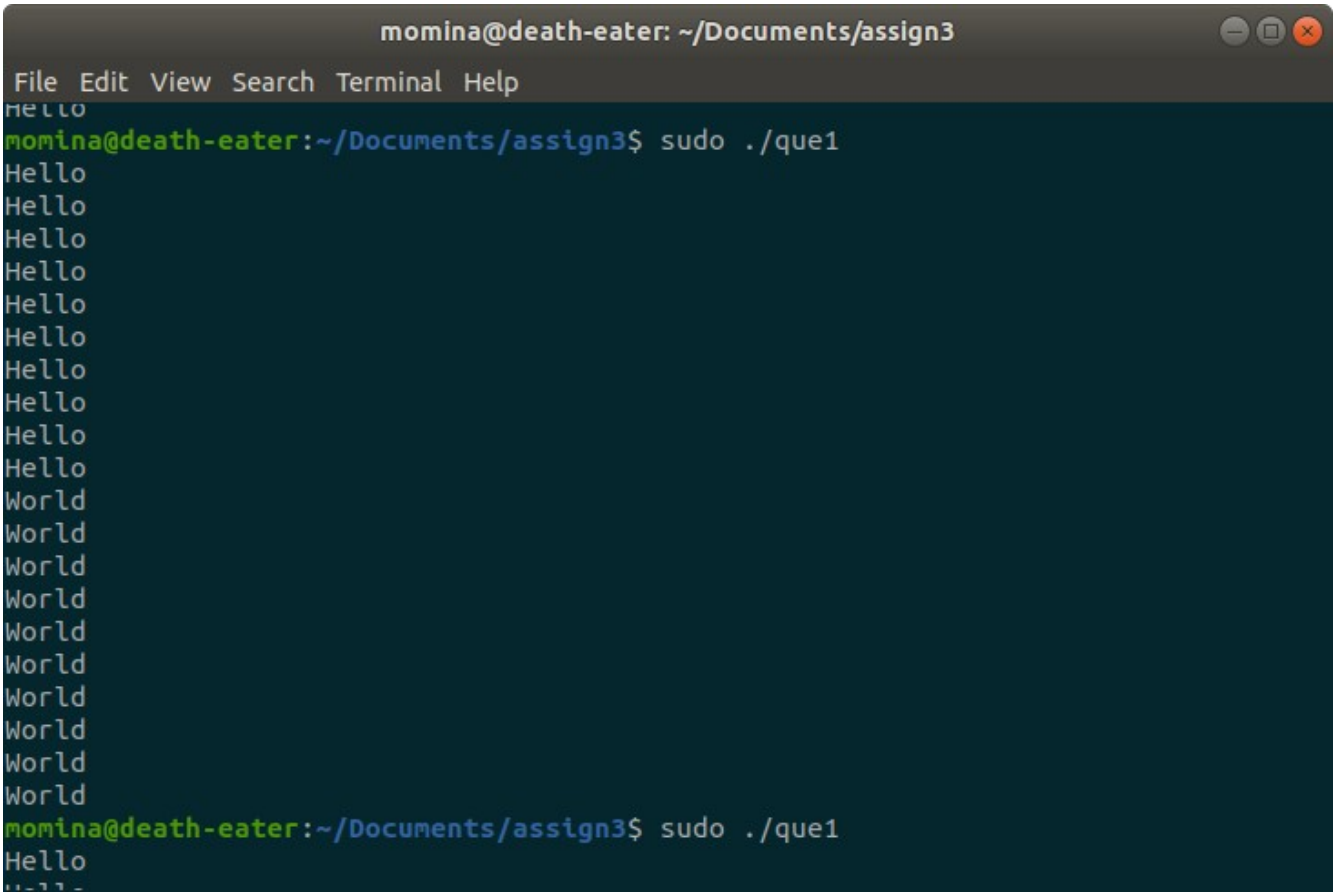
Hello
momina@death-eater:~/Documents/assign3$ sudo ./que1
Hello
Hello


momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ sudo ./que1
Hello
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Hello
Hello
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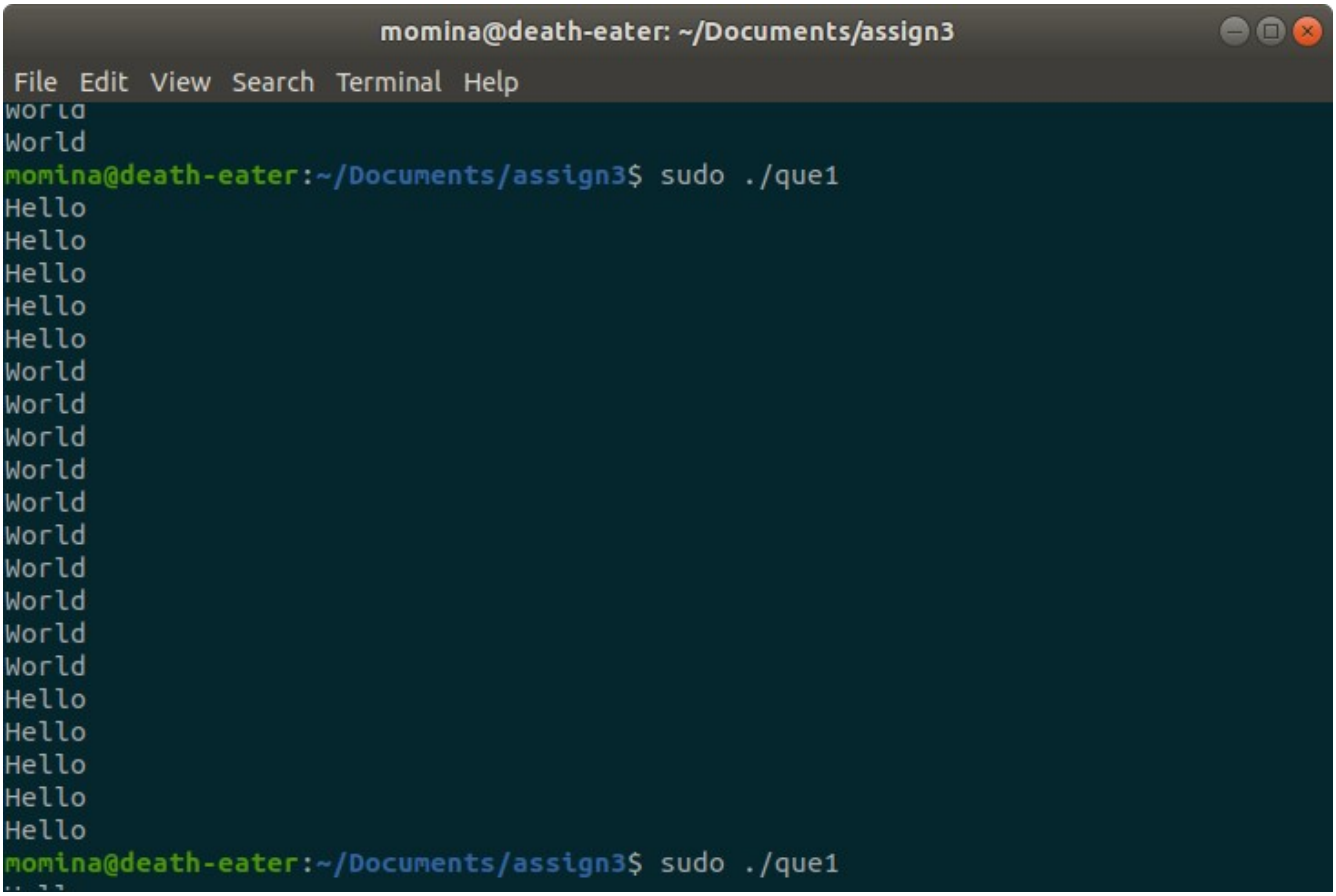
momina@death-eater:~/Documents/assign3$ sudo ./que1
Hello



Explanation:

Sometimes ten ‘Hello’ is printed first which means Thread 1 is executing first without occurrence of race condition/preemption and sometimes ten ‘World’ is printed first which means Thread 2 is executing first without any preemption. Sometimes exact opposite is happening with Thread 2 completely executing first, followed by complete execution of Thread 1.
Sometimes Thread 1 executes for less than ten times and is preempted, Thread 2 is given turn and it starts executing. Thread 2 completes its execution and Thread 1 resumes its execution from where it left.
It can also happen that in the above paragraph/example, Thread 2 doesn’t get to complete its execution and might be preempted. In that case Thread 1 will resume its execution. Preemption can occur at any point in the loops above, no matter what iteration of loop is running.

Modified Version Q1:

que1.c — ~/Documents/assign3 — Atom

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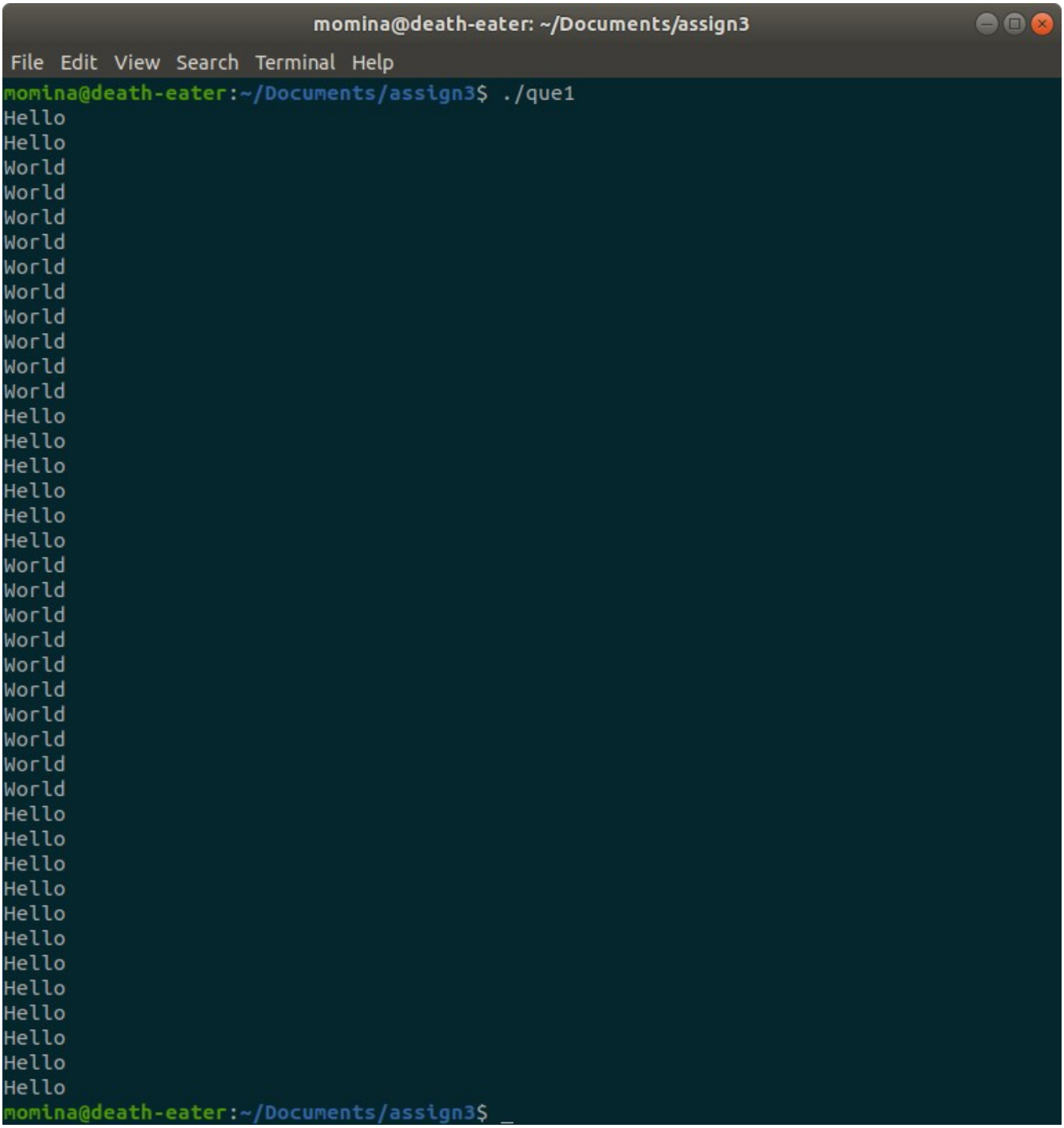
que1.c

```c
#include <stdio.h>
#include <pthread.h>
#include <stdlib.h>

void* thread1() {
  for (int c=0; c<10; c++)
    printf("Hello\n");
}

void* thread2(){
  for (int c=0; c<10; c++)
    printf("World\n");
}

int main(){
  int status;
  pthread_t tid1, tid2, tid3, tid4;

  pthread_create( &tid1, NULL, thread1, NULL);
  pthread_create( &tid2, NULL, thread2, NULL);
  pthread_create( &tid3, NULL, thread1, NULL); //
  pthread_create( &tid4, NULL, thread2, NULL); //

  pthread_join( tid1, NULL);
  pthread_join( tid2, NULL);
  pthread_join( tid3, NULL); //
  pthread_join( tid4, NULL); //

  return 0;
}
```

~/Documents/assign3/que1.c 27:32 LF UTF-8 C GitHub Git (0)


momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ ./que1
Hello
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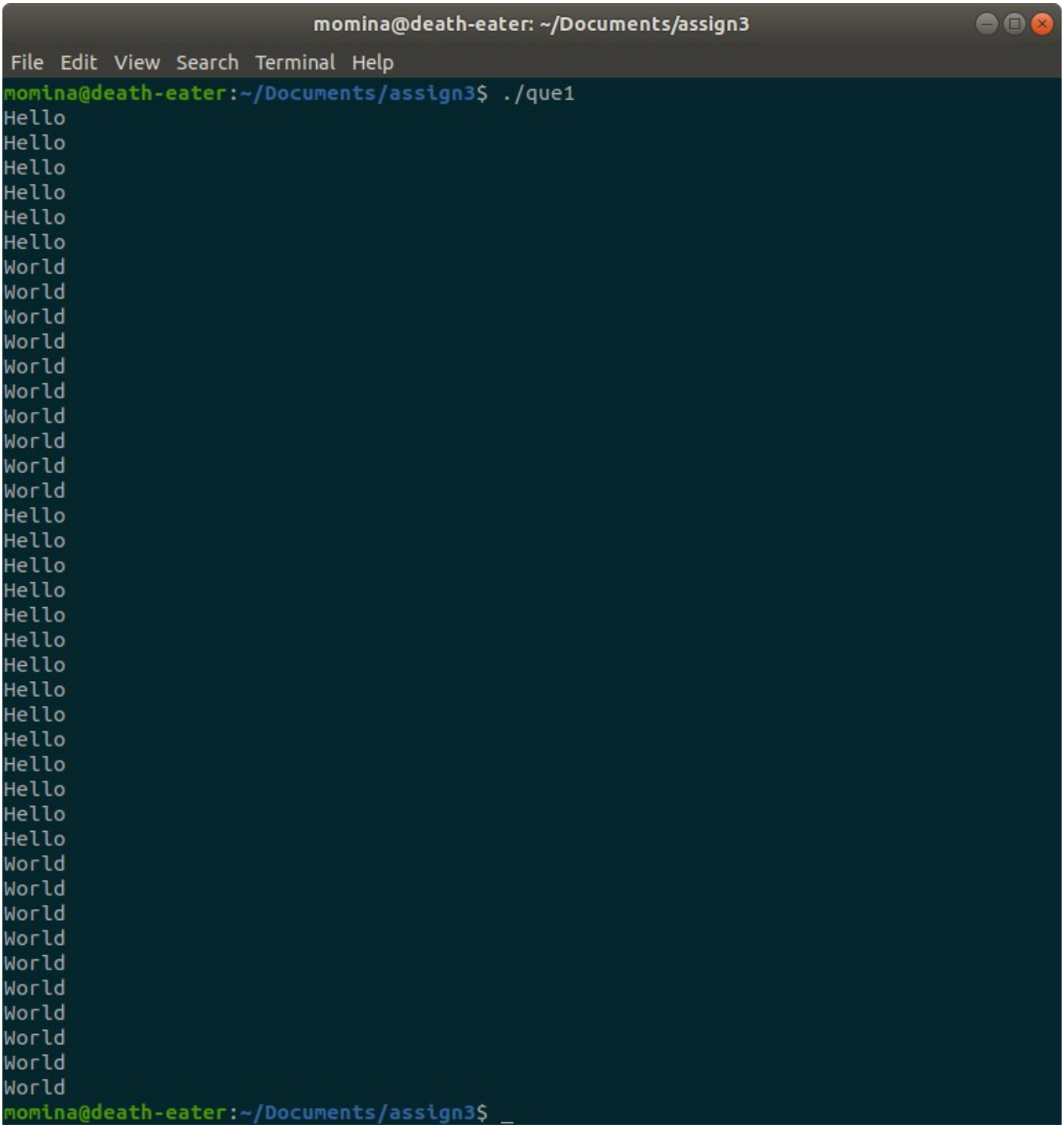
momina@death-eater:~/Documents/assign3$ _


momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ ./que1
Hello
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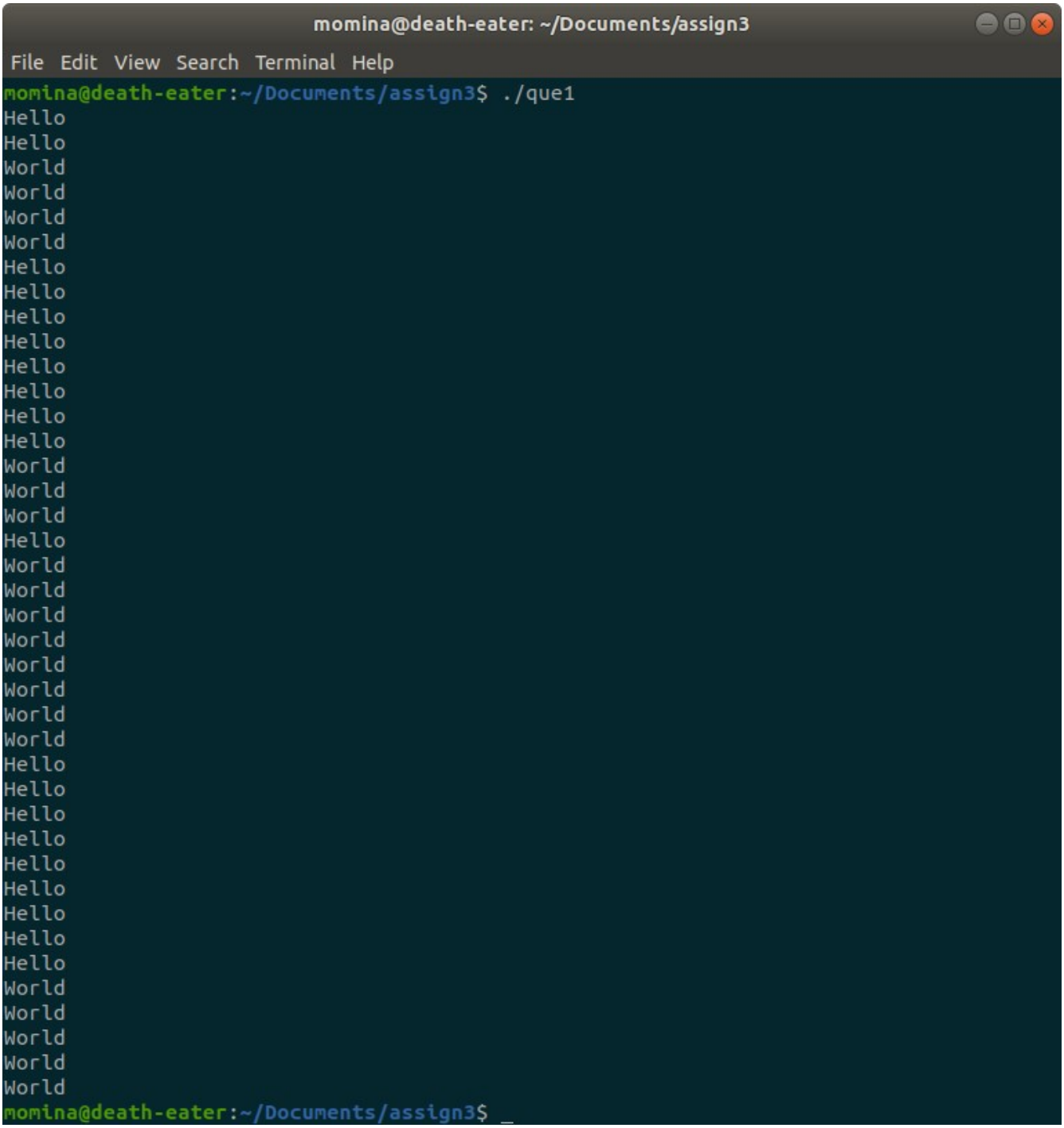
momina@death-eater:~/Documents/assign3$ _



Explanation:

Almost same explanation as above but since two threads will print ‘Hello’ and two will print ‘World’ I cannot clearly say anything about the order of execution. But I can assume that in the last output image, Thread 1 executes, preemption occurs and Thread 2 or Thread 4 has been given the turn to execute, or maybe Thread 2 and Thread 4 are running one after another (printing two ‘World’ each). Then again preemption occurs and turn is given to Thread 1 or Thread 3 or maybe both after one another. This goes on.

Question 2:

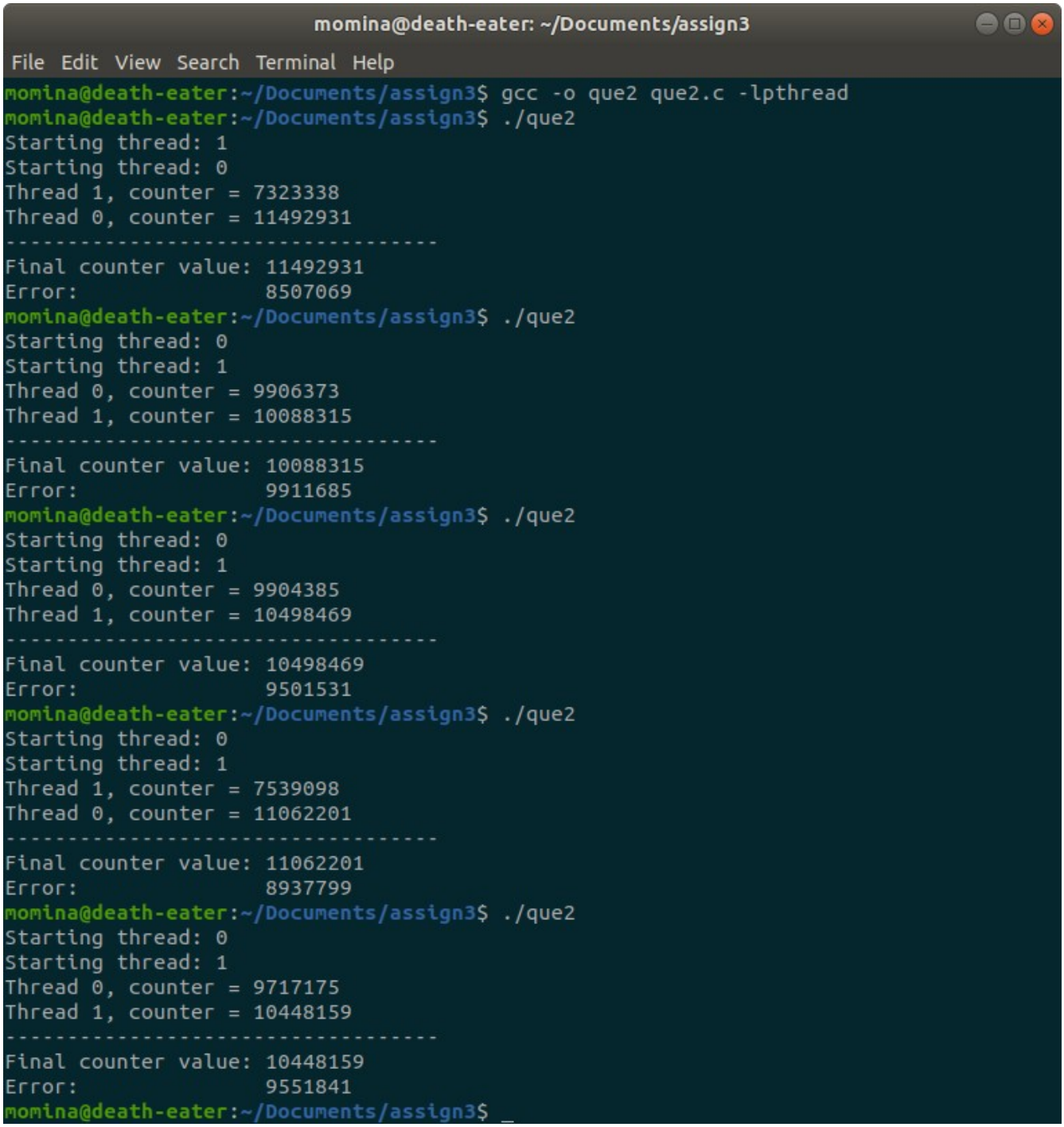
que2.c — ~/Documents/assign3 — Atom

File Edit View Selection Find Packages Help

que1.c | que2.c

```c
#include <unistd.h>
#include <sys/types.h>
#include <errno.h>
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <string.h>

#define NUM_RUNS 10000000

void handler(void *ptr);

int counter;

int main(){
  int i[2];
  pthread_t thread_a;
  pthread_t thread_b;

  i[0] = 0;
  i[1] = 1;

  pthread_create(&thread_a, NULL, (void *) &handler, (void *) &i[0]);
  pthread_create(&thread_b, NULL, (void *) &handler, (void *) &i[1]);

  pthread_join(thread_a, NULL);
  pthread_join(thread_b, NULL);

  printf("-----------------------------------\n");
  printf("Final counter value: %d\n", counter);
  printf("Error:               %d\n", (NUM_RUNS*2-counter));

  exit(0);
}

void handler(void *ptr){
  int iter = 0;
  int thread_num;

  thread_num = *((int *) ptr);

  printf("Starting thread: %d \n", thread_num);

  while(iter < NUM_RUNS){
    counter++;      //20000000
    iter += 1;
  }

  printf("Thread %d, counter = %d \n", thread_num, counter);

  pthread_exit(0);

```

que2.c 40:31 LF UTF-8 C GitHub Git (0)


momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ gcc -o que2 que2.c -lpthread
momina@death-eater:~/Documents/assign3$ ./que2
Starting thread: 1
Starting thread: 0
Thread 1, counter = 7323338
Thread 0, counter = 11492931

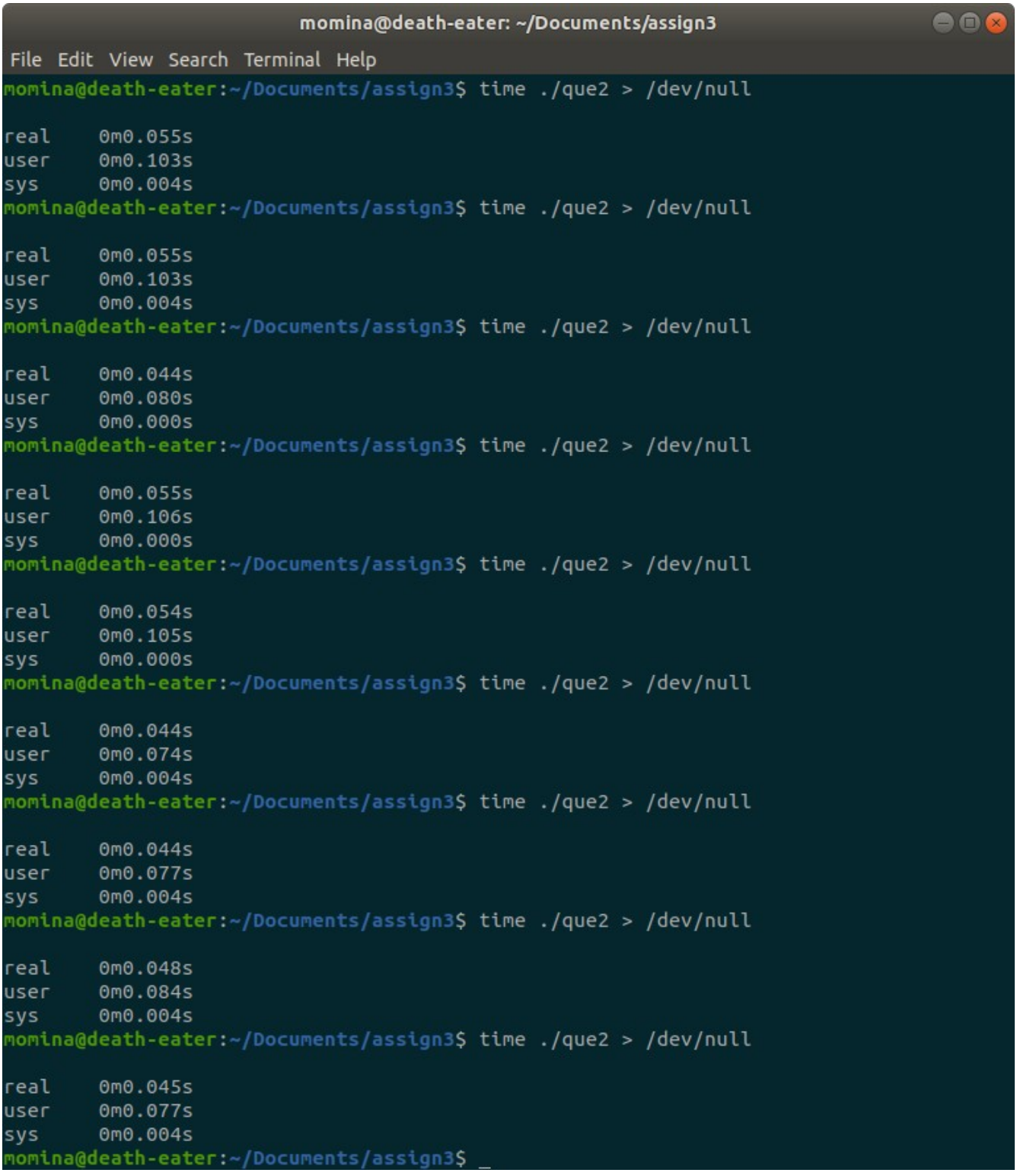
Final counter value: 11492931
Error: 8507069
momina@death-eater:~/Documents/assign3$ ./que2
Starting thread: 0
Starting thread: 1
Thread 0, counter = 9906373
Thread 1, counter = 10088315

Final counter value: 10088315
Error: 9911685
momina@death-eater:~/Documents/assign3$ ./que2
Starting thread: 0
Starting thread: 1
Thread 0, counter = 9904385
Thread 1, counter = 10498469

Final counter value: 10498469
Error: 9501531
momina@death-eater:~/Documents/assign3$ ./que2
Starting thread: 0
Starting thread: 1
Thread 1, counter = 7539098
Thread 0, counter = 11062201

Final counter value: 11062201
Error: 8937799
momina@death-eater:~/Documents/assign3$ ./que2
Starting thread: 0
Starting thread: 1
Thread 0, counter = 9717175
Thread 1, counter = 10448159

Final counter value: 10448159
Error: 9551841
momina@death-eater:~/Documents/assign3$ _


momina@death-eater: ~/Documents/assign3
File Edit View Search Terminal Help
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.055s
user 0m0.103s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.055s
user 0m0.103s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.044s
user 0m0.080s
sys 0m0.000s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.055s
user 0m0.106s
sys 0m0.000s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.054s
user 0m0.105s
sys 0m0.000s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.044s
user 0m0.074s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.044s
user 0m0.077s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.048s
user 0m0.084s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ time ./que2 > /dev/null
real 0m0.045s
user 0m0.077s
sys 0m0.004s
momina@death-eater:~/Documents/assign3$ _

Questions:

i. 20000000

ii. 10448159

iii. 9551841. Sometimes it increases to approximately 1400000 and sometimes it decreases to approximately 400000 (by taking the difference between errors).

iv. By taking average, 0.089s.