CSC 8980
Distributed Systems
Fall 2022

Homework #1 (Warm-Up)

Due date: September 15th

1. (20pts) Nowadays, we frequently use a Global Positioning System (GPS) Receiver to determine our location and to find the shortest way to a specific destination. GPS technology uses satellites that continuously send certain signals to earth. How does the receiver utilize these signals to determine its dancer's current location? To what precision can the GPS determine a location? Is it possible to determine the hiker's altitude? (How about the hiker's attitude? ☺) Research the workings of a GPS system and find answers to the questions above. Specifically, determine the following:
    a. how many satellites are participating in GPS system? Why?
    b. how many satellites are needed to determine a location? Why?
    c. how many satellites are required to determine one's altitude? Explain!
    d. what synchronization is required between satellites and receivers? Explain!
    e. what is WAAS?
    f. why is a general-purpose GPS receiver less precise than a military-grade receiver?

2. (20pts) Consider a system of 9 processes, **P** = {p1, …, p9}
Associated with the system are 6 memory cells, **M** = {M1, .., M6}

The domain and range for each process is given in the following table:

Process pi	Domain D(pi)	Range R(pi)
p1	M1, M2	M3
p2	M1	M5
p3	M3, M4	M1
p4	M3, M4	M5
p5	M3	M4
p6	M4	M4
p7	M5	M5
p8	M3, M4	M2
p9	M5, M6	M6

In addition, you are given the following precedence relation:
➔ = {(1,2),(1,6),(2,3),(2,4),(2,5),(3,6),(3,8),(4,6),(4,7),(5,7),(5,8),(6,8),(6,9),(7,9),(8,9)}

a. Construct the Precedence Graph (not containing redundant/transitive edges) from the given precedence relation.
b. As per the given precedence relation, which processes can be executed concurrently?
c. Make the necessary modifications to guarantee that the system is determinate for all interpretations fp.
d. Modify the precedence relation above to construct a maximally parallel system.

3. (25pts) Outline a formal proof of the following theorem: *"A mutually non-interfering system of processes is determinate"*

4. (40pts) Write a simple sequence-number system through which three concurrent processes, P1, P2, and P3, **each** obtain unique integers in the range [1, 500]. Use the fork() call to create P1, P2, and P3. Given a file, F, containing a single number, each process performs the following steps:

   a. Open F.
   b. Read the sequence number N from the file.
   c. Close F.
   d. Output N and the process' PID (either on screen or test file).
   e. Increment N by 1
   f. Open F.
   g. Write N to F.
   h. Flush F.
   i. Close F.

   Describe the behavior of the three processes and explore the reason for this behavior. Provide evidence for your conclusion in the form of test-output. You must clearly document your code. Explain WHY the sequence number file must be **located on the local disk. HINT: On Linux, the \tmp directory is located on the local file system.** What do you observe when the sequence number file resides in your home directory?