CMPS 4760/6760 Distributed Systems – Spring 21

Homework 3 (20+6 points)

Due 04/15/21 before class

Note: (1) Clearly justify your answers to each of the questions below. (2) The starred problem is required for graduate students only.

1 **(6 points)** Three processes 0, 1, 2 of a group communicate with one another, and their requirement is *causally ordered multicast*. A message from process 0 has a vector time stamp (1, 2, 0), and it reaches node 2 when its local vector clock is (0, 1, 2).

(a) **(4 points)** Draw a diagram reconstructing the exchange of all the messages in the group (up to the message mentioned above).

(b) **(2 points)** Will the message be acceped by process 2? Explain.

2 **(2 points)** The members of a group use *view-synchronous multicast* to communicate with one another. Initially, there are four processes 0, 1, 2, 3. Process 0 sent a message m in the view $(0, 1, 2, 3)$. Processes 0, 1, and 2 delivered the msessage m, but process 3 did not. Is this an acceptable behavior? Justify your answer.

3 **(6 points)** Consider the consensus algorithm for synchronous systems under crash failures that we discussed in class. Show by an example that if the algorithm decided the final value after f rounds instead of $f + 1$ rounds, then it might violate the agreement property.

4 (**6 points)** Consider the Byzantine generals problem with one commander and four lieutenants, where one of them is a traitor. The algorithm we discussed in class ensures that a consensus can always be reached in this case. However, it does not suggest how to identify the traitor. Is it always possible to identify the traitor without ambiguity? Justify your answer.

*5 **(6 points)** We showed in class how to construct a solution to the Byzantine generals (BG) problem using a solution to the consensus problem. Show how to construct a solution to the consensus problem using a solution to BG. Show that the terminaion, agreement, and integrity conditions are preserved. Hint: you can run BG multiple times.