Homework 3 (24+6 points)
Due 04/16/19 at the beginning of class

Note: (1) Clearly justify your answers to each of the questions below. (2) The starred problems are required for graduate students only (undergraduates are encouraged to try them to get extra credit).

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 accepted by process 2? Explain.

2 (6 points) Show that the FIFO-ordered multicast algorithm we discussed in class does not work for overlapping groups, by considering two messages sent from the same source to two overlapping groups, and considering a process in the intersection of those groups. Adapt the protocol to work for this case. Hint: processes should include with their messages the latest sequence numbers of messages sent to all groups.

3 (12 points) Consider the consensus algorithm for synchronous systems under crash failures that we discussed in class.

(a) (6 points) Show by an example that if the algorithm decided the final value after $f$ rounds instead of $f + 1$ rounds, then it might violate agreement property.

(b) (6 points) Observe that processes use only the minimum value in the set $V$ to decide on the agreement problem. Use this observation to reduce the space and the communication complexity of the algorithm.

*4 (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 termination, agreement, and integrity conditions are preserved. Hint: you can run BG multiple times.