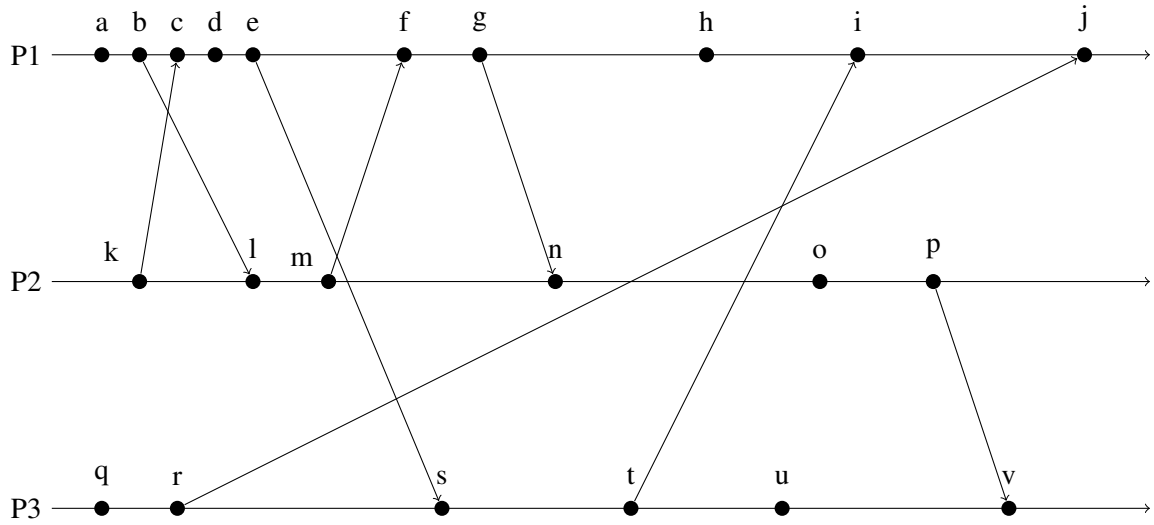
CS 237 Homework 1

Middleware, Spring 2022

Due: Monday, April 18th, 2022 at 11:59pm, via Gradescope

Problem 1: Lamport Logical Clocks

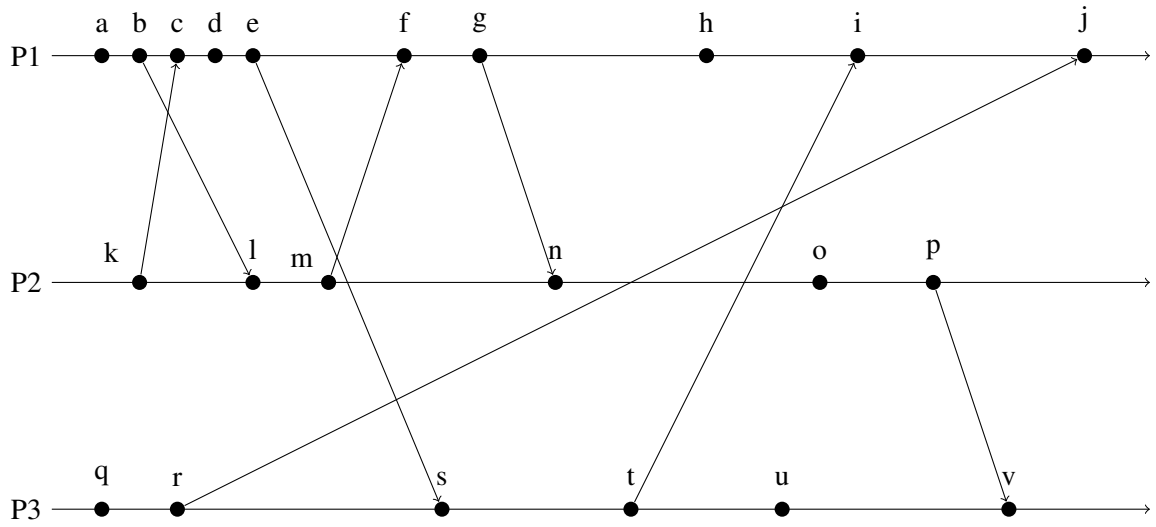
Three processes P_1, P_2 and P_3 communicate using a protocol implementing *Lamport logical clocks* (i.e., a scalar clock timestamp is included in messages). At the beginning of time, assume that all processes begin with their logical clock set to zero, and a clock tick increases the time by 1.



1. For the event diagram above, label all events with scalar clocks.
2. Are events n and t concurrent? Briefly explain.
3. Are events h and m concurrent? Briefly explain.
4. Are events k and s causally connected? Briefly explain.
5. In general, if two events e_i and e_j are concurrent, can $C(e_i) < C(e_j)$? Briefly explain.

Problem 2: Vector Clocks

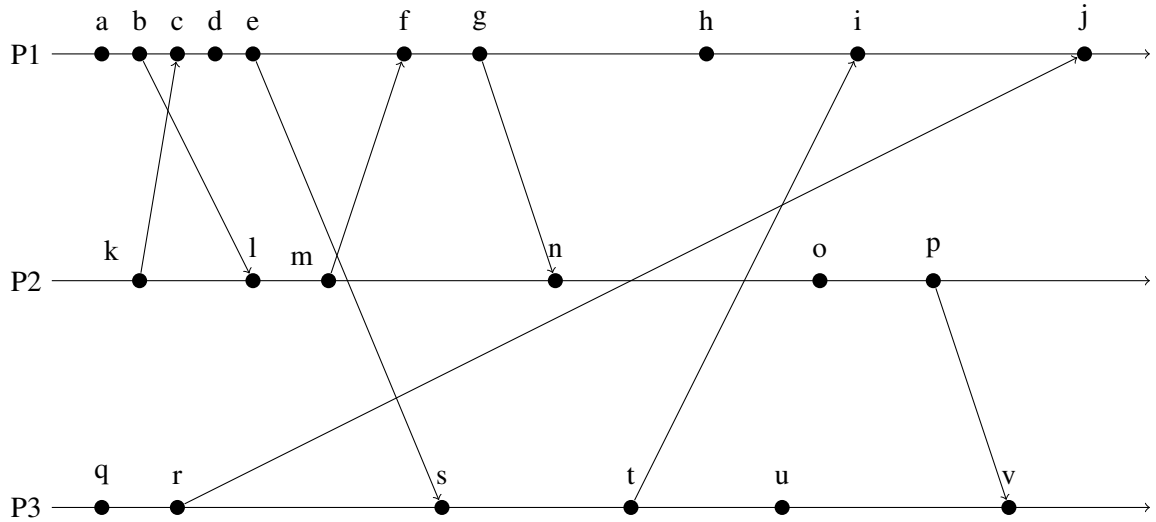
Three processes P_1, P_2 and P_3 communicate using a protocol implementing *vector clocks* (i.e., a vector clock timestamp is included in messages). At the beginning of time, assume that all processes begin with their logical clock set to the zero vector, and a clock tick increases the associated process' time by 1.



1. For the event diagram above, label all events with vector clocks.
2. Are events s and h concurrent? Briefly explain.
3. Are events k and t concurrent? Briefly explain.
4. Are events i and v causally connected? Briefly explain.
5. In general, if two events e_i and e_j are concurrent, can $C(e_i) < C(e_j)$? Briefly explain.

Problem 3: Global States

In the event diagram below, suppose that P1 wishes to obtain a global state of the system using the Chandy-Lamport Algorithm. **For both problems below, assume that P1 initiates this algorithm immediately after event g (and before event h).**



1. Define the *earliest consistent cut* as the consistent cut that creates that takes a snapshot at the earliest possible time for each process. Draw the earliest consistent cut in the event diagram above.
2. How many consistent cuts exist in the event diagram above? Note: You do not need to draw them, just give a total count.

Problem 4: Paper Summaries

Summarize 2 papers selected from the topics given in the course timeline for Summary Set 1. They should be 1 to 1.5 pages of text (suggested size 10-11 pt, single spaced, 1-inch margins). Your summaries should provide the following information about the paper in your own words:

1. The main contributions of the paper: the key problem(s), proposed techniques and approaches
2. The critiques of the approach: its advantages and its limitations
3. The implications to technology practice, i.e., implementation feasibility in a distributed computing environment