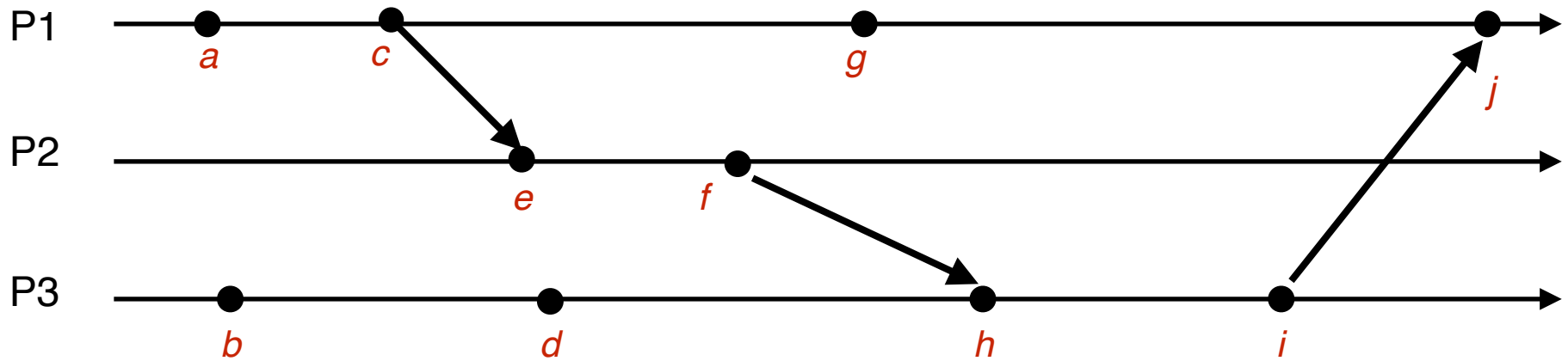


# Logical Clocks

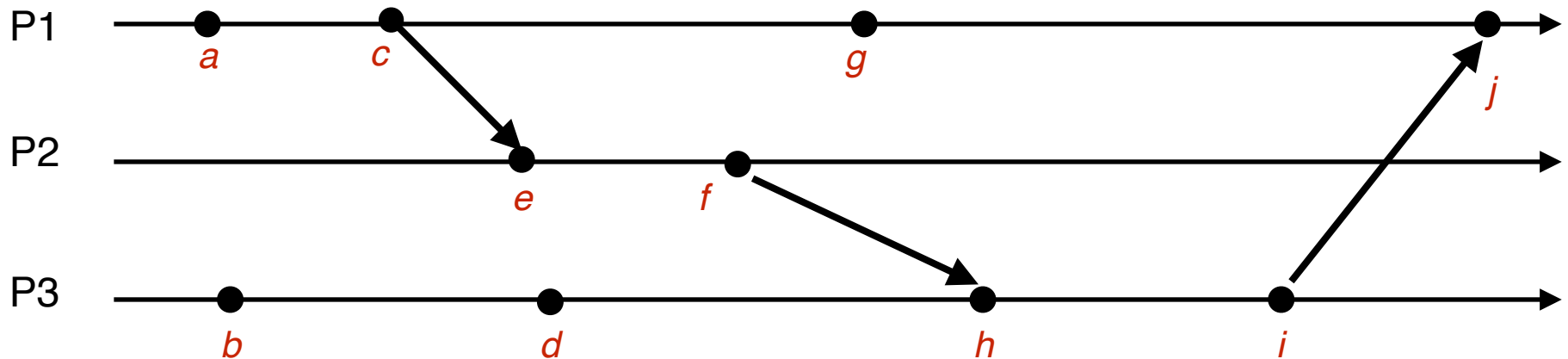
## 1. Lamport Clocks

Annotate the process timelines with Lamport clocks for each event.



## 2. Vector Clocks

Annotate the process timelines with Vector clocks for each event.



Using your vector clocks, indicate whether an event happens before (  $\rightarrow$  ), after (  $\leftarrow$  ) or is concurrent (  $\parallel$  )

*a* \_\_\_\_\_ *b*

*c* \_\_\_\_\_ *i*

*d* \_\_\_\_\_ *f*

*b* \_\_\_\_\_ *h*

*g* \_\_\_\_\_ *h*

*e* \_\_\_\_\_ *d*

*f* \_\_\_\_\_ *j*

*b* \_\_\_\_\_ *g*

*b* \_\_\_\_\_ *j*

## 3. Comparing Clocks

Given this set of events and vector clocks for four processes, specify the relationship between each event.

P1	P2	P3	P4
a: 1,0,0,0	e: 1,1,0,0	i: 0,0,1,0	l: 0,0,0,1
b: 2,0,0,0	f: 1,2,0,1	j: 0,0,2,2	m: 0,0,0,2
c: 3,0,0,0	g: 1,3,0,1	k: 0,0,3,2	n: 0,0,0,3
d: 4,2,0,1	h: 1,4,3,2		

*a* \_\_\_\_\_ *f*

*m* \_\_\_\_\_ *g*

*l* \_\_\_\_\_ *c*

*m* \_\_\_\_\_ *h*

*g* \_\_\_\_\_ *k*

*b* \_\_\_\_\_ *g*