Process Mining: Data Science in Action

Petri Nets (2/2)

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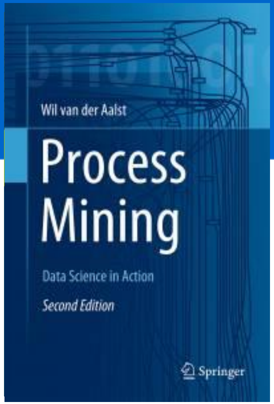
www.processmining.org



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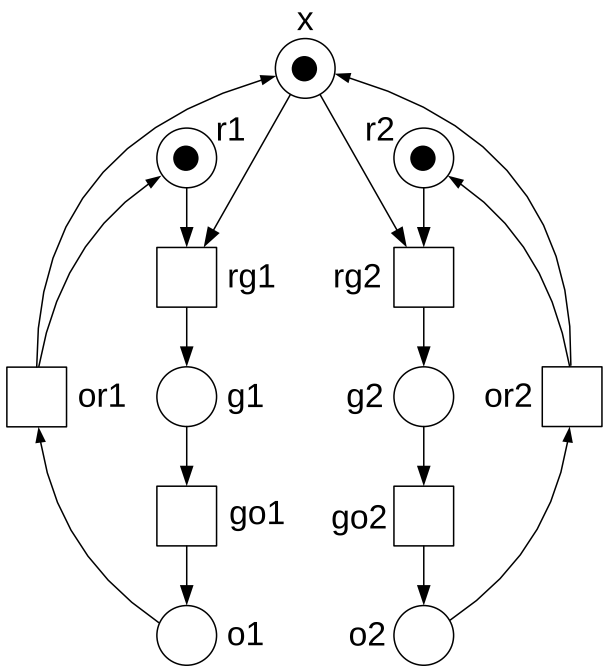
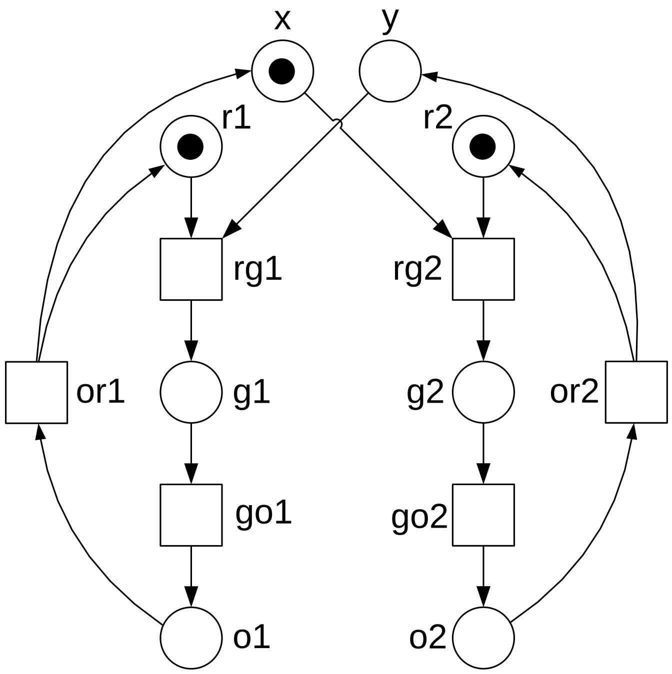
Where innovation starts

Safe traffic lights

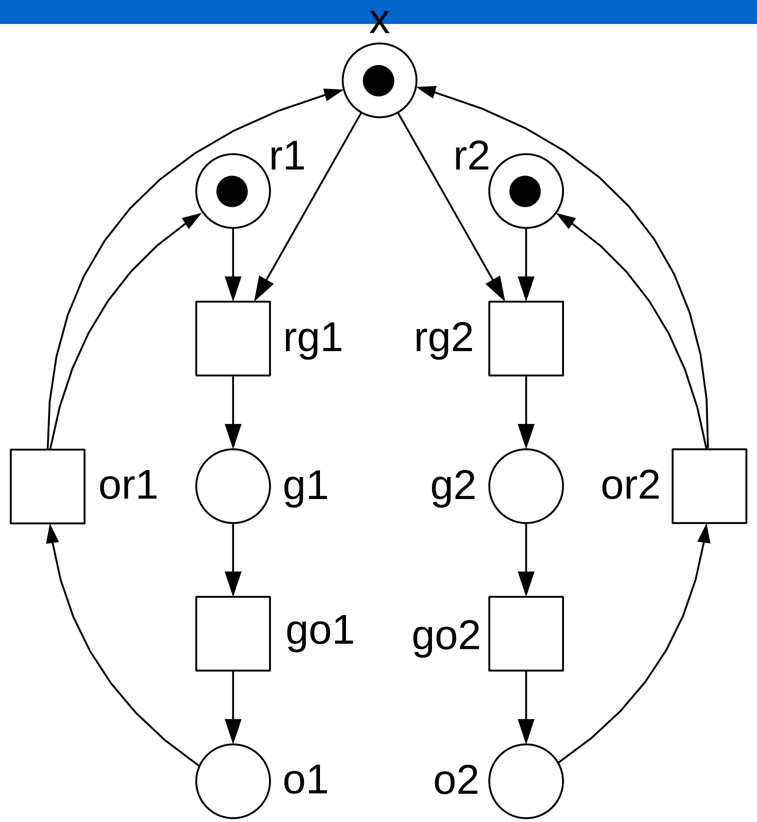


non-deterministic



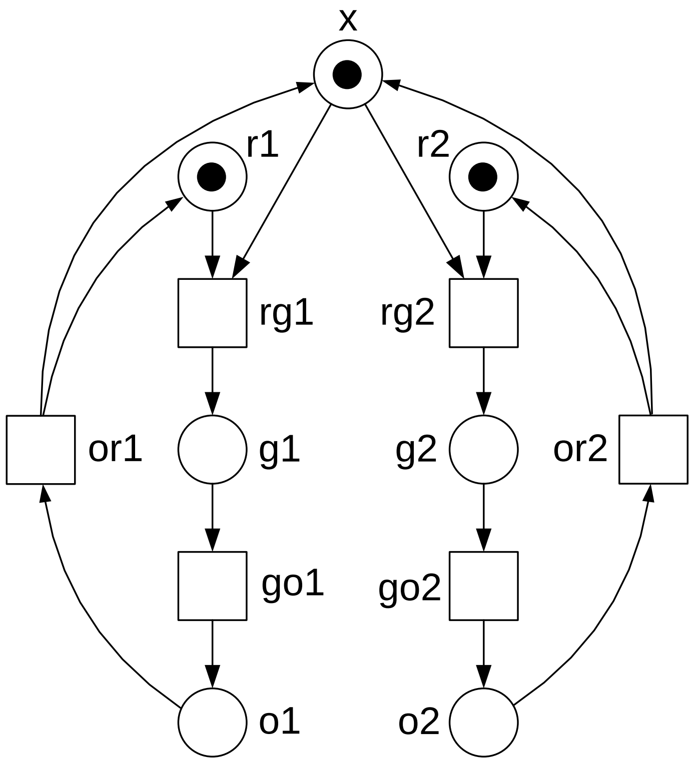
alternating

Non-deteministic traffic lights

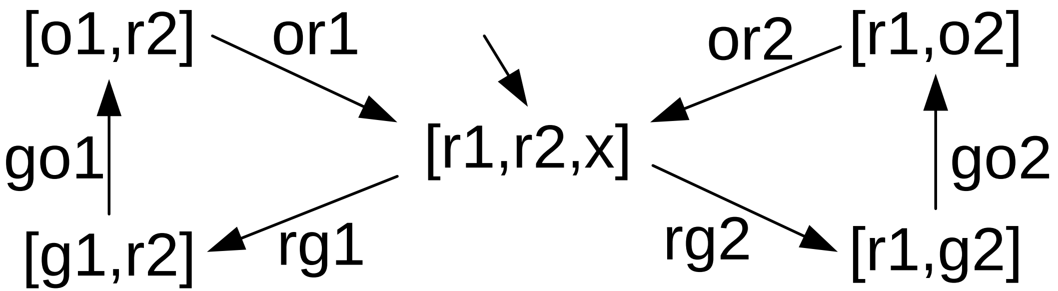


- **Initial marking:** [r1,r2,x]
- **Set of reachable markings:** { [r1,r2,x], [g1,r2], [r1,g2], [o1,r2], [r1,o2] }

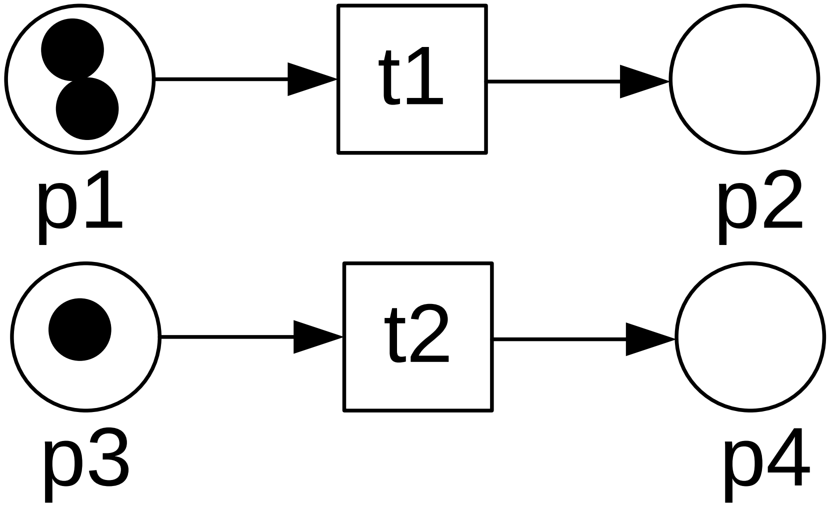
Reachability graph

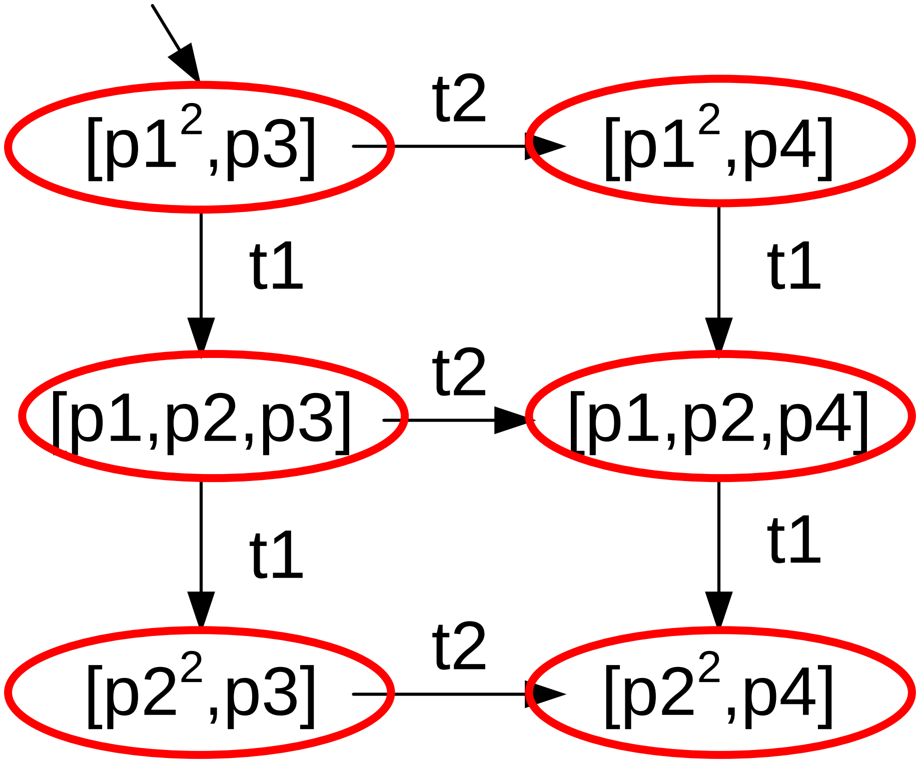


The reachability graph of a Petri net is a transition system with one initial state (initial marking) and no explicit final marking.

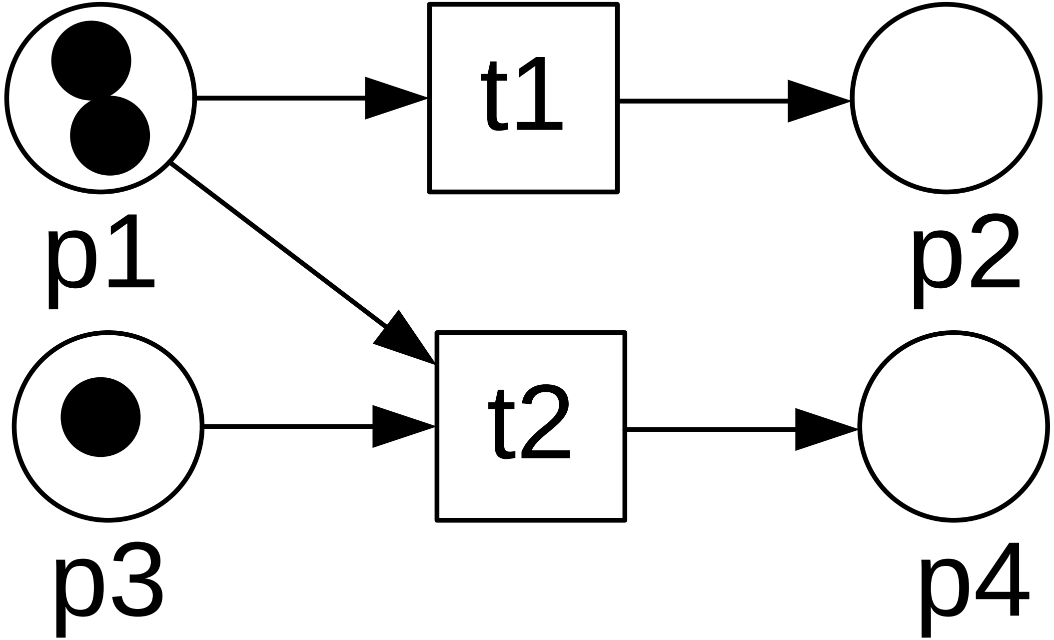


Reachability graph



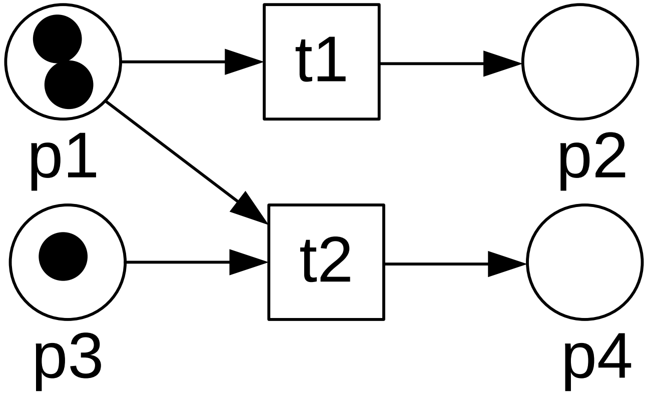


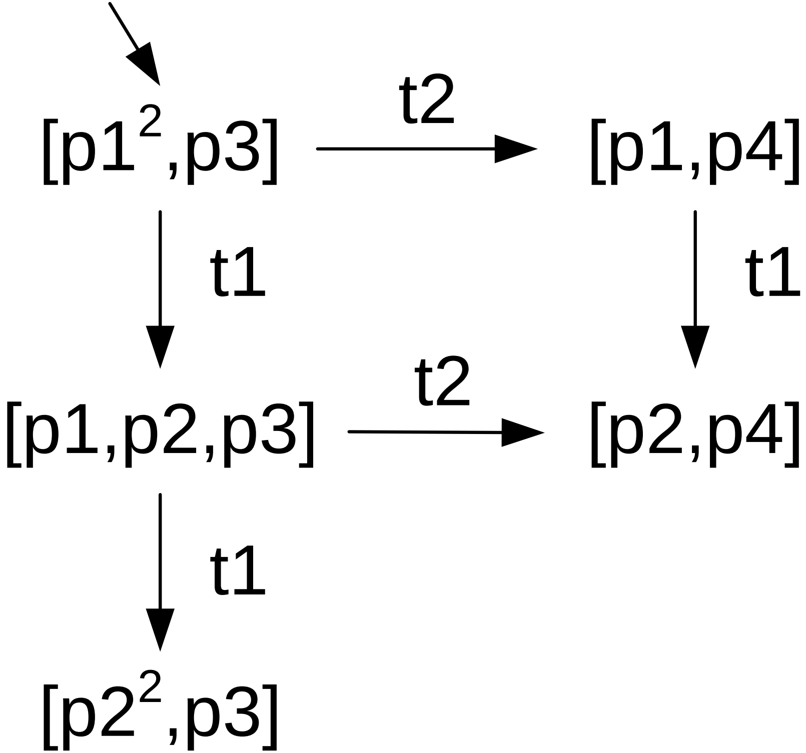
Question



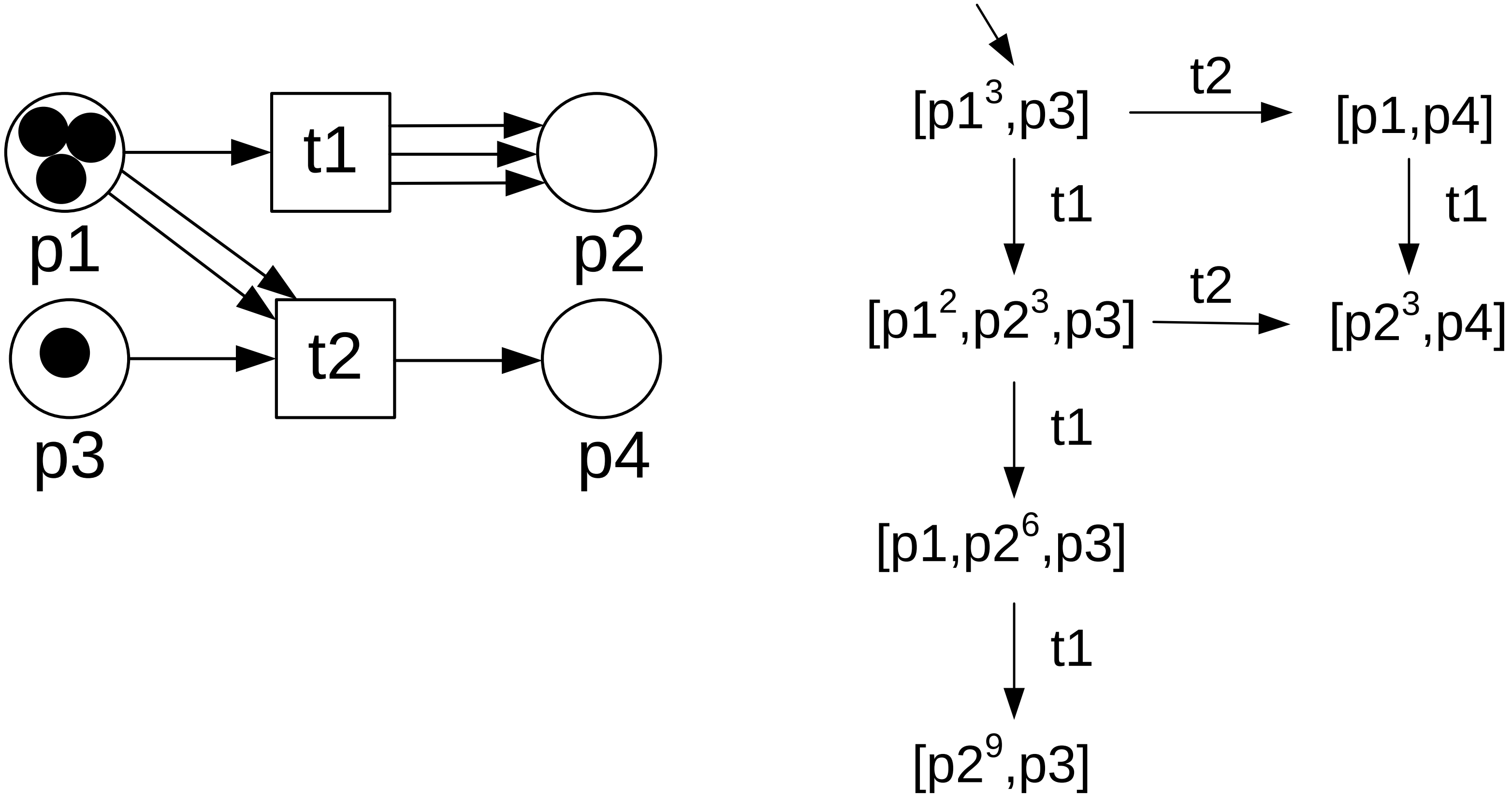
Construct the reachability graph

Answer

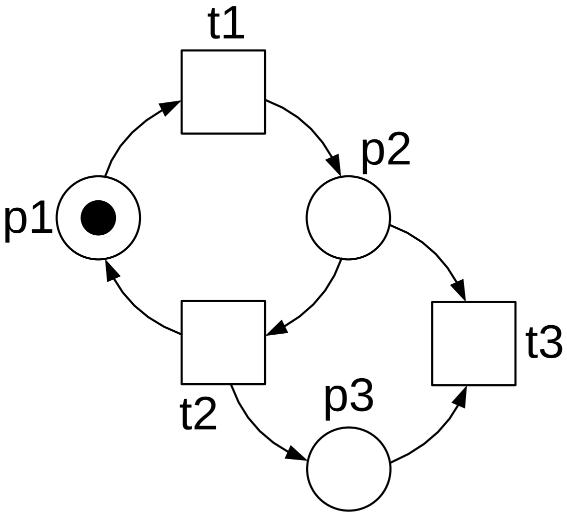




Multiple arcs connecting a place and a transition



Reachability graph does not need to be finite



$$[p1] \xrightarrow{t1} [p2] \xrightarrow{t2} [p1,p3] \xrightarrow{t1} [p2,p3] \xrightarrow{t2} [p1,p3^2] \xrightarrow{t1} [p2,p3^2] \xrightarrow{t2} \ldots$$

$$[p2,p3] \xrightarrow{t3} [\,]$$

$$[p2,p3^2] \xrightarrow{t3} [p3]$$


Modeling can be very challenging …
practice, practice, practice, …

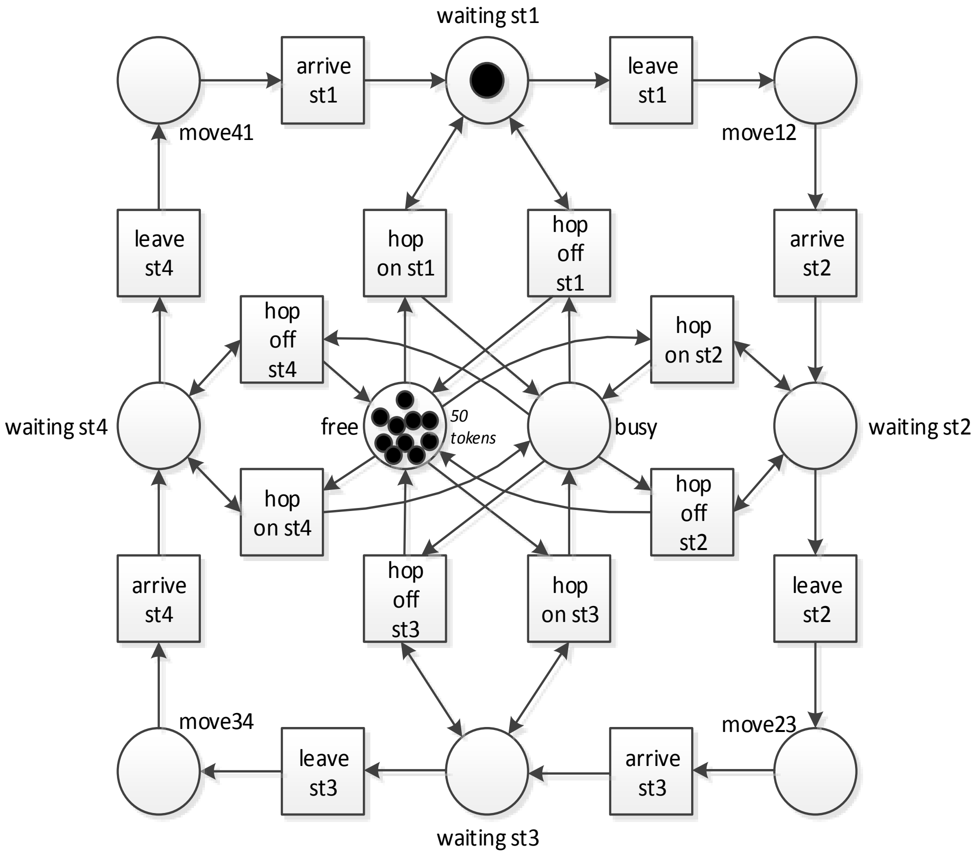
Question (not easy, takes 10 minutes!)

- Model a circular railway system with four stations (st1, st2, st3, and st4) and one train.
- At each station passengers may "hop on" or "hop off". This is impossible if the train is moving.
- The train has a capacity of 50 persons; if the train is full, no new passengers may hop on.
- Model the above process in terms of a Petri net.
- What is the number of reachable states?

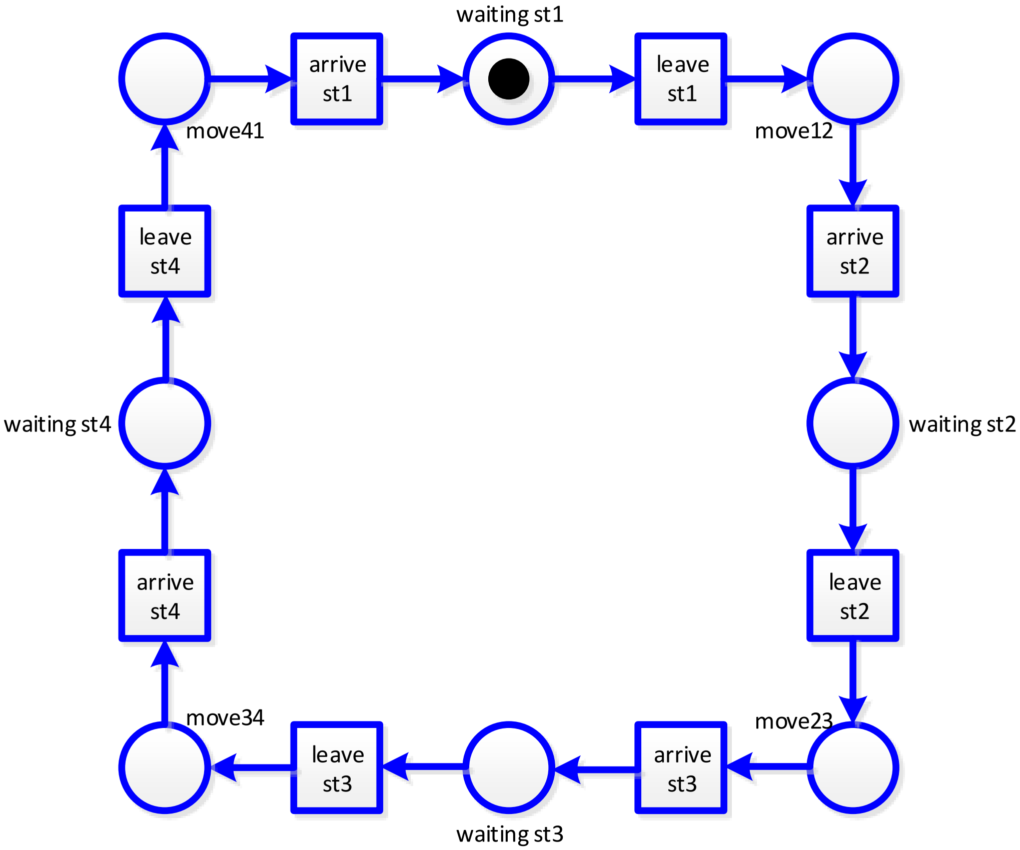
Hints

- How to describe the state of the train in terms of its location (e.g., moving from st1 to st2) and number of passengers (e.g., 36)?
- What are possible actions?
- When are they possible?

Answer (1/4)

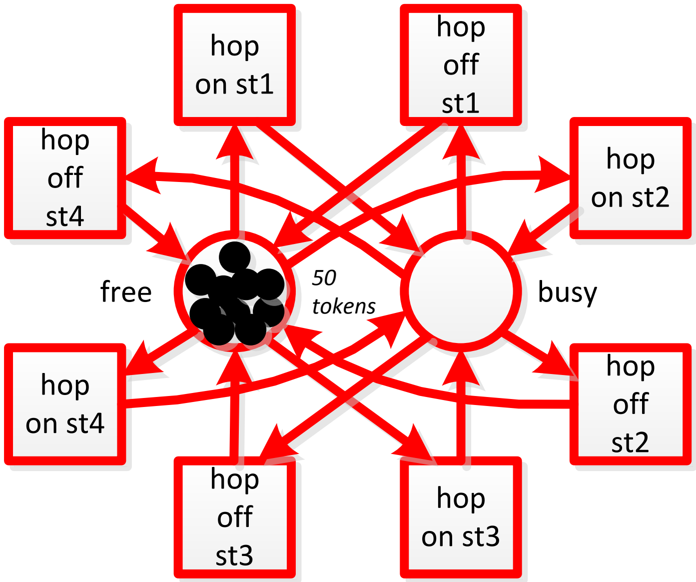

waiting st1
arrive st1
leave st1
move41
move12
leave st4
hop on st1
hop off st1
arrive st2
hop off st4
hop on st2
waiting st4
free
50 tokens
busy
waiting st2
hop on st4
hop off st2
arrive st4
hop off st3
hop on st3
leave st2
move34
move23
leave st3
arrive st3
waiting st3

Answer (2/4)



state of the train: location

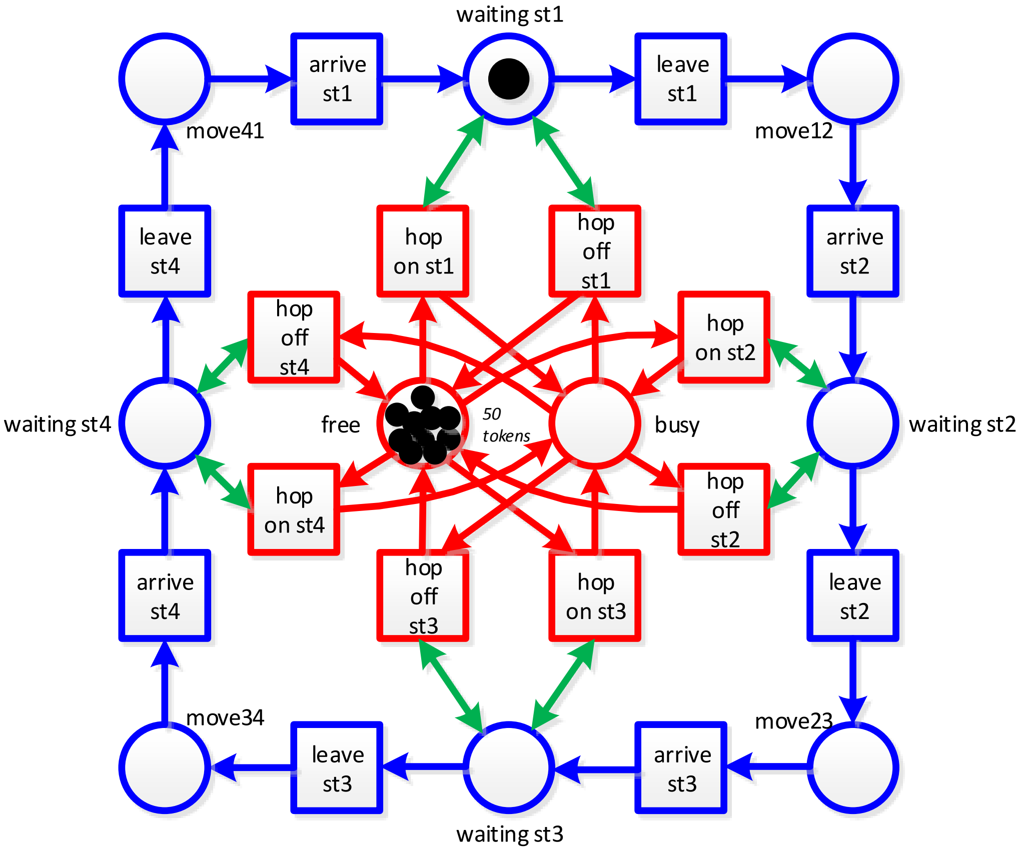
Answer (3/4)



state of the train: passengers

Answer (4/4)

51 x 8 = 408 reachable markings

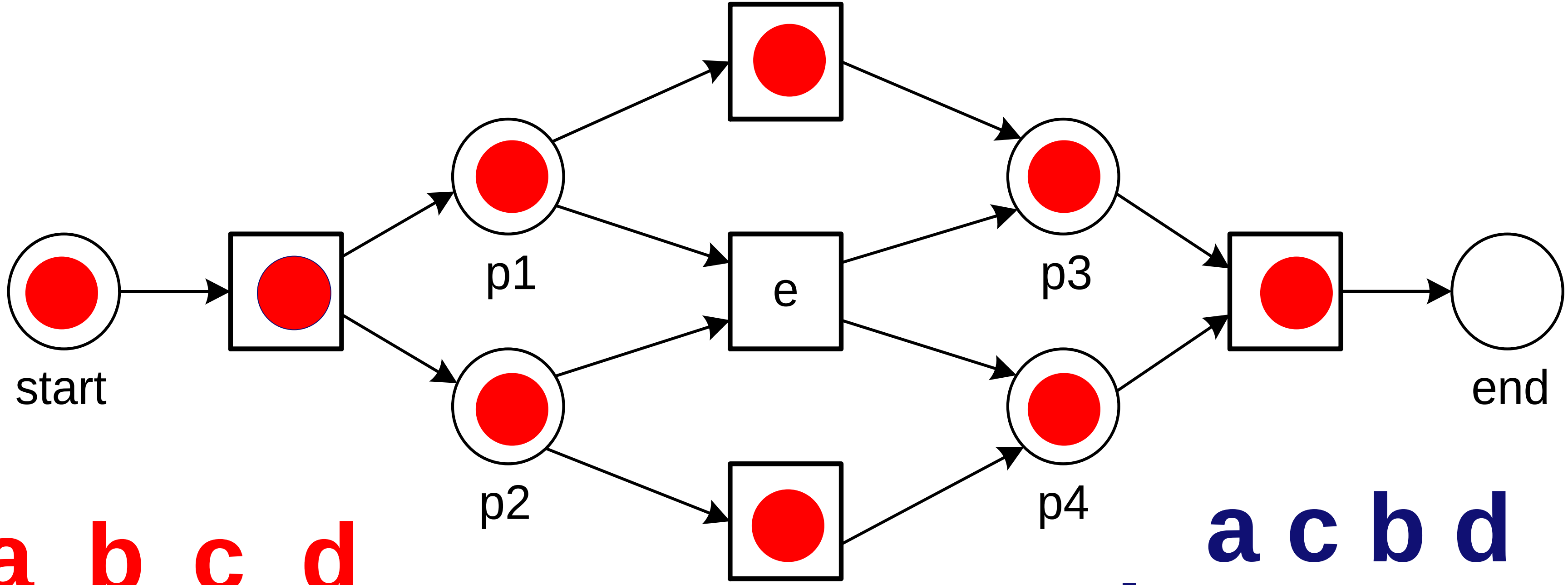


Reachability graph is already too large to draw manually!

merged model

"Token game" defines play-out

Play-Out (Classical use of models)



a b c d

a c b d

a e d

a b c d

a e d

a c b d

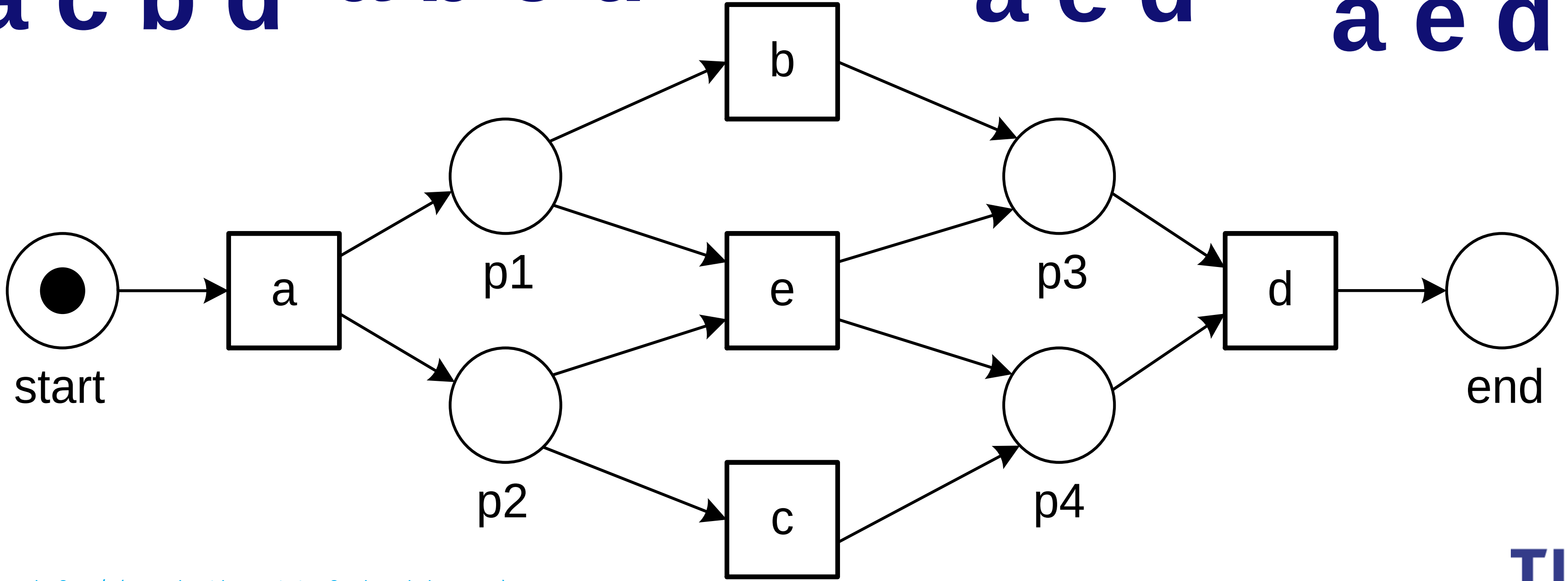
a c b d

a e d

Play-In

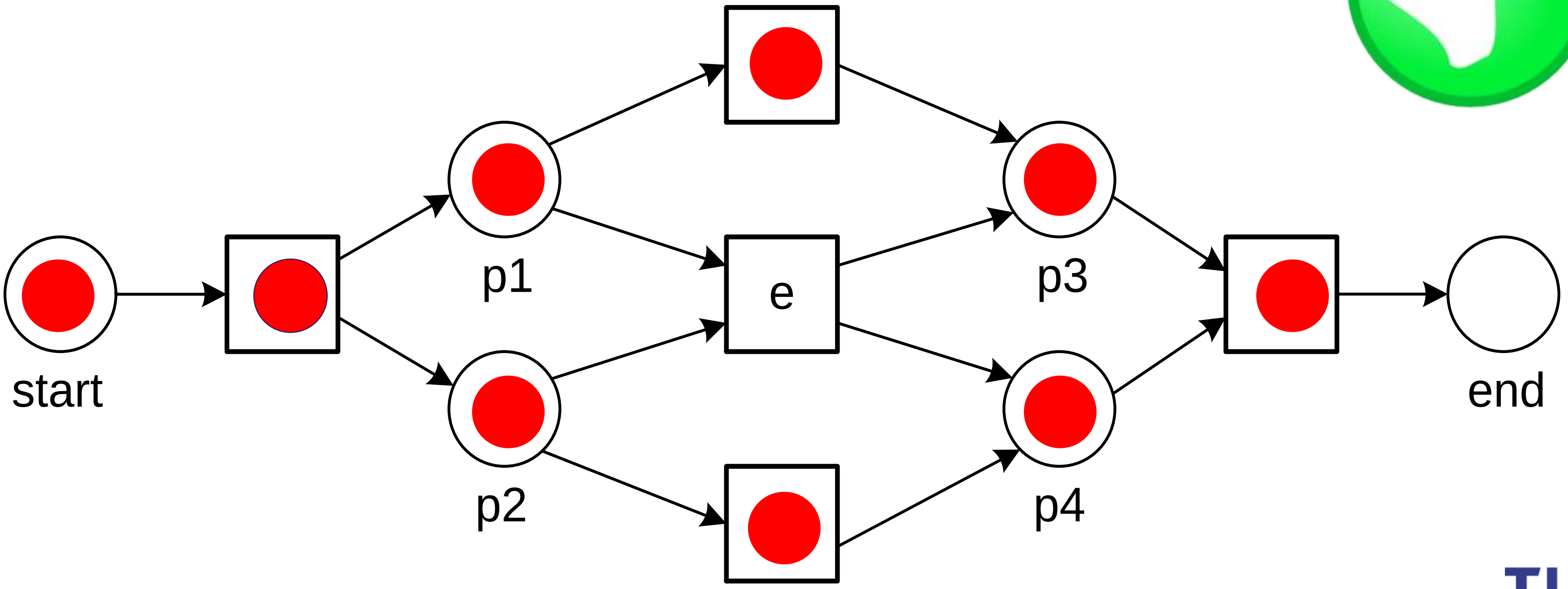
a b c d a e d a c b d a c b d

a c b d a b c d a e d a e d



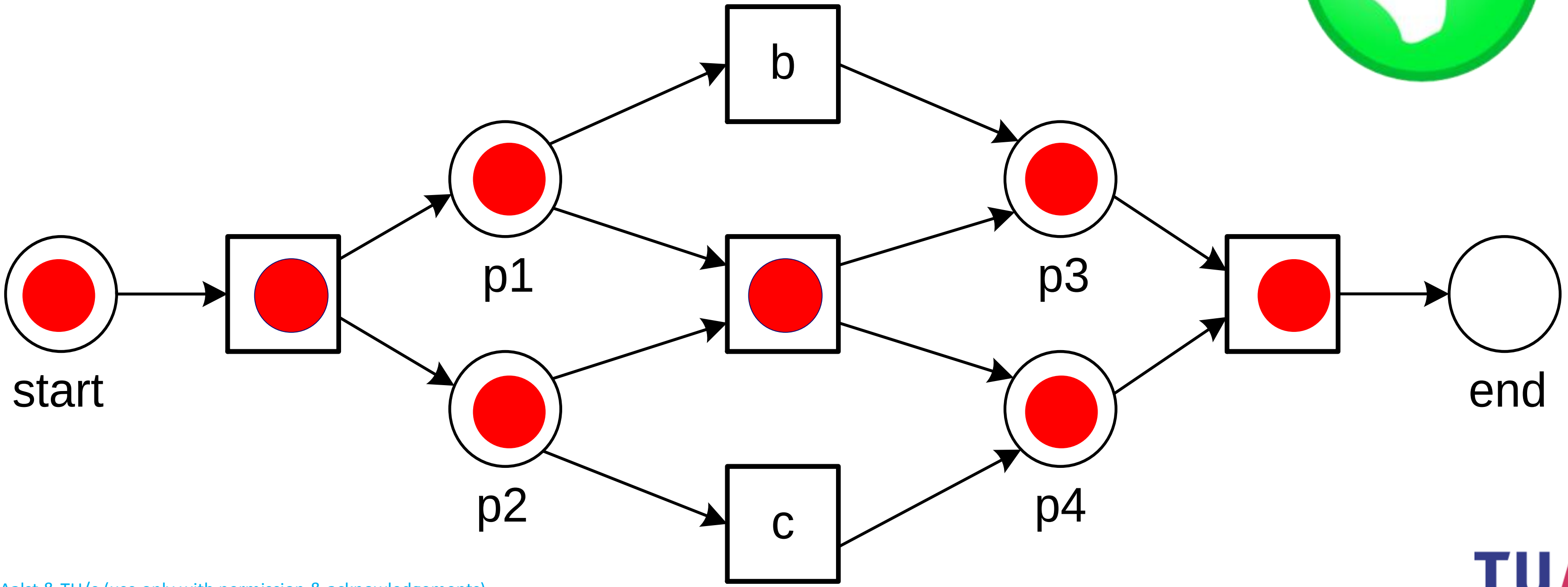
Replay

a b c d



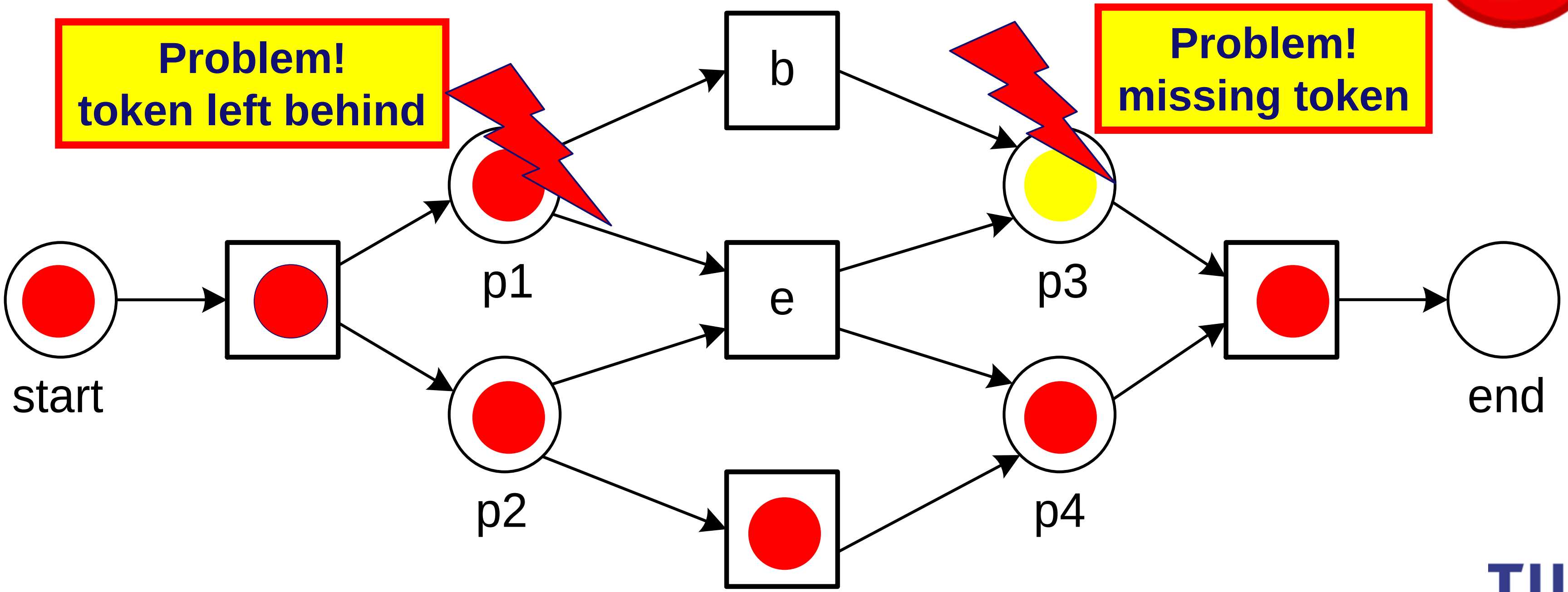
Replay

a e d



Replay can detect problems

a c d



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