CS 4072 – Topics in CS Process Mining

Lecture # 07

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FAST – NUCES, CFD Campus

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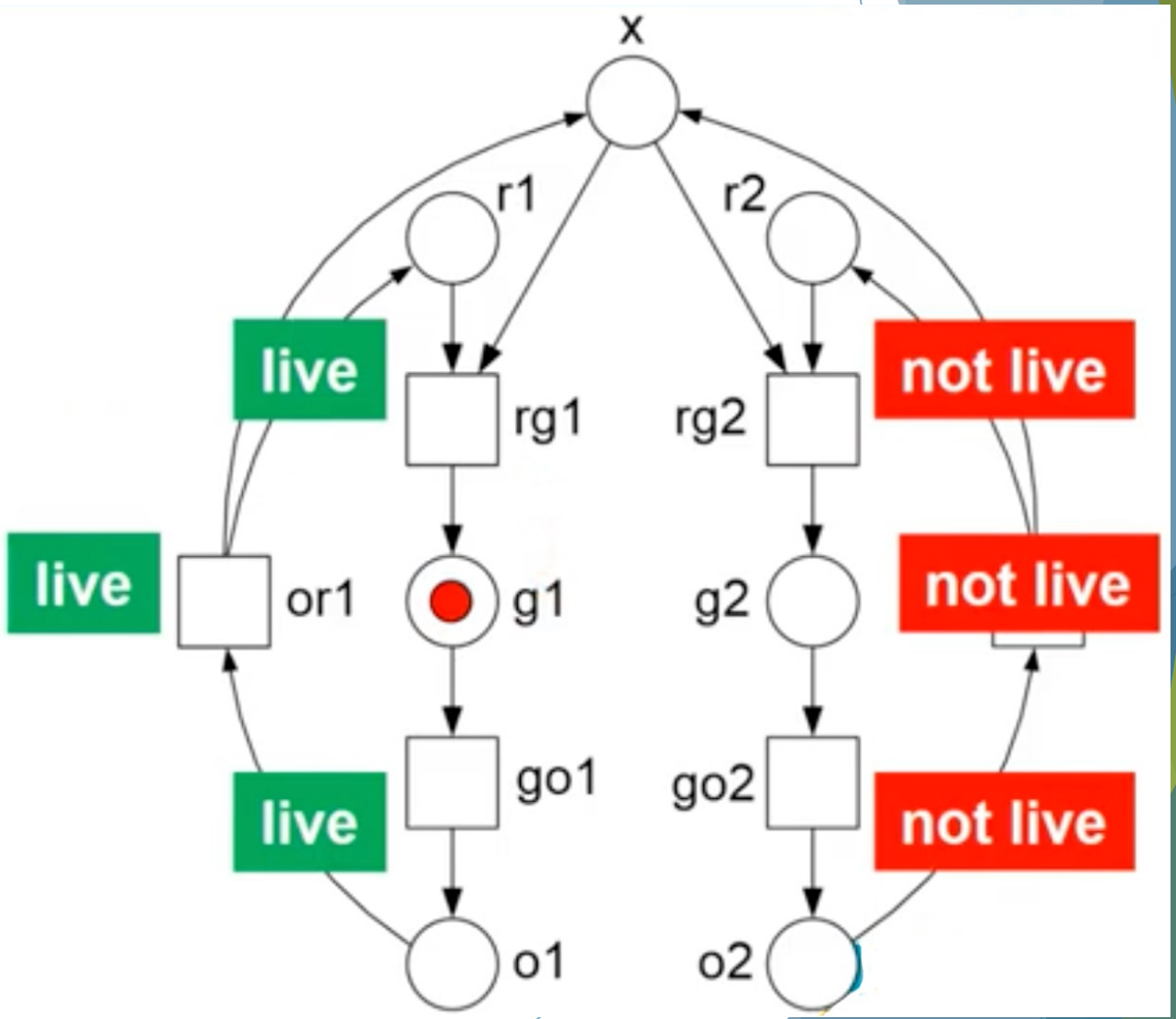
Today's Topics

- Workflow nets and soundness

Traffic Light: liveness

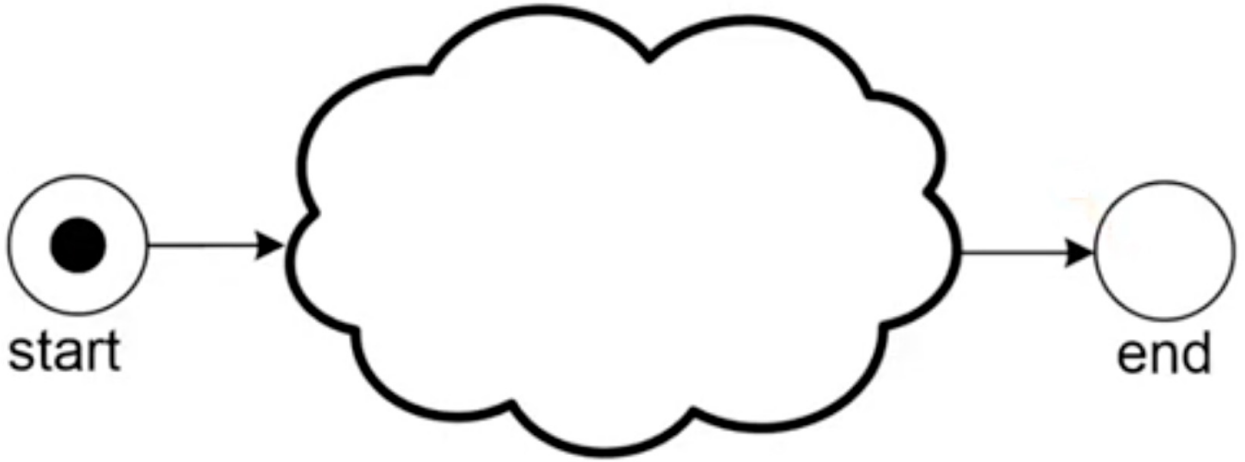
Deadlock-free but not live

- A transition t is live if from any reachable marking it is possible to reach a marking that enables t.
- A petri net is live if all transitions are live.
- A petri net that is live is deadlock-free but not vice-versa



Workflow Nets

- A **workflow net** (WF-net) has **one source place** (typically called start or i) and one sink place (typically called end or o) and all other nodes are on a path from source to sink.



Workflow Nets

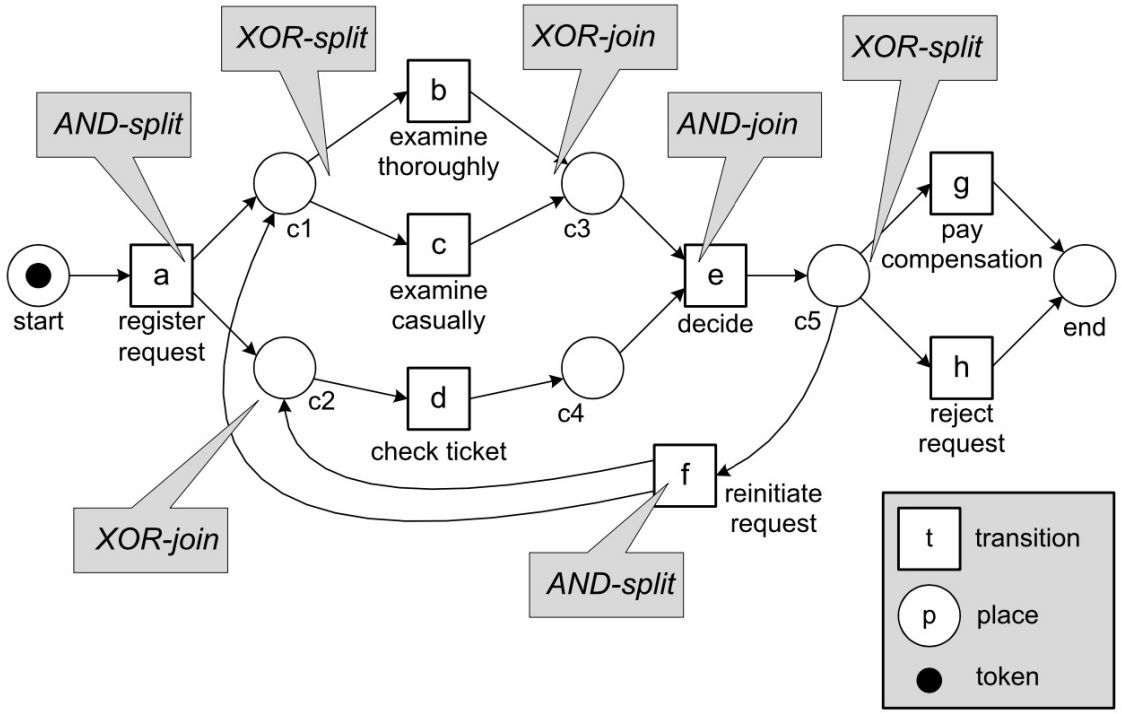
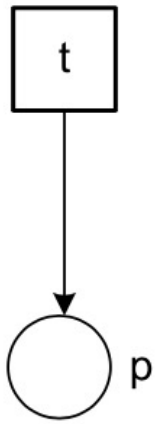
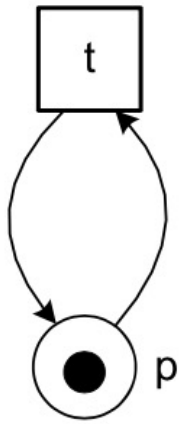
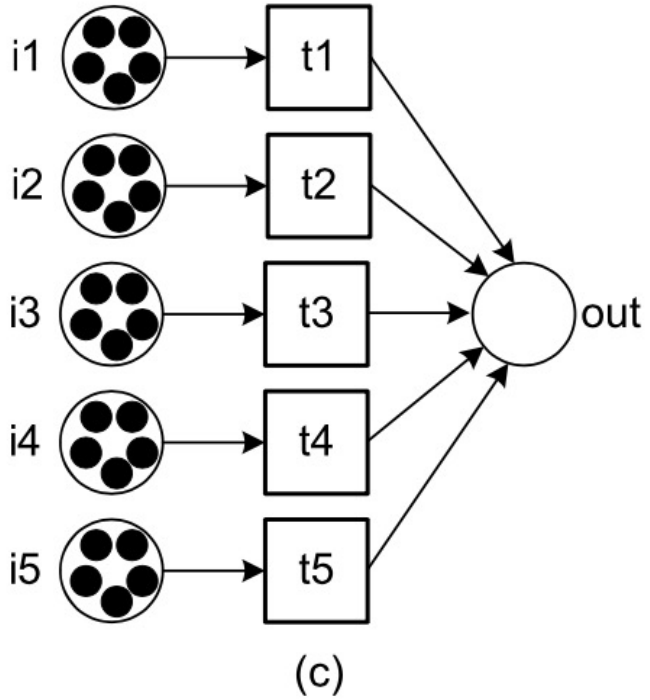


Fig. 3.2 A marked Petri net







A WF-net

Not WF-nets

Alpha algorithm discovers WF-nets from event logs

Workflow Nets

WF-nets may exhibit errors:

- Deadlocks
- Activities can never become active
- Garbage being left in the process after termination

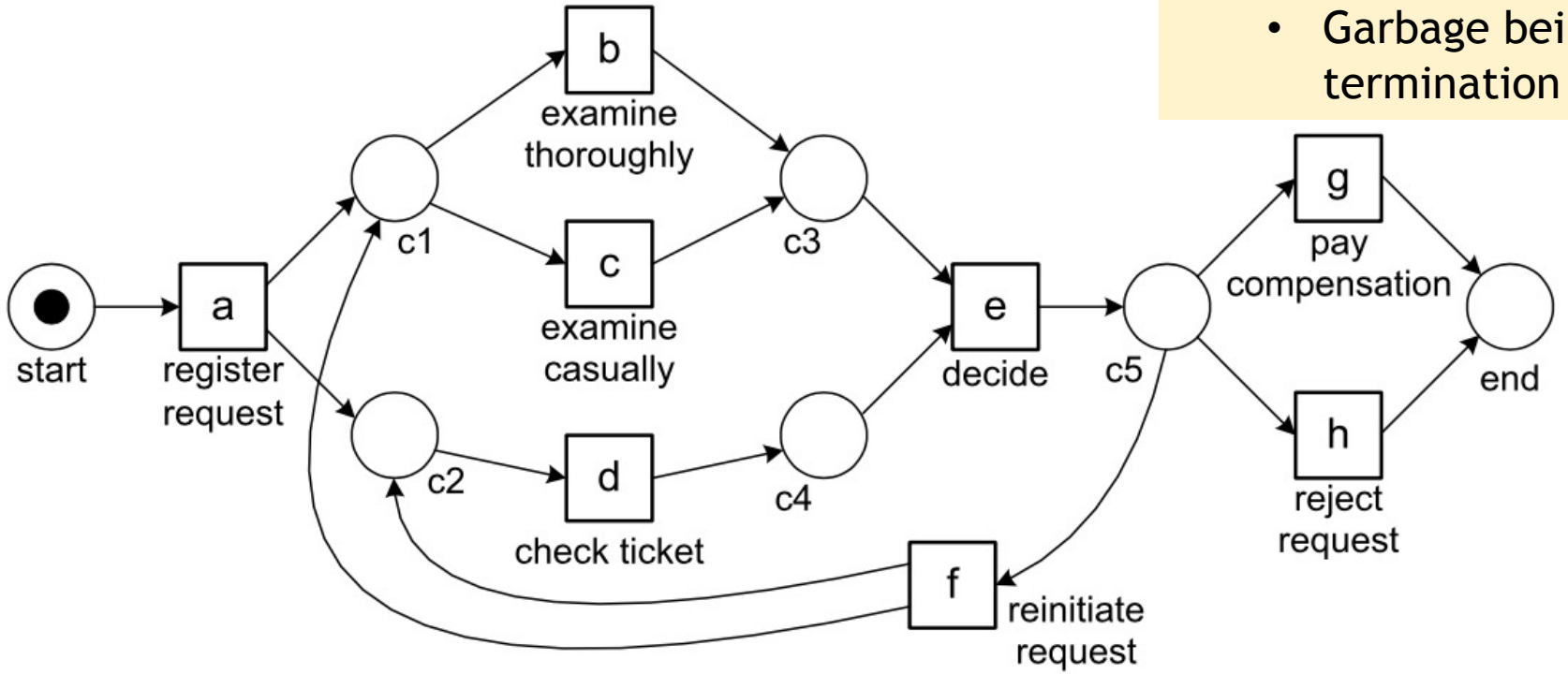


Fig. 2.6 The process model discovered by the α-algorithm [157] based on the set of traces $\{\langle a, b, d, e, h\rangle, \langle a, d, c, e, g\rangle, \langle a, c, d, e, f, b, d, e, g\rangle, \langle a, d, b, e, h\rangle, \langle a, c, d, e, f, d, c, e, f, c, d, e, h\rangle, \langle a, c, d, e, g\rangle\}$

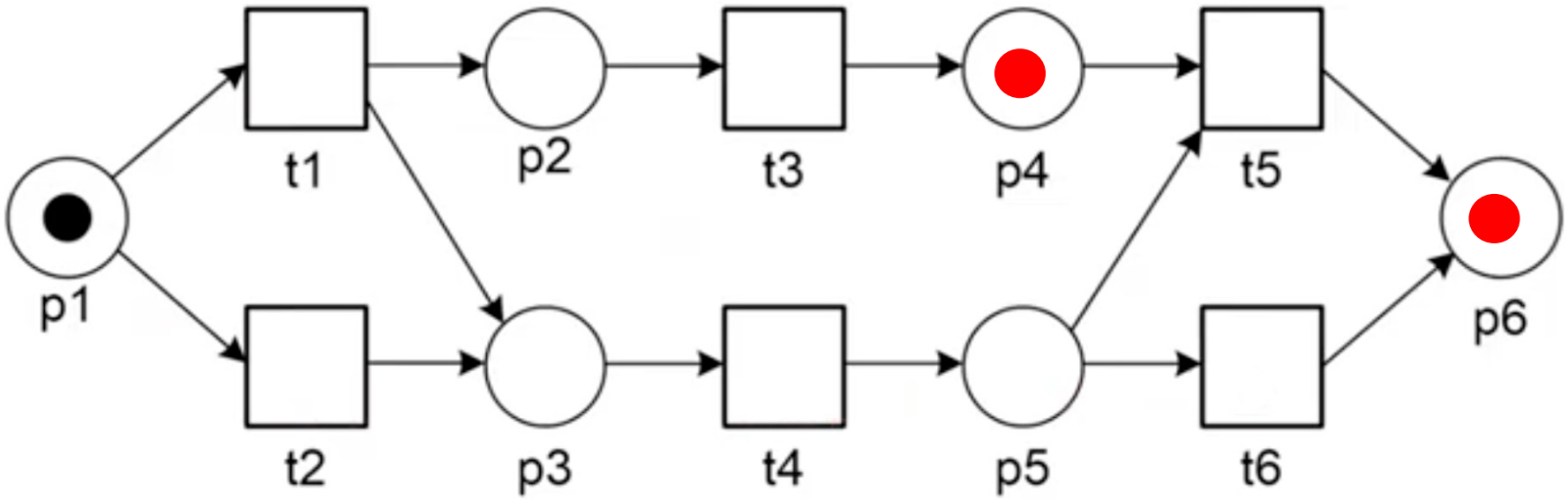
Soundness

- A **WF-net** is **sound** if and only if the following properties hold:
  - **safeness:** places cannot hold multiple token at the same time,
  - **proper completion:** if the sink place is marked, all other places are empty,
  - **option to complete:** it is always possible to reach the marking that marks just the sink place, and
  - **absence of dead parts:** for any transition there is a firing sequence enabling it (i.e., no dead transition)

Not always required

Practice Work

Is this WF-net sound?



safeness: places cannot hold multiple token at the same time

~~**proper completion:** if the sink place is marked, all other places are empty~~

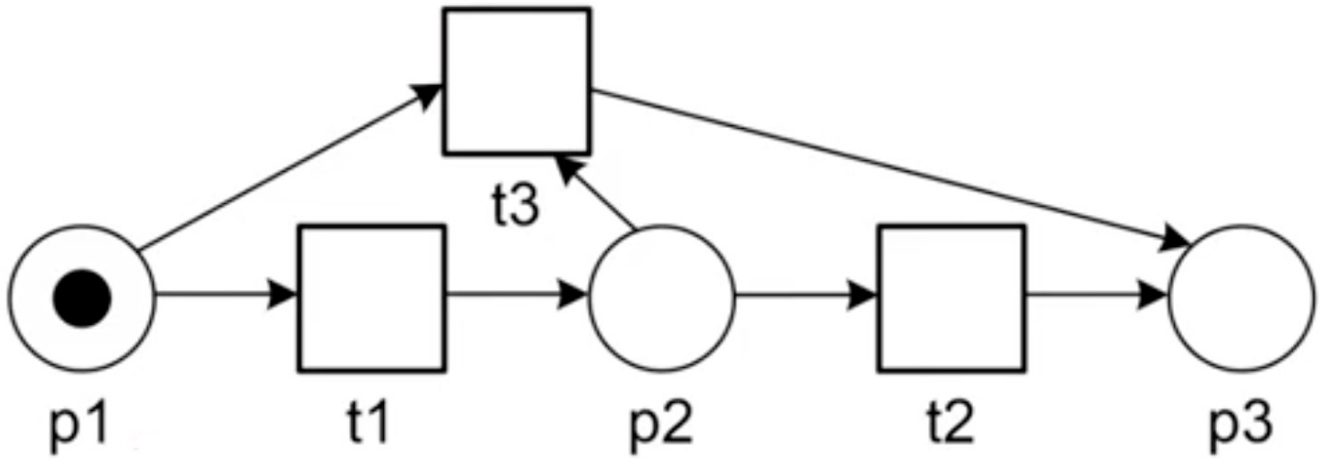
~~**option to complete:** it is always possible to reach the marking that marks just the sink place~~

absence of dead parts: for any transition there is a firing sequence enabling it

Practice Work

Is this WF-net sound?

t3 will never be enabled



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proper completion: if the sink place is marked, all other places are empty
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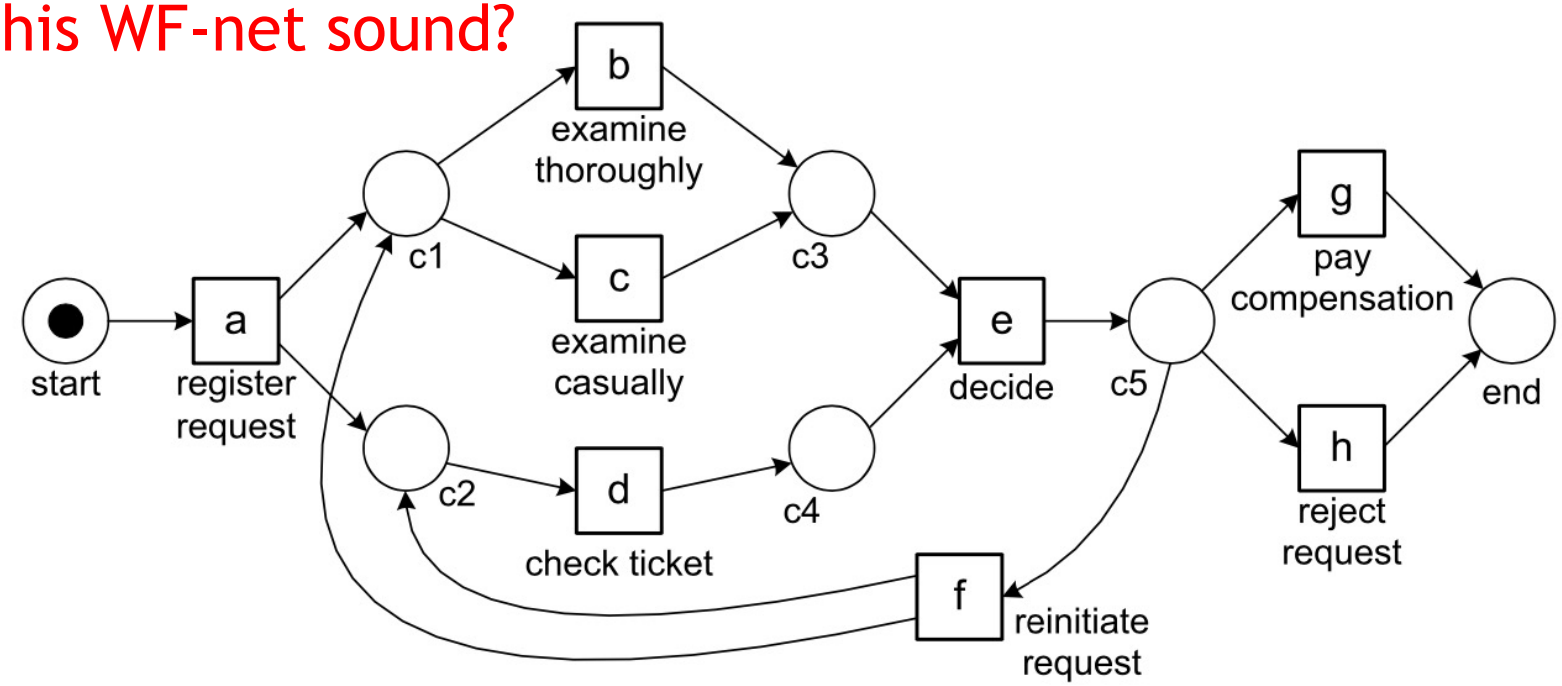
WF-net soundness

Is this WF-net sound?



safeness: places cannot hold multiple token at the same time
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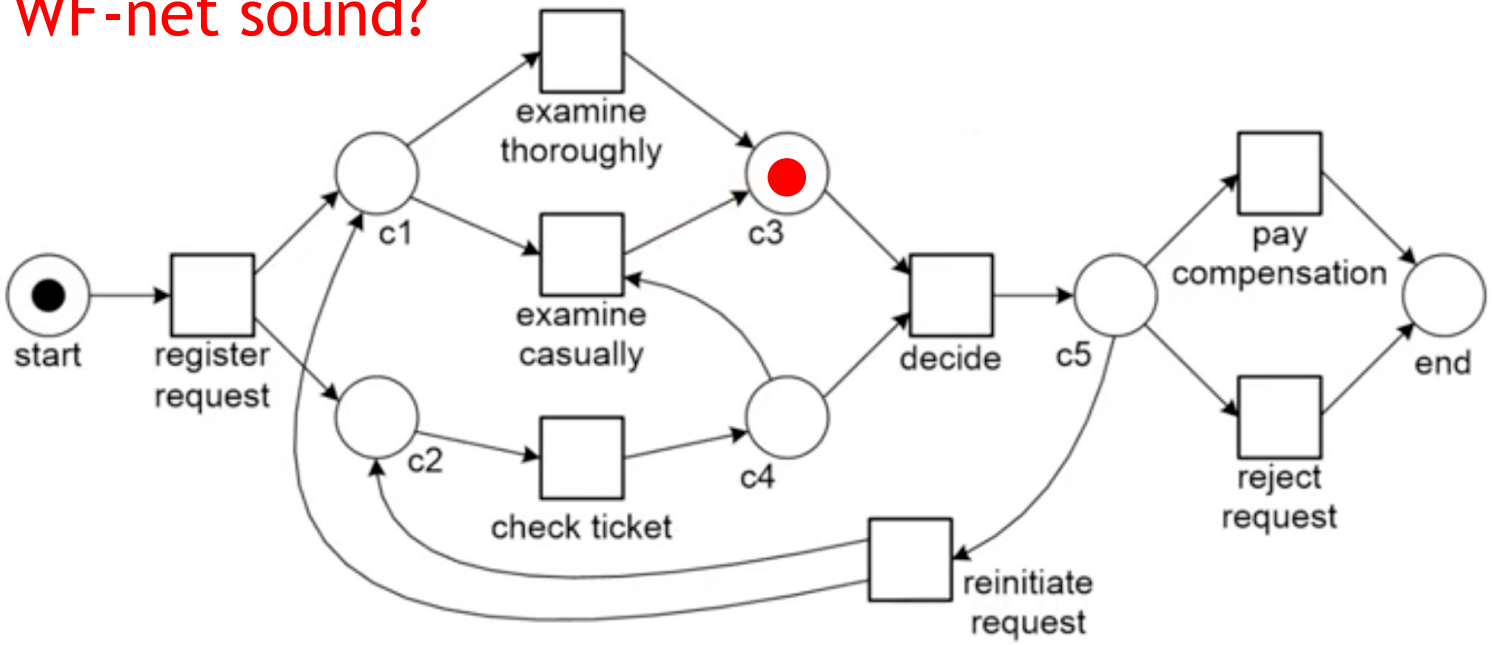
WF-net soundness

Draw the reachability graph(s) to prove your answers.

Is this WF-net sound?



safeness: places cannot hold multiple token at the same time

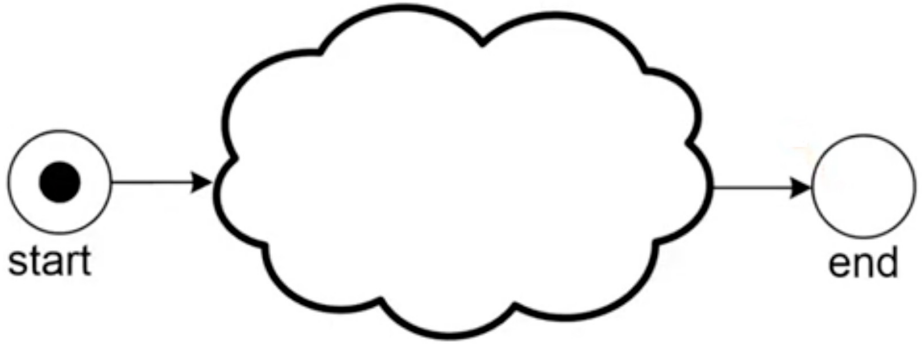
~~**proper completion:** if the sink place is marked, all other places are empty~~

~~**option to complete:** it is always possible to reach the marking that marks just the sink place~~

absence of dead parts: for any transition there is a firing sequence enabling it

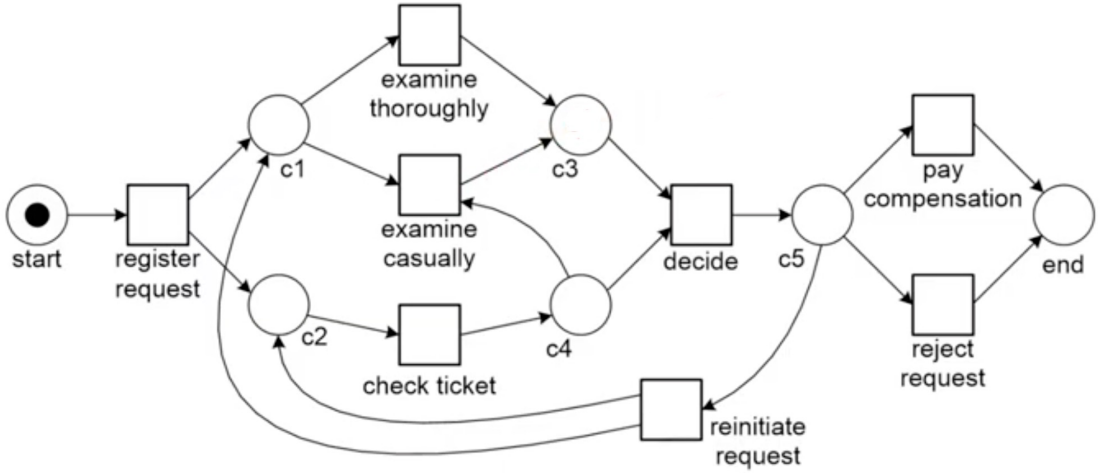
Workflow Nets

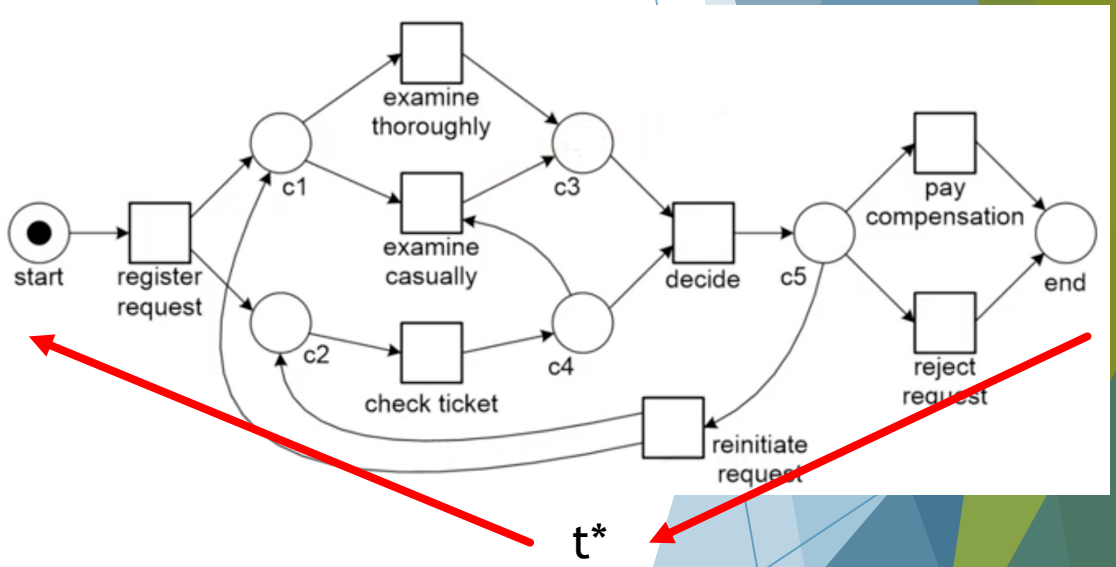
- No need to check proper completion, it is implied by other properties



option to complete (it is always possible to reach the marking that marks just the sink place) implies **proper completion** (if the sink place is marked all other places are empty)

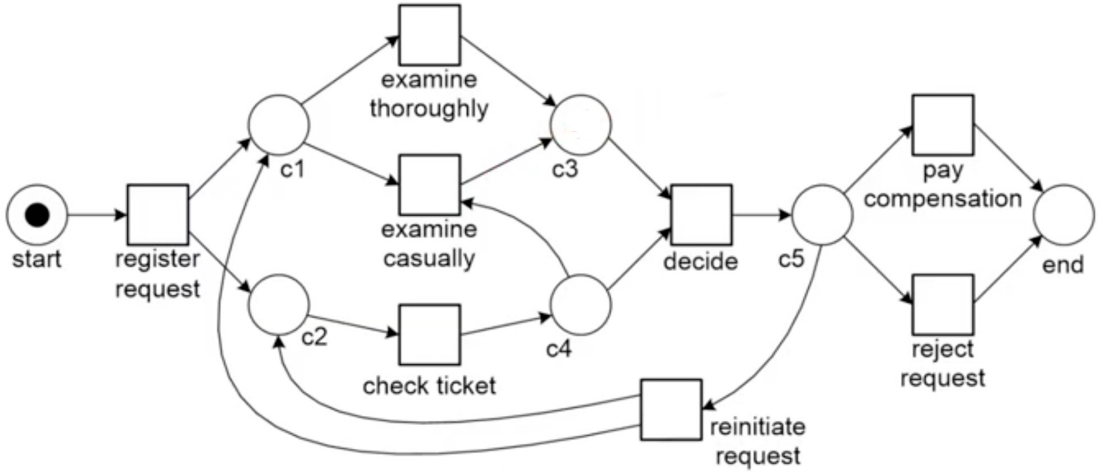
Linking WF-net soundness and classical Petri-net properties

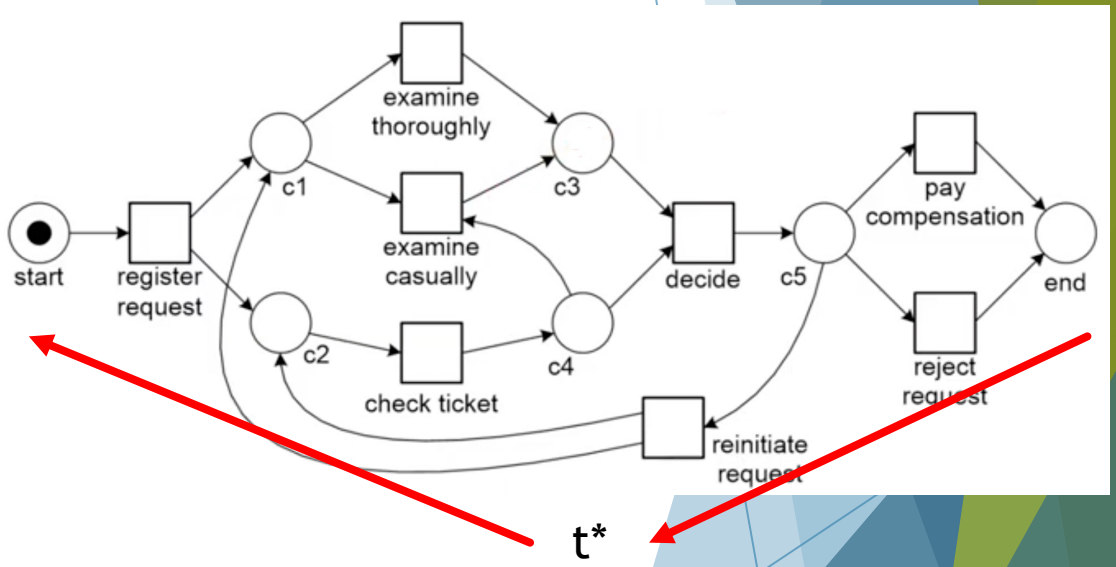




A WF-net is **sound** if and only if the corresponding "short-circuited" Petri-net is **live** and **bounded**!

Linking WF-net soundness and classical Petri-net properties





A WF-net is **sound** if and only if the corresponding "short-circuited" Petri-net is **live** and **bounded**!

If **safeness** is required, the short-circuited net should also be safe

Reading Material

- Chapter 3: Aalst