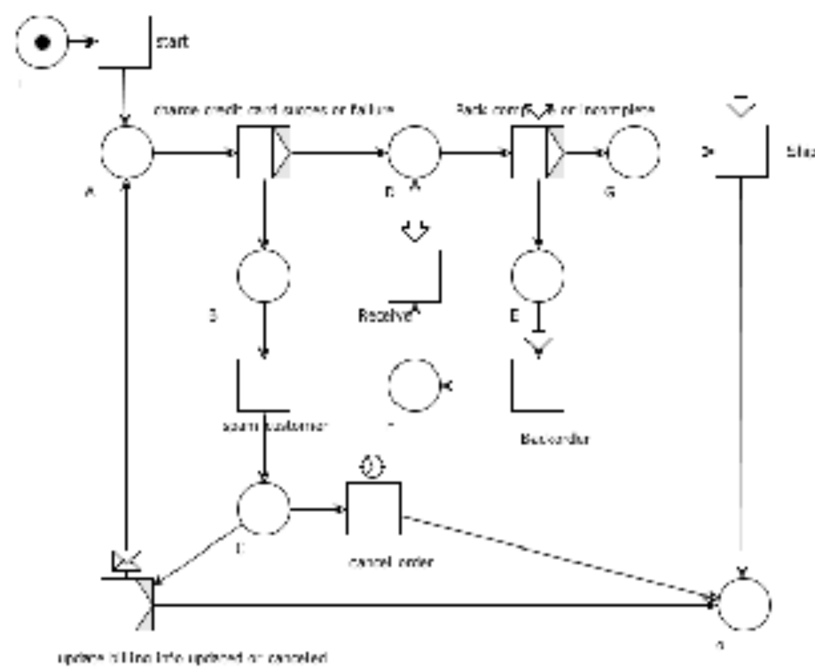
Business Processes Modelling

MPB (6 cfu, 295AA)

Roberto Bruni
http://www.di.unipi.it/~bruni

13 - Workflow nets

Object



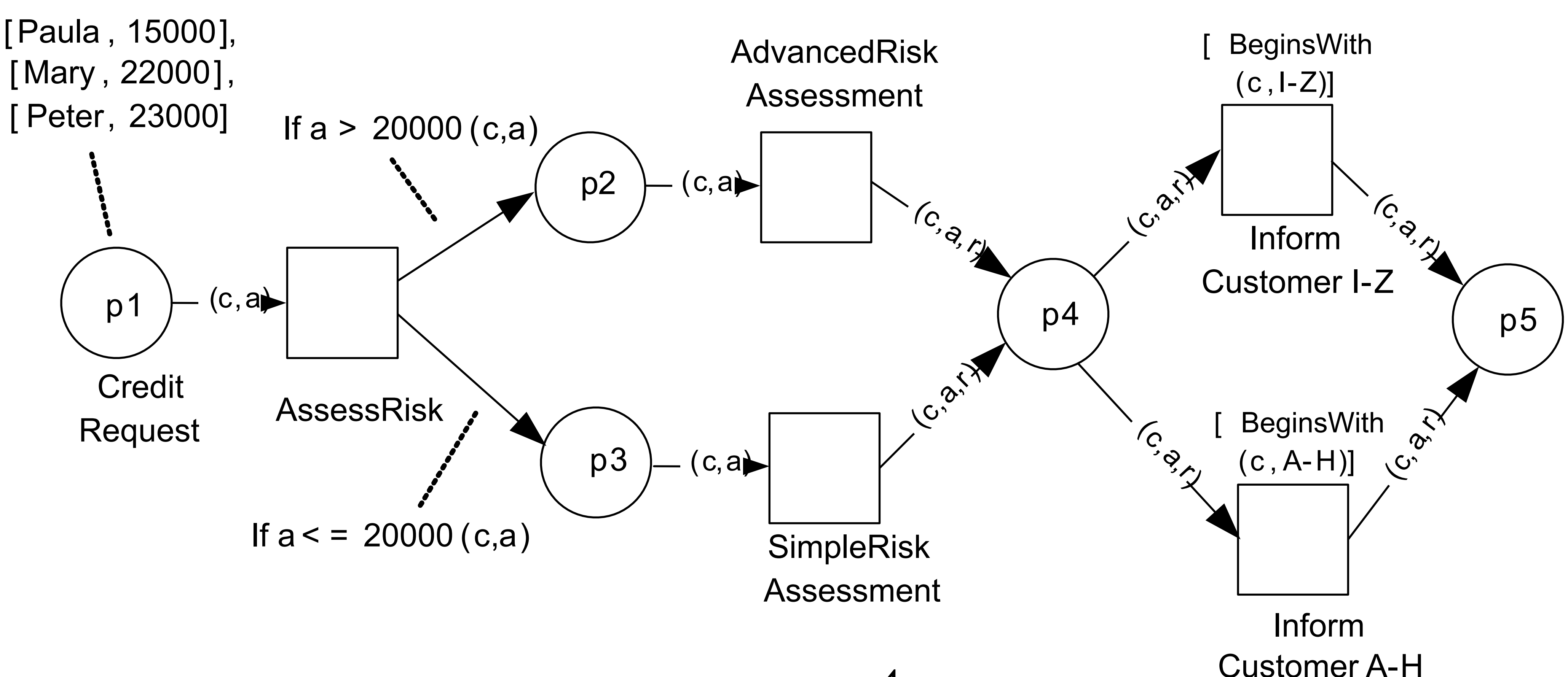
We study some special kind of Petri nets,
that are suitable models of workflows

Ch.4.4 of Business Process Management: Concepts, Languages, Architectures

There are many, many variants of Petri nets

Example: Coloured nets (also called High-Level)

A **coloured net** is a Petri net whose tokens can carry data and whose transitions can check data (see exact definition in Weske's book)



M. Weske: Business Process Management, © Springer-Verlag Berlin Heidelberg 2007

Workflow nets

Workflow nets features

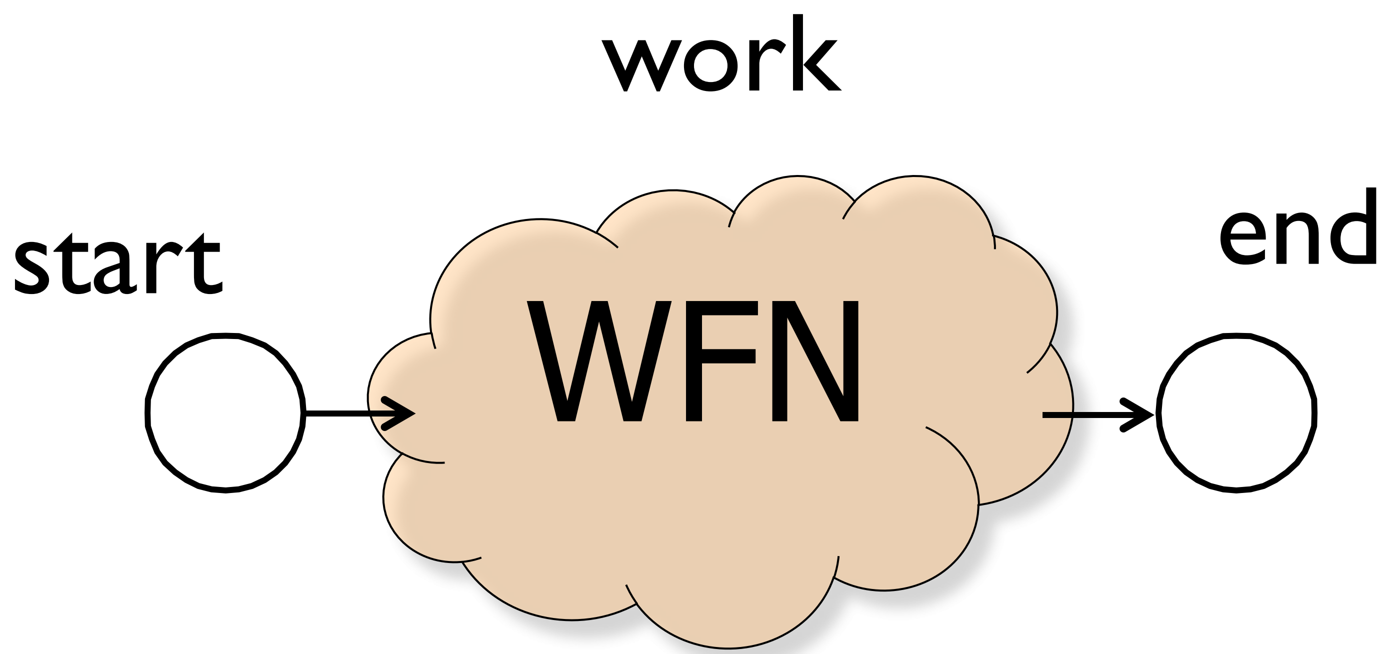
Tailored to the representation of business processes

Formal (unambiguous) semantics

Structural restrictions

Decorated graphical representation

Workflow net: idea



Workflow net

Definition:
A Petri net (P, T, F) is called **workflow net** if:

1. there is a distinguished *initial place* $i \in P$ with $\bullet i = \emptyset$
2. there is a distinguished *final place* $o \in P$ with $o \bullet = \emptyset$
3. every other place and transition belongs to a path from i to o

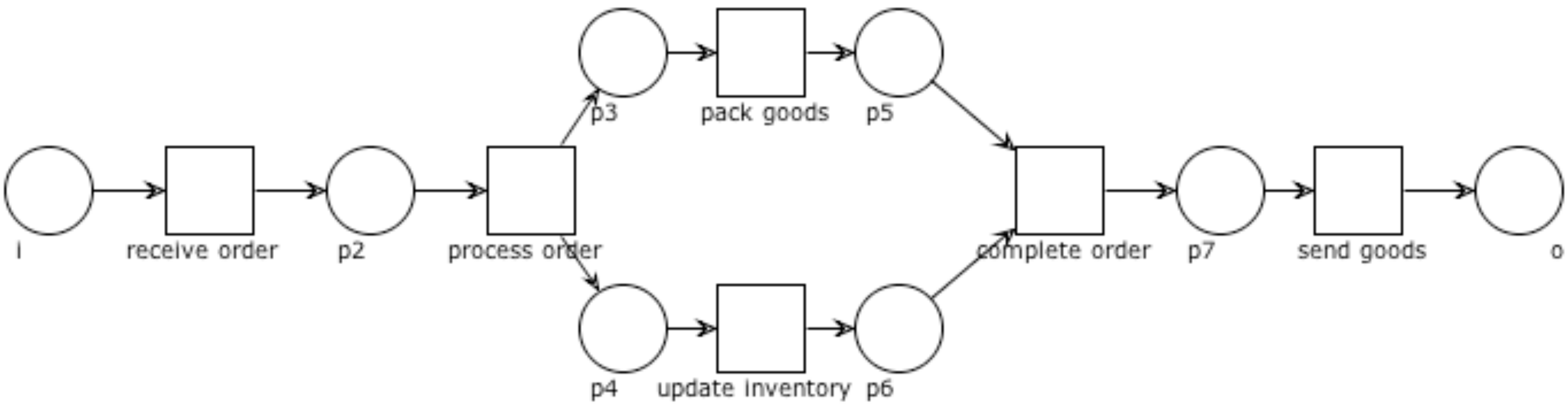
Workflow net: Rationale

1. a token in i represents a process instance not yet started
2. a token in o represents a finished case
3. each place and each transition can participate in a case

Definition:
A Petri net (P, T, F) is called **workflow net** if:

1. there is a distinguished *initial place* $i \in P$ with $\bullet i = \emptyset$
2. there is a distinguished *final place* $o \in P$ with $o\bullet = \emptyset$
3. every other place and transition belongs to a path from i to o

WF net: Example



Basic properties

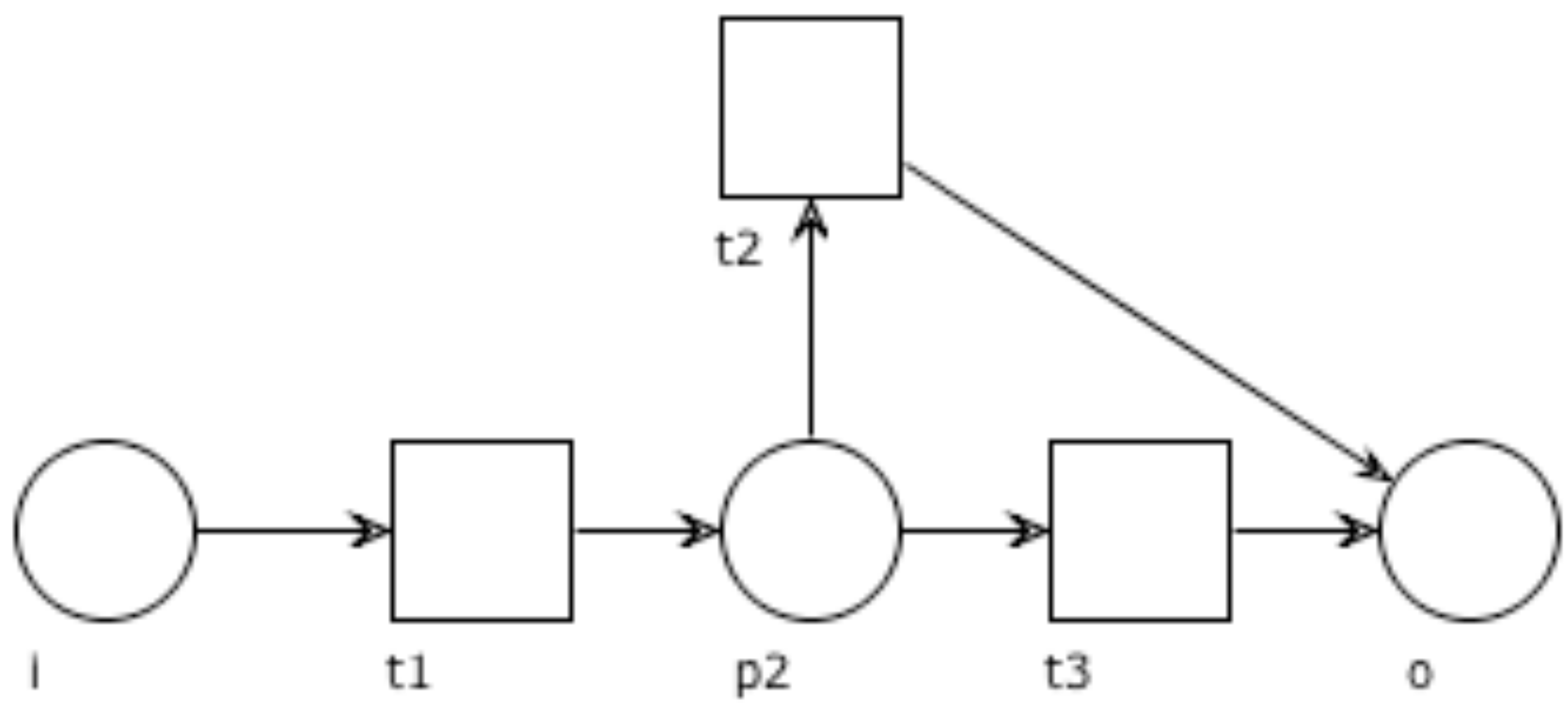
Lemma: In a workflow net there is a **unique** node with no incoming arc

Lemma: In a workflow net there is a **unique** node with no outgoing arc

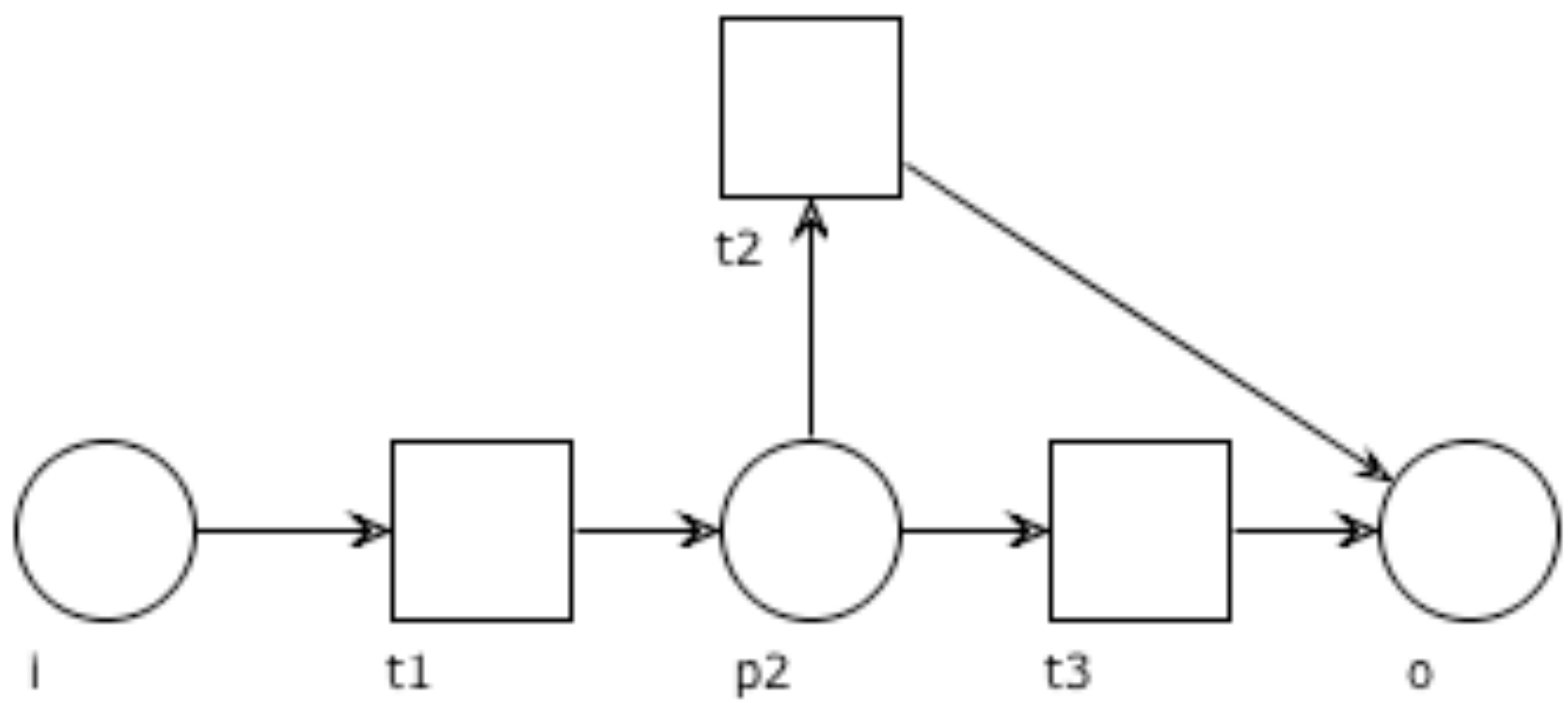
Exercise: Guess which nodes are those

Exercise: Prove the above lemmas
(hint: suppose the nodes are not unique, reach a contradiction)

Question time: WF net?

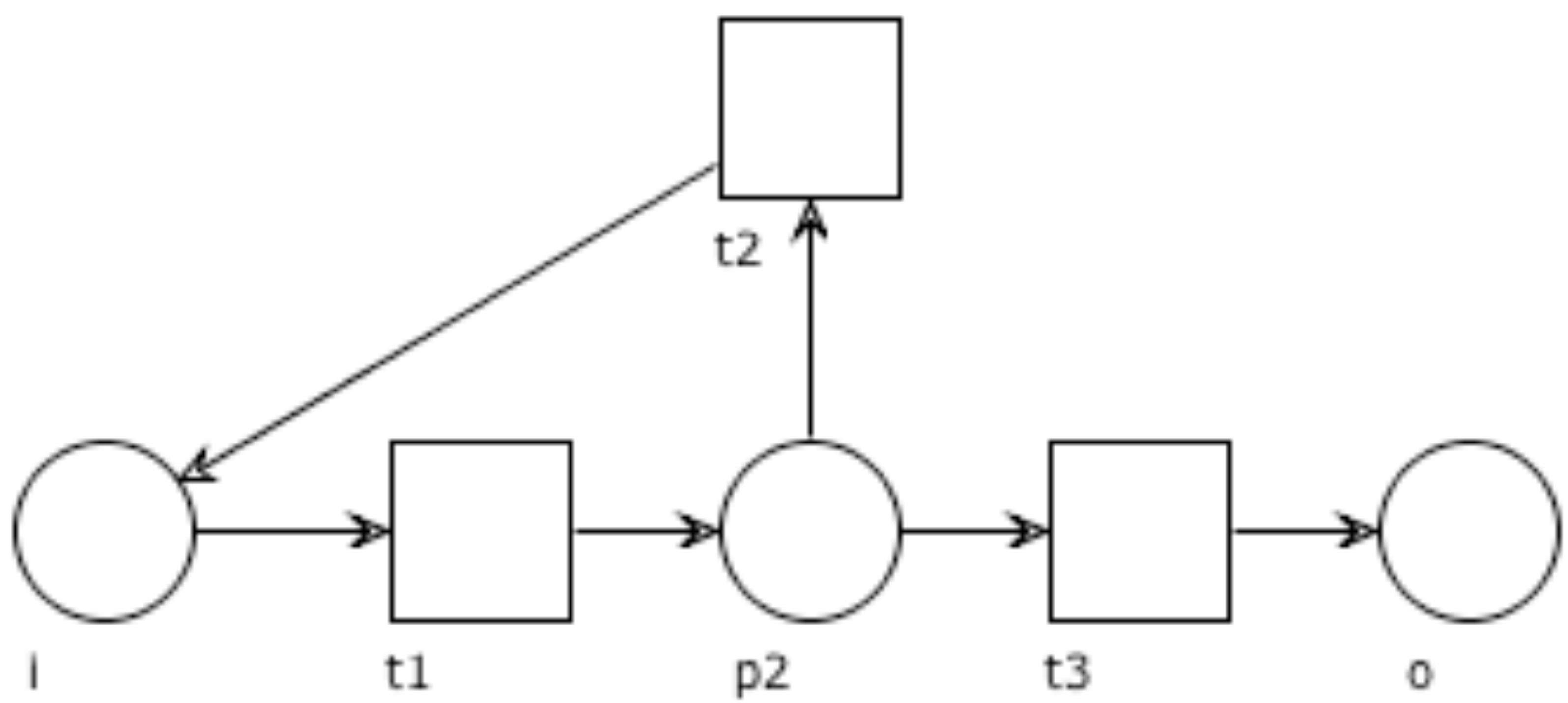


Question time: WF net?

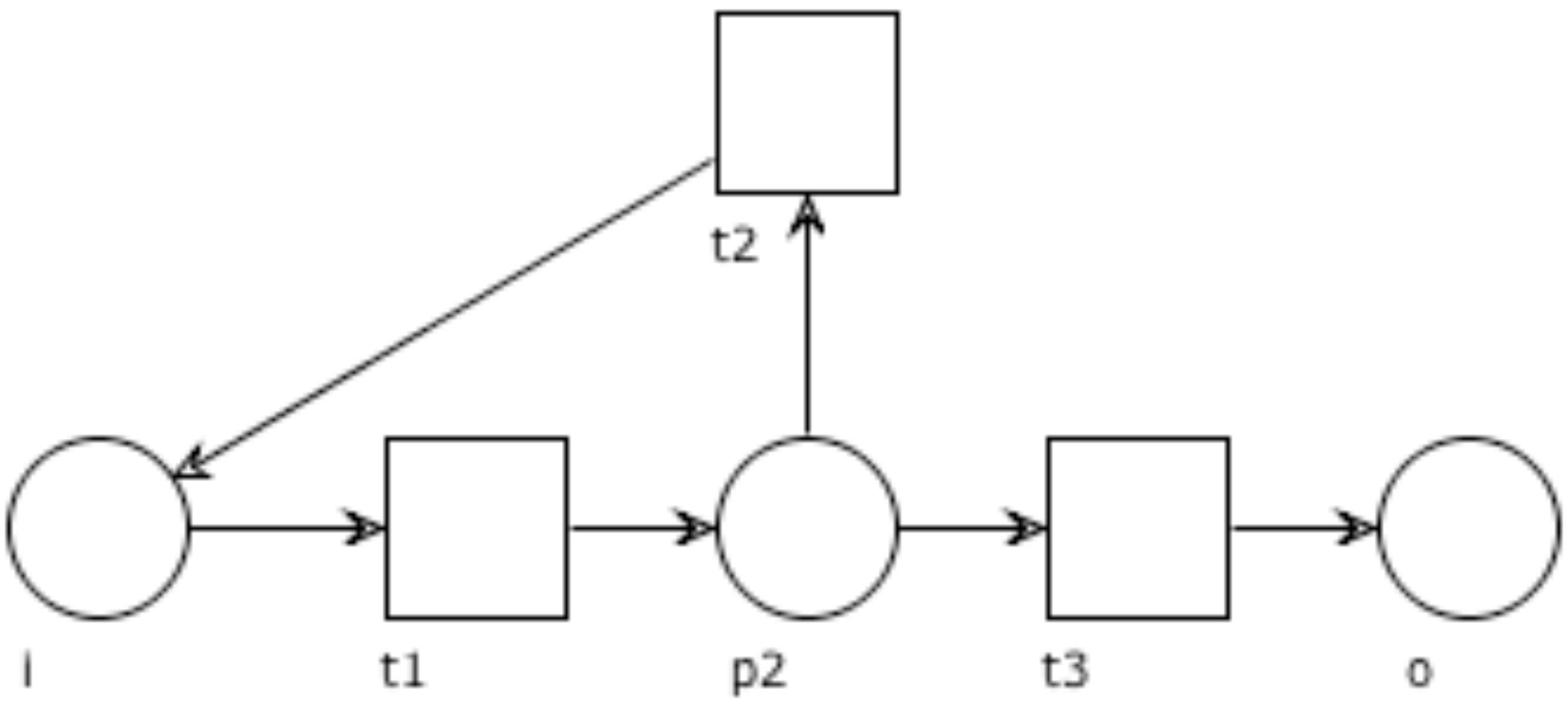


Yes

Question time: WF net?

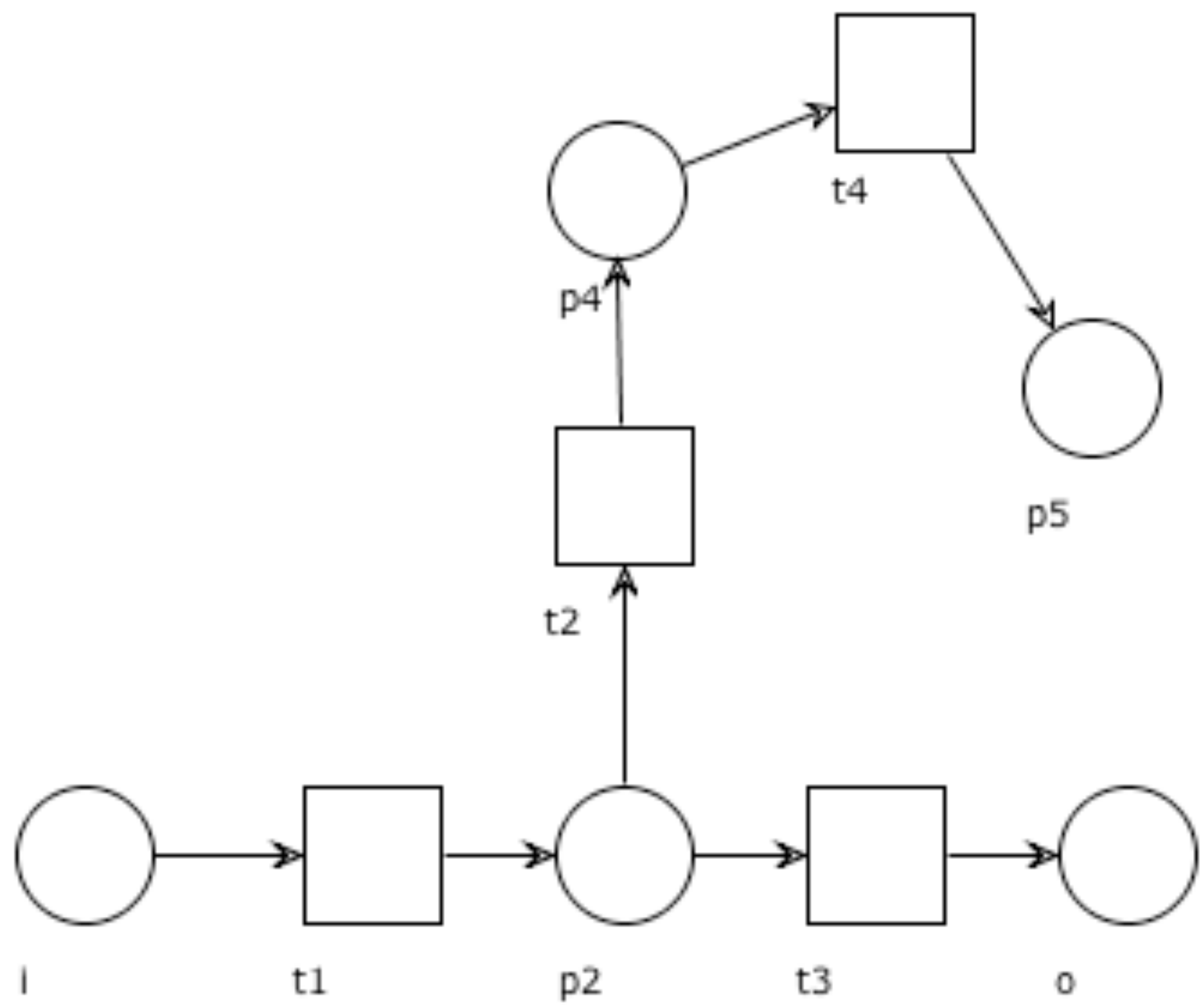


Question time: WF net?

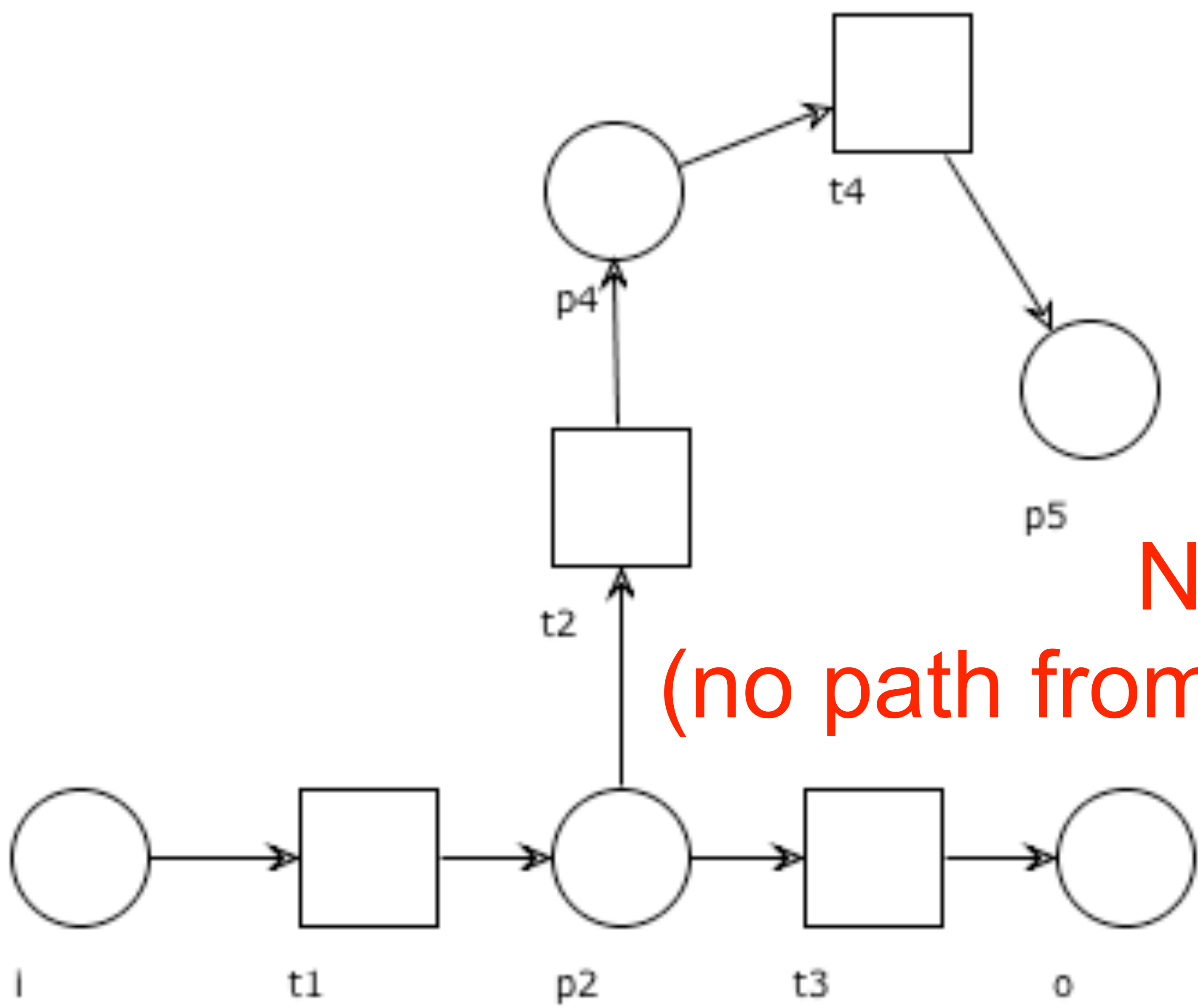


No
(no initial place)

Question time: WF net?

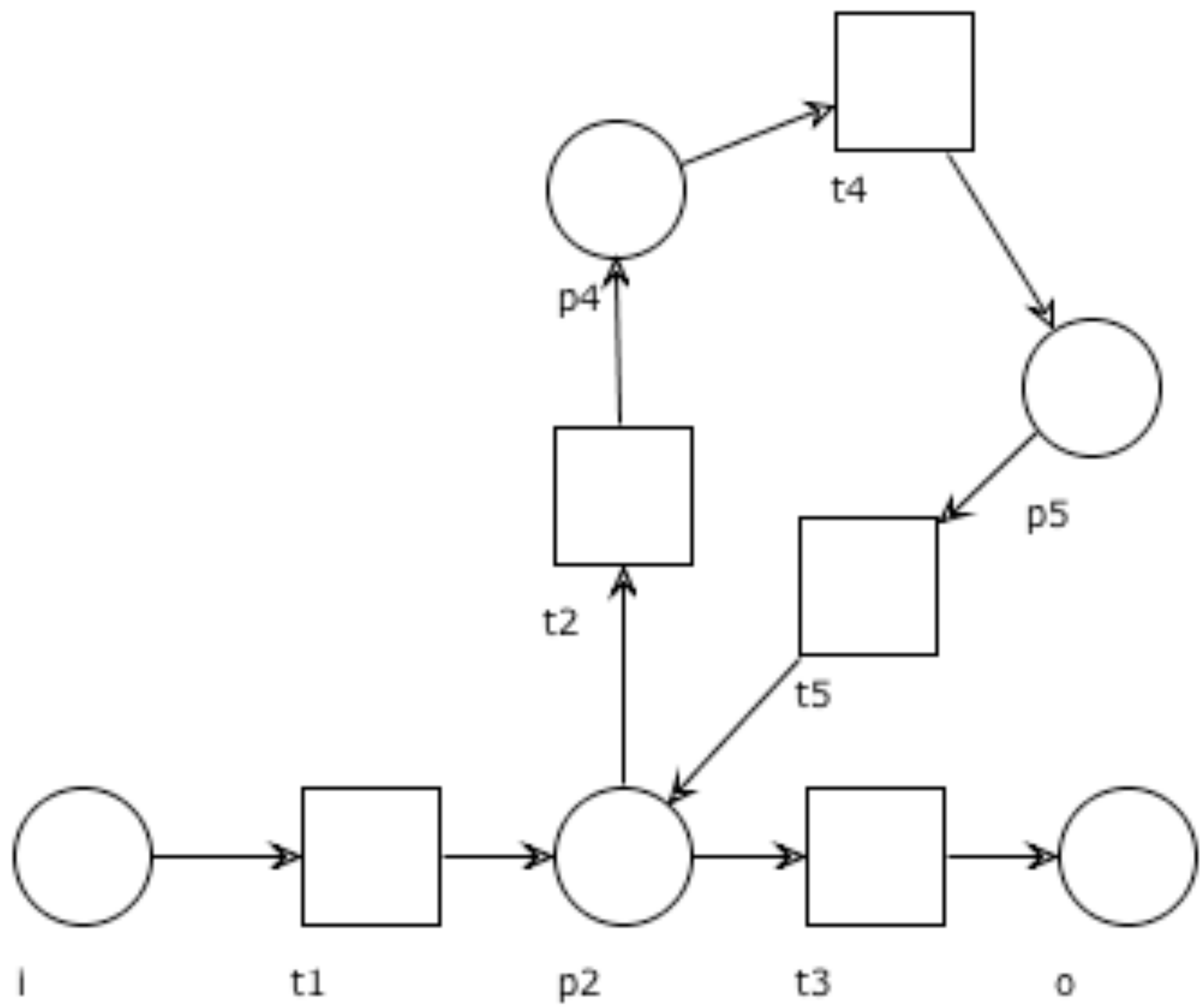


Question time: WF net?

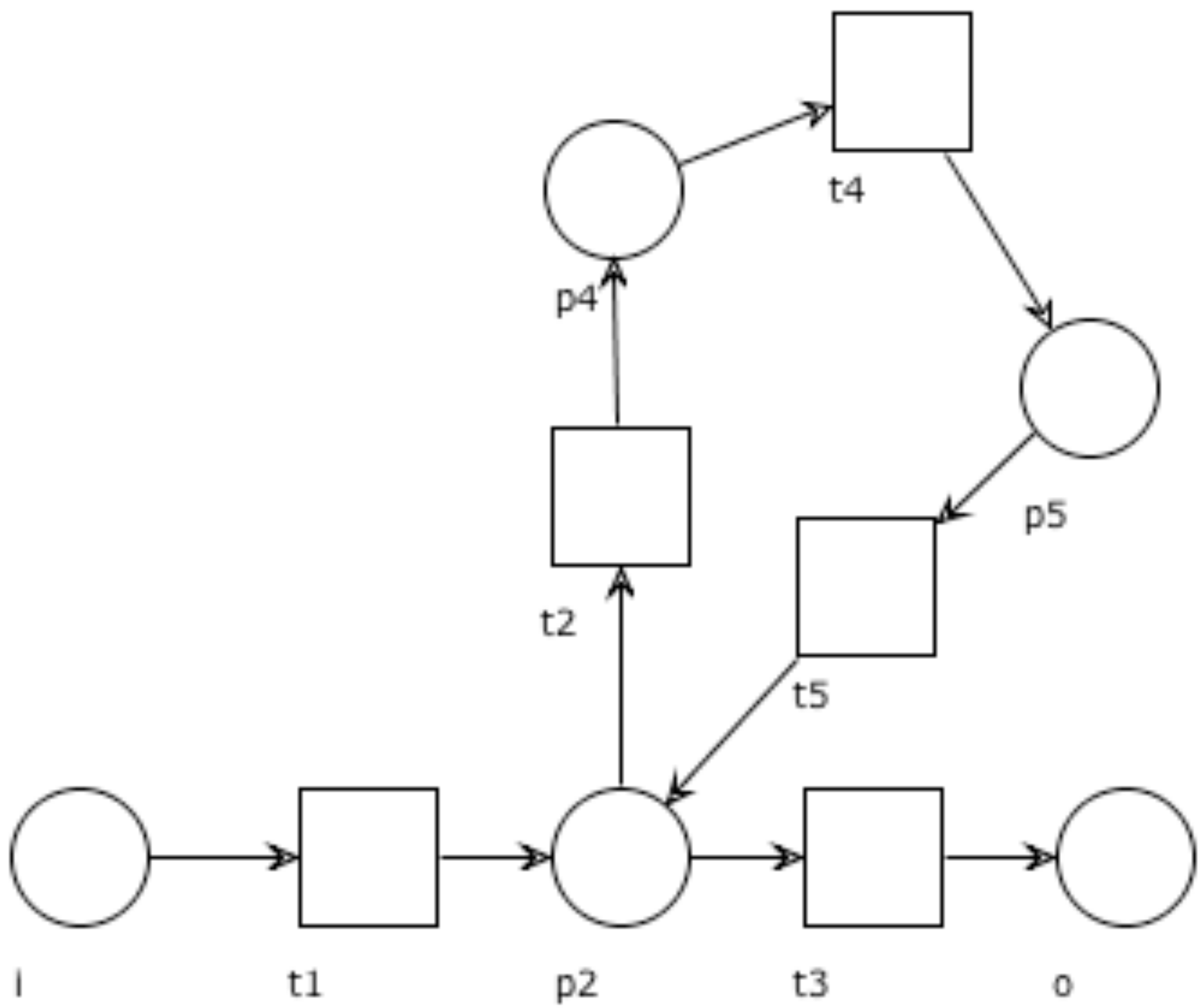


No
(no path from i to o via t2)

Question time: WF net?

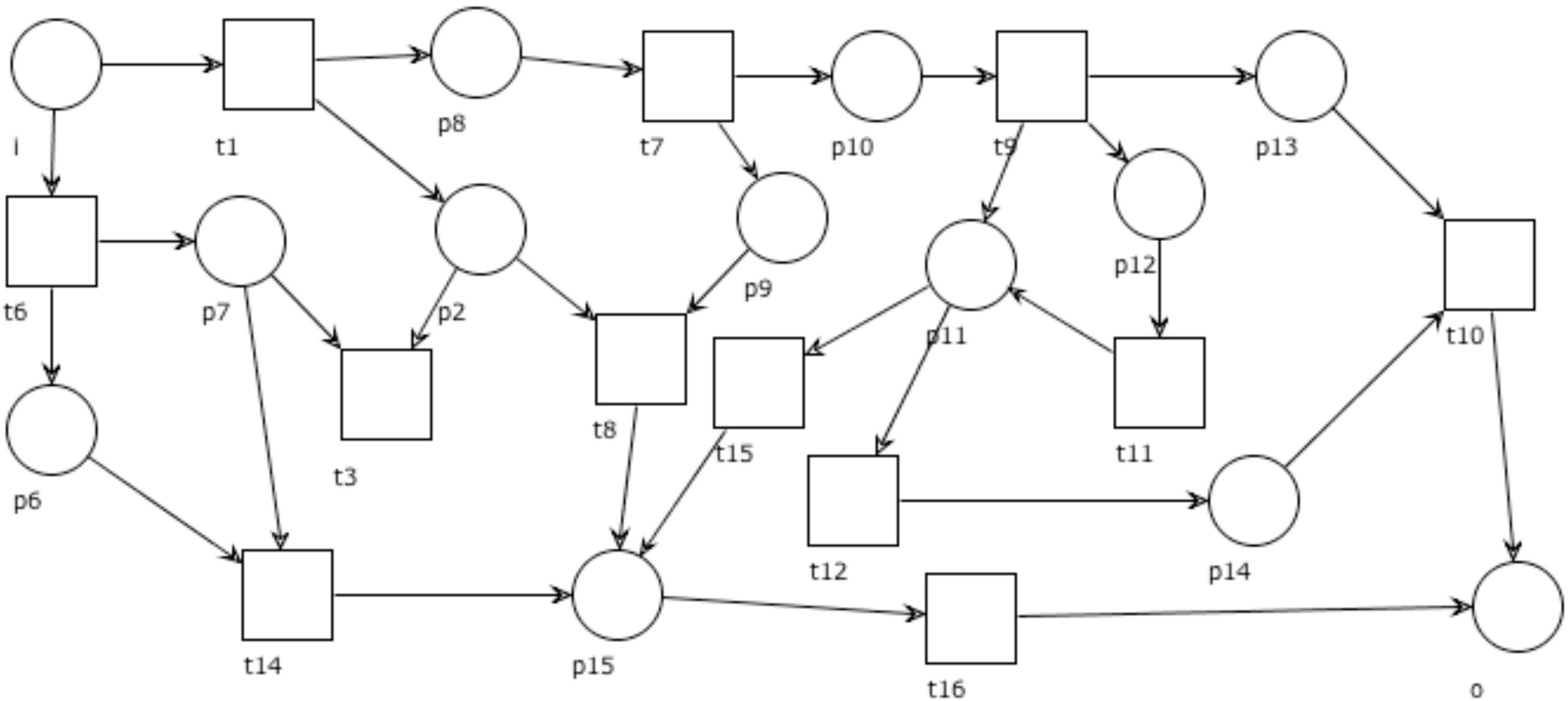


Question time: WF net?

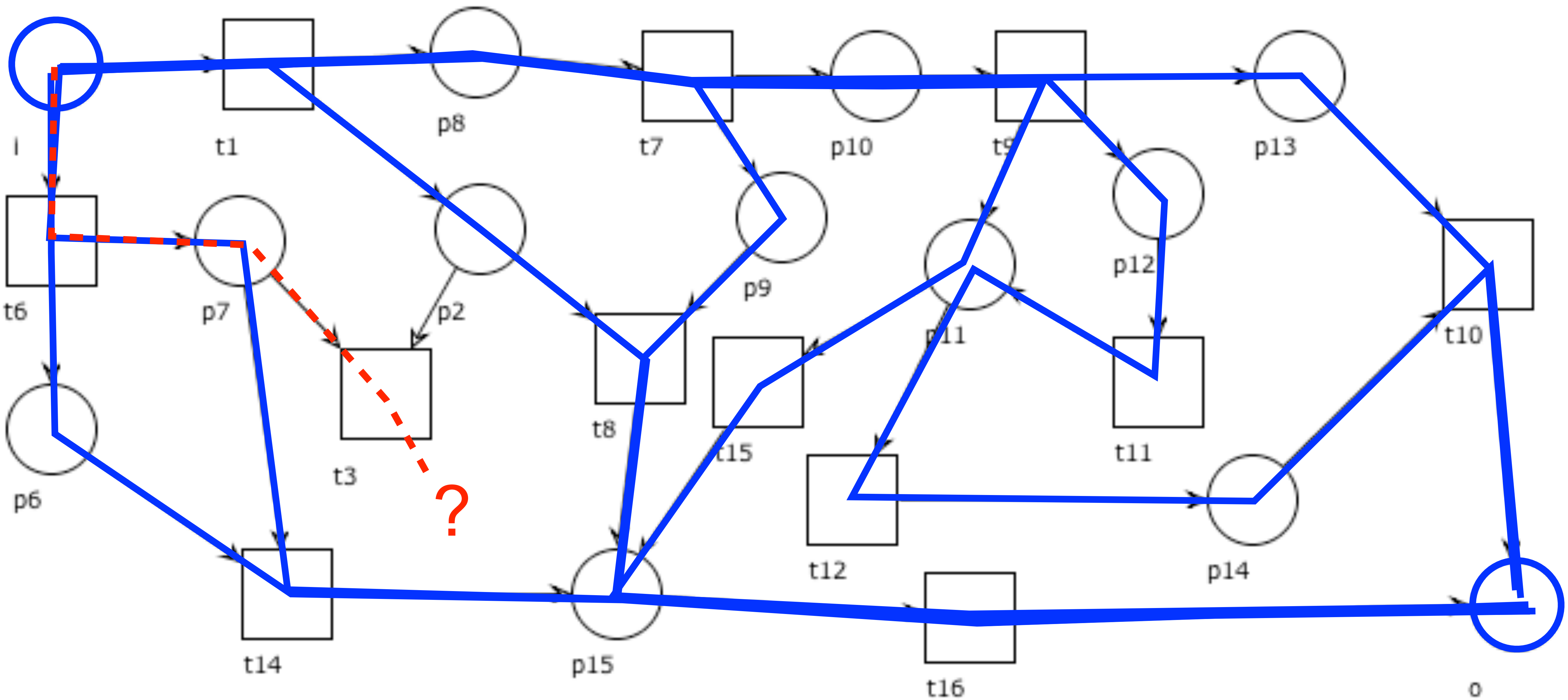


Yes

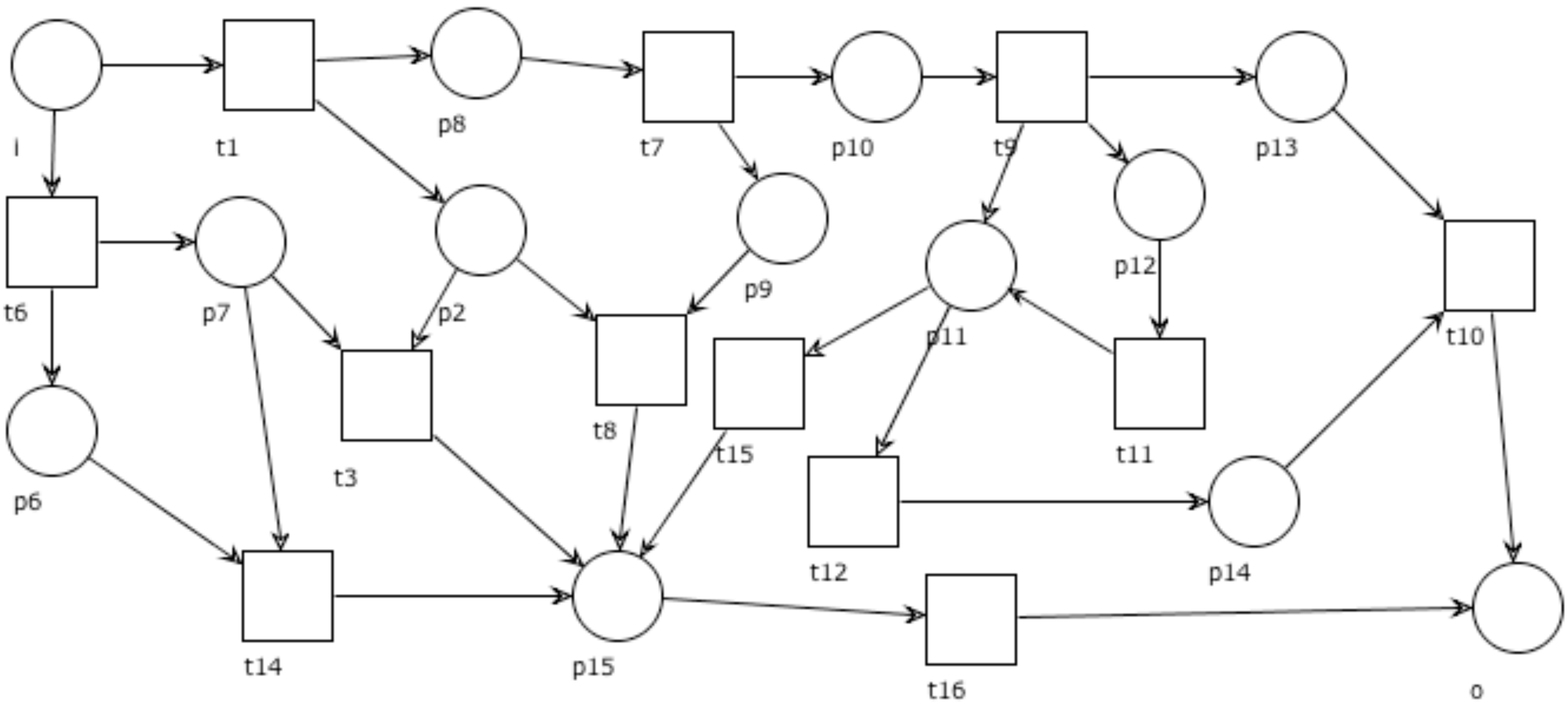
Question time: WF net?



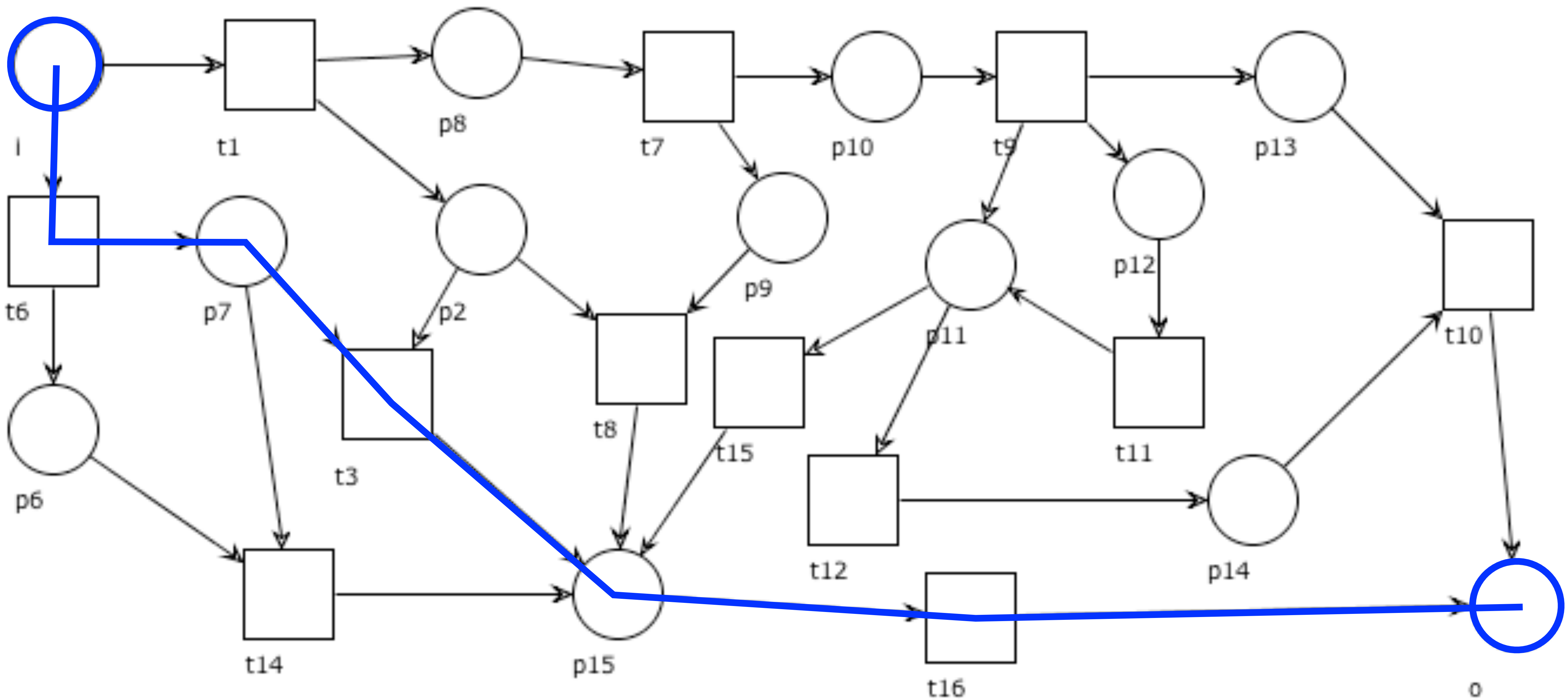
Question time: WF net?



Question time: WF net?

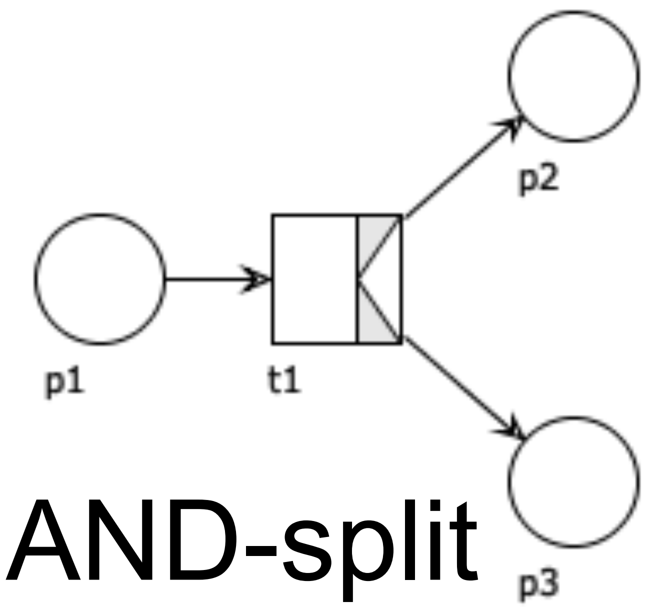


Question time: WF net?

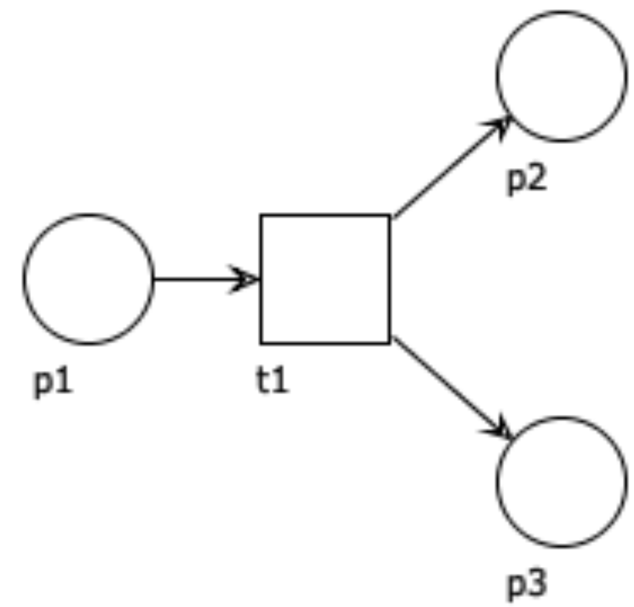


Yes

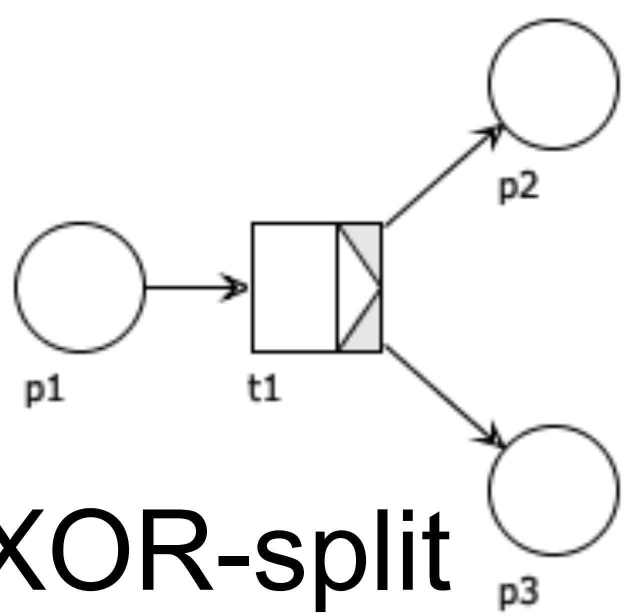
Syntax sugar: split



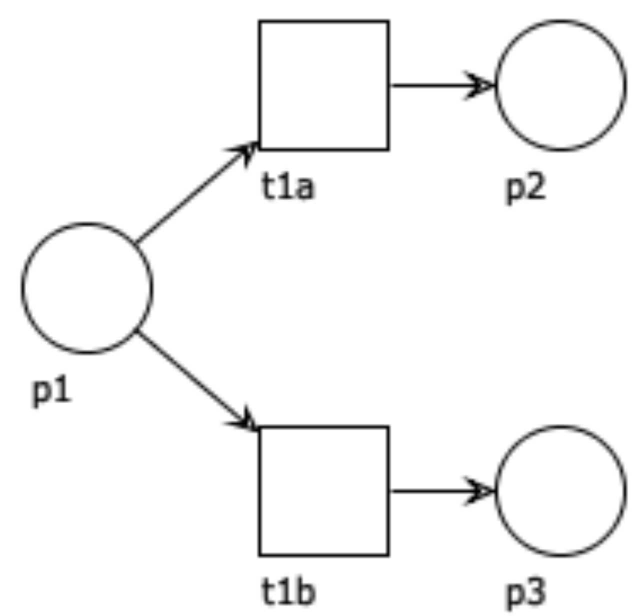
stands for



AND-split

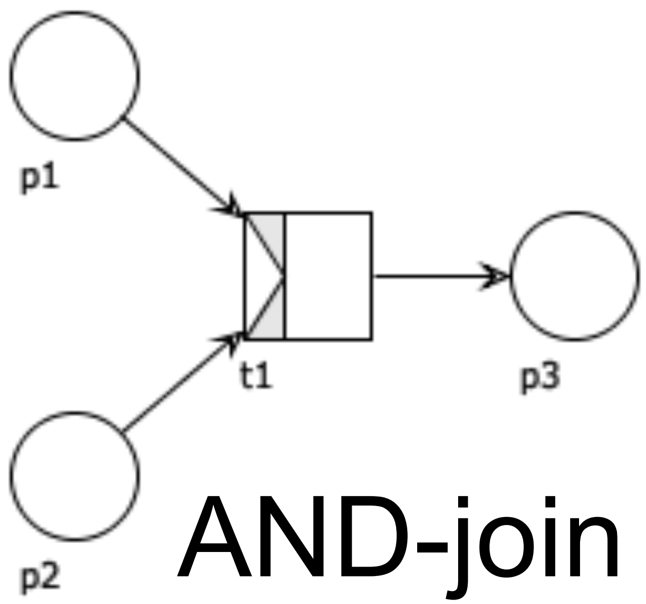


stands for

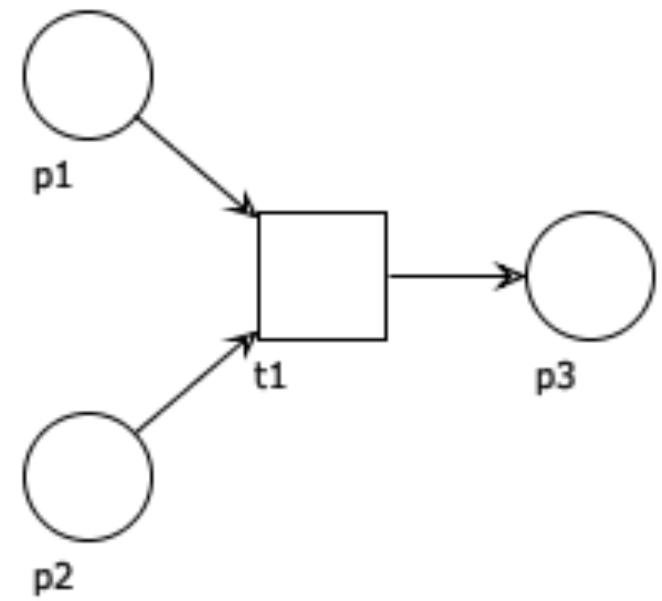


XOR-split

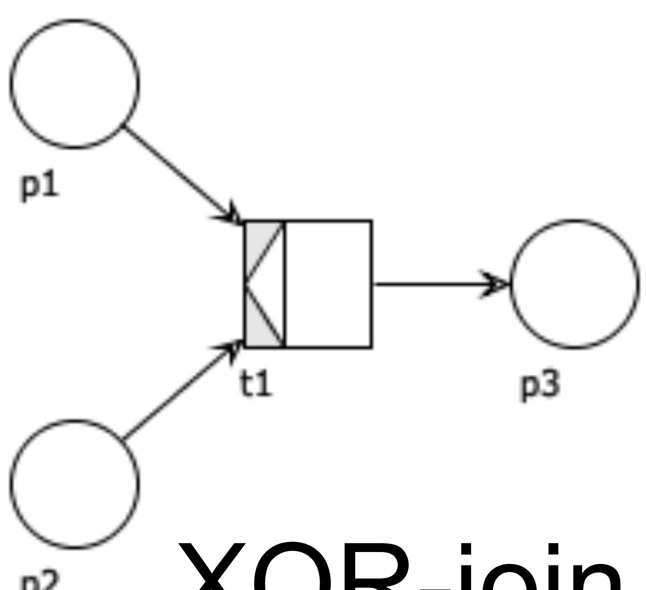
Syntax sugar: join



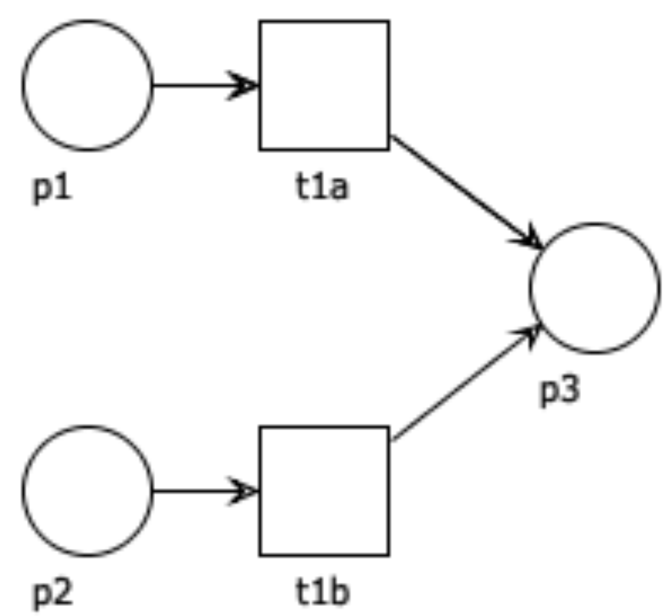
stands for



AND-join

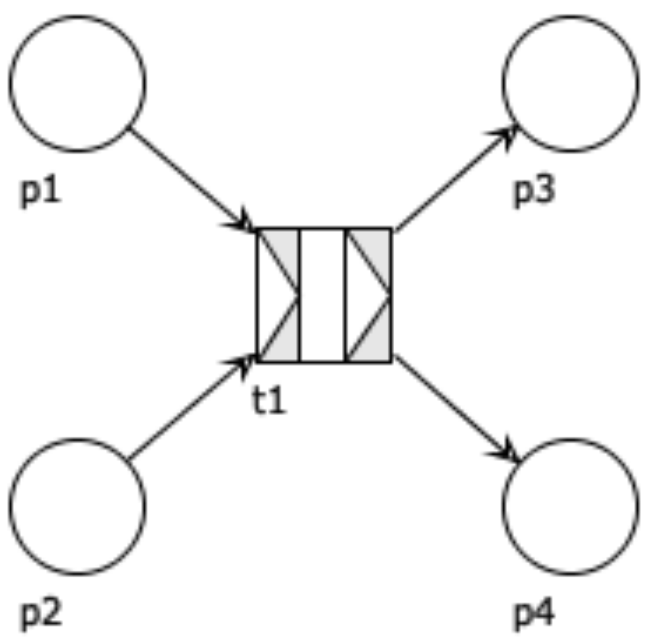


stands for

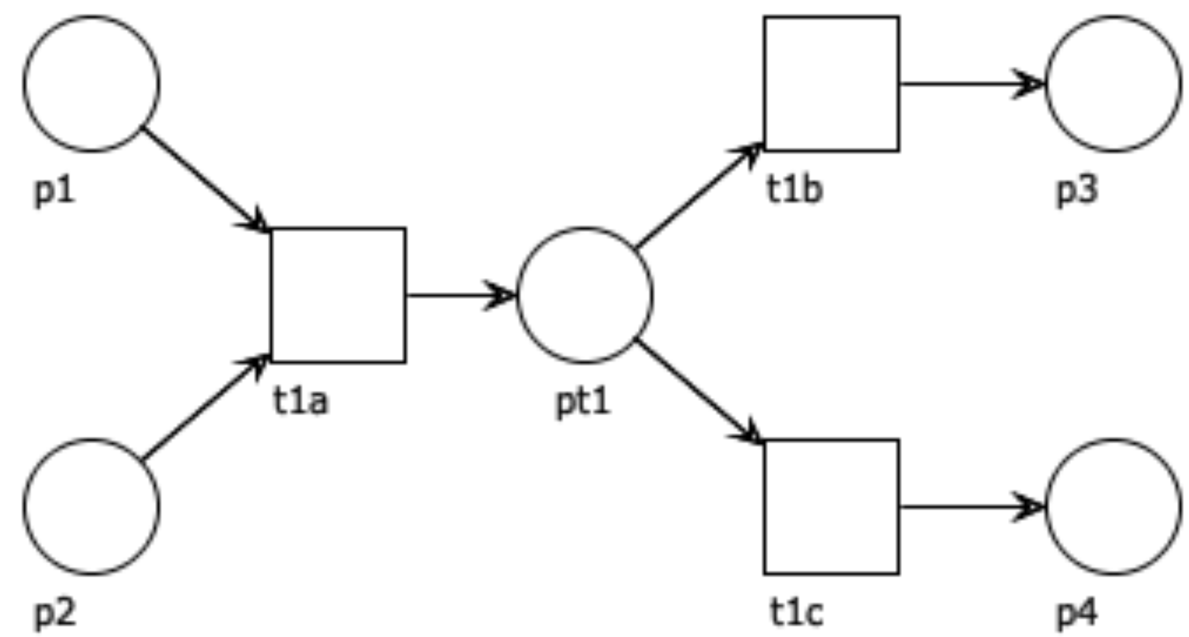


XOR-join

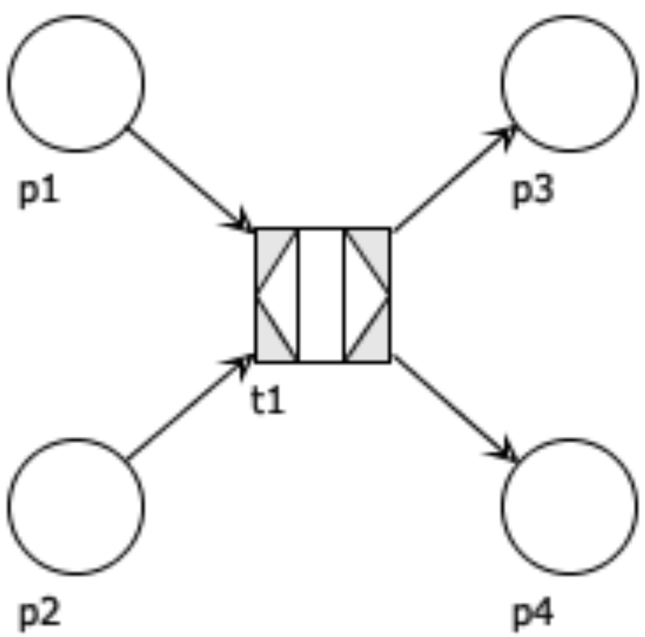
Syntax sugar: any combination is also possible



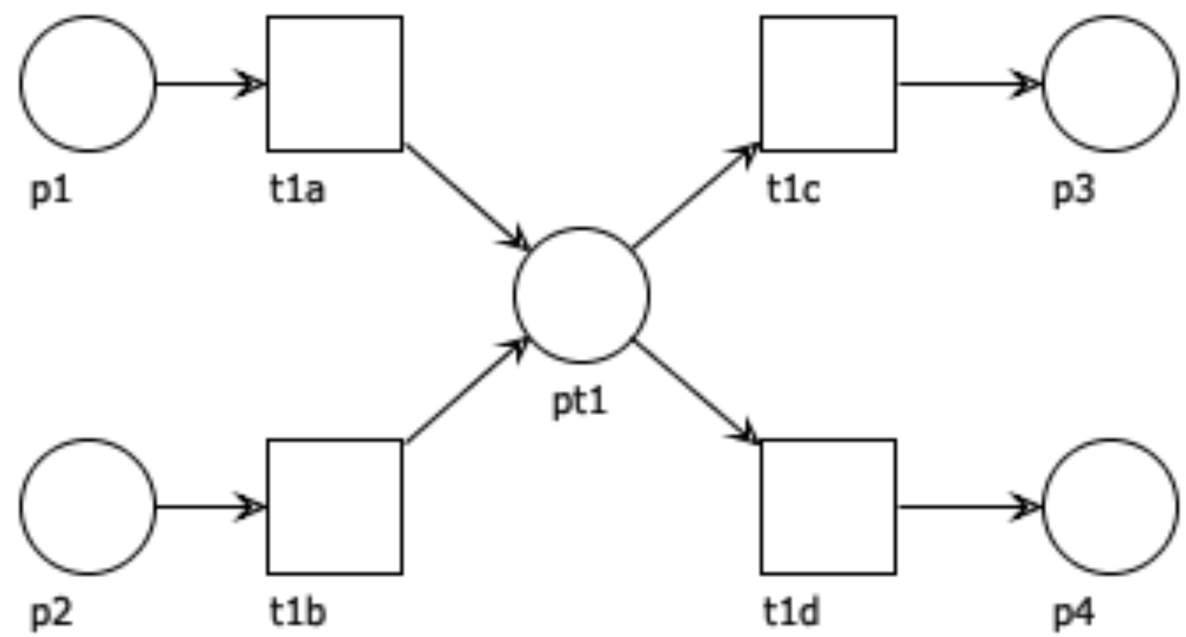
stands for



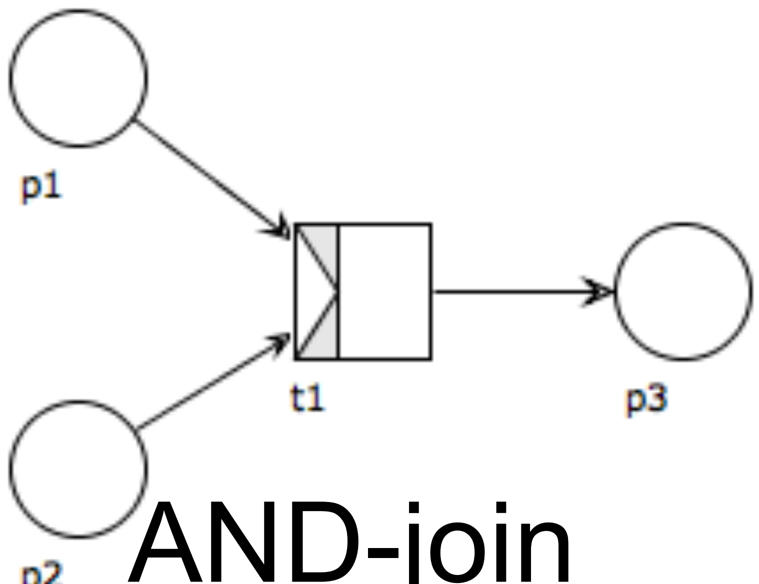
Syntax sugar: any combination is also possible



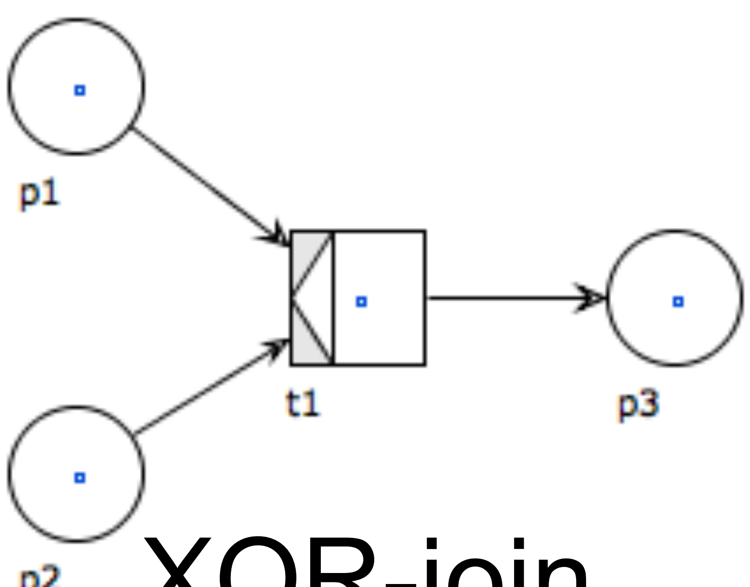
stands for



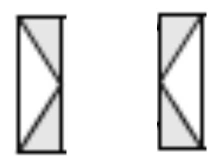
Syntax sugar: a personal note



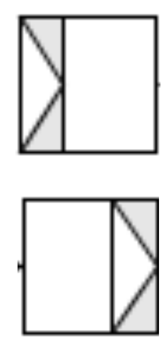
AND-join



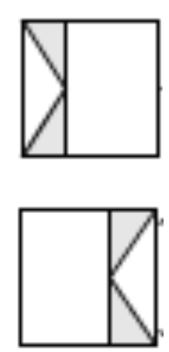
XOR-join



Chosen decorations are too similar!



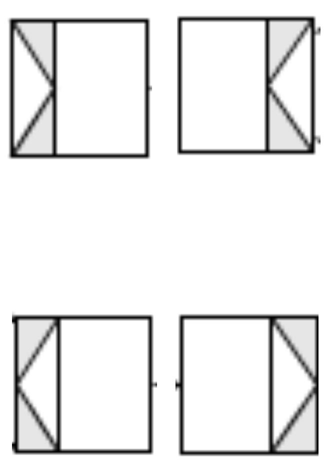
Different meanings if differently placed!



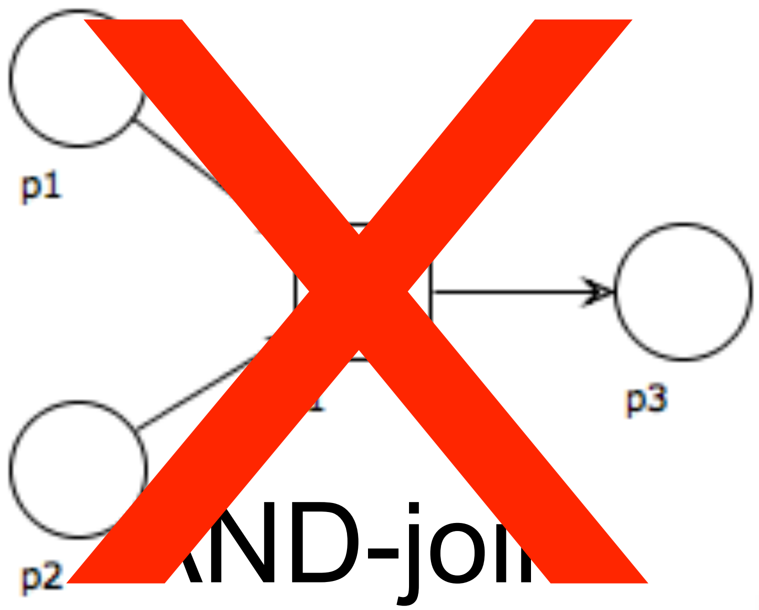
Unnecessary for AND (redundant)!

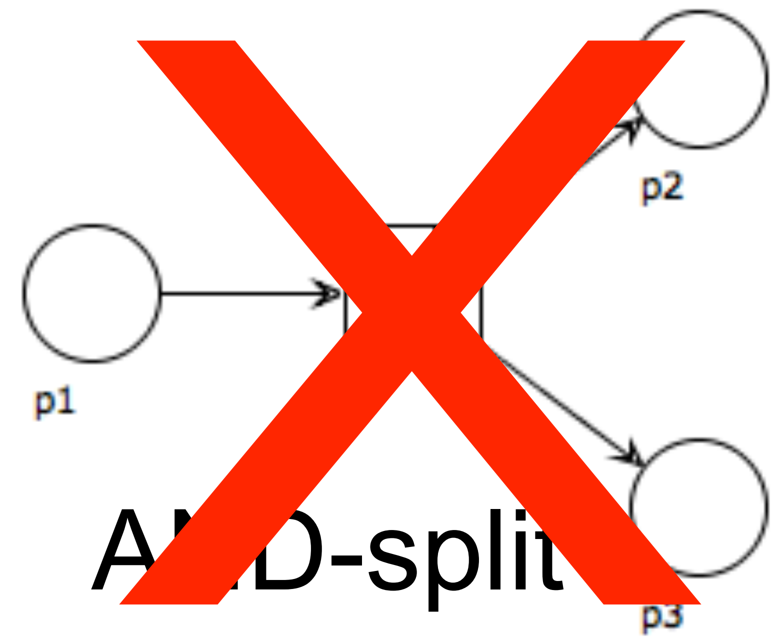
Syntax sugar: a personal note

Why there? Because of gateways

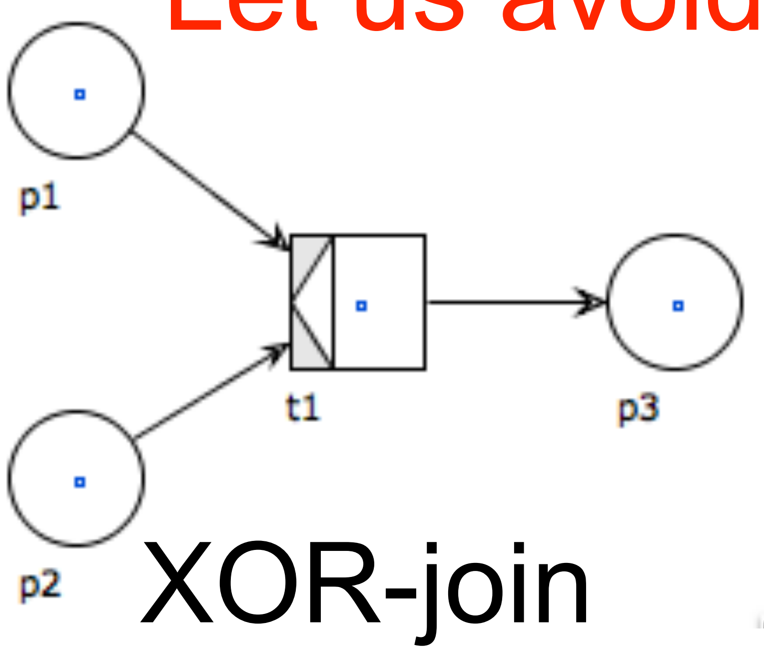


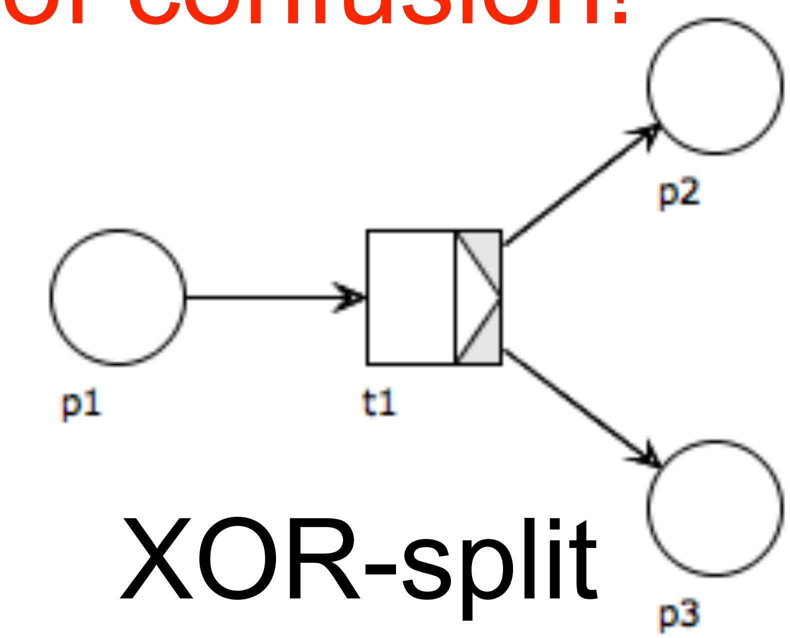
Syntax sugar: a personal note





Let us avoid any source of confusion!

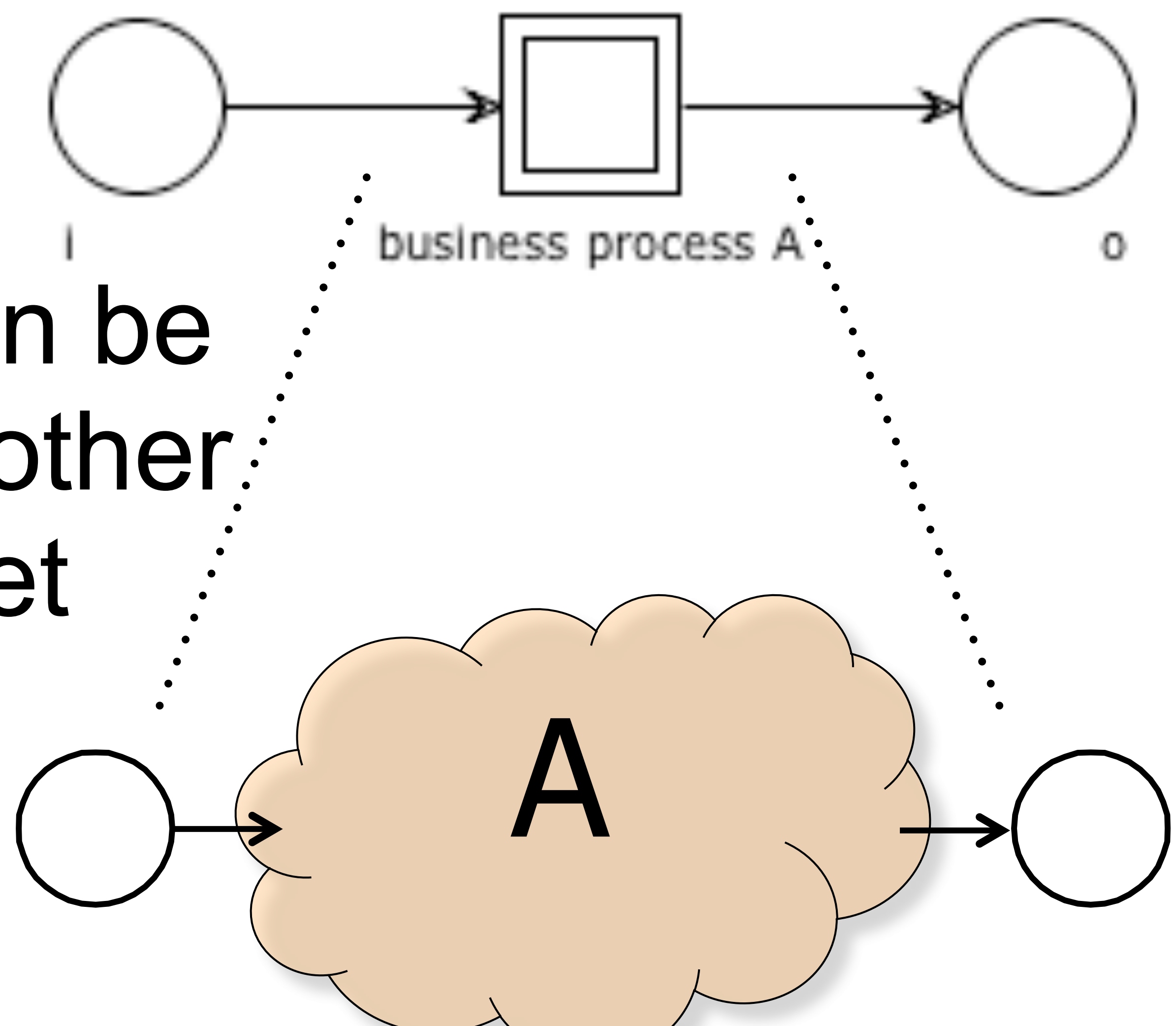




Hierarchical structuring

Uniqueness of entry / exit point facilitate the hierarchical structuring of WF nets

a transition can be realized by another workflow net

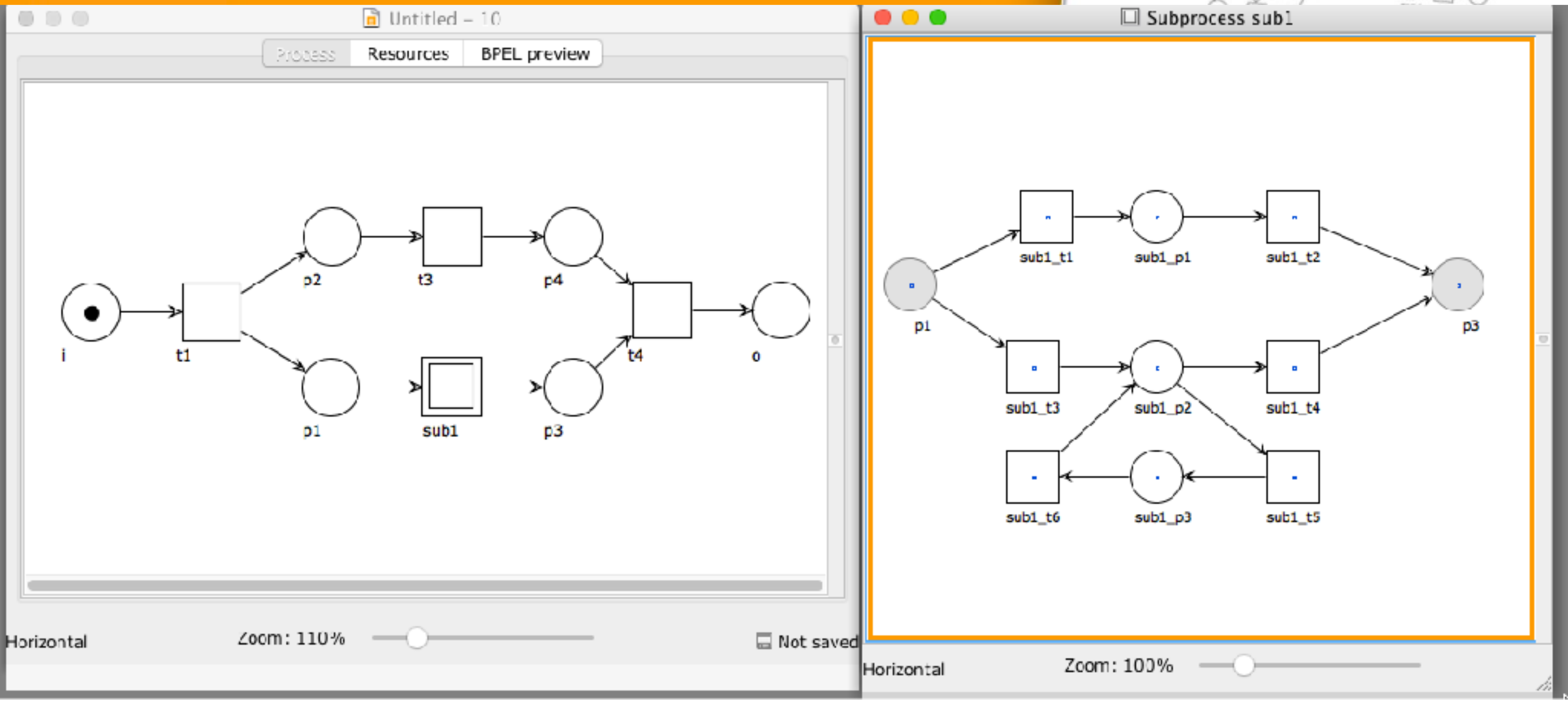


http://woped.dhbw-karlsruhe.de/woped/

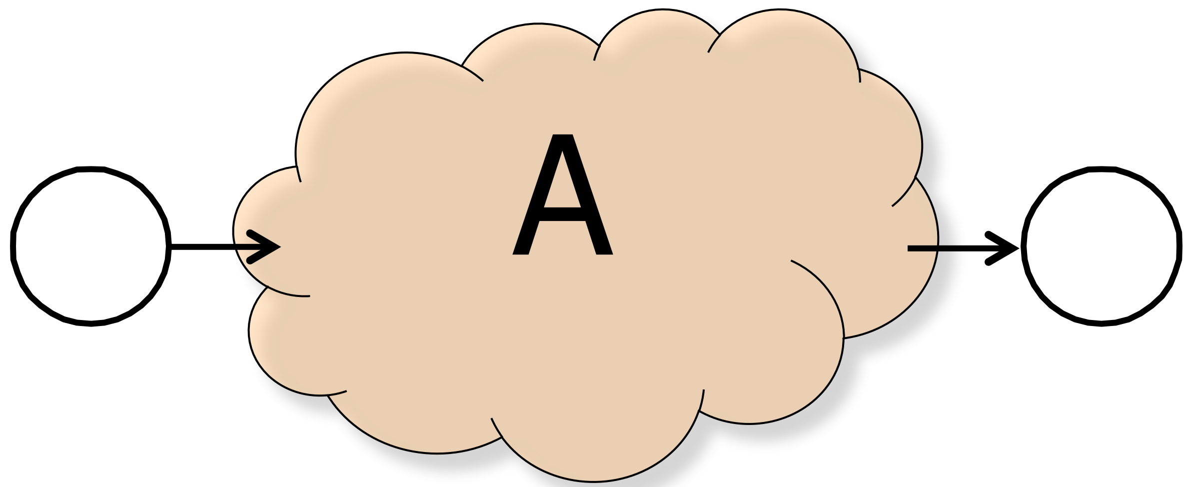
WoPeD

Workflow Petri Net Designer

Download WoPeD at sourceforge!



Language of a workflow net



The language of a workflow net is the set of firing sequences that go from i to o

$$L(N) = \{\sigma \mid i \xrightarrow{\sigma} o\}$$

L(N) defines the admissible traces of the workflow

Typical control flow aspects

Sequencing

Parallelism (AND-split + AND-join)

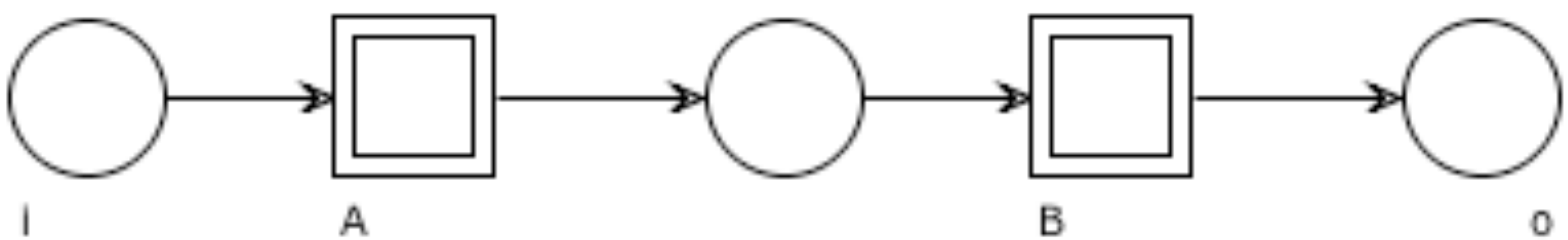
Selection (XOR-split + XOR-join)

Iteration (XOR-join + XOR-split)

Capacity constraints:
Feedback loop
Mutual exclusion
Alternating

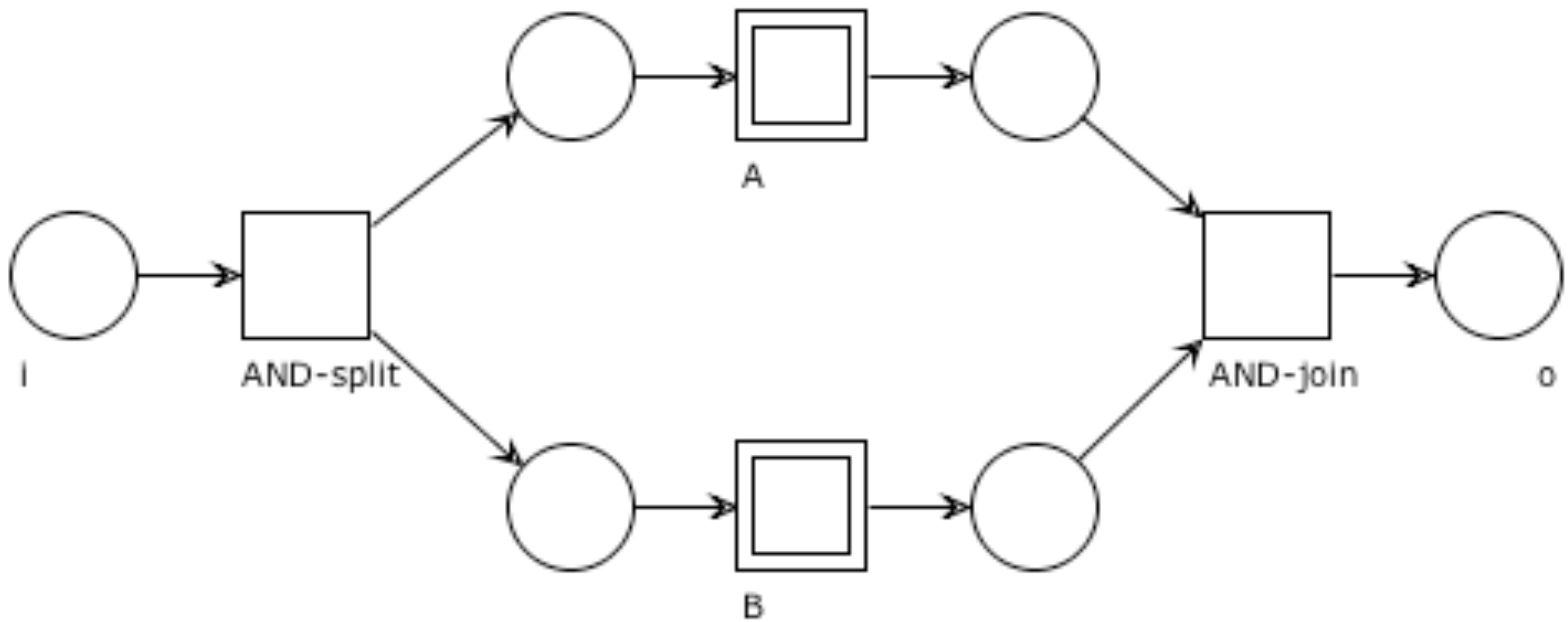
Sequencing

B is executed after A



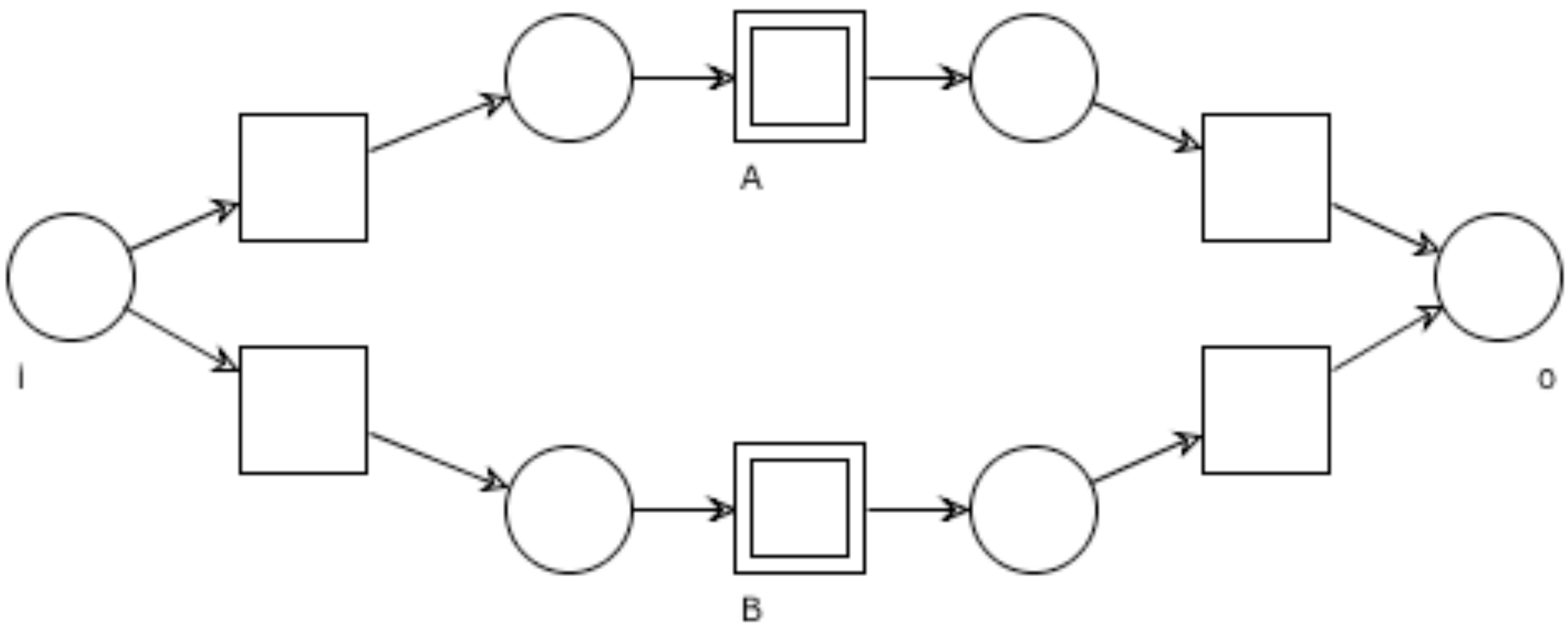
Parallelism (AND-split + AND-join)

A and B are both executed in no particular order



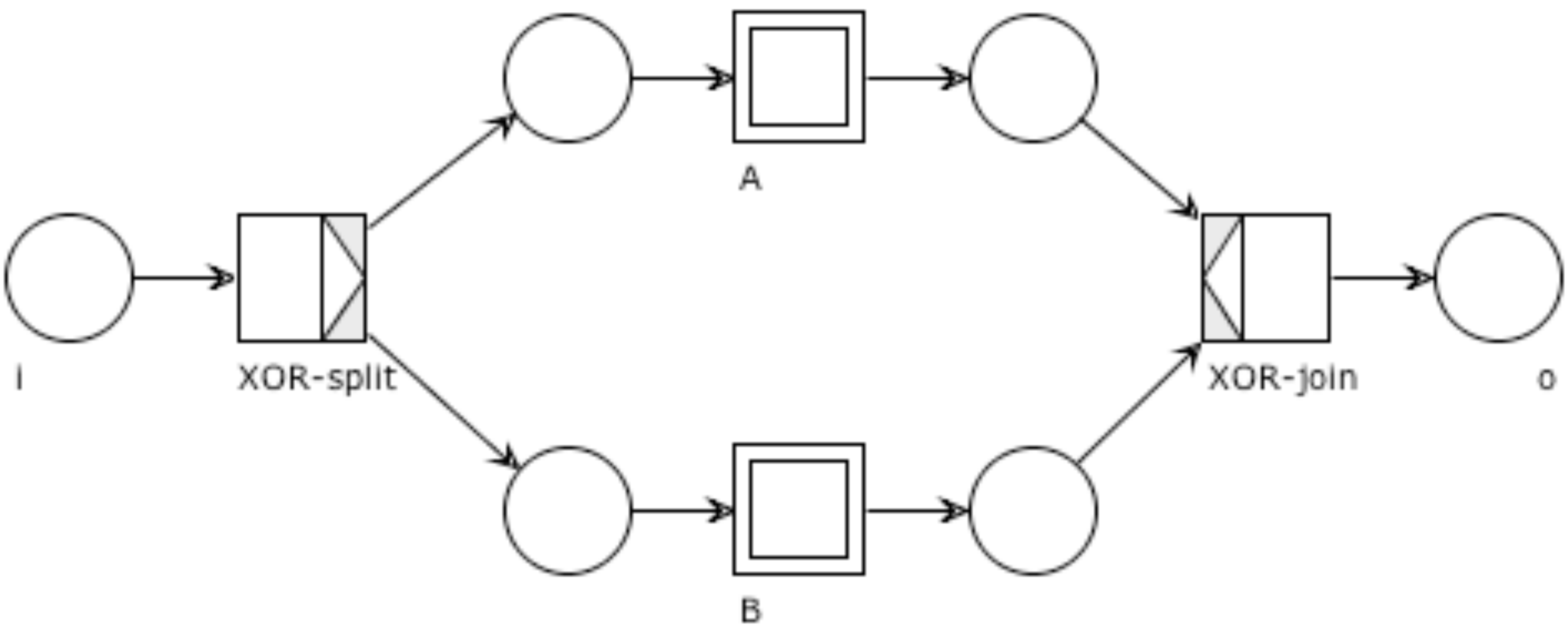
Explicit choice (XOR-split + XOR-join)

Either A or B is executed (choice is **explicit**)



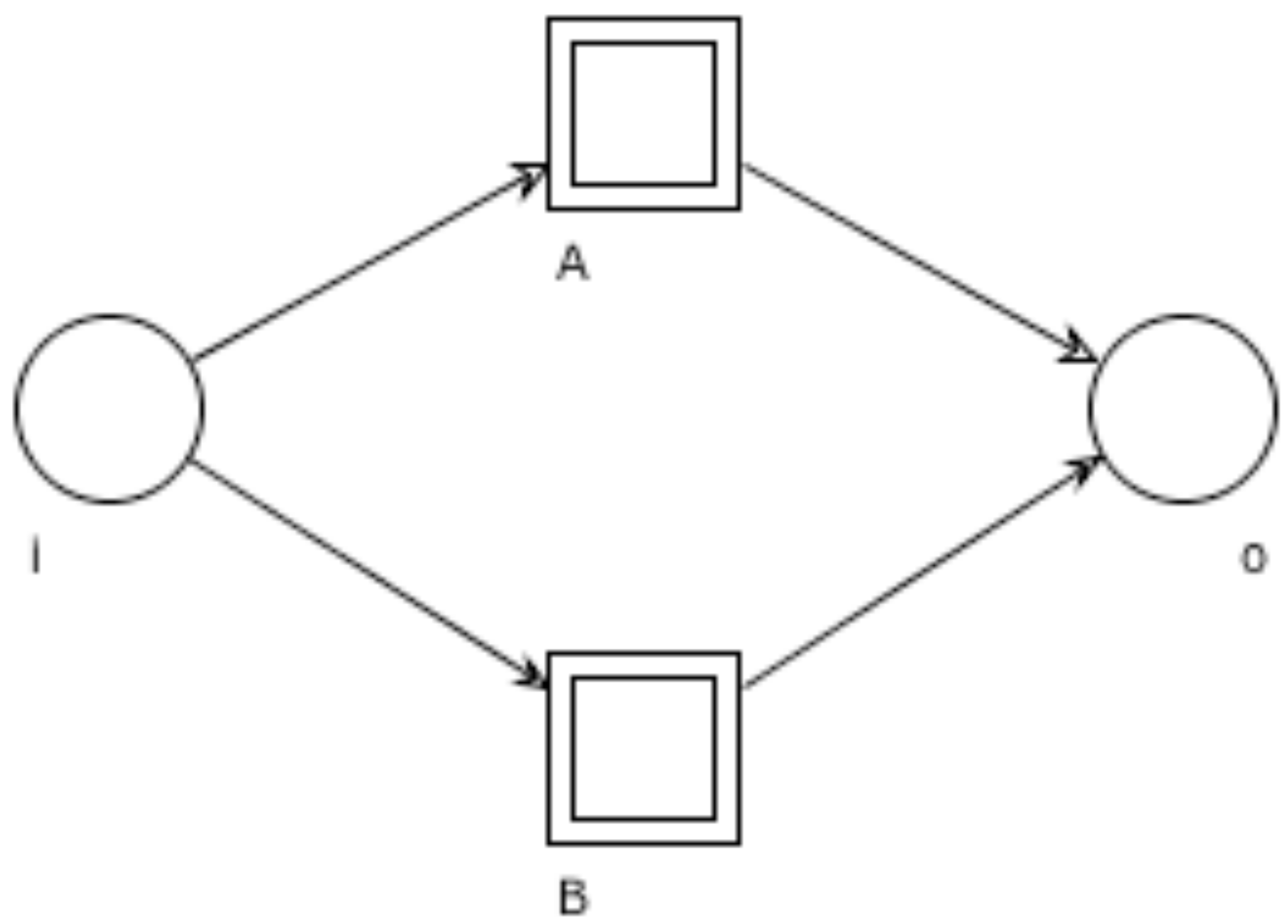
Explicit choice ("sugared" version)

Decorated version



Deferred choice

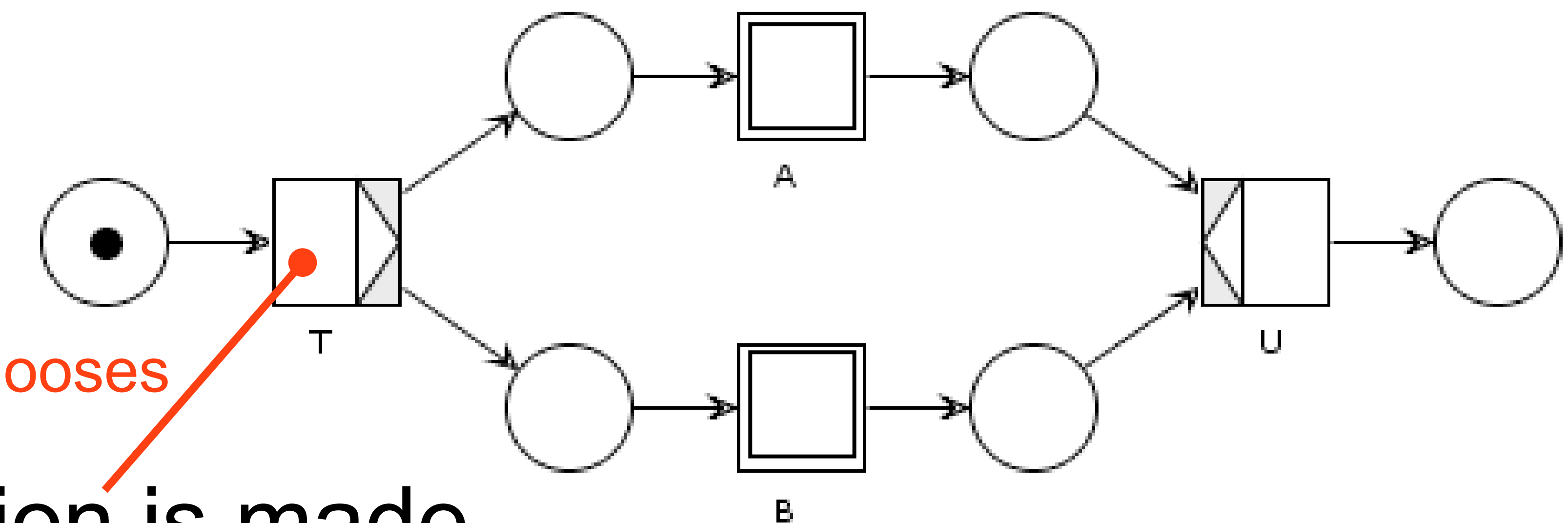
Either A or B is executed (choice is **implicit**)



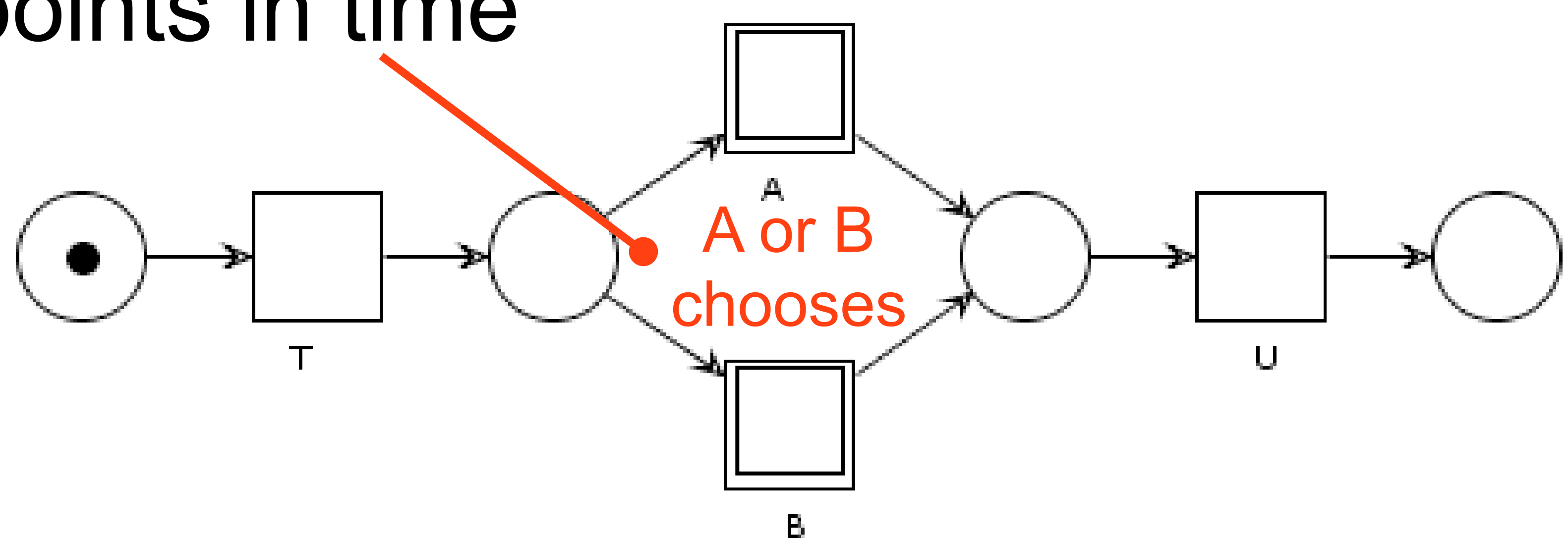
Remember

Explicit choice ≠ Implicit choice

T chooses

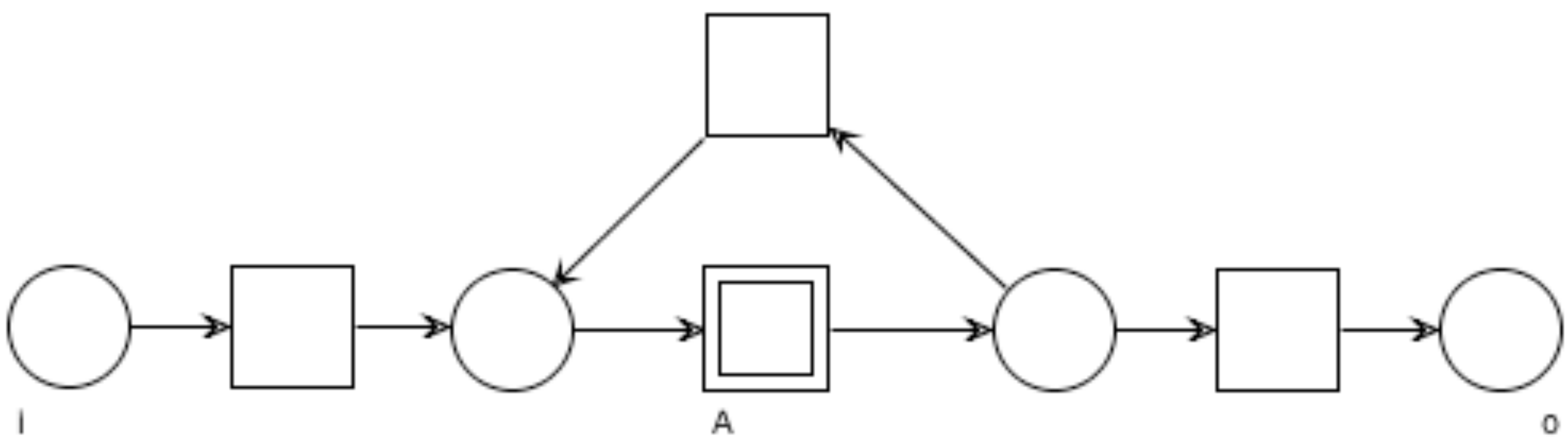


The decision is made
at different points in time



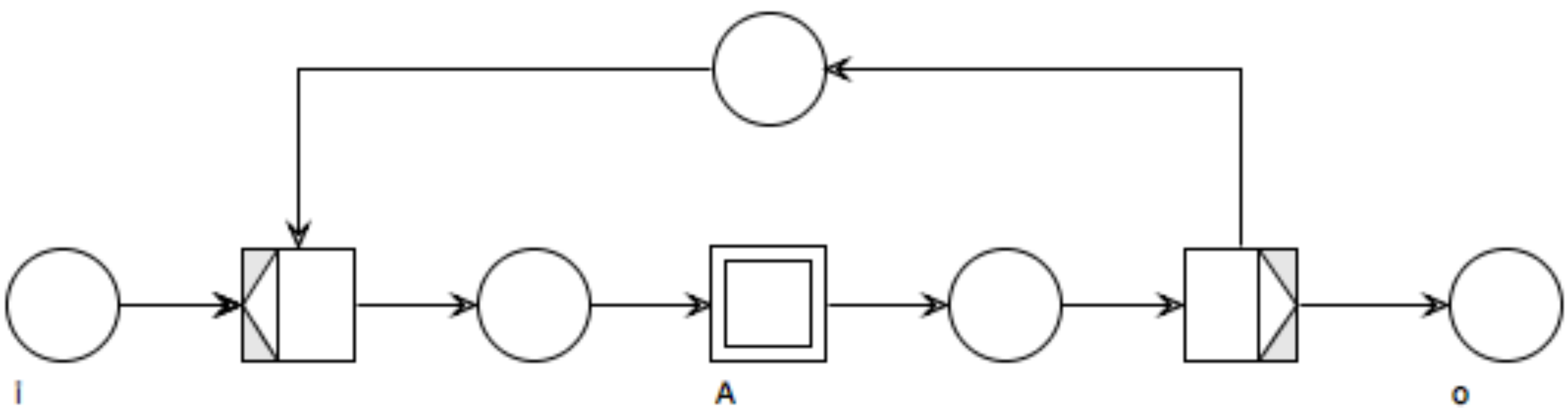
Iteration (one or more times)

A is executed 1 or more times



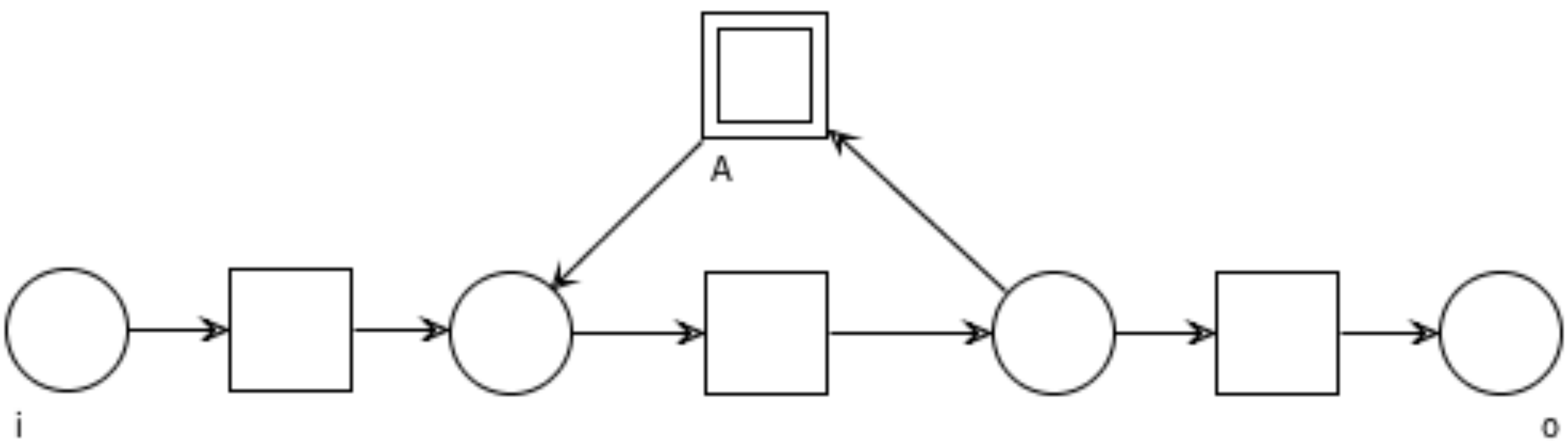
One-or-more iteration ("sugared" version)

Decorated version



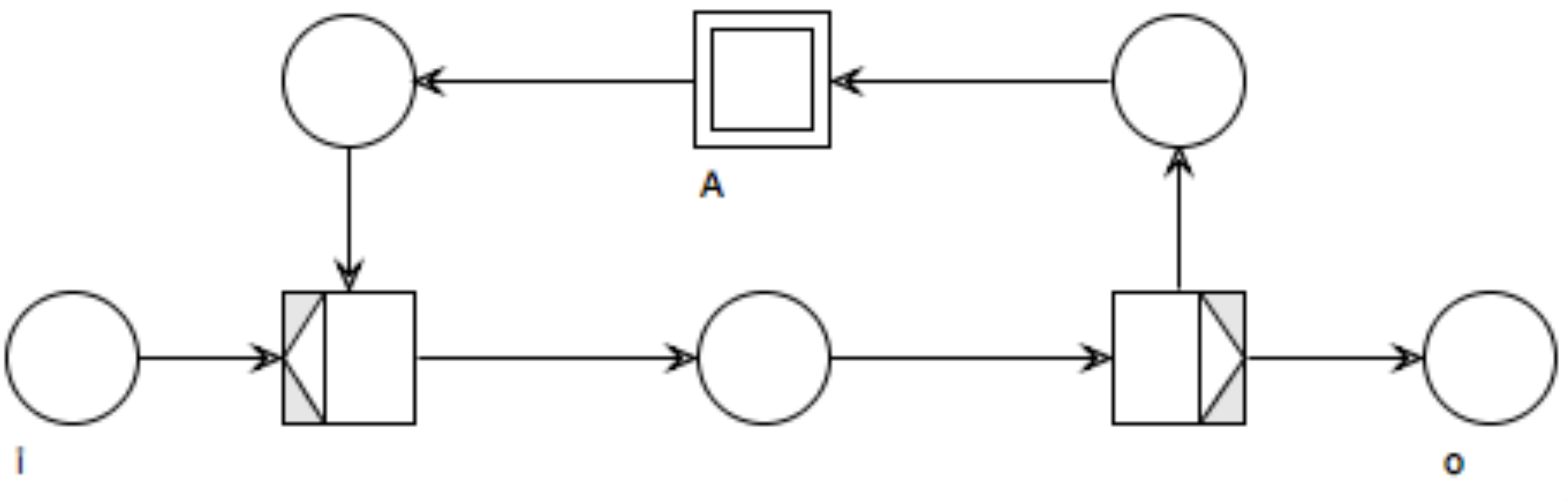
Iteration (zero or more times)

A is executed 0 or more times



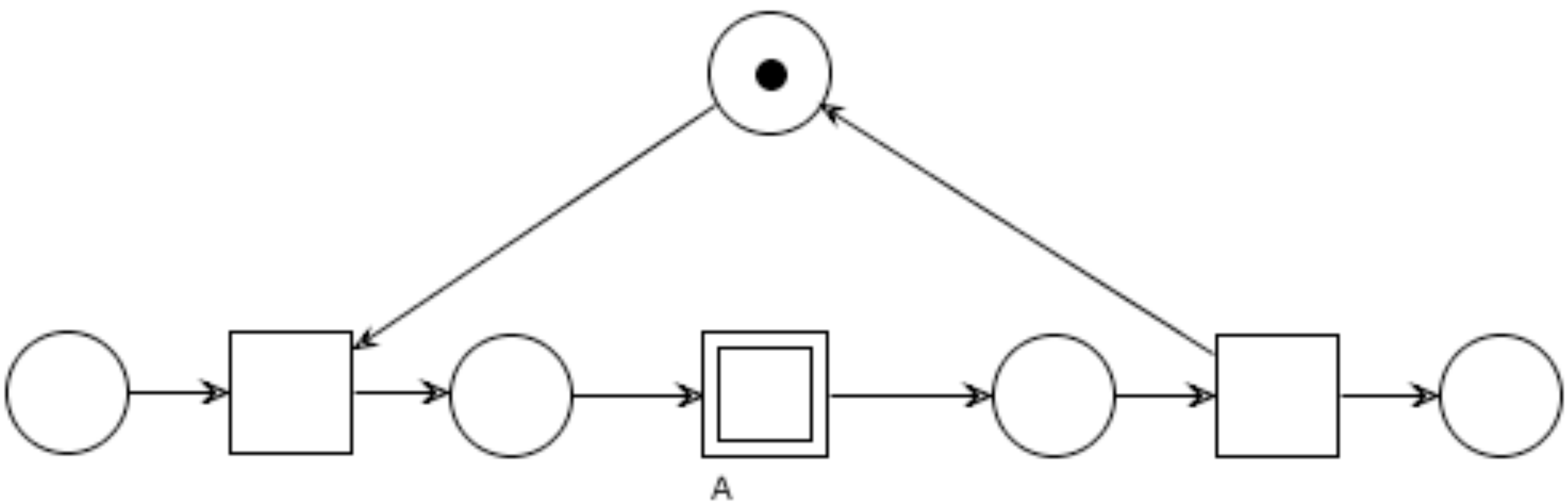
Zero-or-more iteration ("sugared" version)

Decorated version



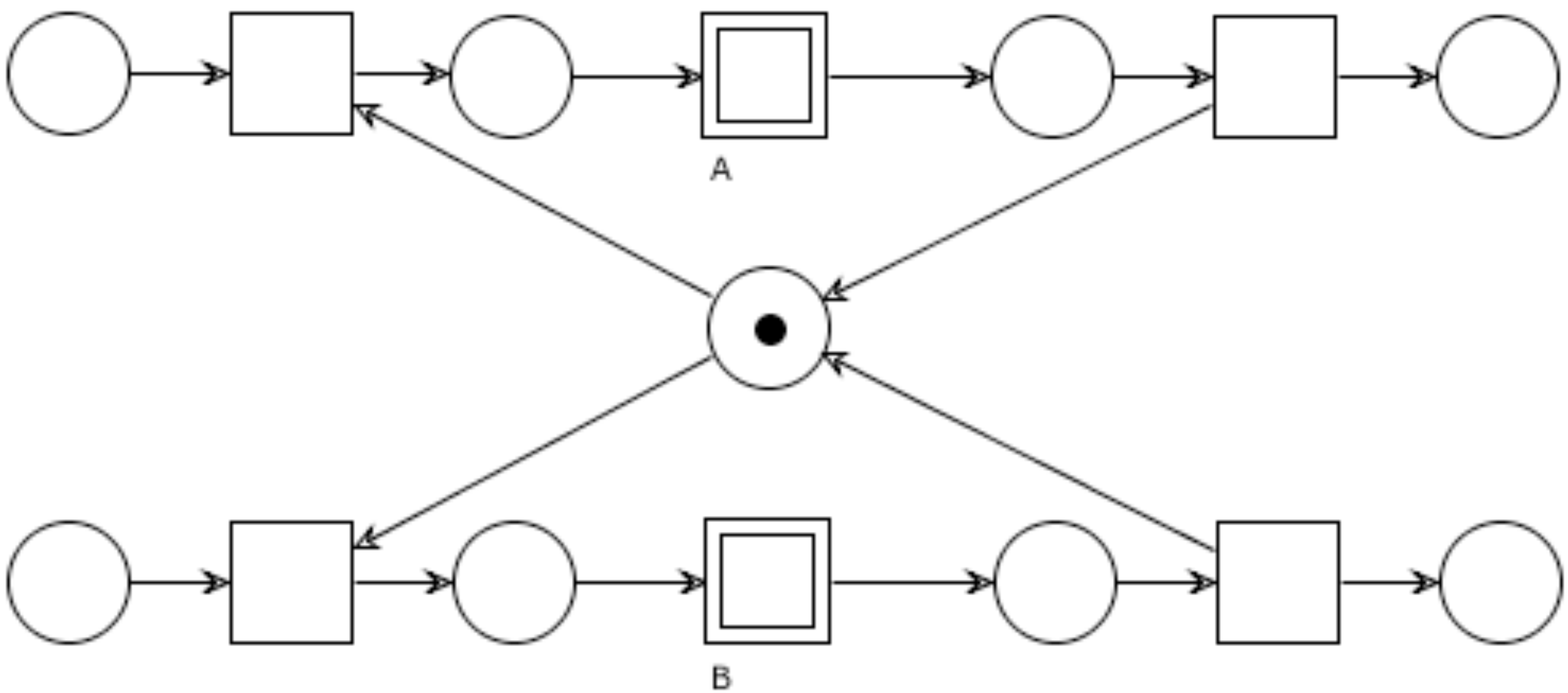
One serve per time

Multiple activations are handled one by one



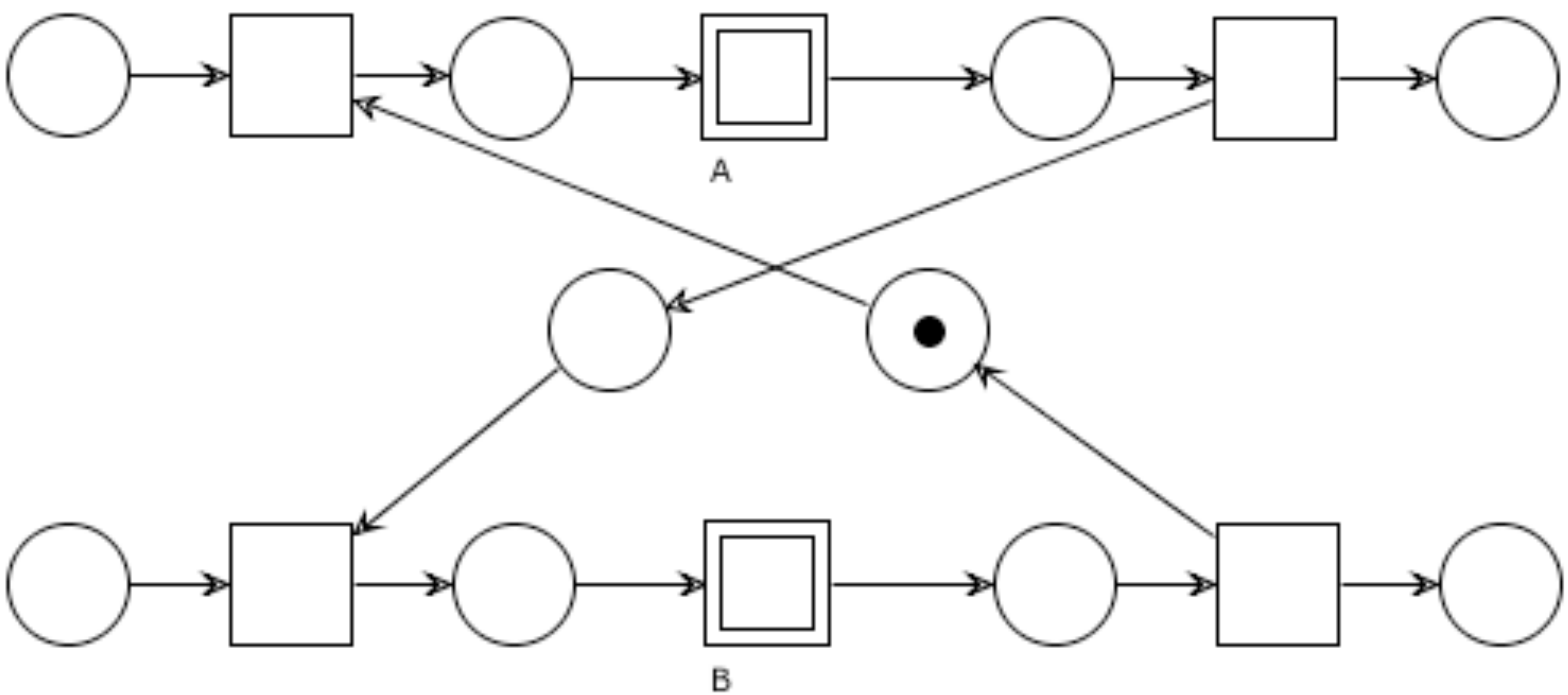
Mutual exclusion

A and B cannot execute concurrently



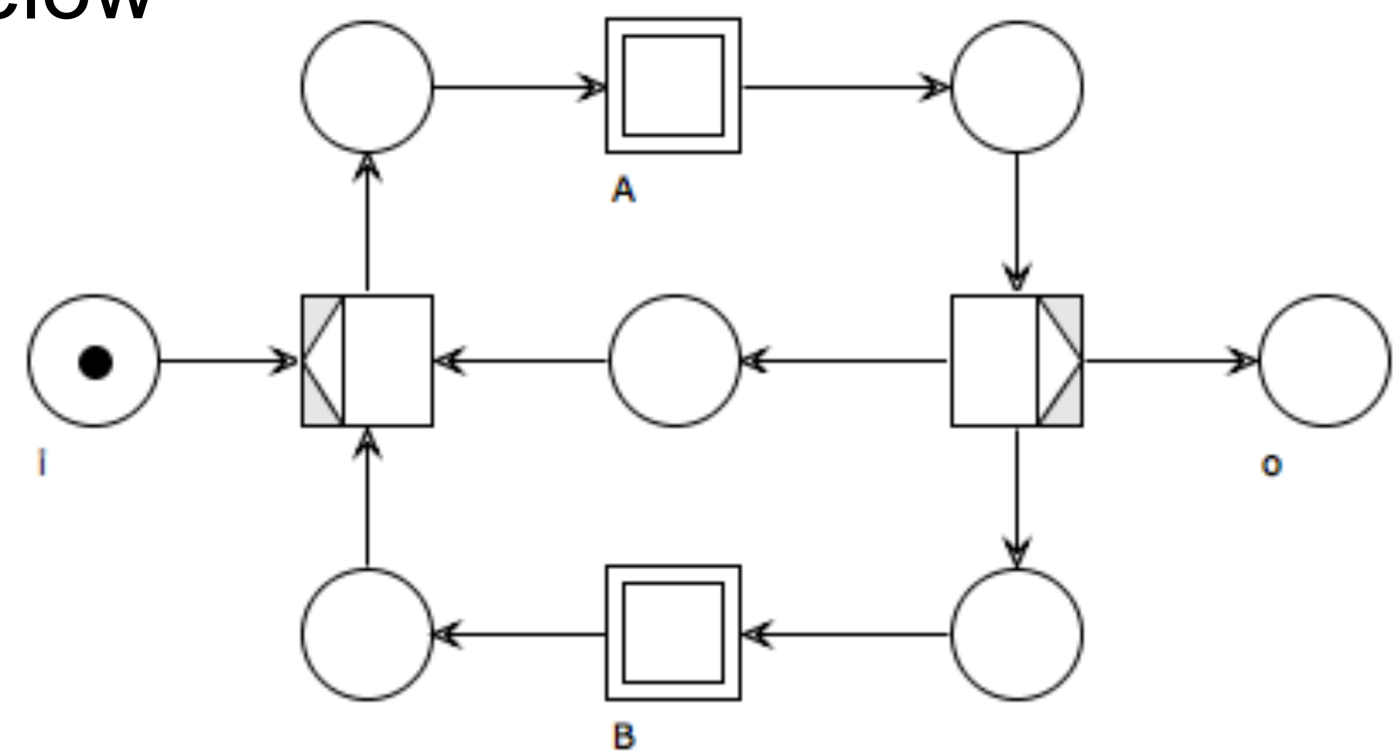
Alternation

A and B execute one time each (A first)



Question time

Consider the workflow net below



How many times can A be executed?

How many times can B be executed?

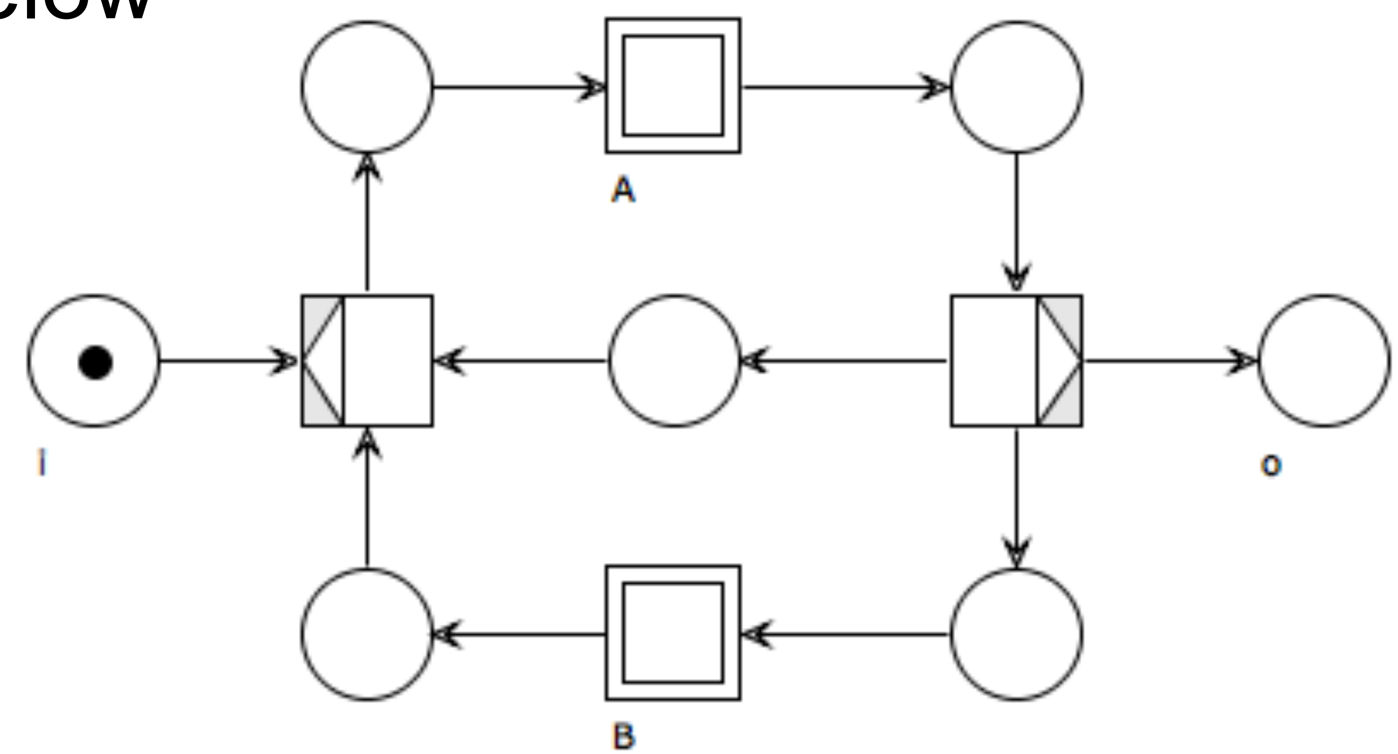
Can a firing sequence contain two As in a row?

Can a firing sequence contain two Bs in a row?

Can a firing sequence contain more Bs than As?

Question time

Consider the workflow net below



How many times can A be executed? 1 or more

How many times can B be executed? 0 or more

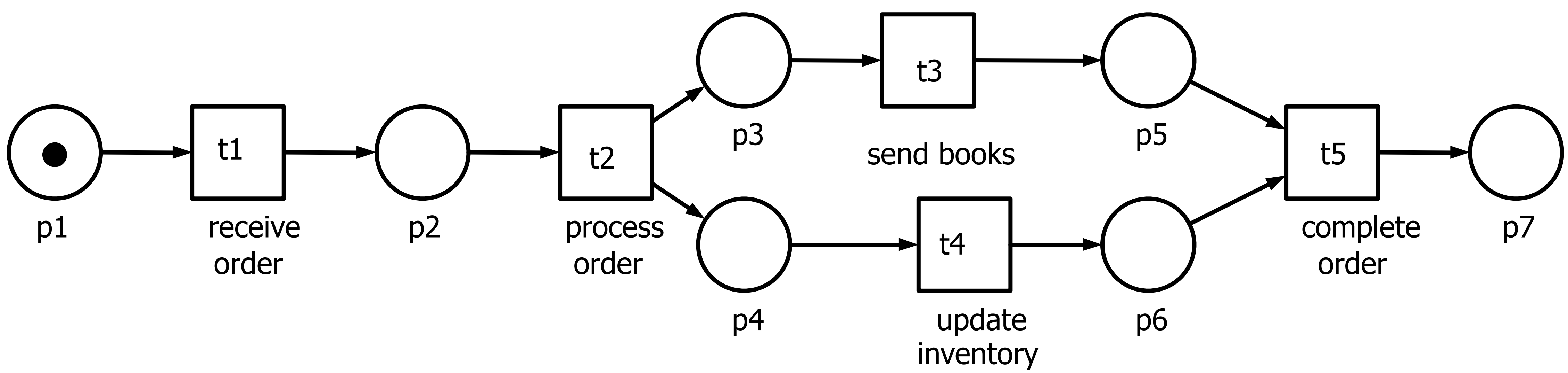
Can a firing sequence contain two As in a row? yes

Can a firing sequence contain two Bs in a row? no

Can a firing sequence contain more Bs than As? no

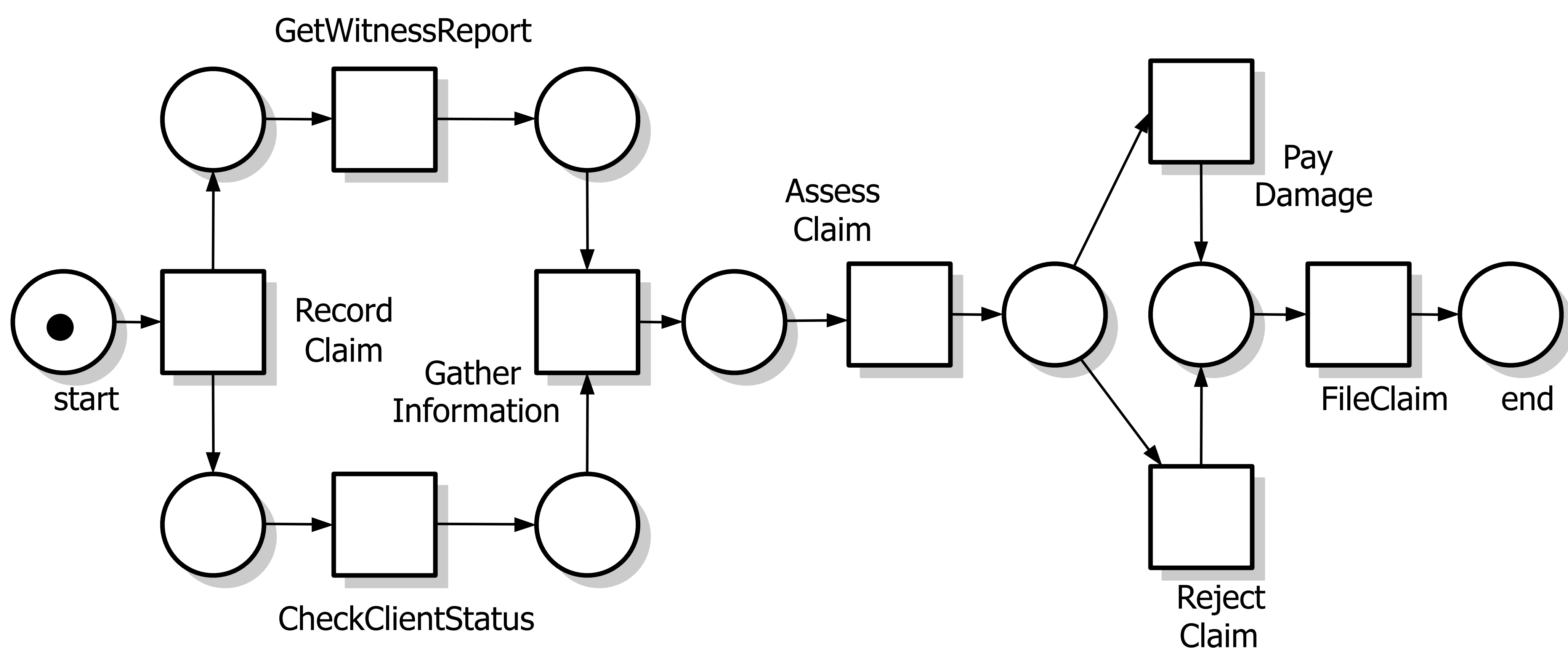
Exercises

- Which "patterns" can be found in the workflow net below?
- Draw the corresponding Reachability Graph
- What is its language?



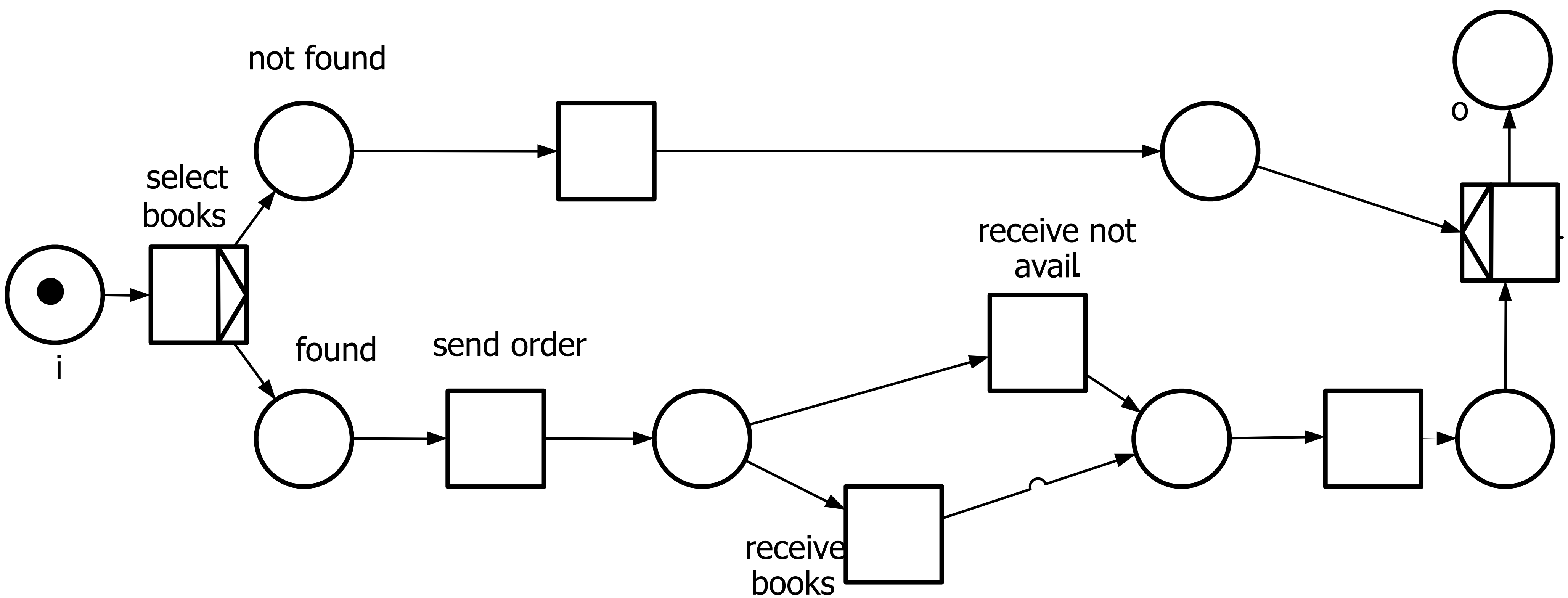
Exercises

- Which "patterns" can be found in the workflow net below?
- "Sugarize" the net (where it makes sense)
- Name all places and draw the Reachability Graph
- What is its language?



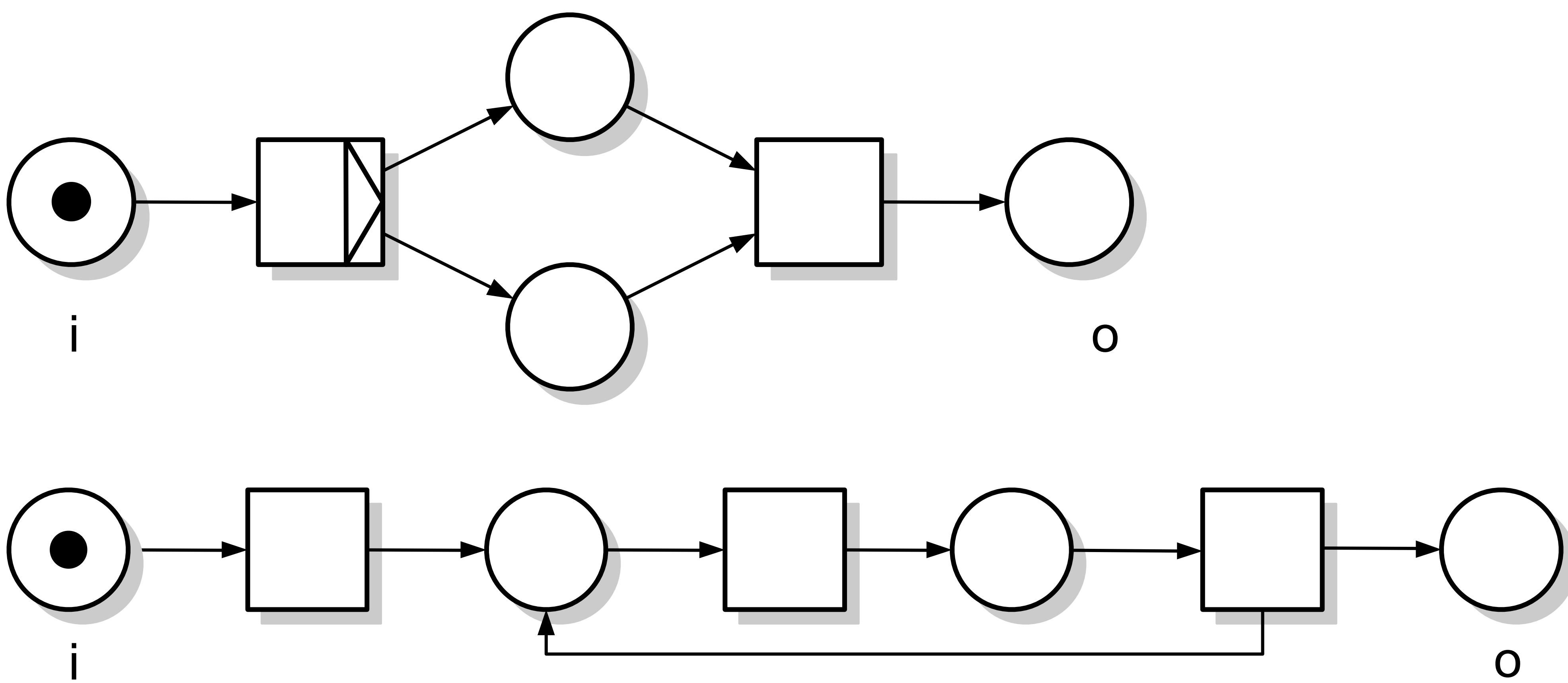
Exercises

- "Desugarize" the workflow net below
- Name all nodes and draw the Reachability Graph
- What is its language?



Exercises

- "Desugarize" the workflow nets below
- Name all nodes and draw the Reachability Graphs
- What are their languages?



Triggers

Execution constraints can depend on the environment in which processes are enacted.

In workflow nets, transitions can be decorated with the information on who (or what) is responsible for the "firing" of that task.

Such annotations are called **triggers**

Triggers

Triggers can be:

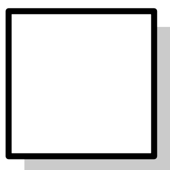
a human interaction

the receipt of a message

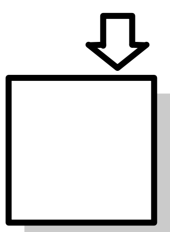
the expiration of a time-out

Transitions with no trigger can fire automatically

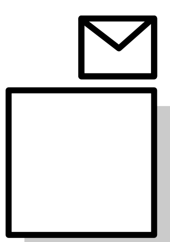
Symbols for triggers



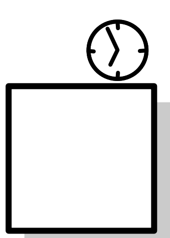
Automatic Trigger: Task enacted automatically



User Trigger: A human user takes initiative and starts activity

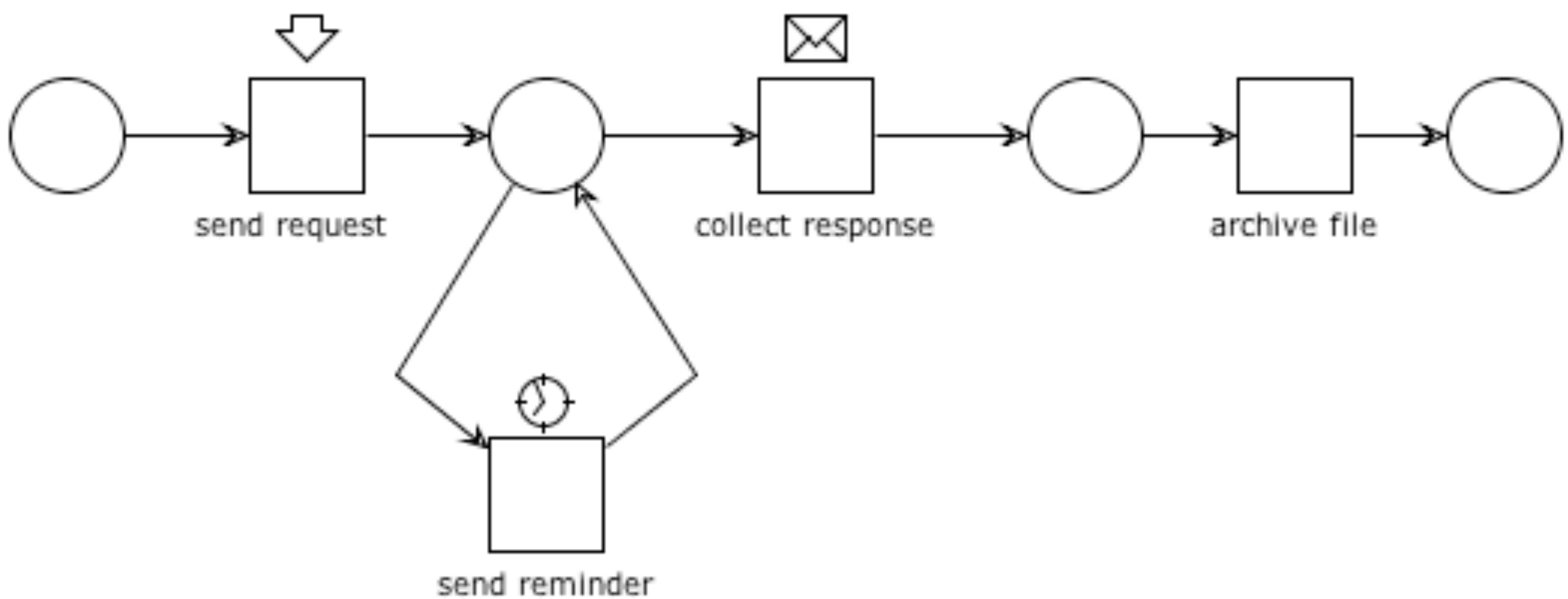


External Trigger: External event required to start activity

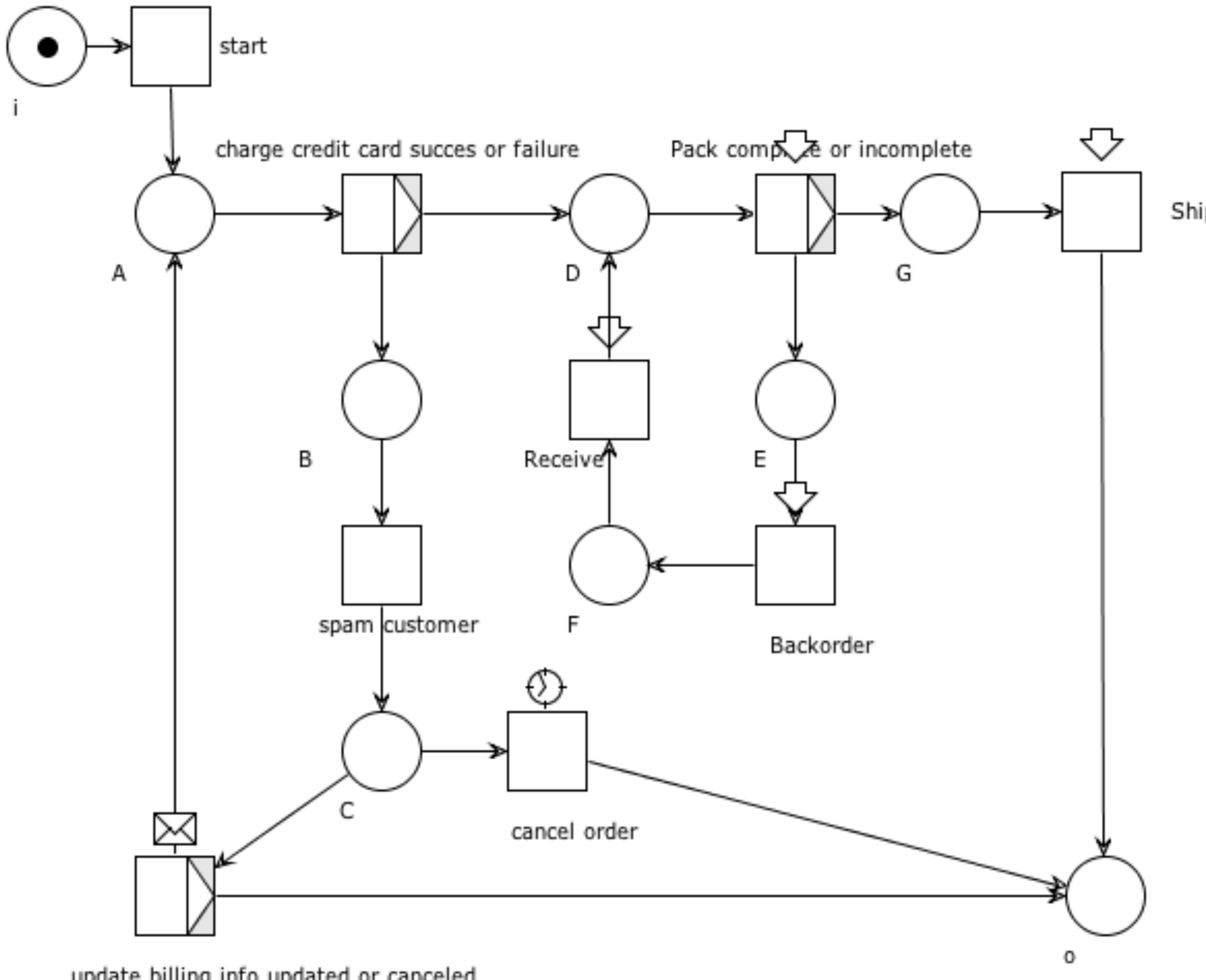


Time Trigger: Activity started when timer elapses

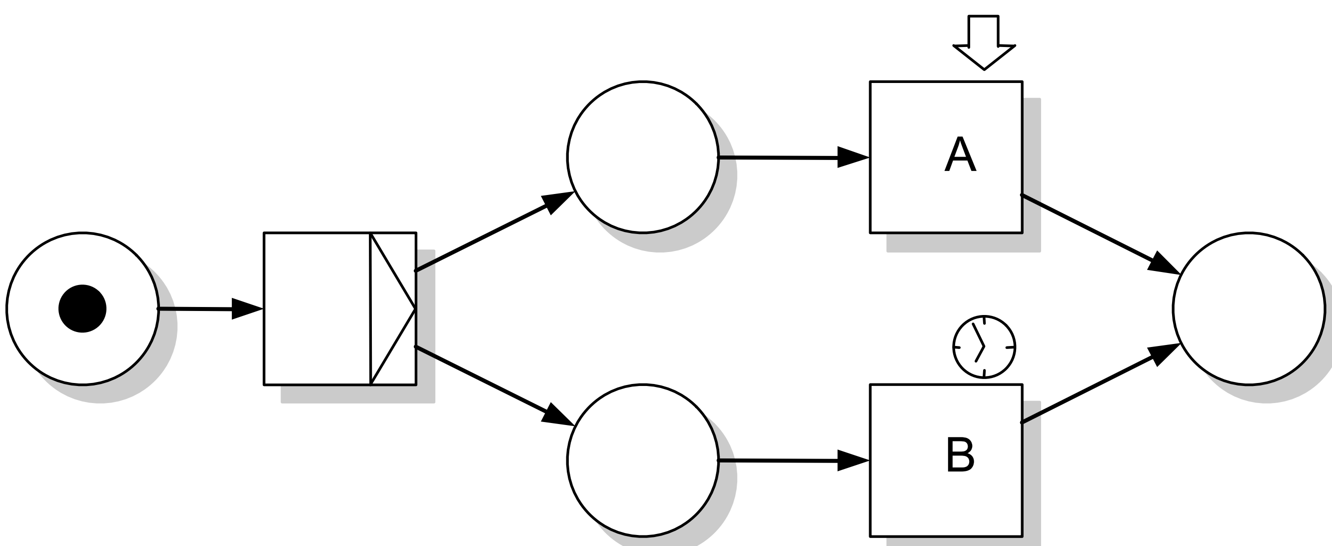
Triggers: example



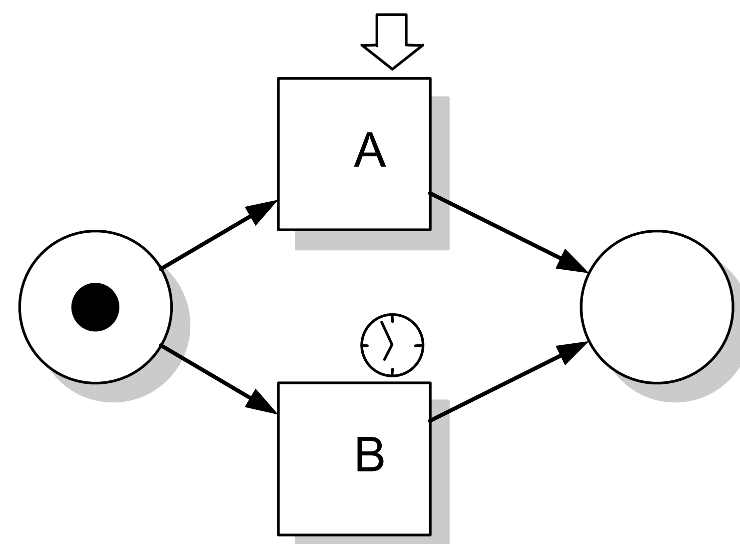
Triggers: example



Explicit vs Implicit XOR-split



(a) *Explicit xor split* does not enable A and B concurrently



(b) *Implicit xor split* enables A and B concurrently

Motivation for the analysis

L(N) shows the correct ways to run the process
if it is empty there is clearly some problem

Are we guaranteed that nothing can go wrong?
Are we guaranteed that once a case is started
it will reach an end?

BPs are large, with increasing complexity
flawed situations are frequent

Is this WF net ok?

What does it mean "to be ok"?