Business Processes Modelling

MPB (6 cfu, 295AA)

Roberto Bruni

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

13 - Sound by construction

Object

We show a technique to build sound Workflow nets

Soundness proof by construction

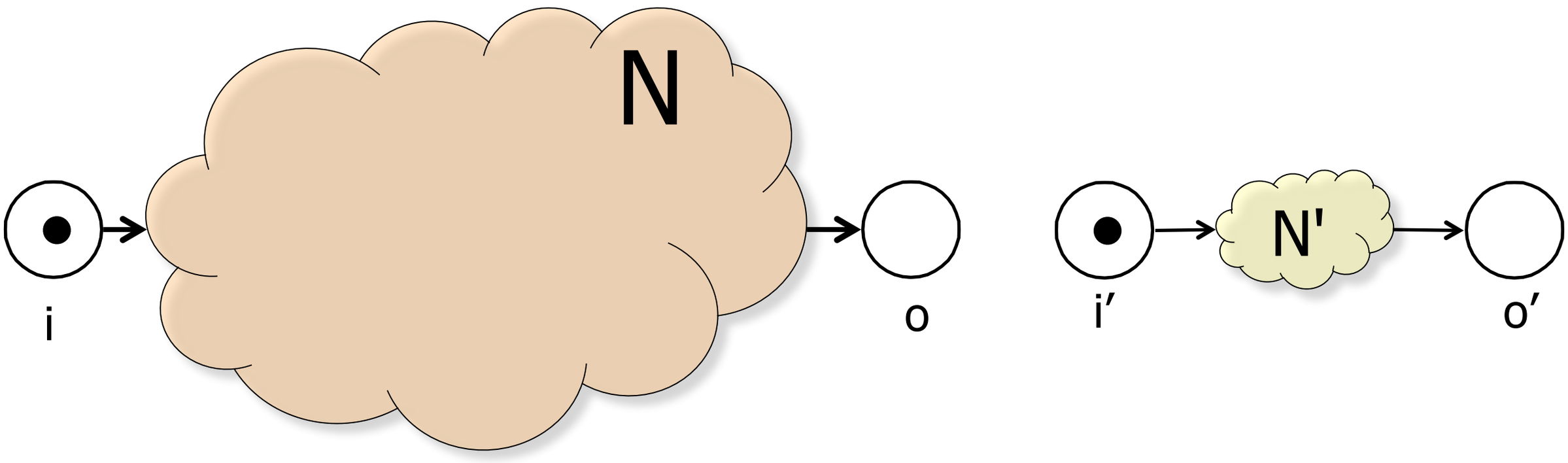
Idea

1. Find a suitable set of "building blocks"
they are (small) workflow nets
that can be (easily) proved
to be **sound** and
to be **safe** (1-bounded)

2. Define composition patterns so that
by composing **safe and sound** WF nets
we get **safe and sound** WF nets

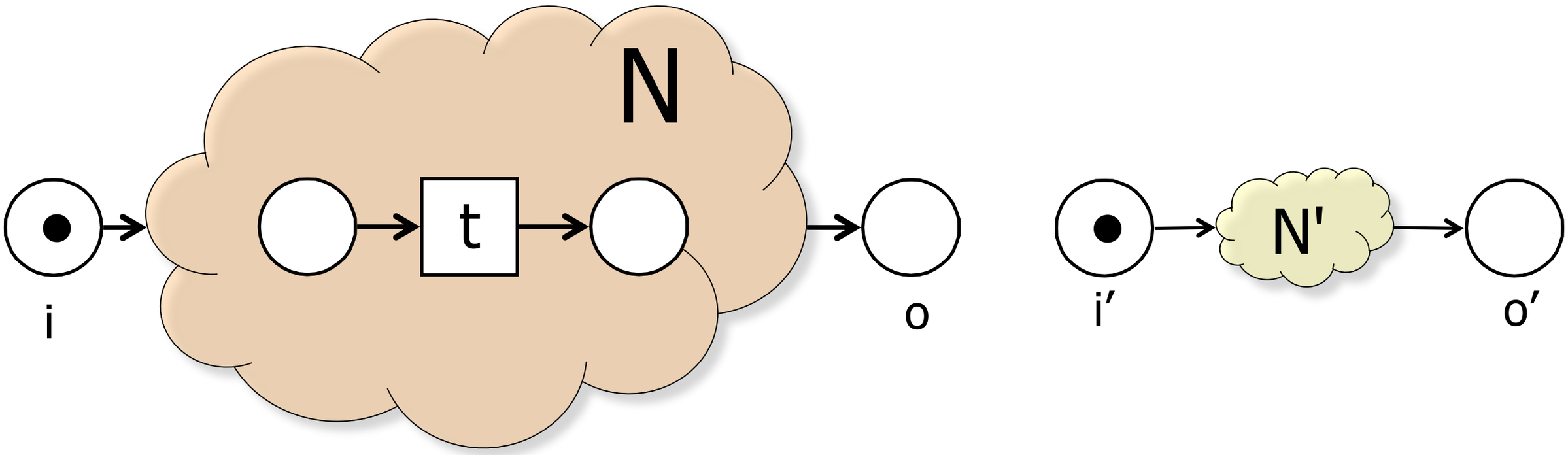
Sound and safe by composition

Let N, N' be two safe and sound workflow nets



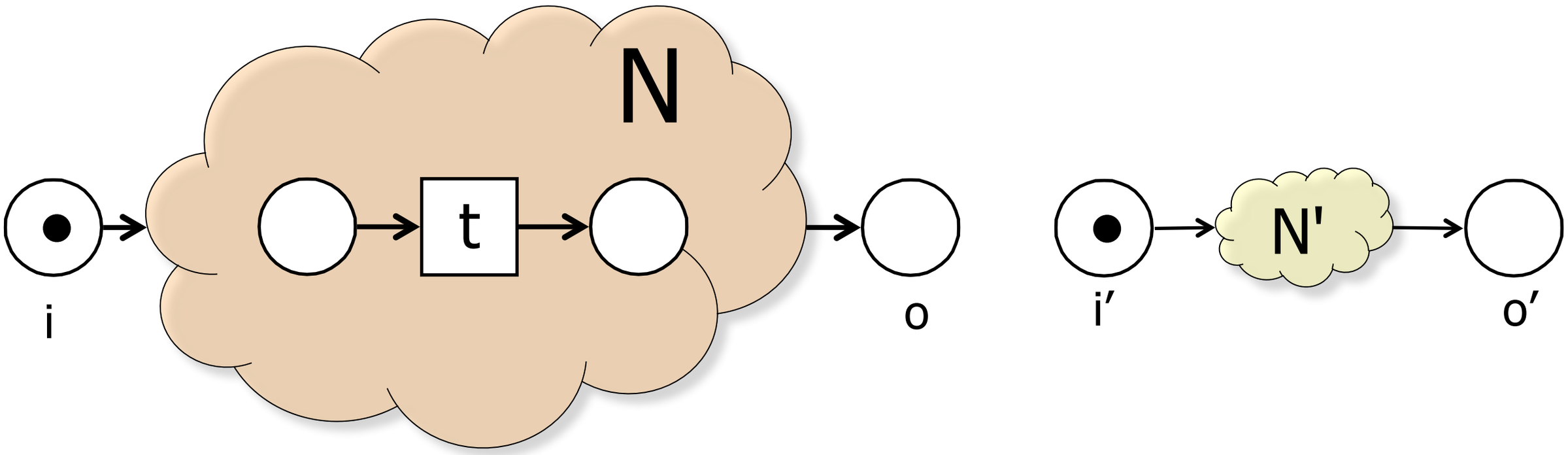
Sound and safe by composition

Let t be a task of N with exactly one input and one output place



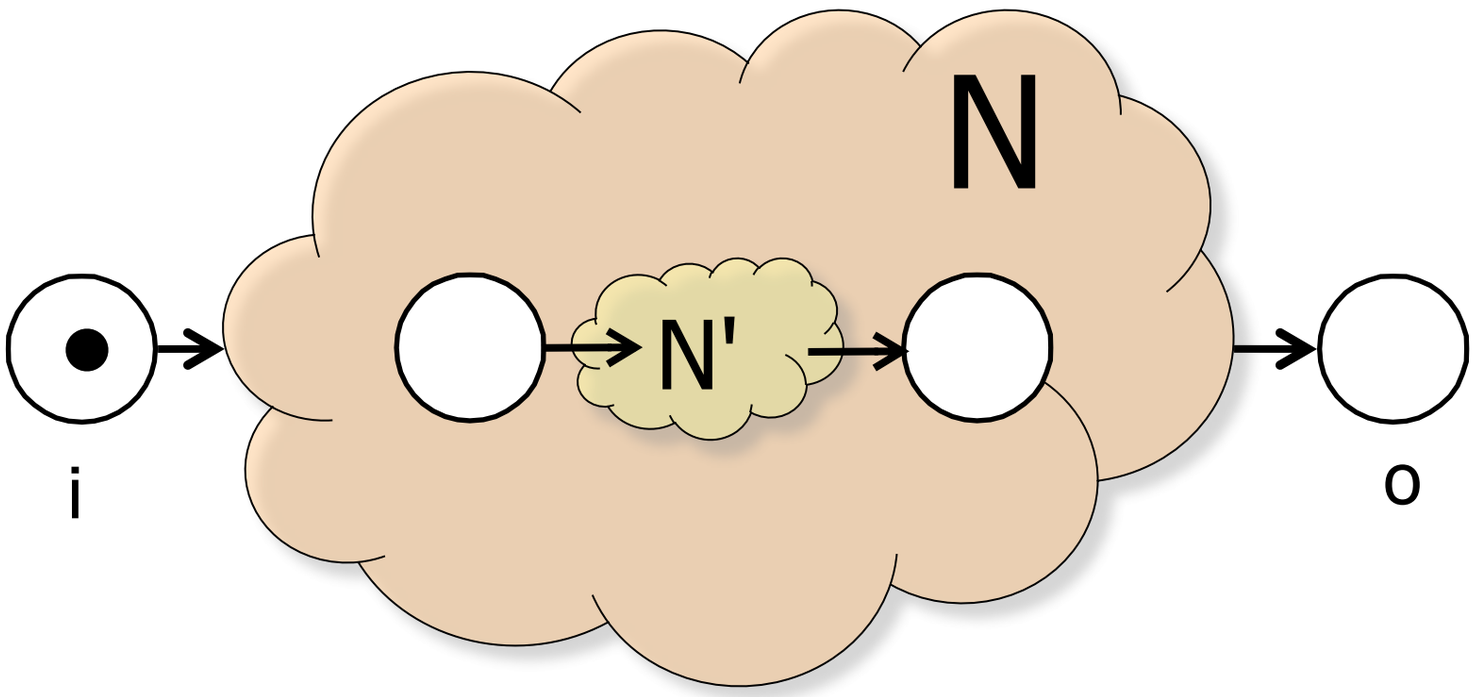
Sound and safe by composition

Let **N[N'/t]** denote the net obtained by replacing the task t in N by N'

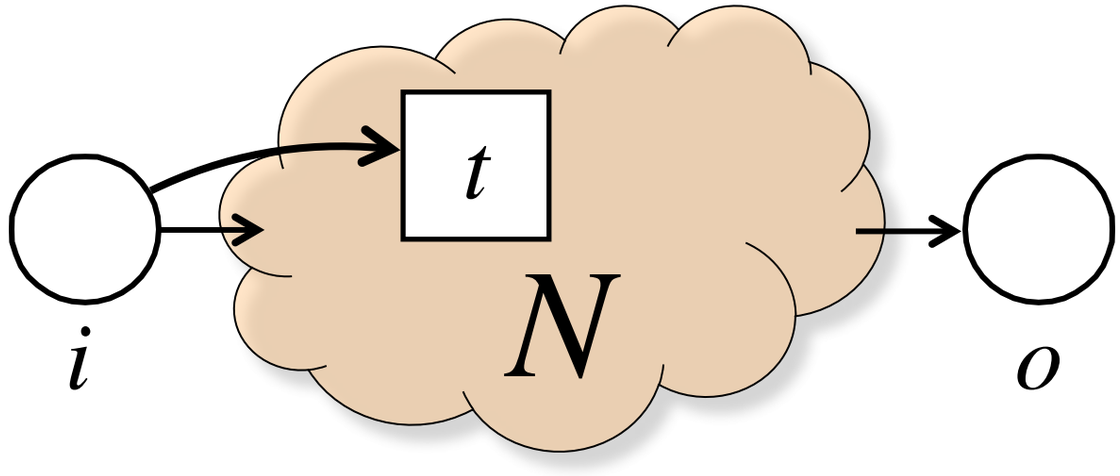


Sound and safe by composition

The net **N[N'/t]** is
a **sound** and **safe workflow net**
(proof omitted)

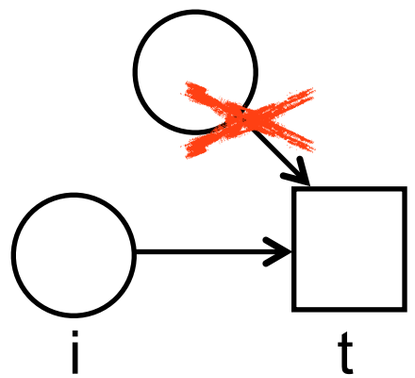


Initial transitions



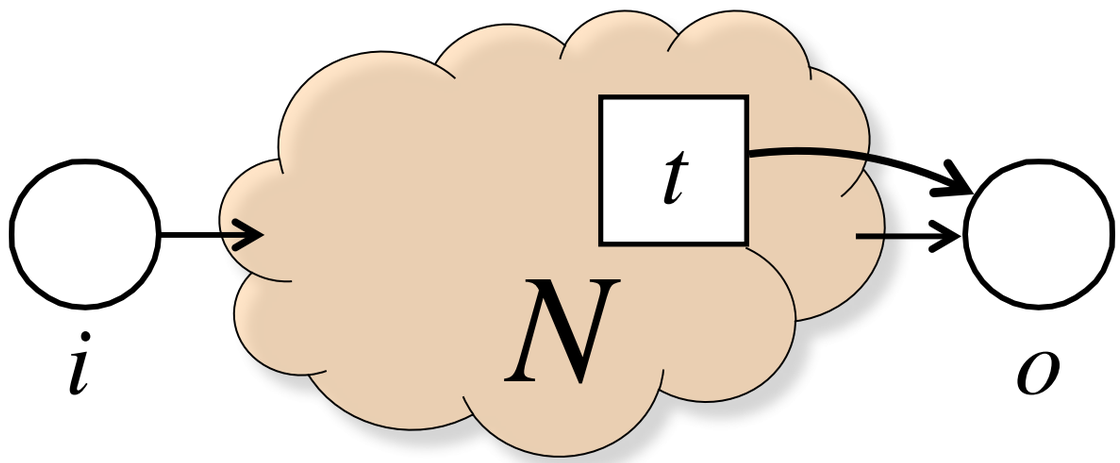
A transition t of a workflow net N is called initial if there is an arc from the initial place i to the transition t

Lemma: Let N be a sound WF net.
If the transition t is initial then $\bullet t = \{i\}$



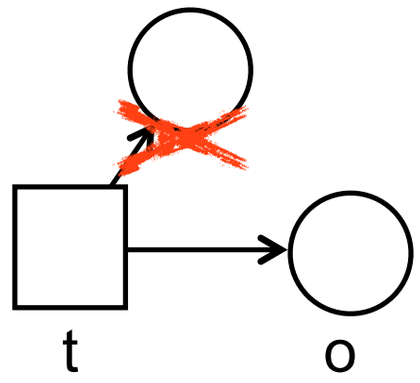
(otherwise t would be a dead transition)

Final transitions



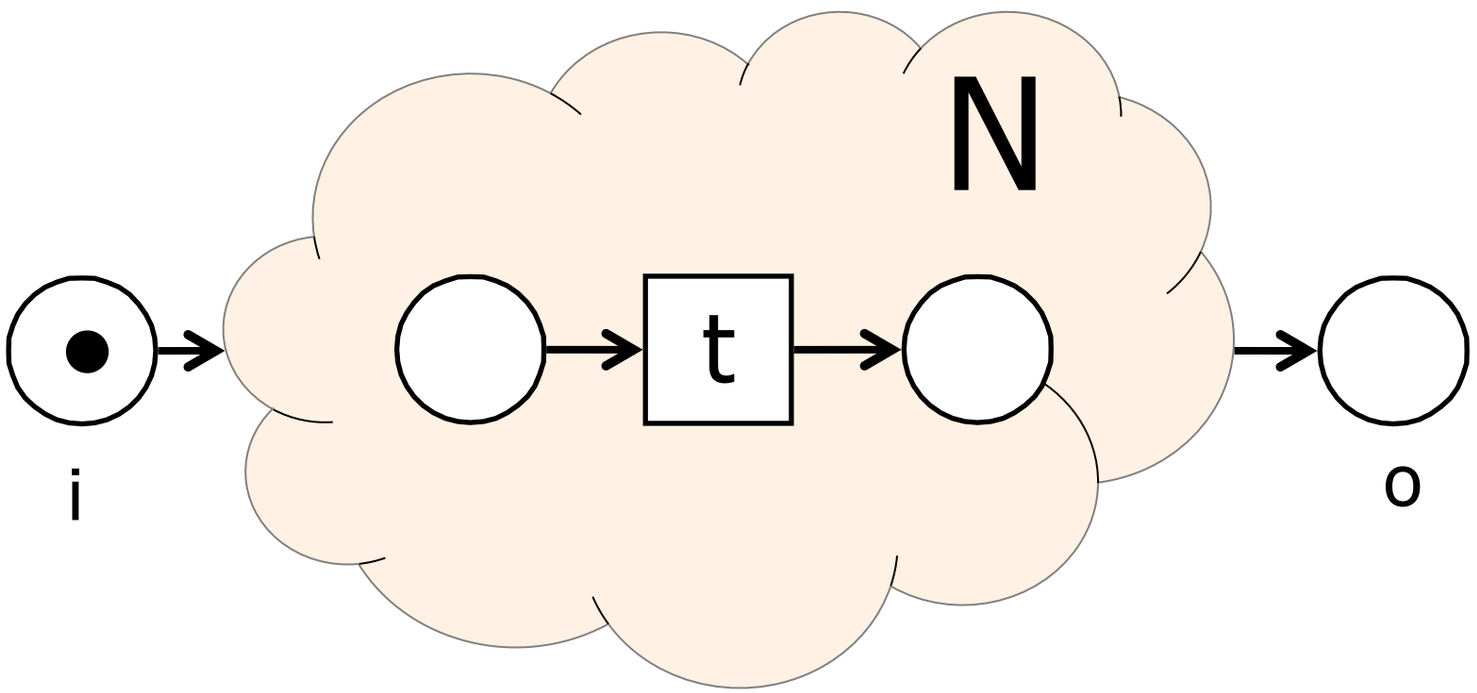
A transition t of a workflow net N is called final
if there is an arc from the transition t to the final place o

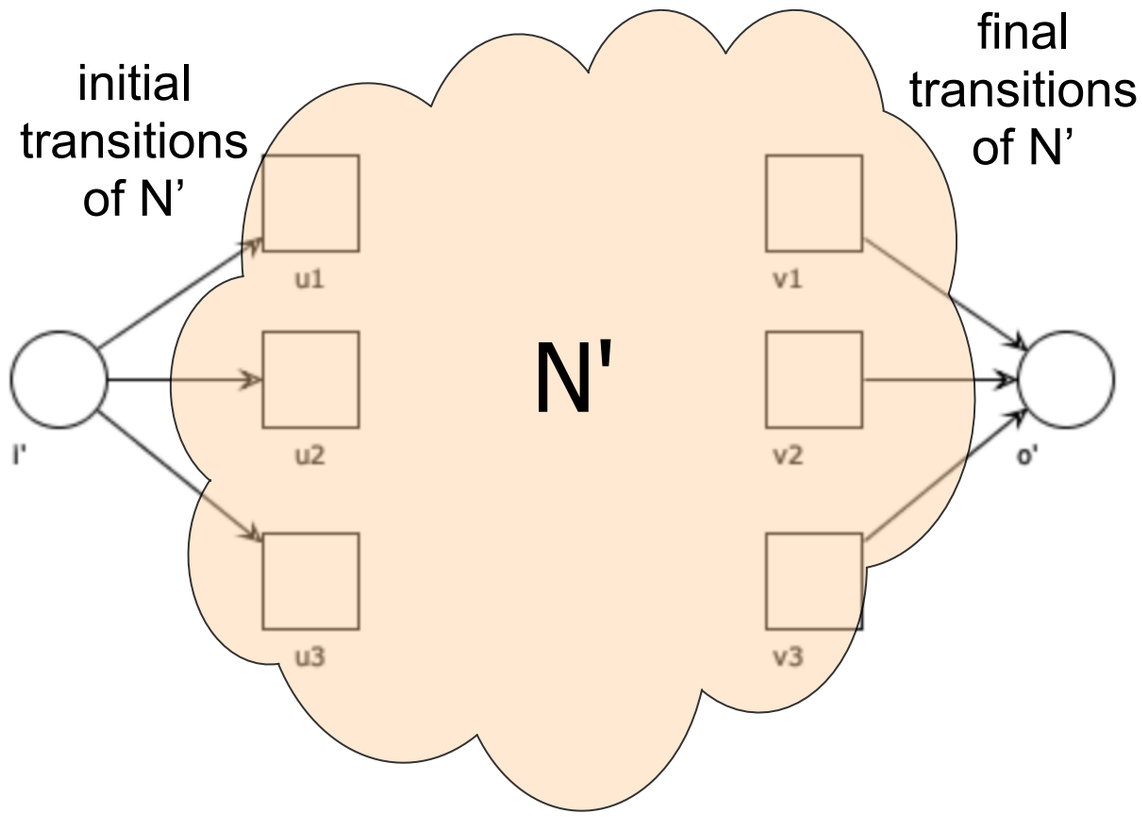
Lemma: Let N be a sound WF net.
If the transition t is final then $t\bullet = \{o\}$



(otherwise t would be dead or proper completion would not hold)

Sketching the idea





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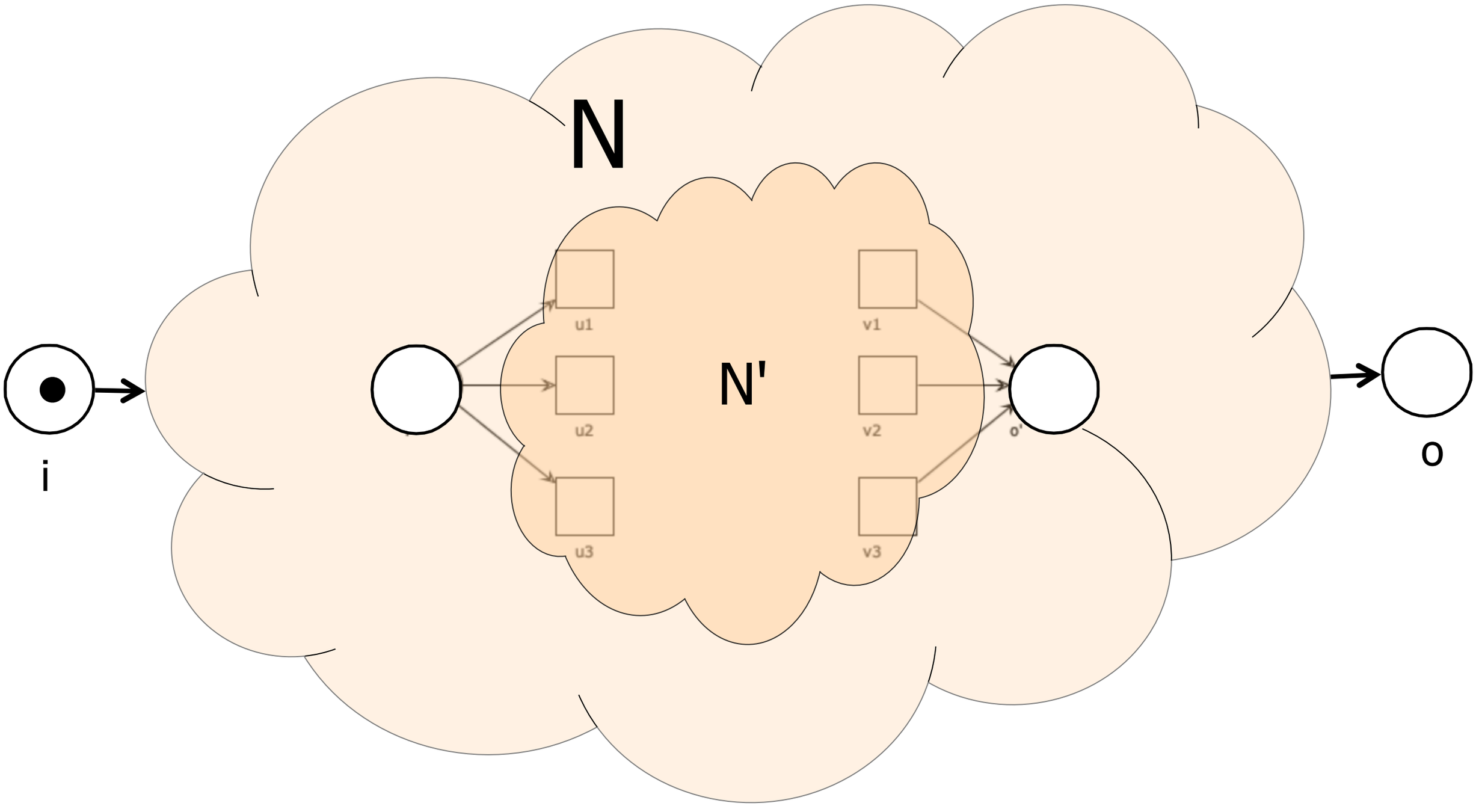


Proof sketch

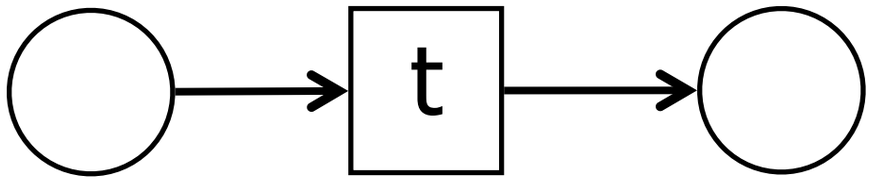
Intuitively

a sound workflow net behaves as a transition:
it takes one token from its input place and
it produces one token to its output place
(but not atomically)

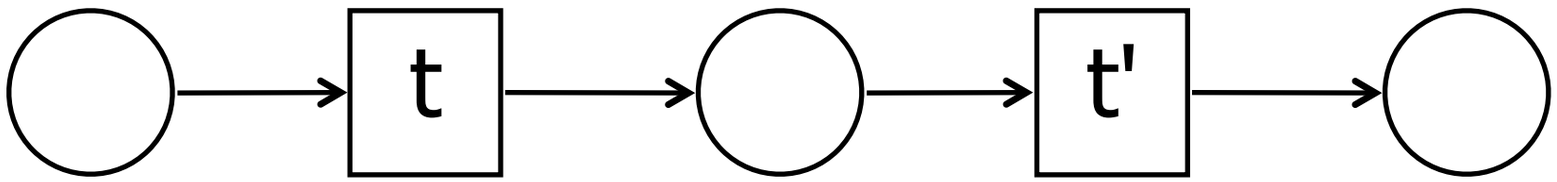
Formally

the crux of the proof is showing a bijective correspondence between
markings of the composed net N[N'/t]
and the pairs of markings in N and N'

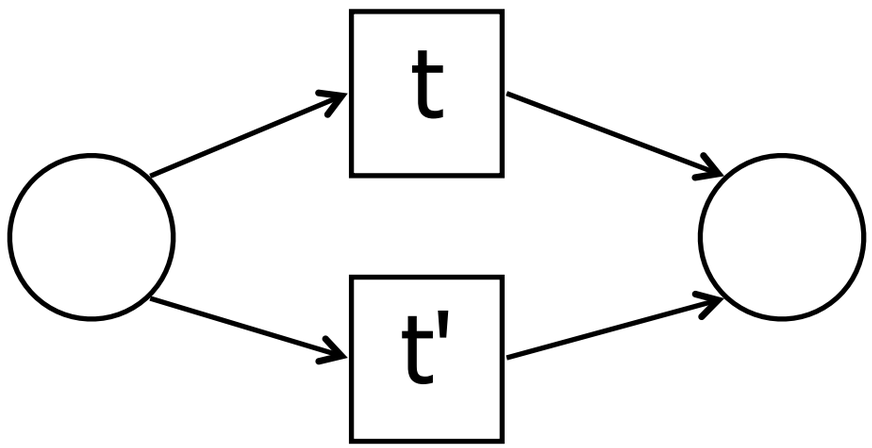
Some Building Blocks 1



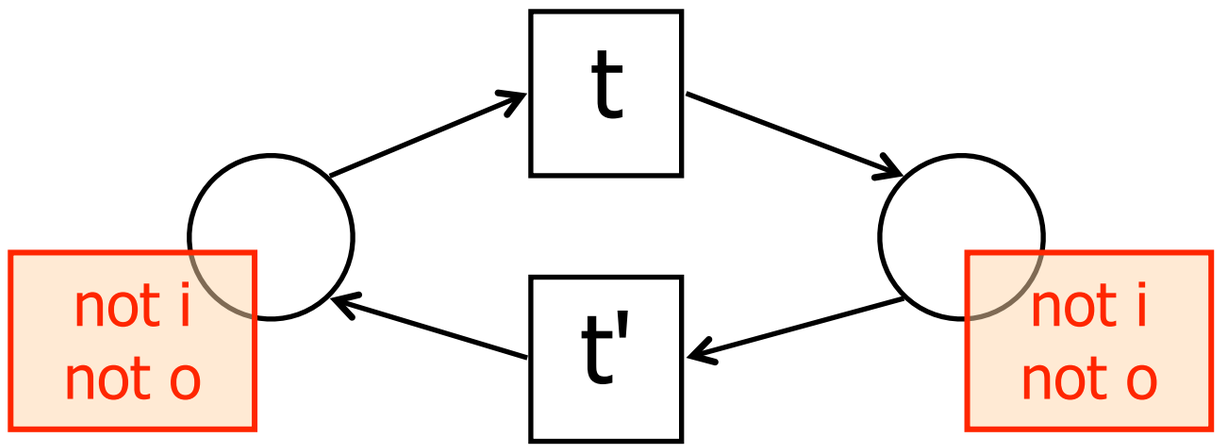
basic



sequence

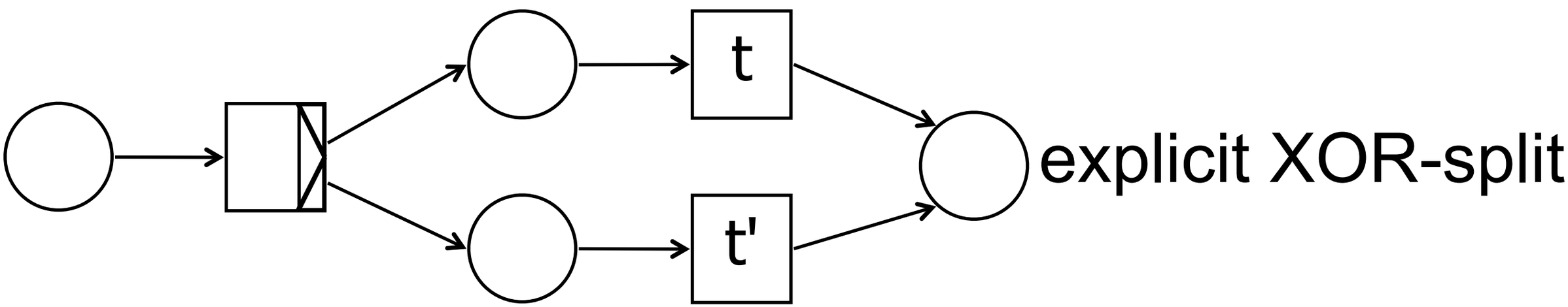


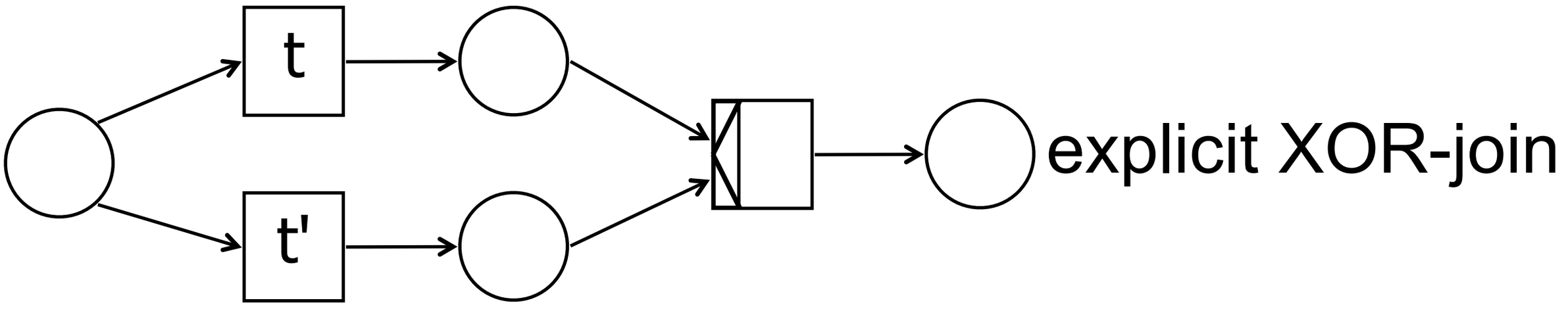
implicit XOR



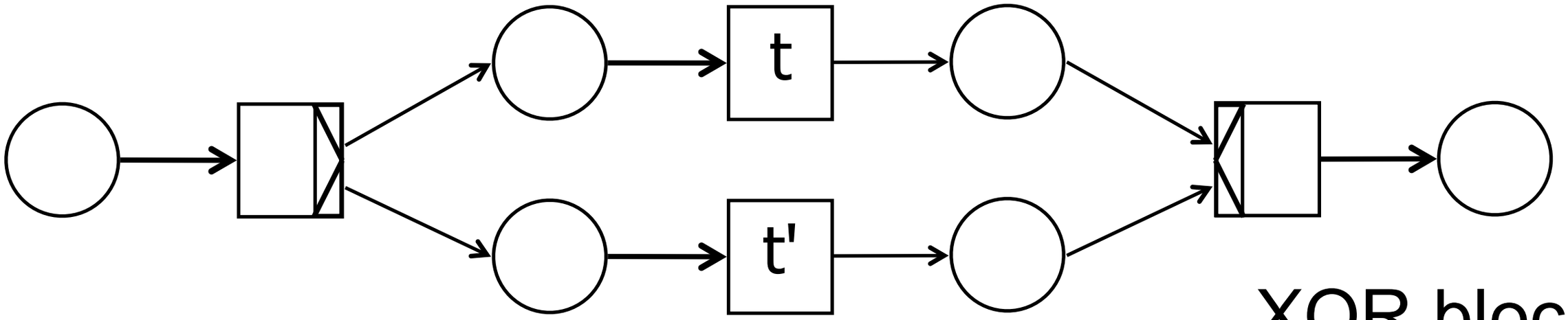
iteration

Some Building Blocks 2



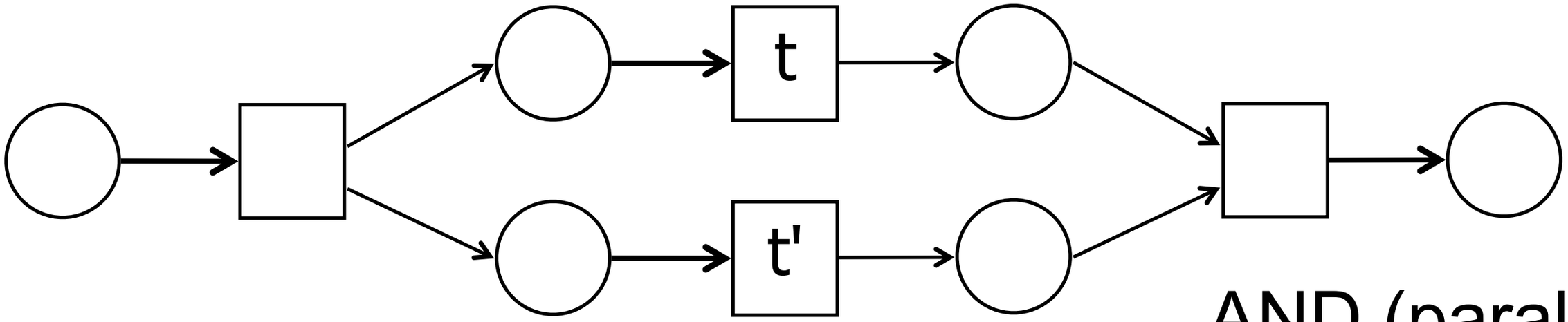


Some Building Blocks 3



XOR block

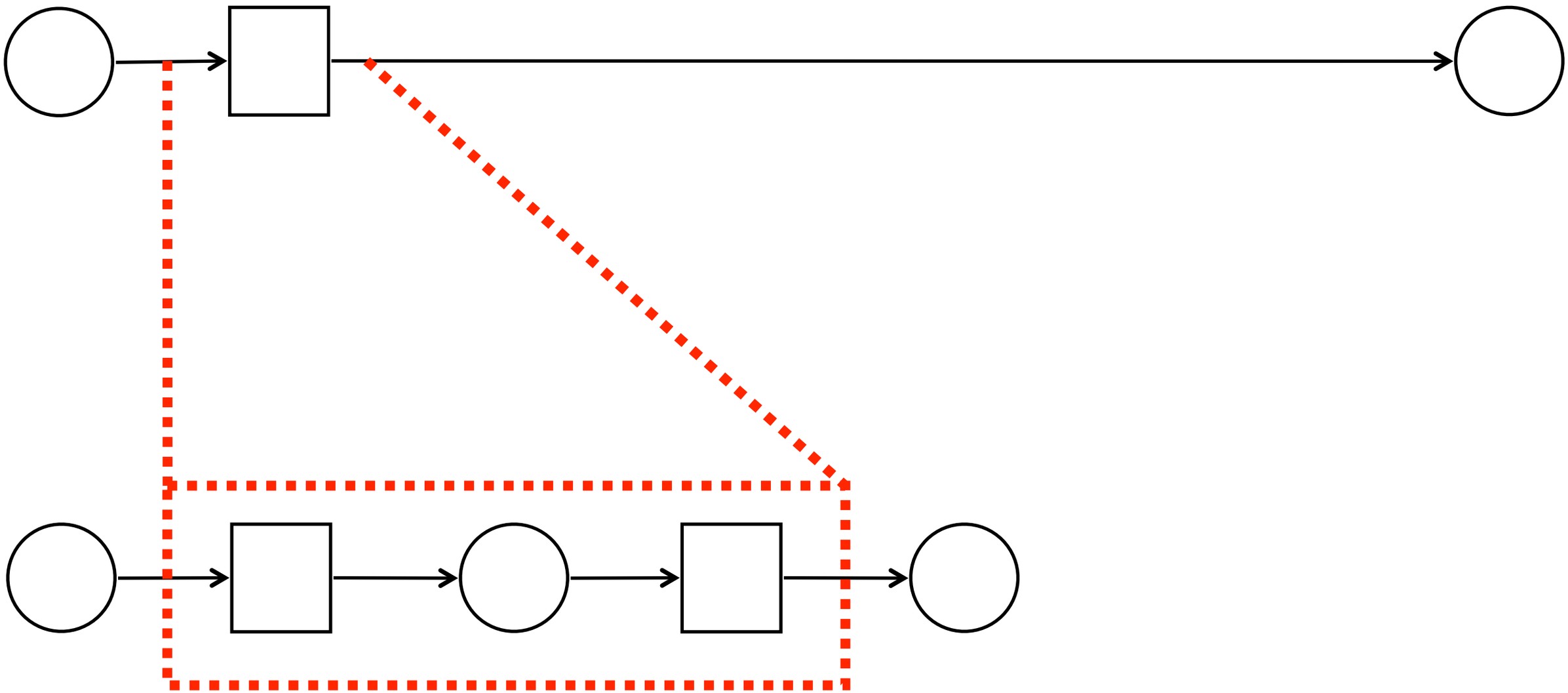
Some Building Blocks 4



AND (parallel)

But you can define more blocks on your own

Example: refinement



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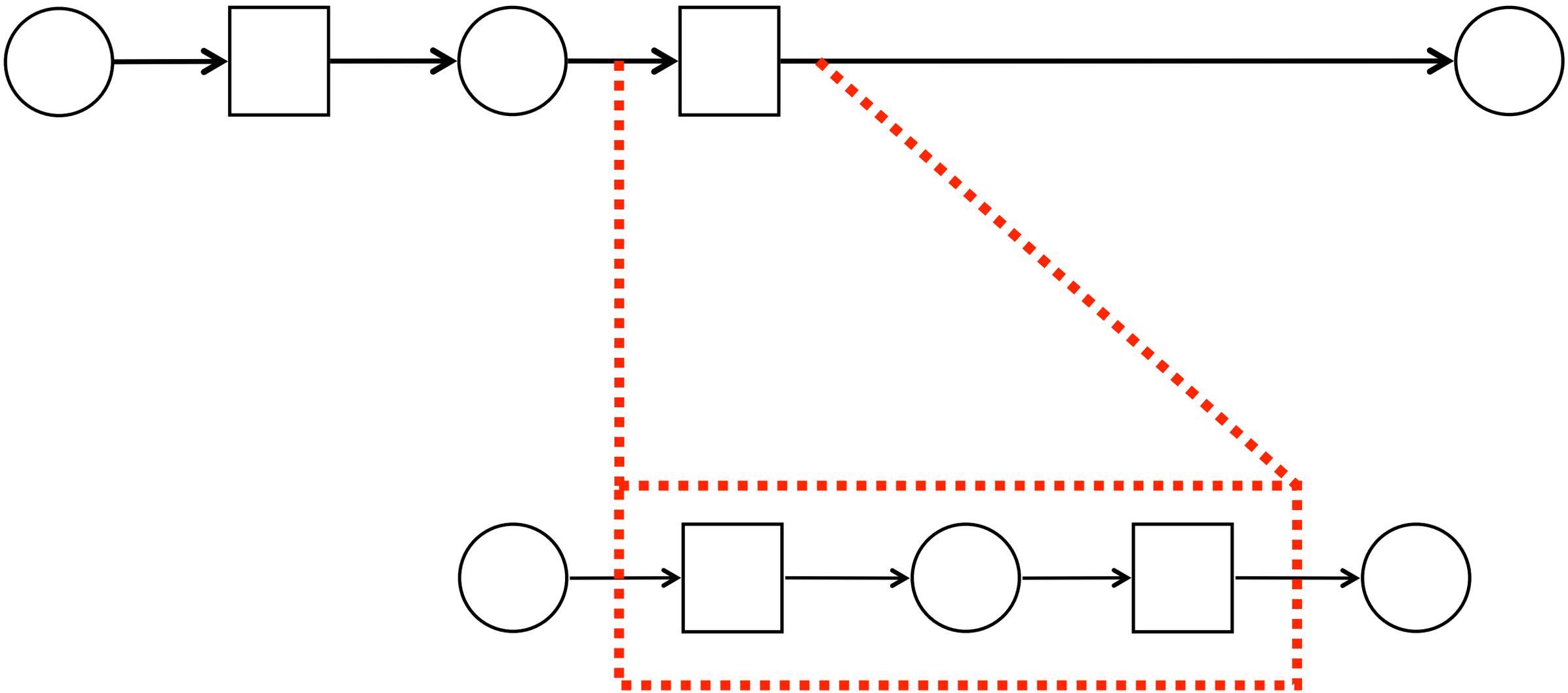

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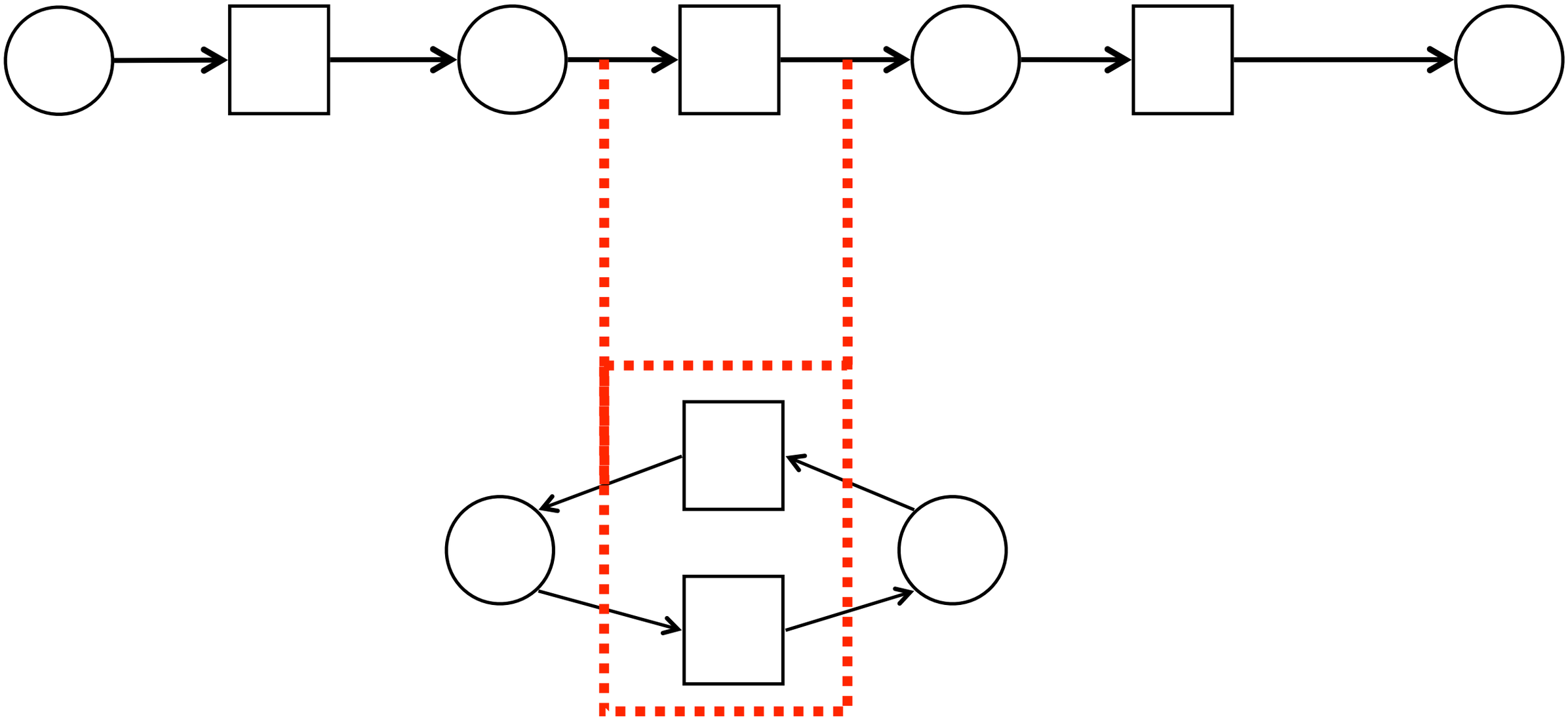

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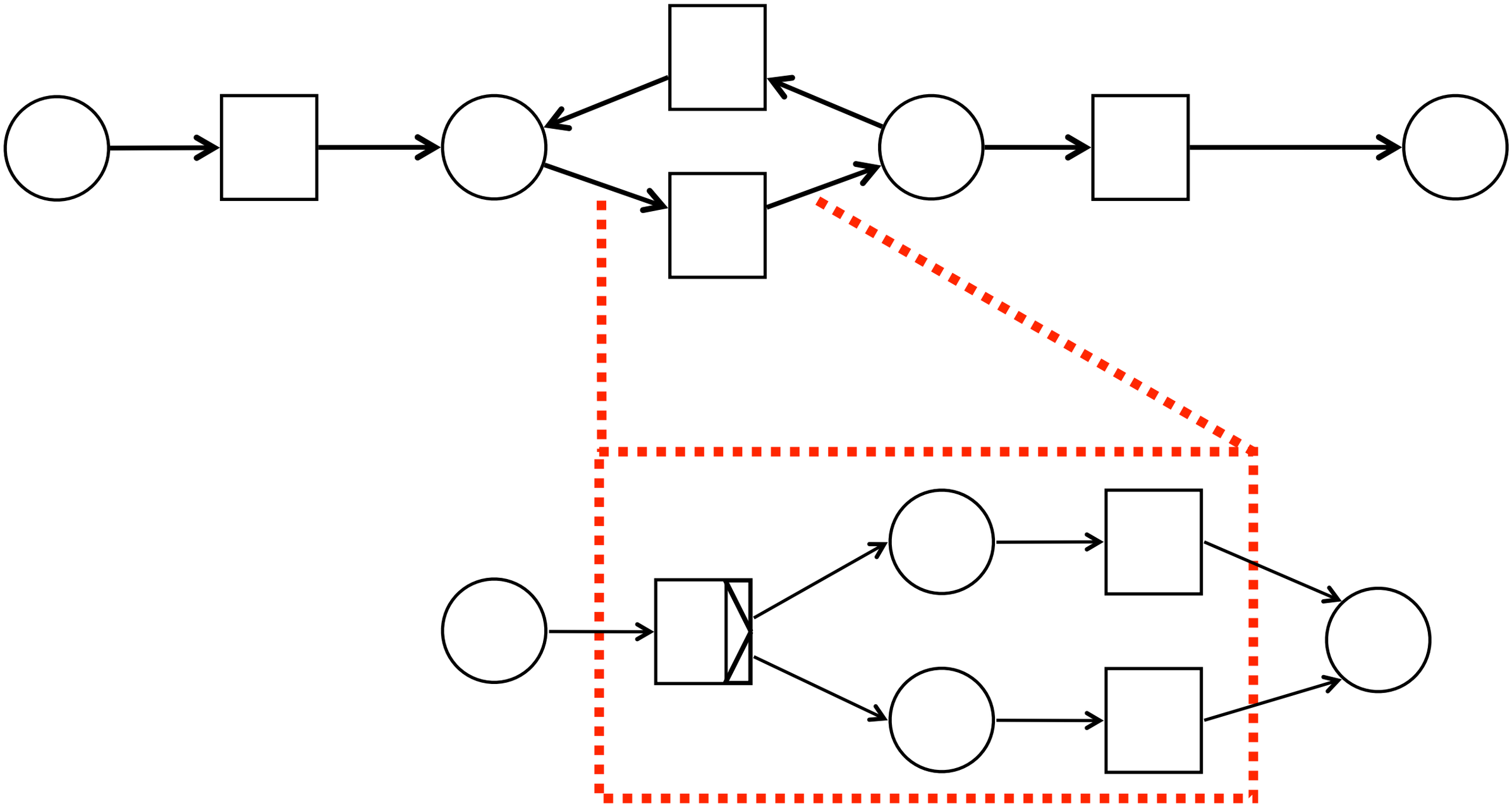

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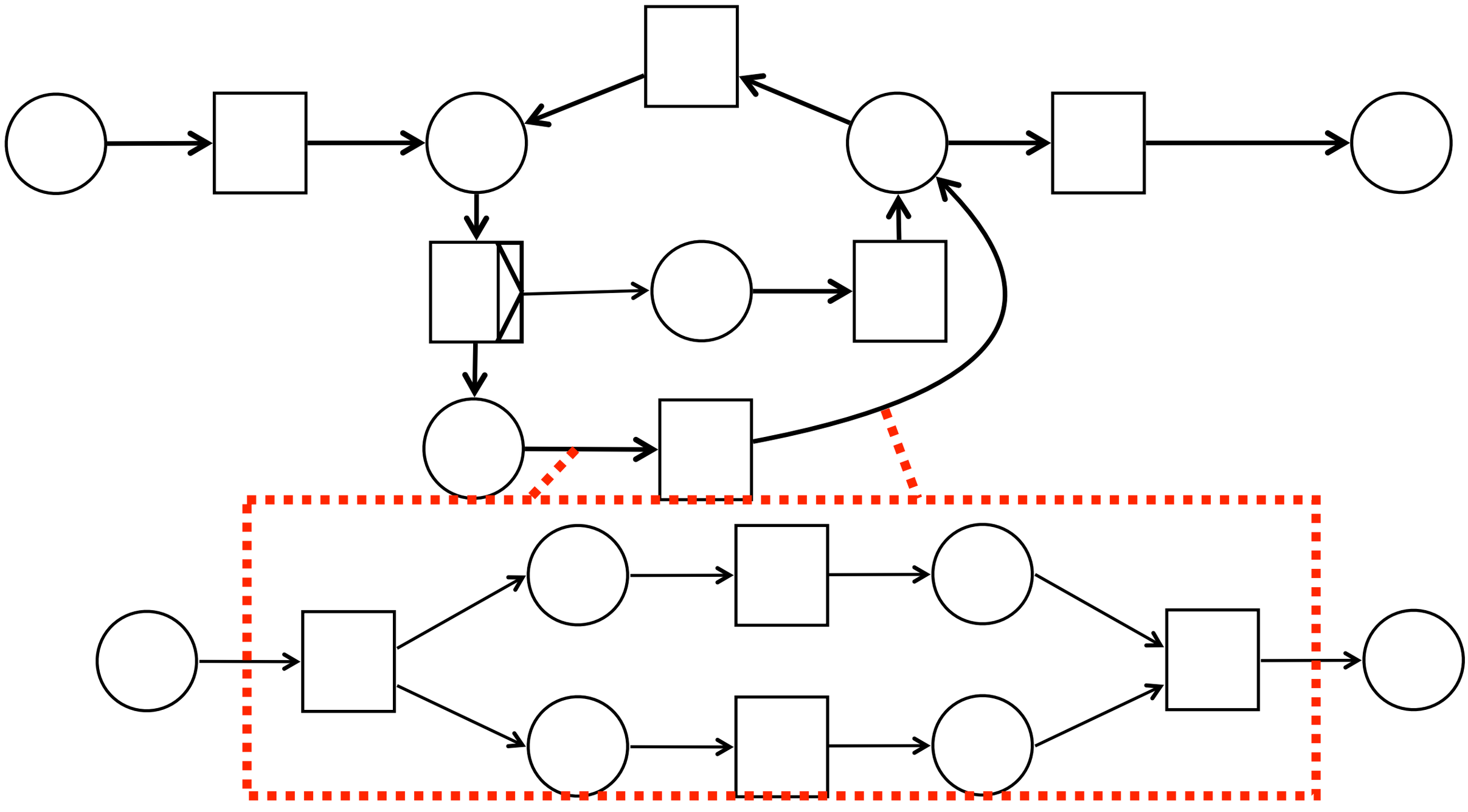

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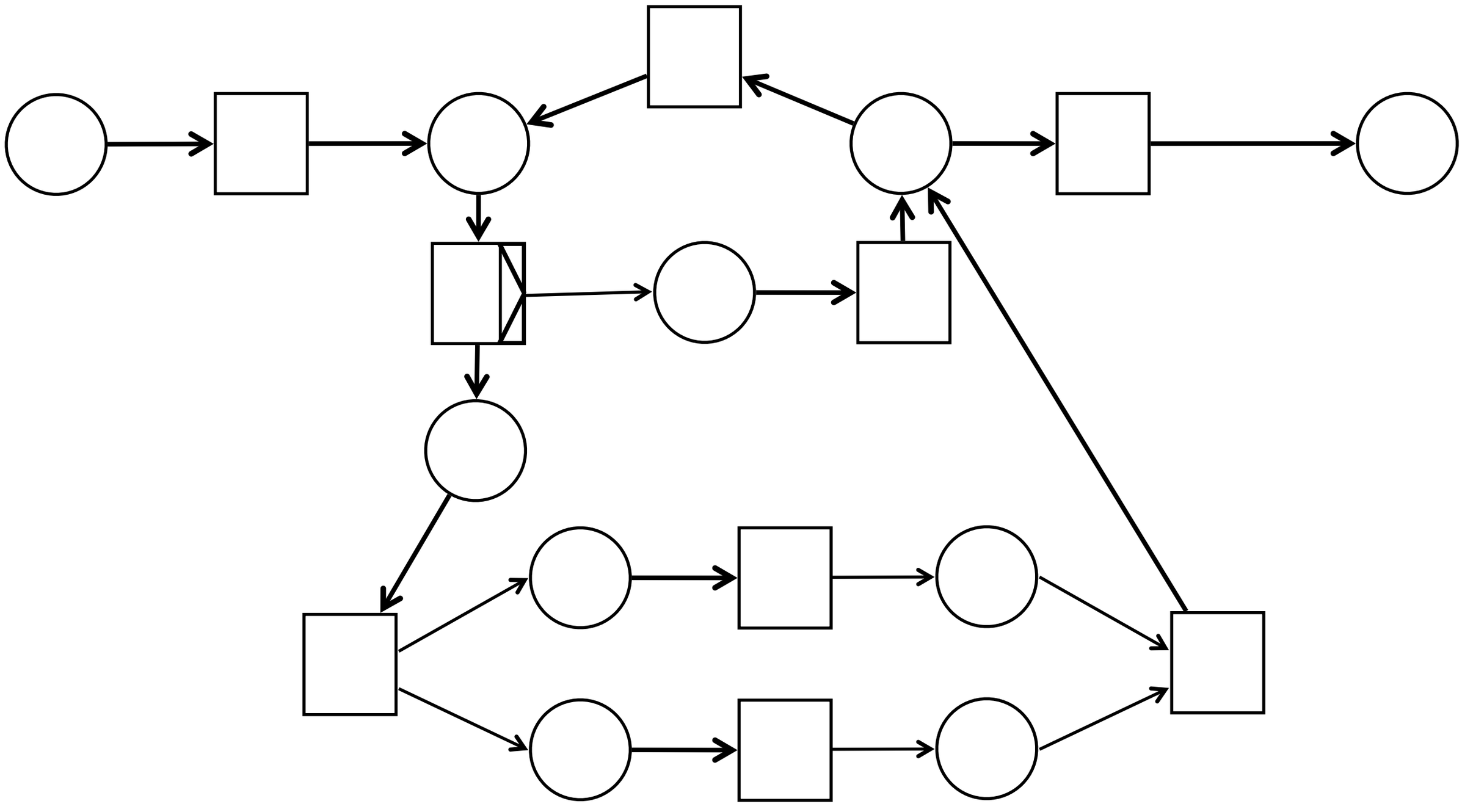
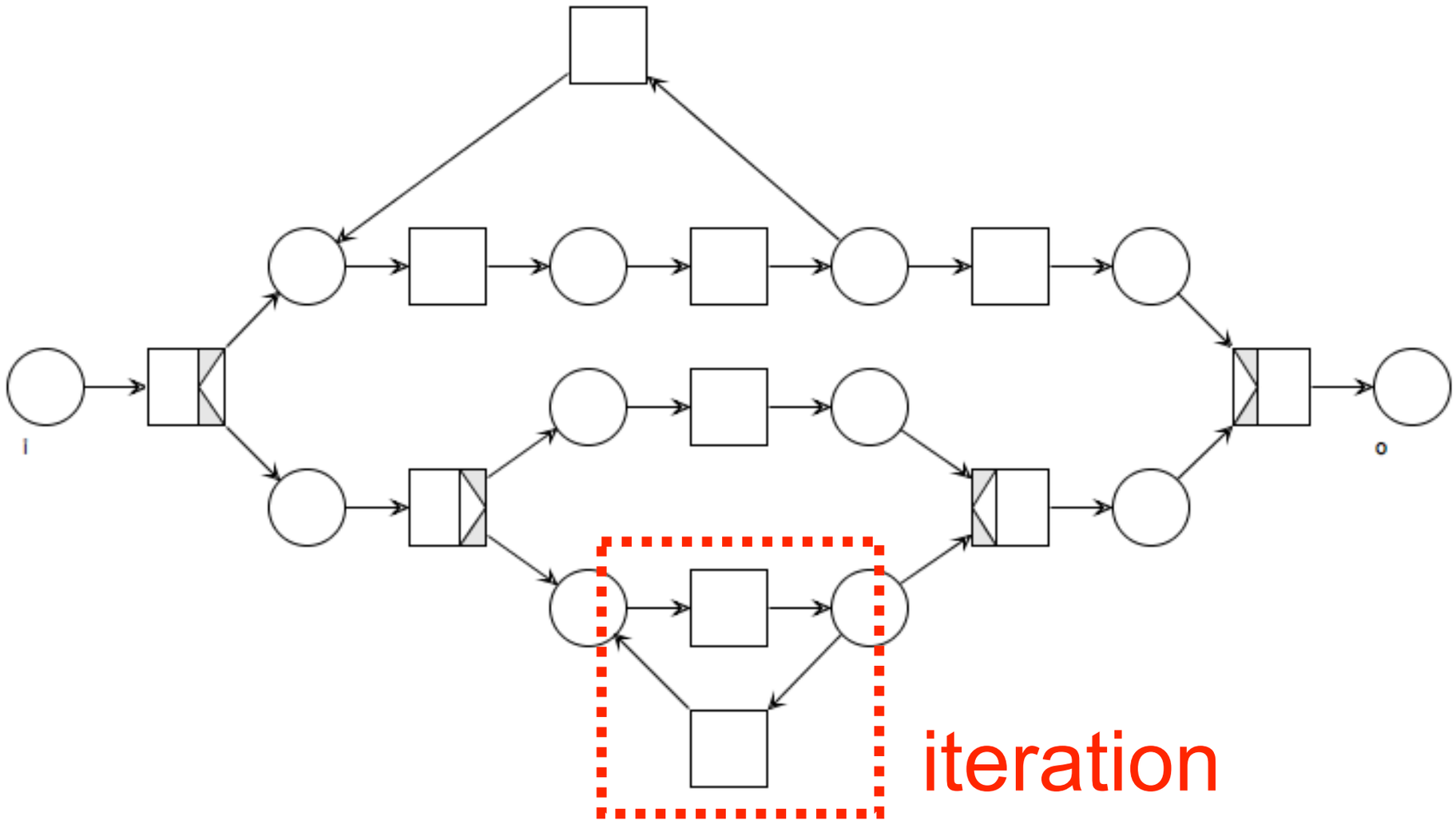


Example: abstraction

Prove that the net below is
a safe and sound workflow net



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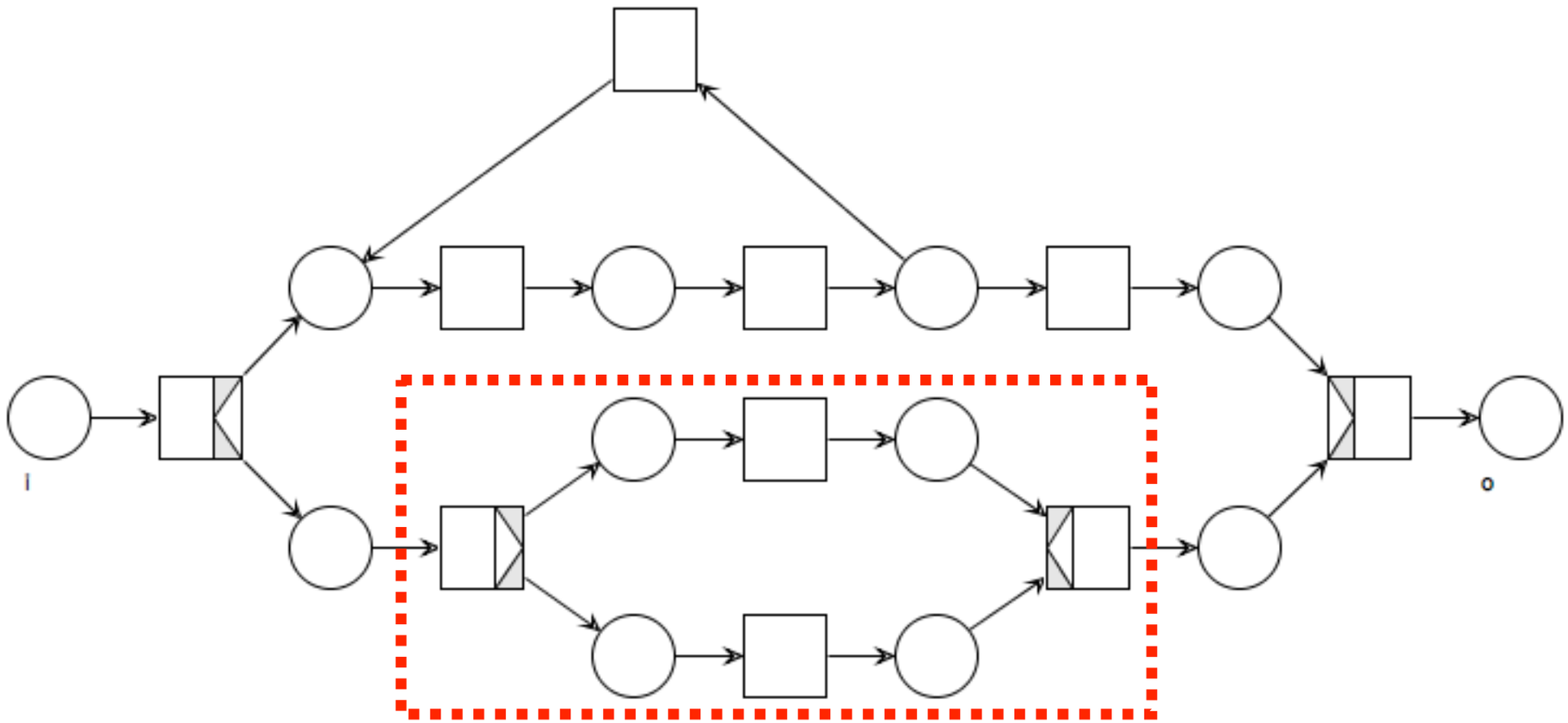

explicit XOR block

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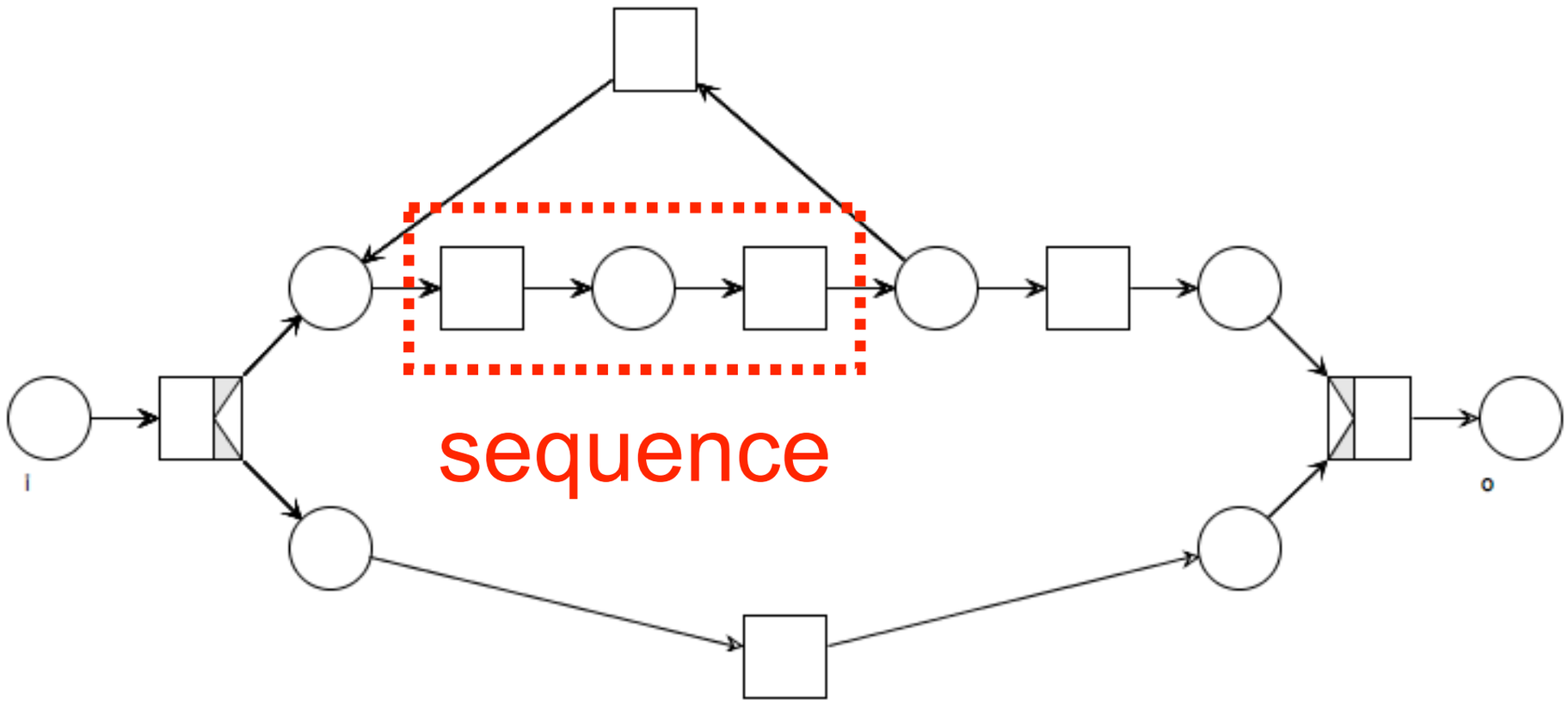

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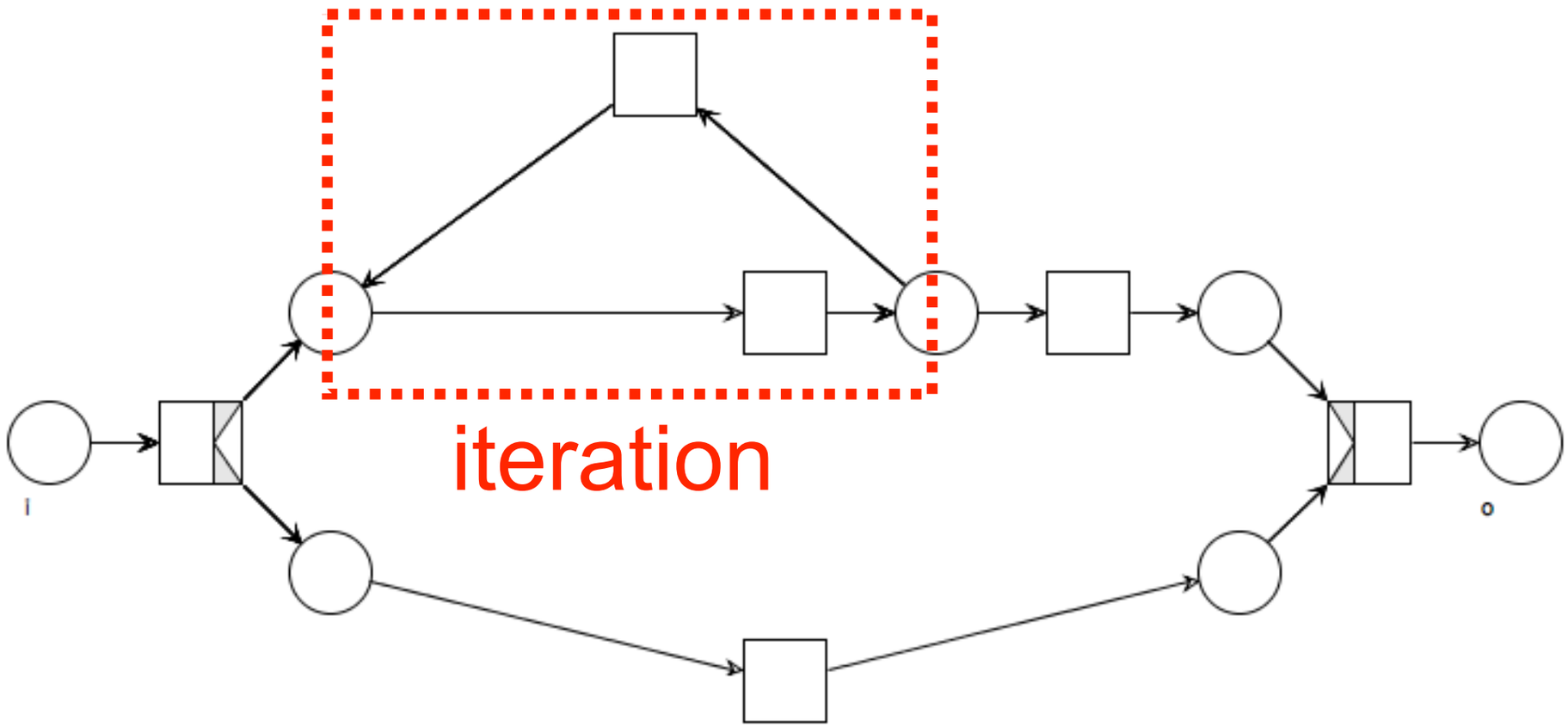

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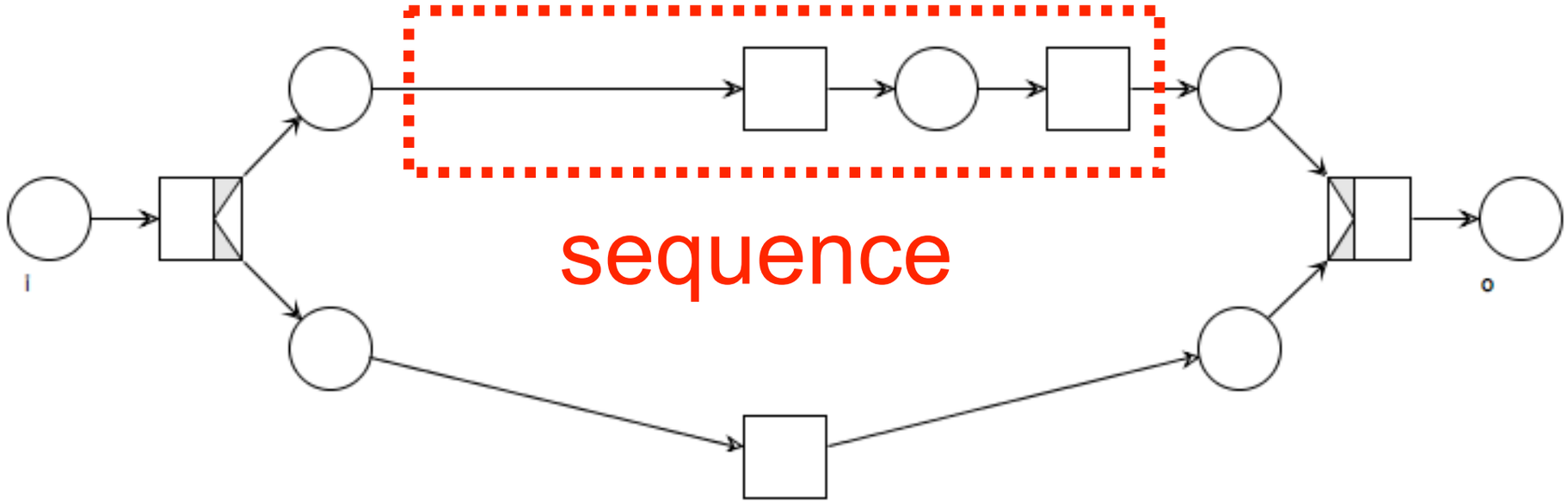

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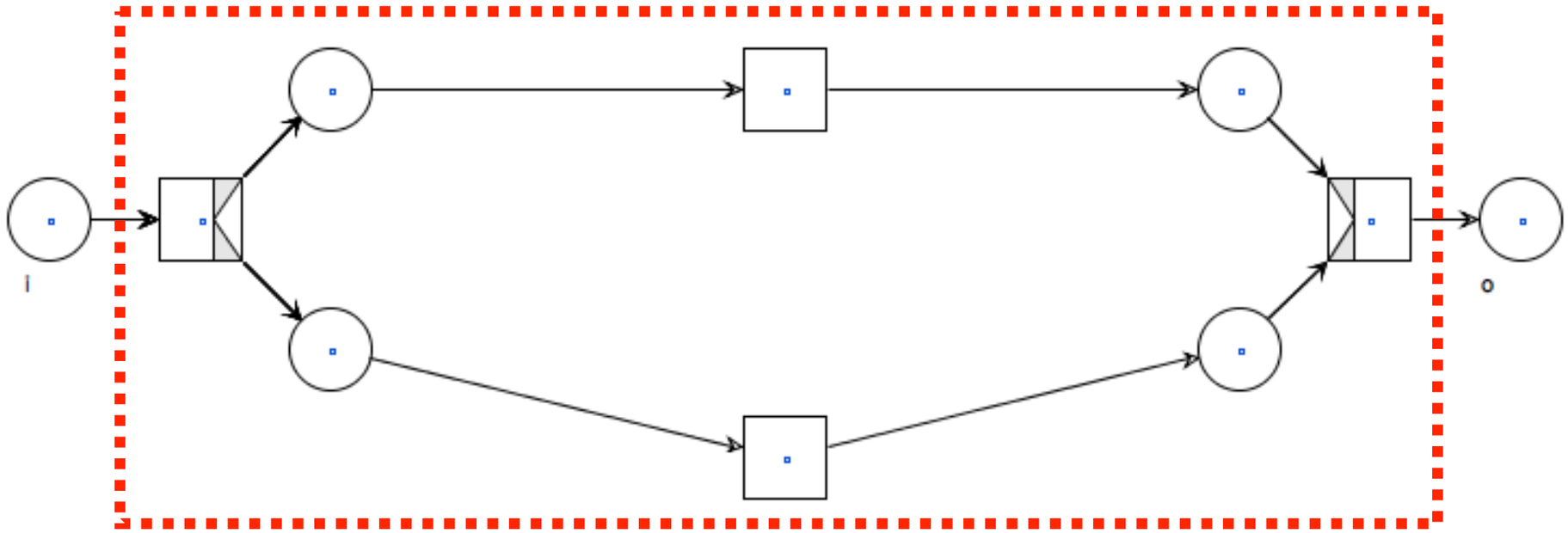

parallel (AND) block

Example: abstraction

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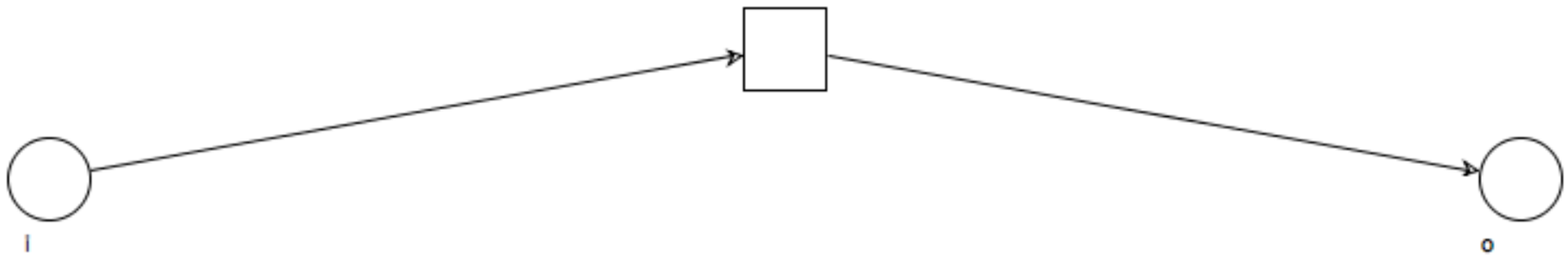
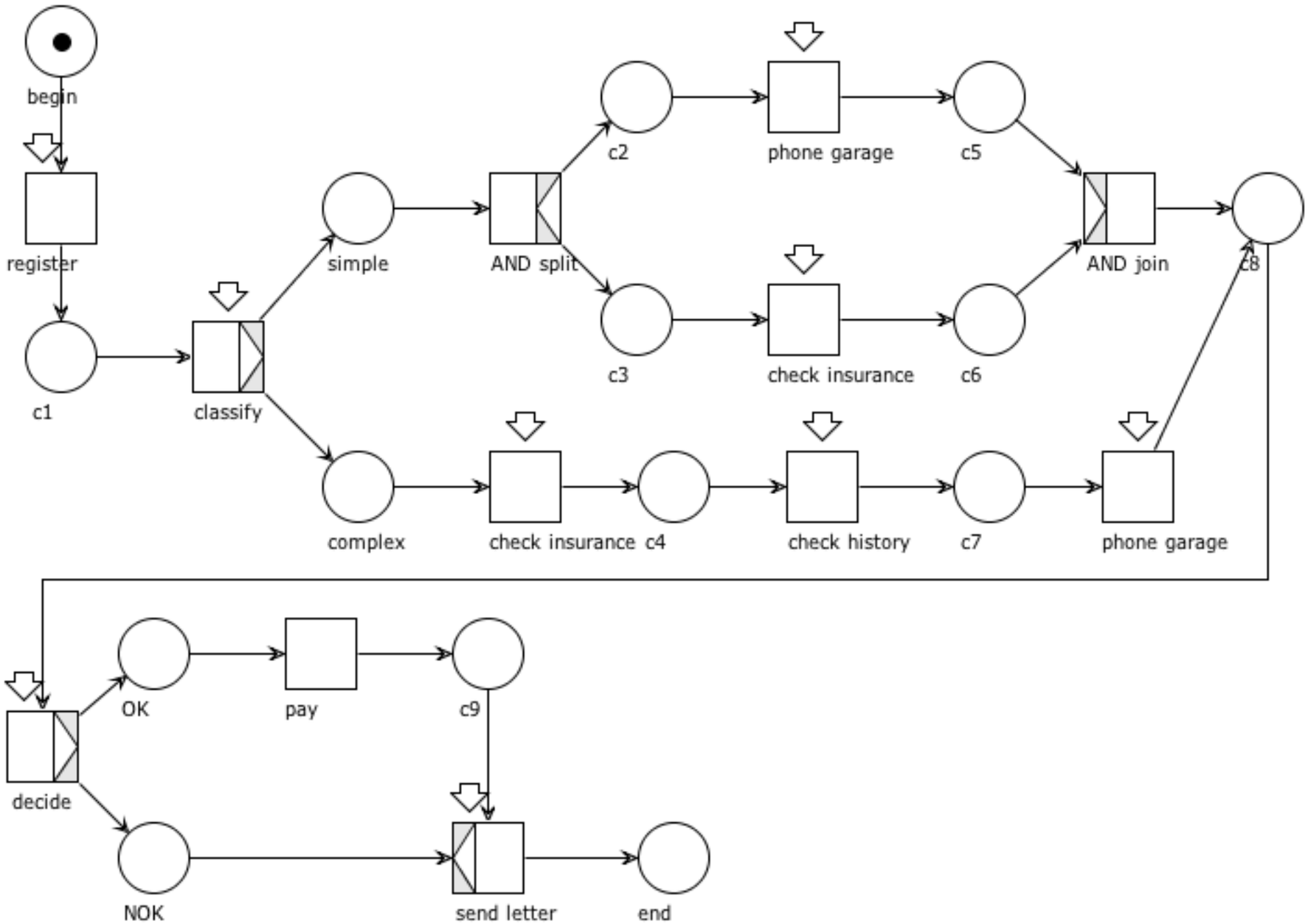


Design Example: Car Damage



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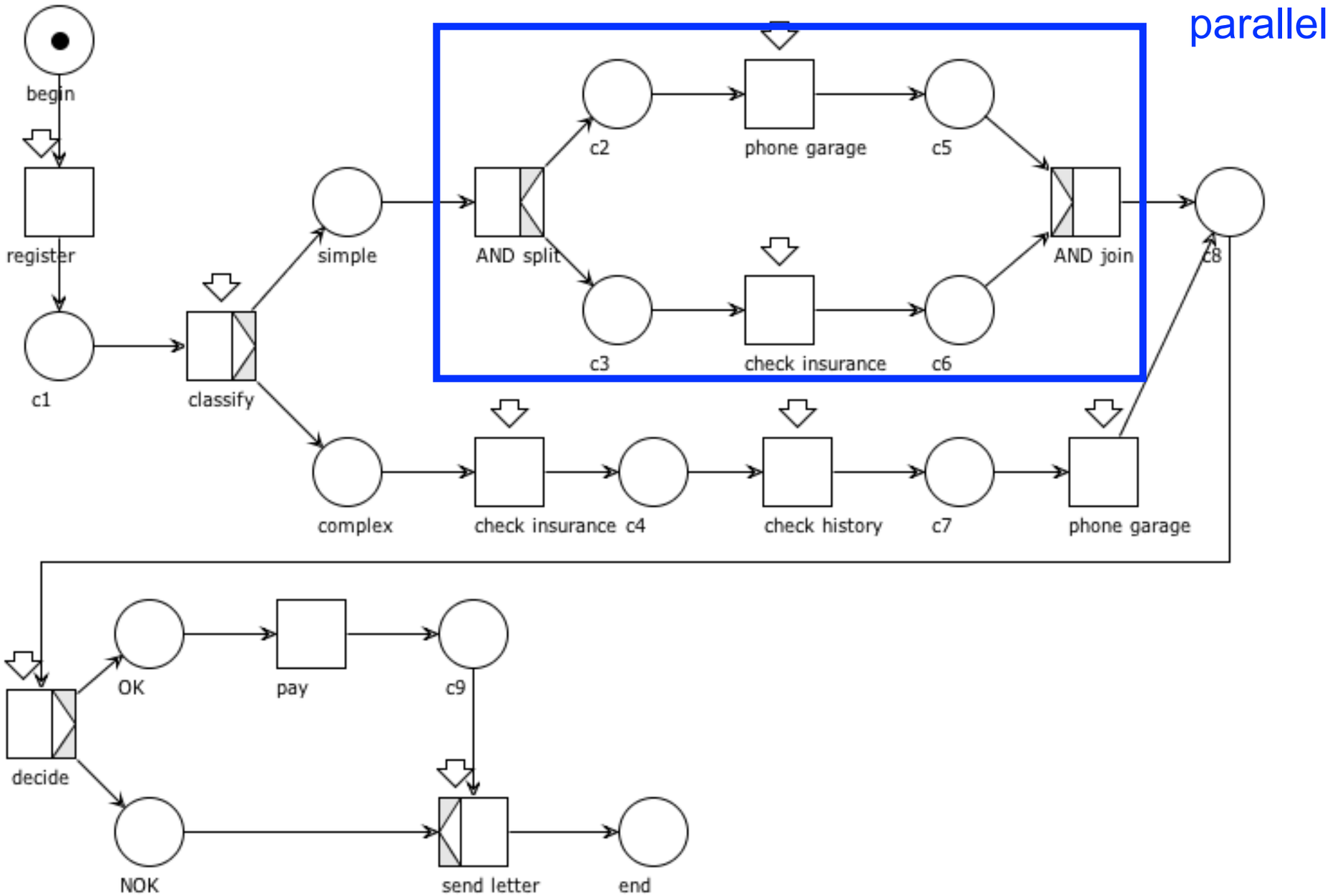

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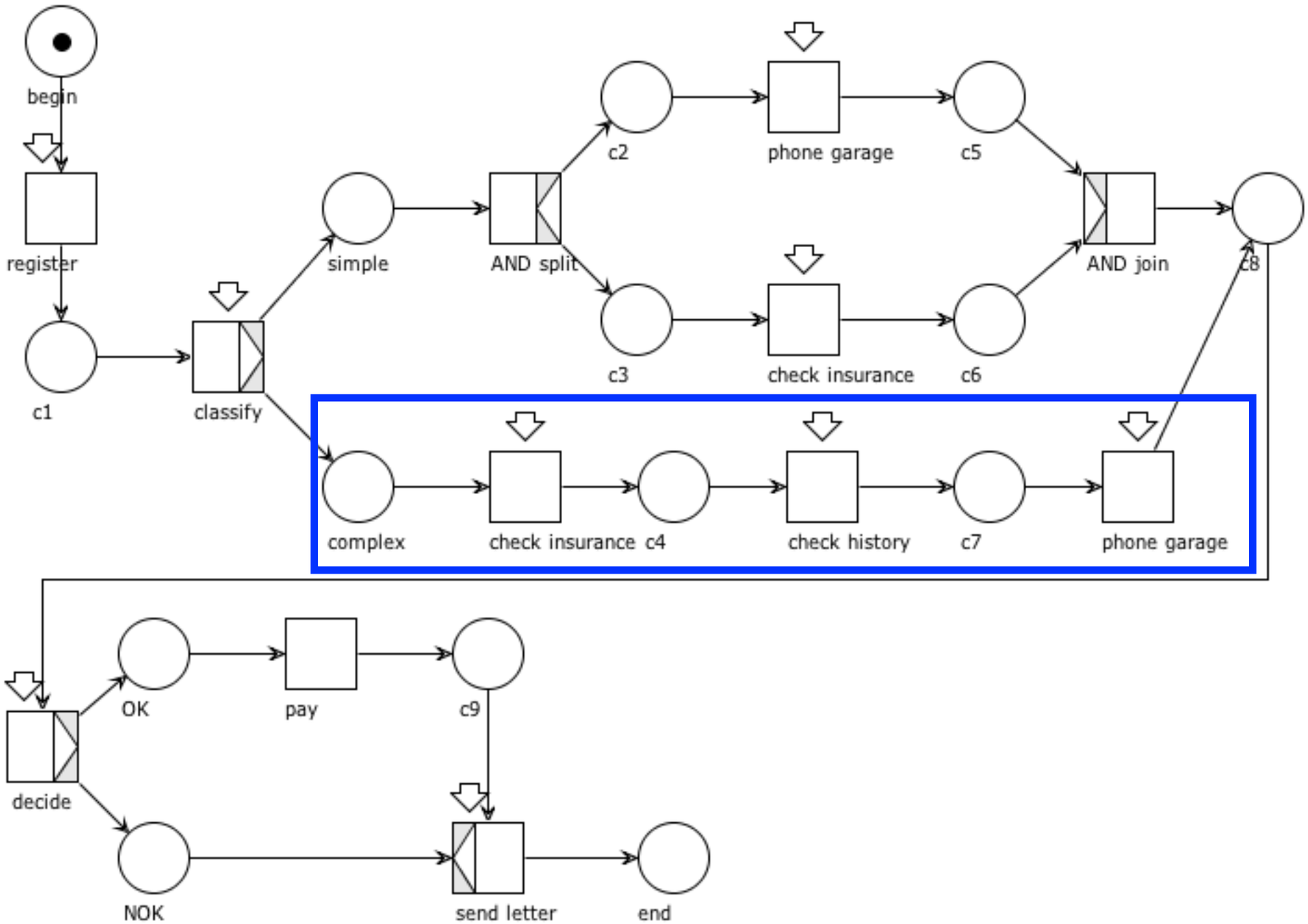

sequence

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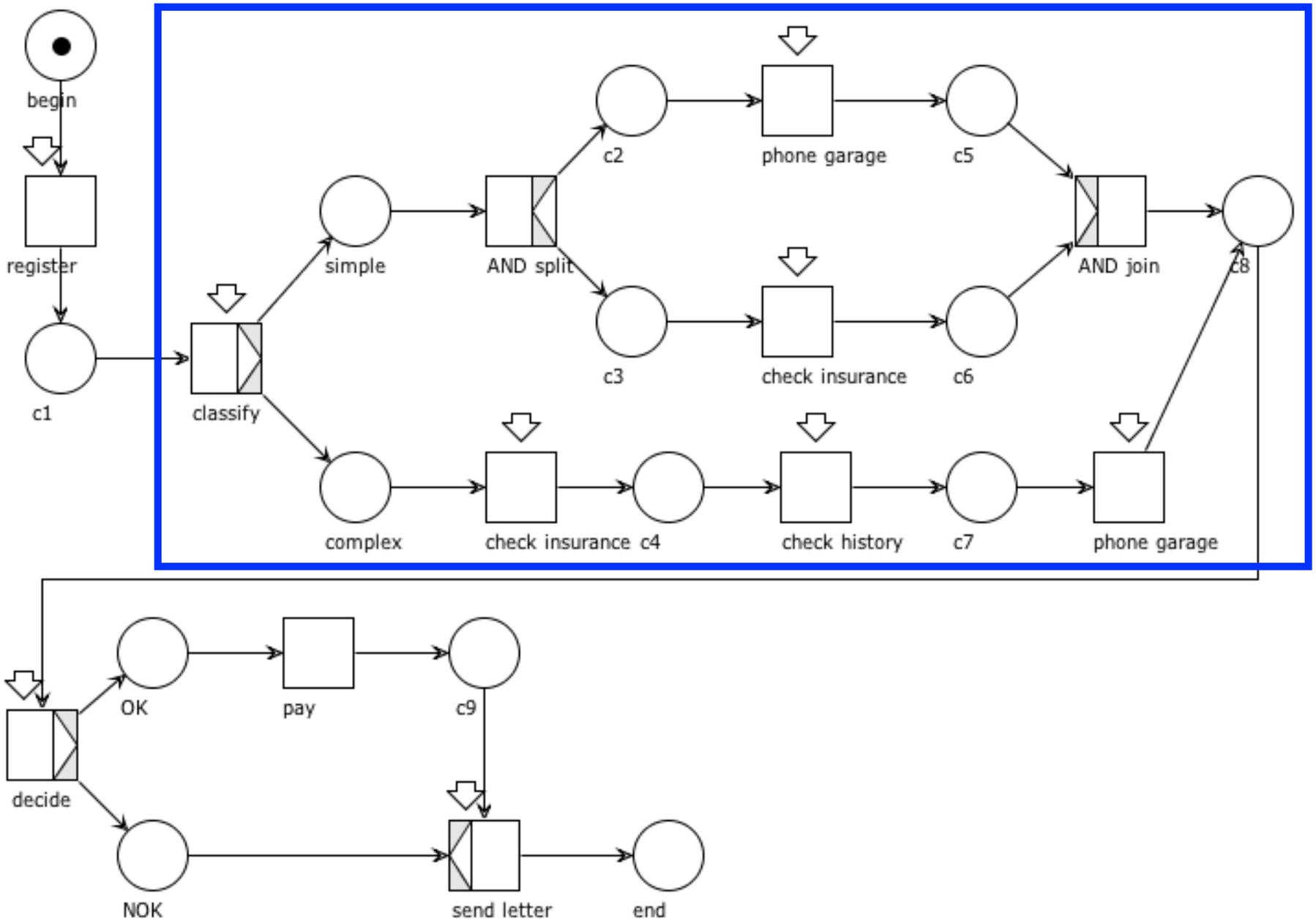

choice

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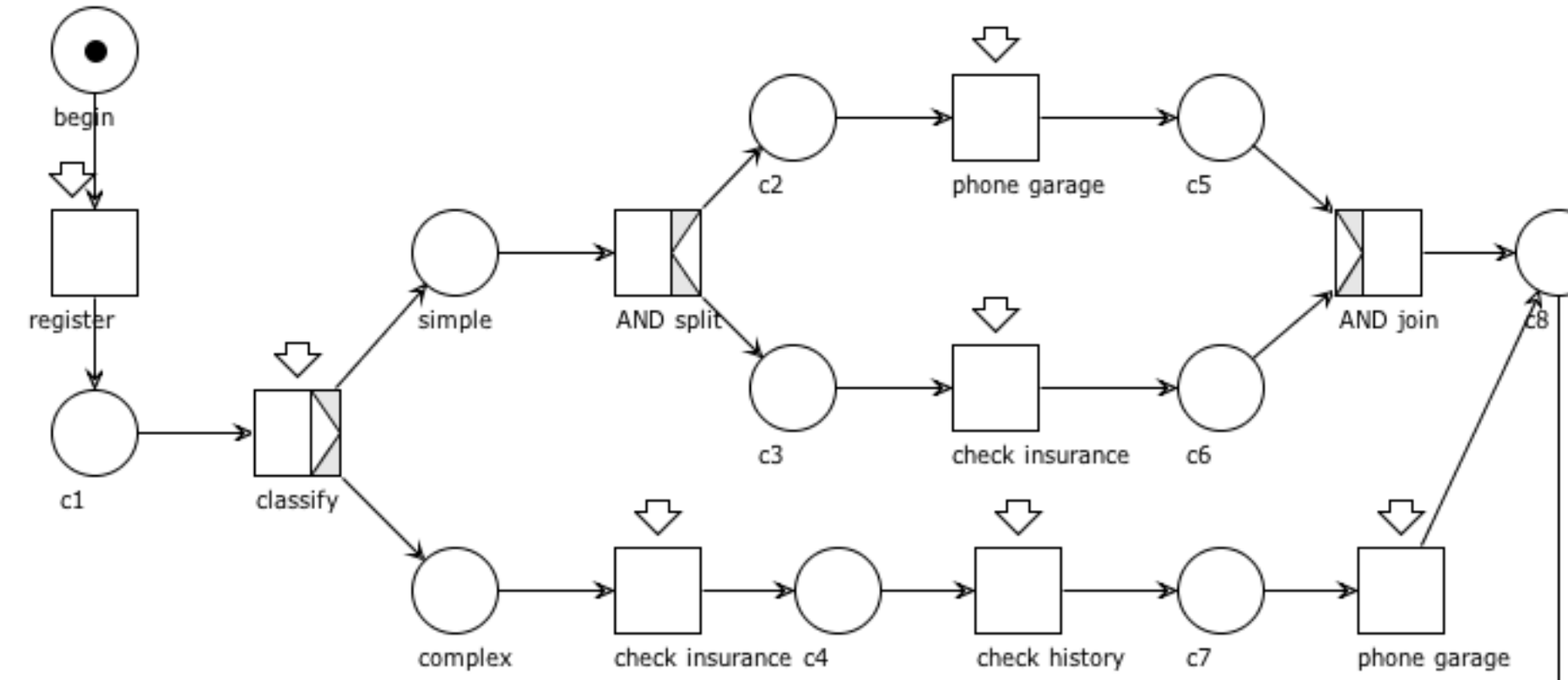

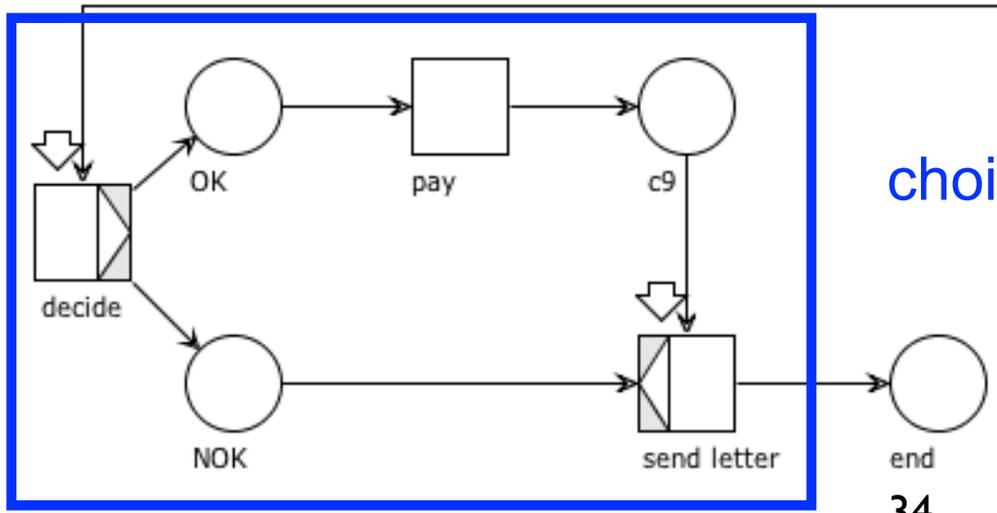

choice

Sound and safe by construction!

Exercise

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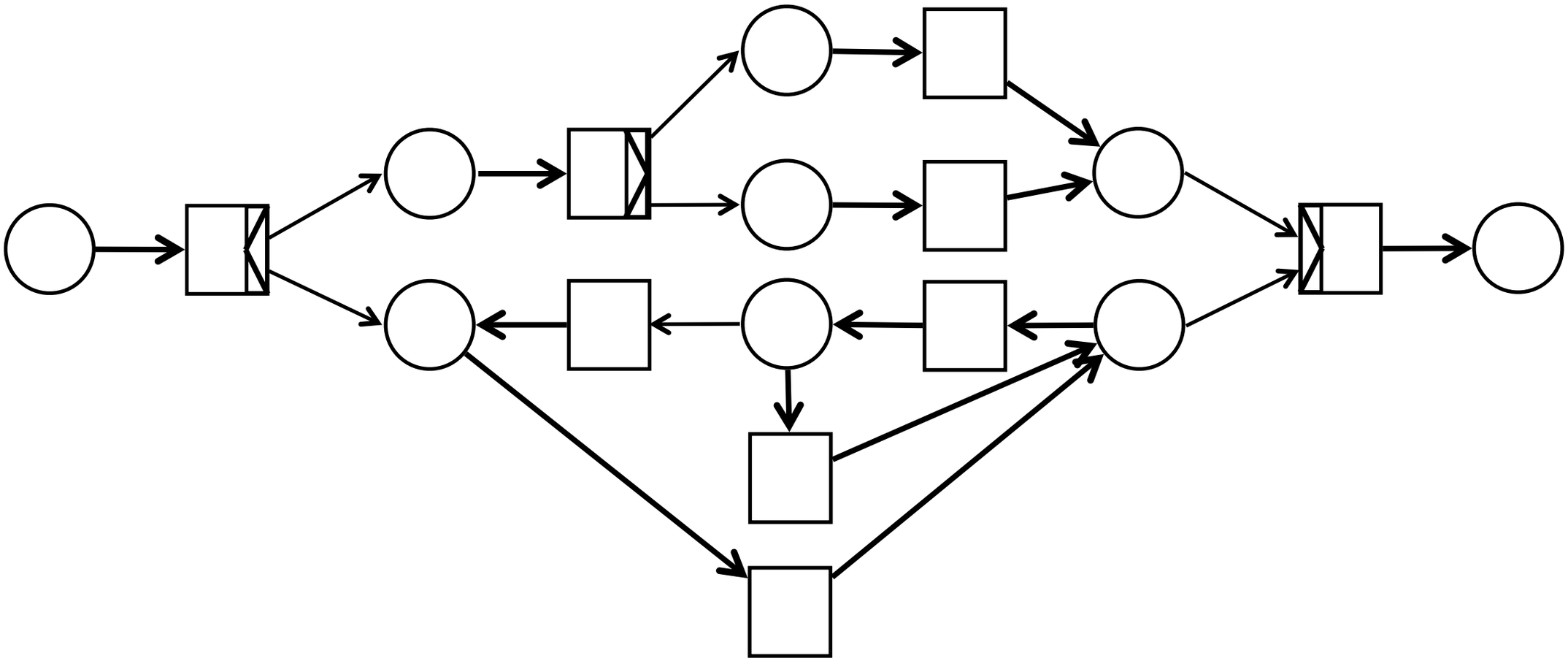
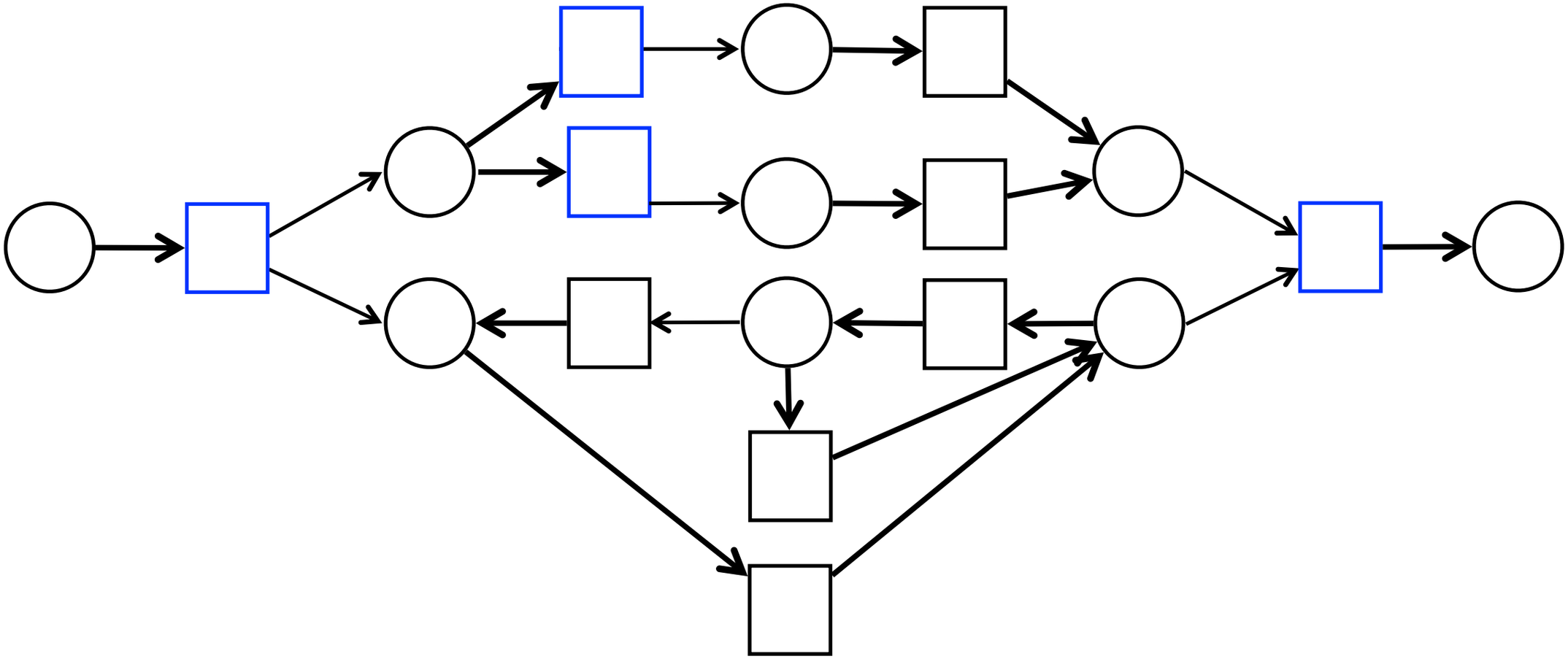


Exercise

Prove that the desugarized net below is a safe and sound workflow net



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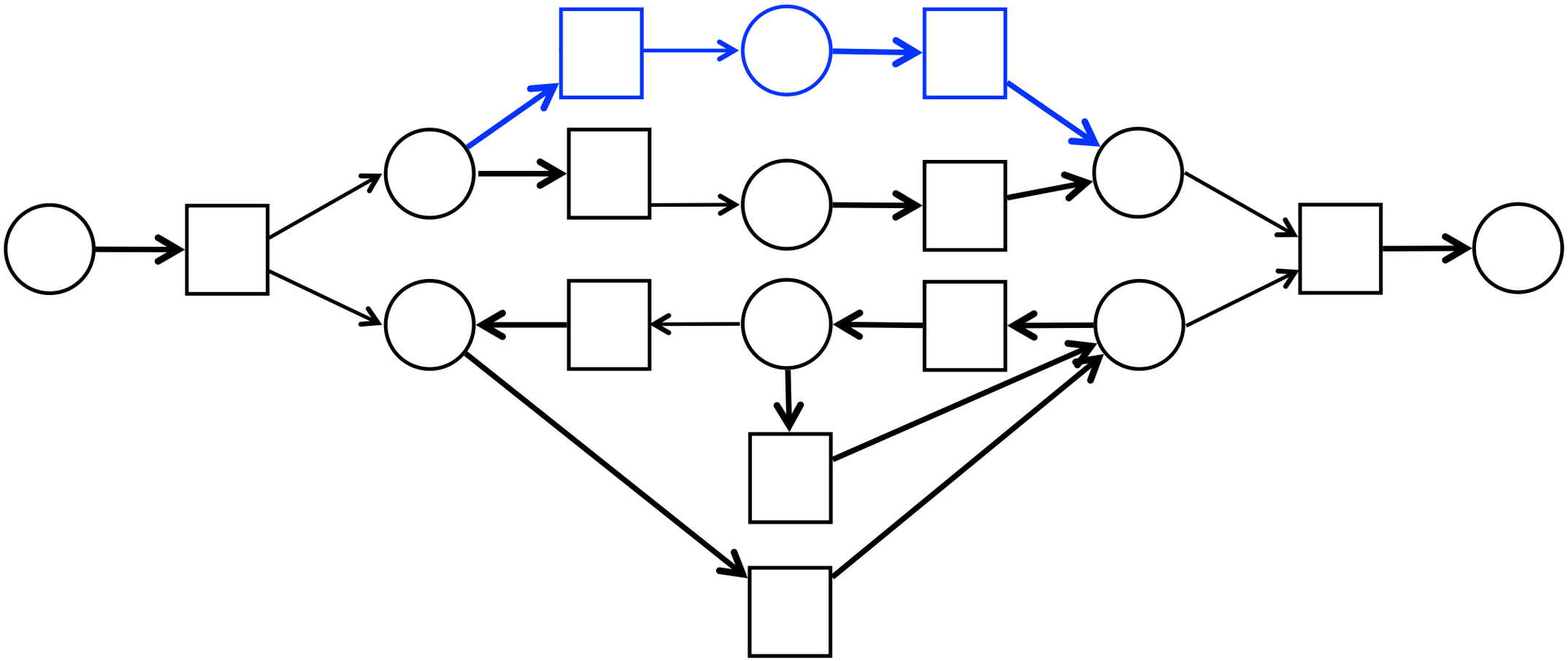

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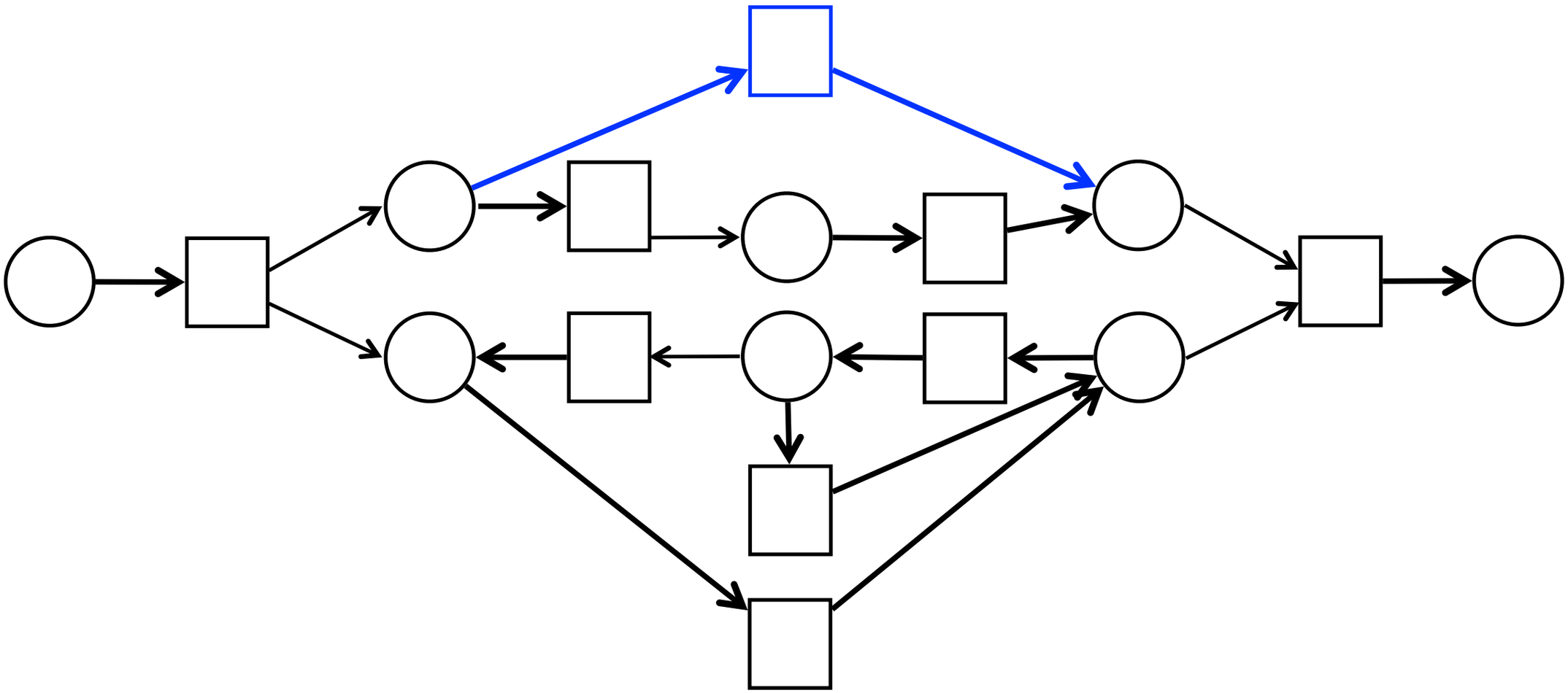

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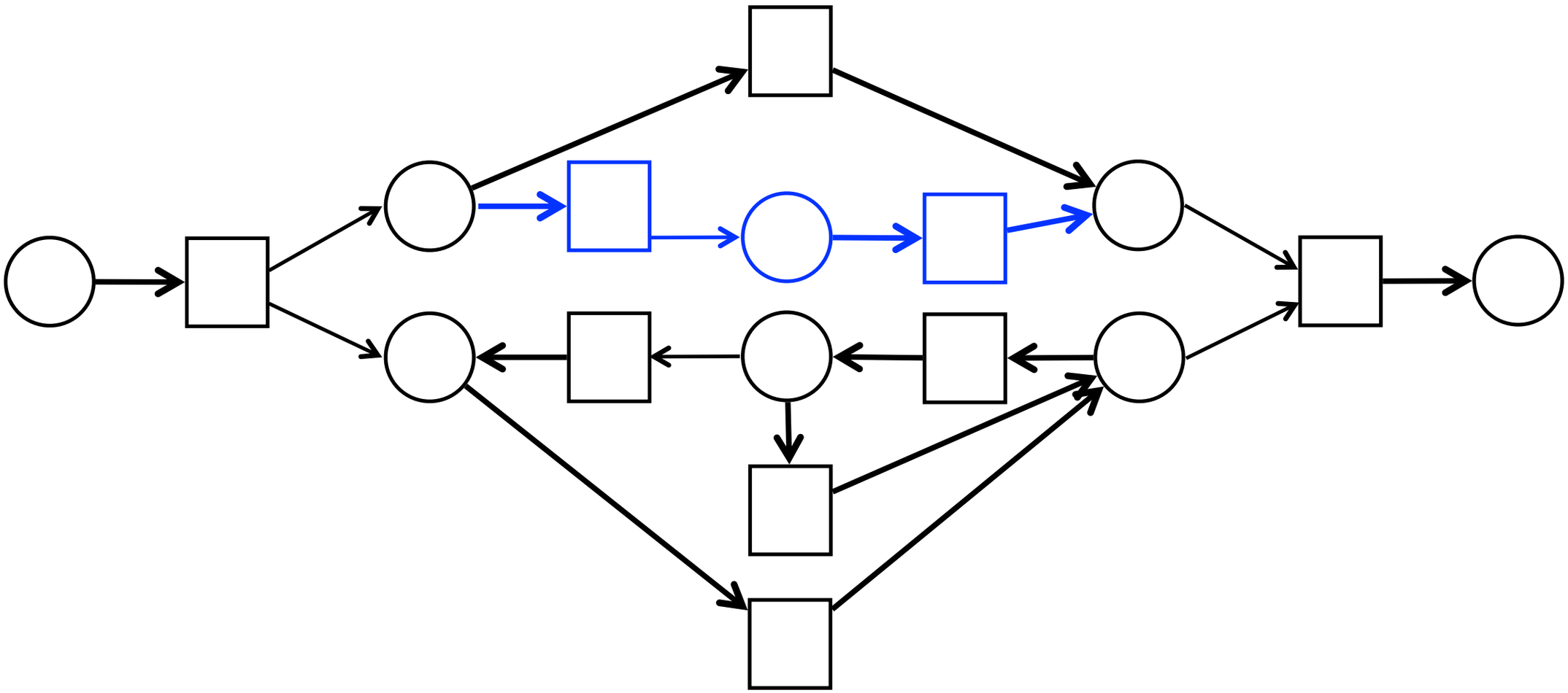

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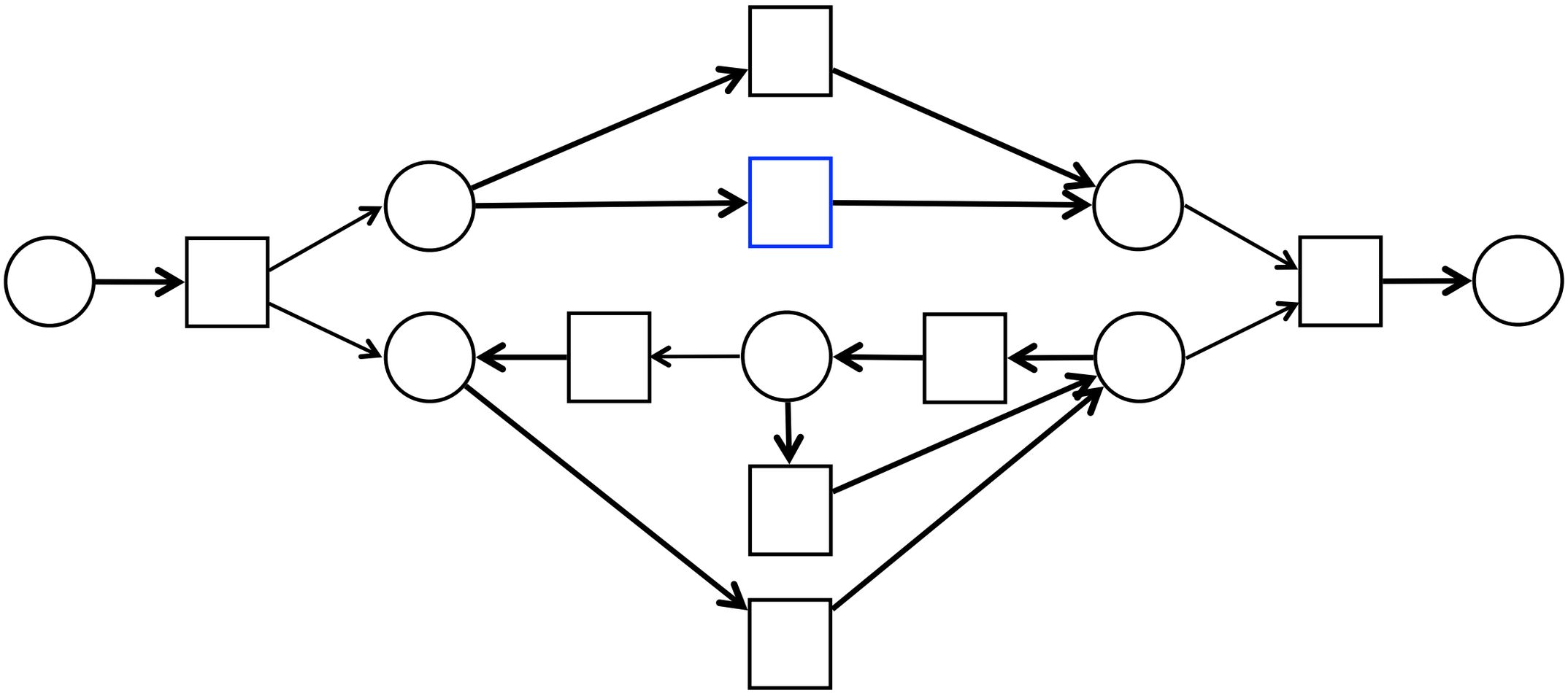

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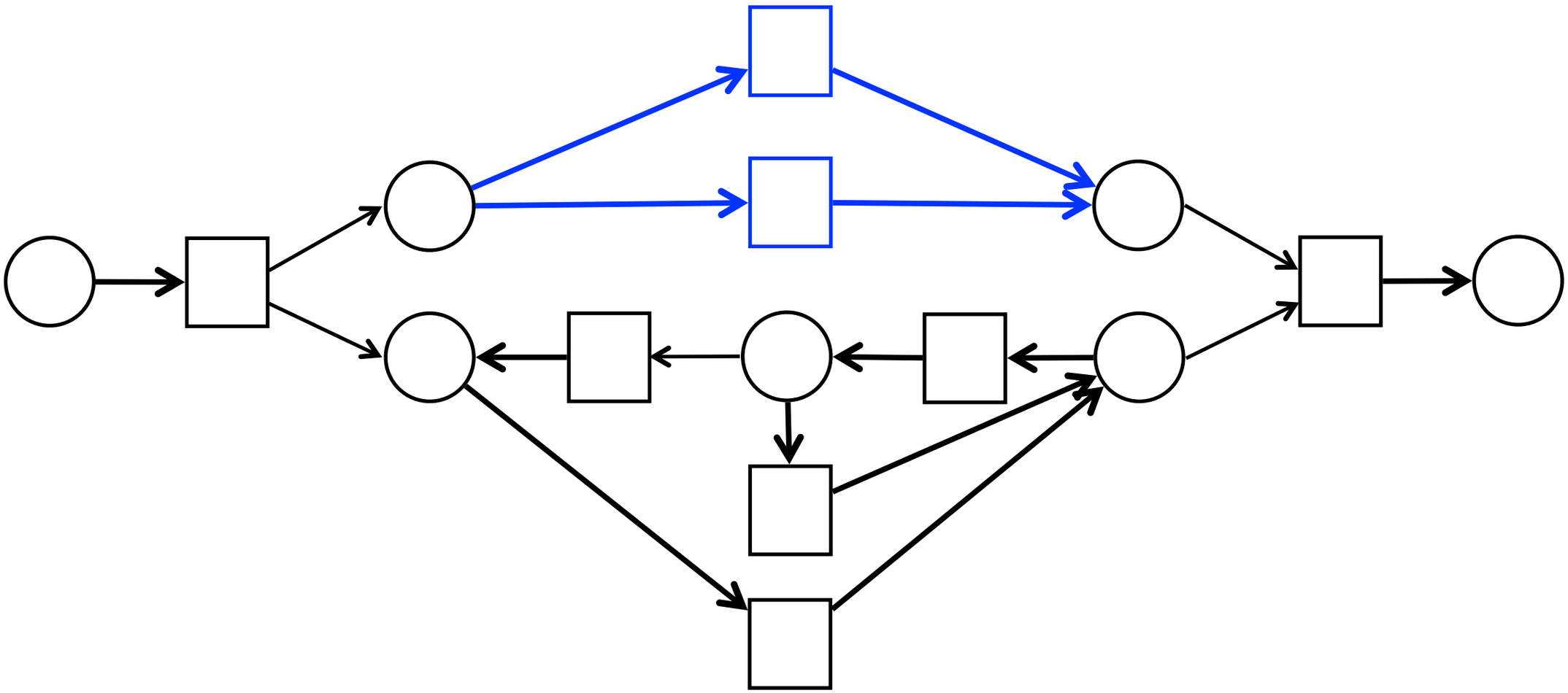

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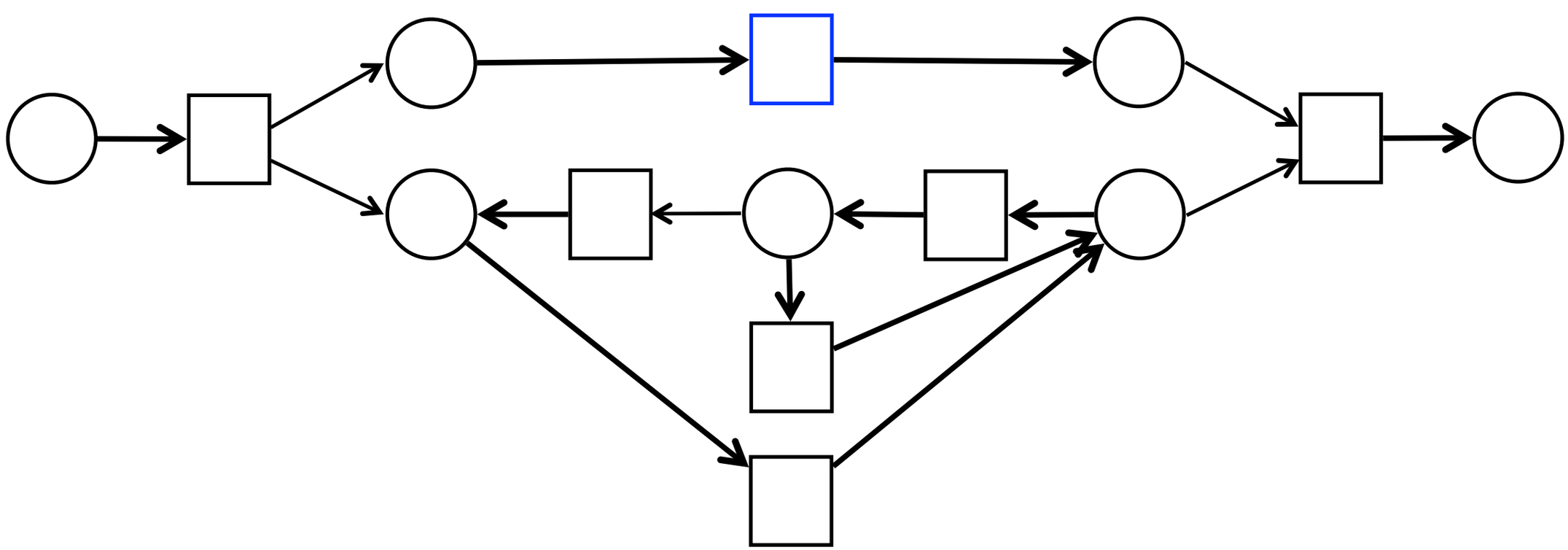

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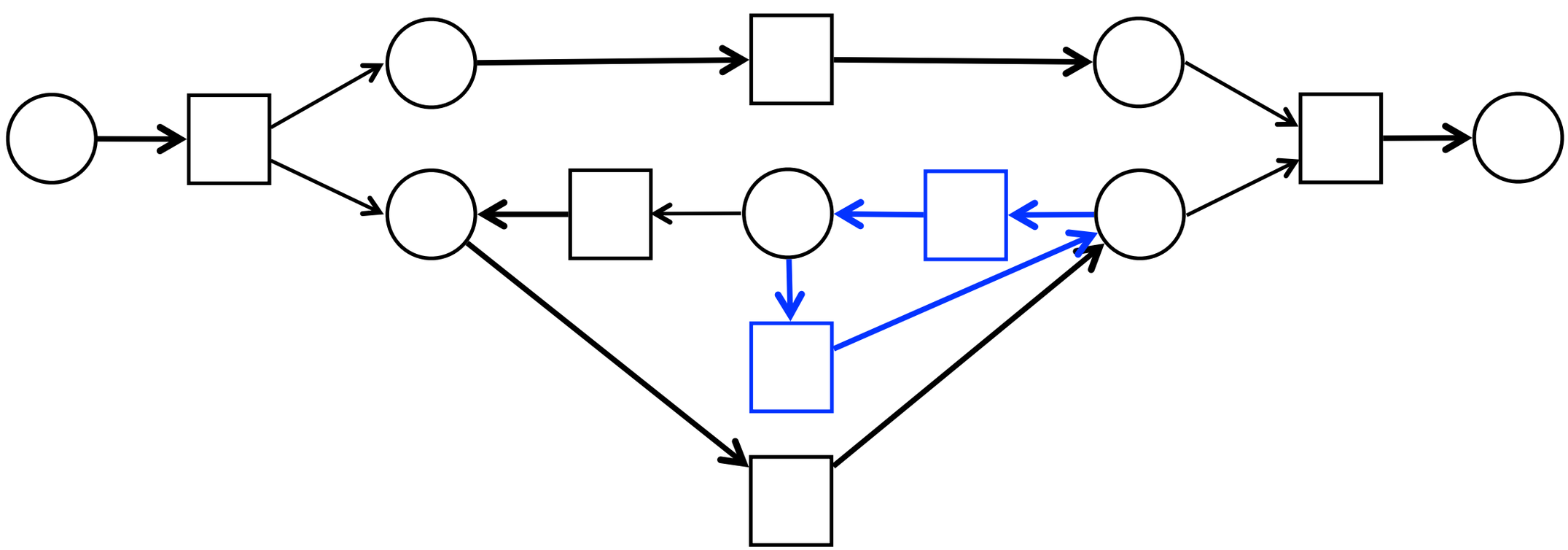

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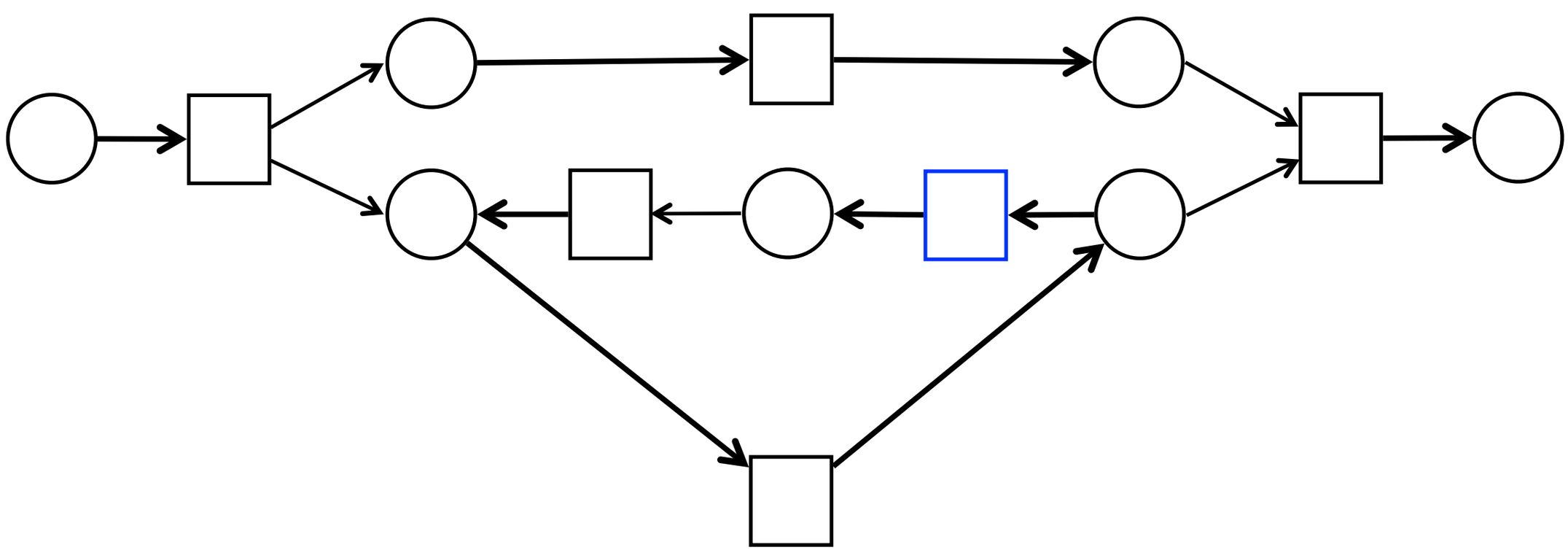

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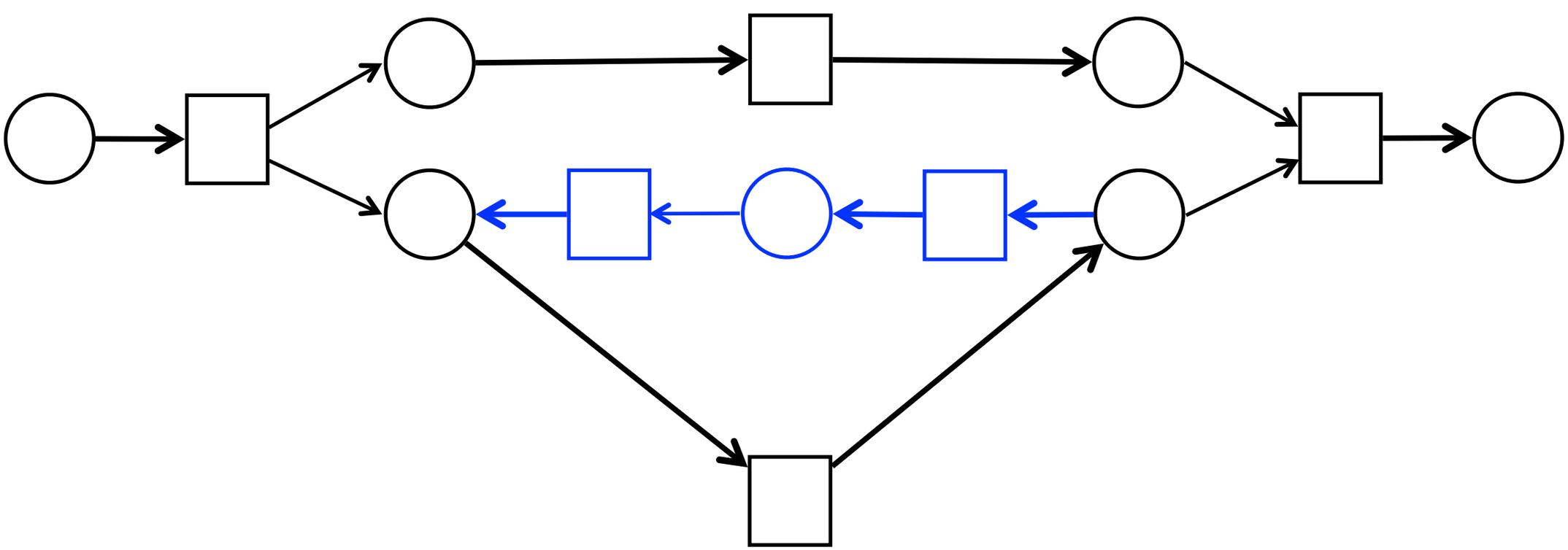

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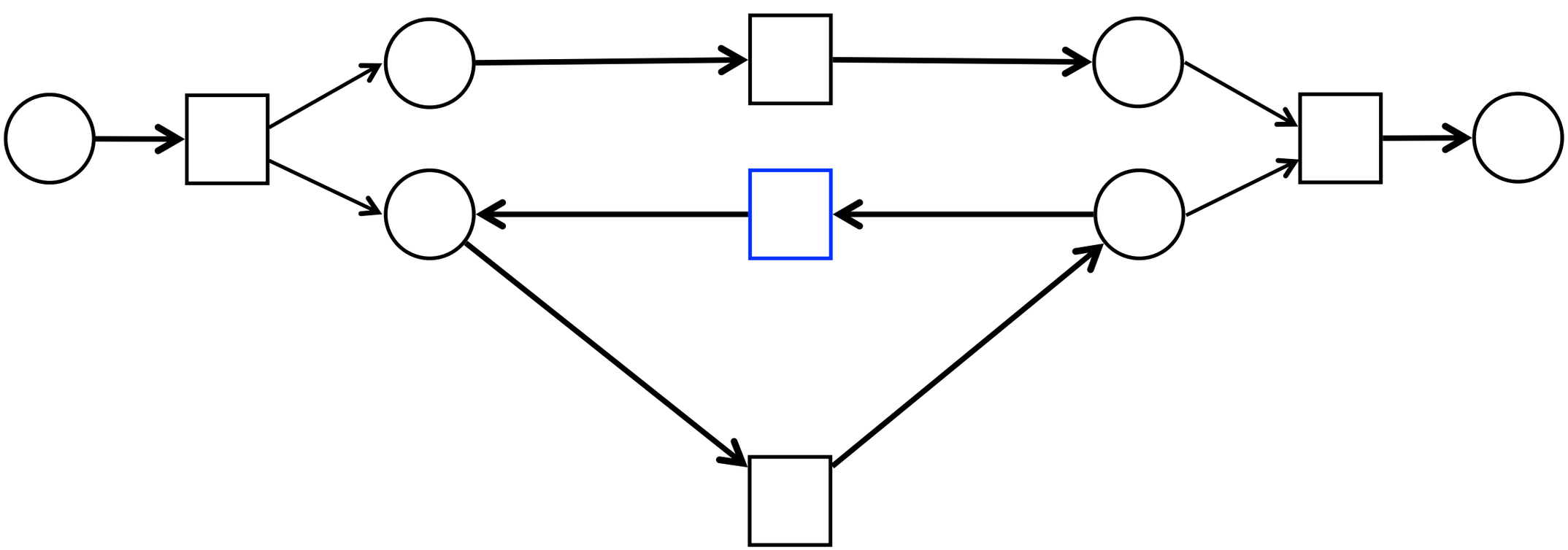

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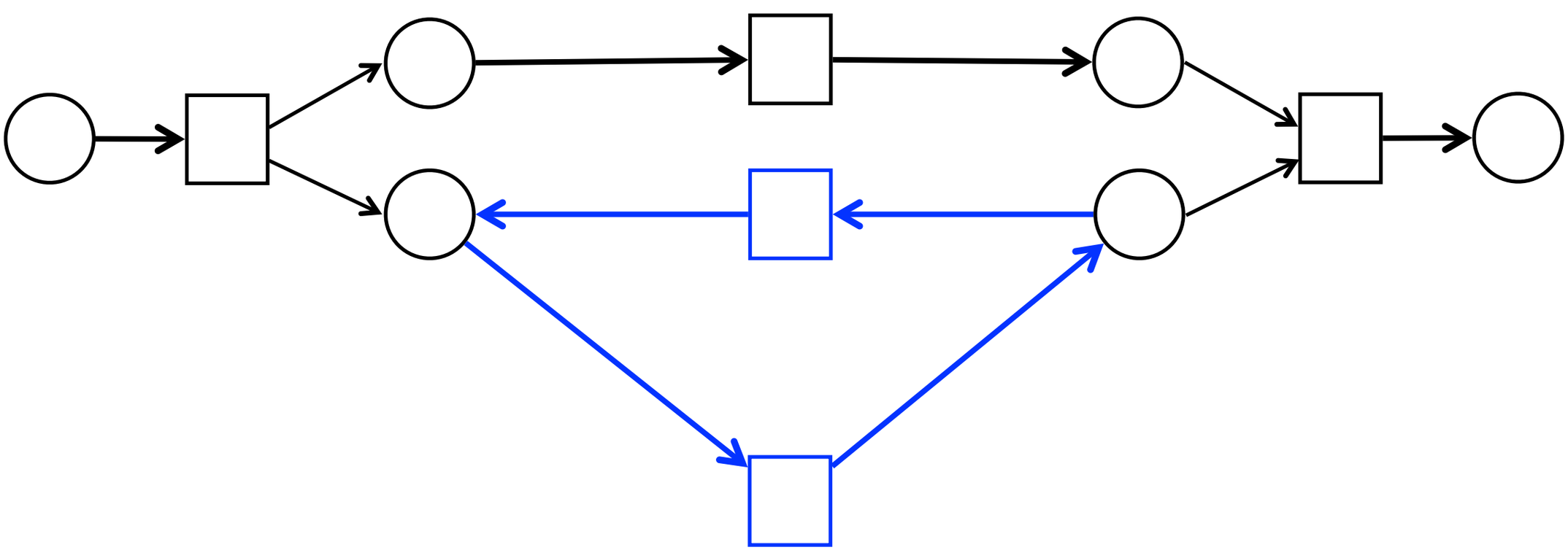

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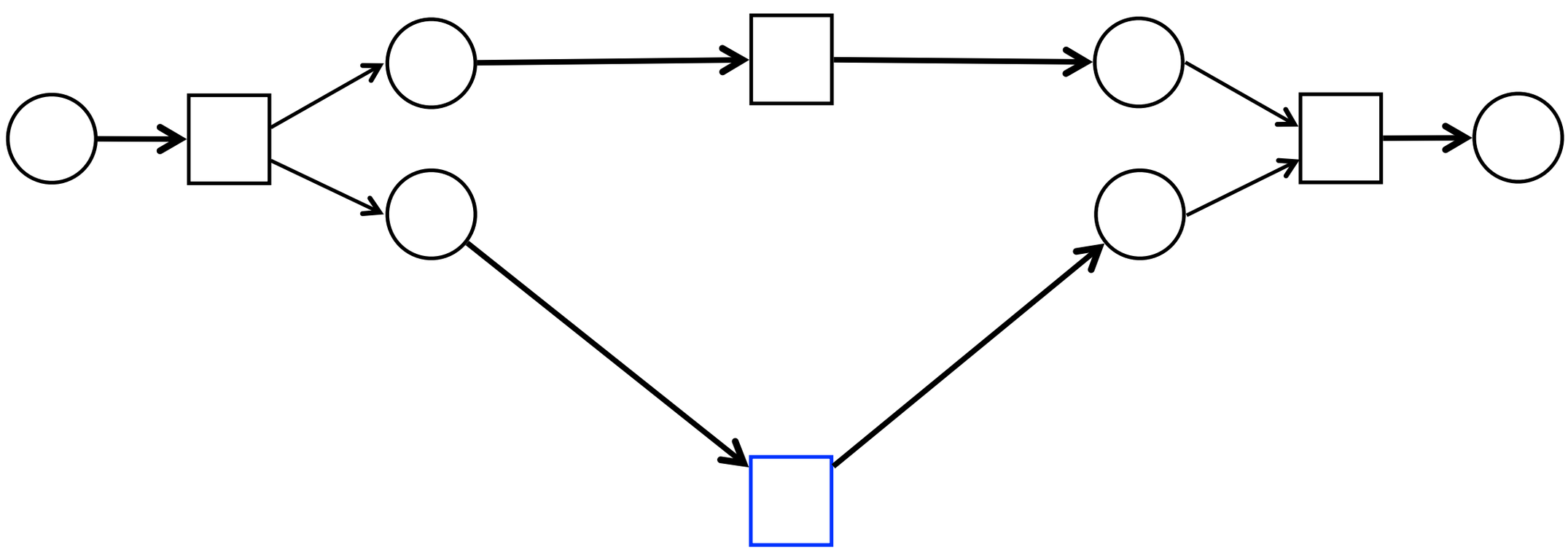

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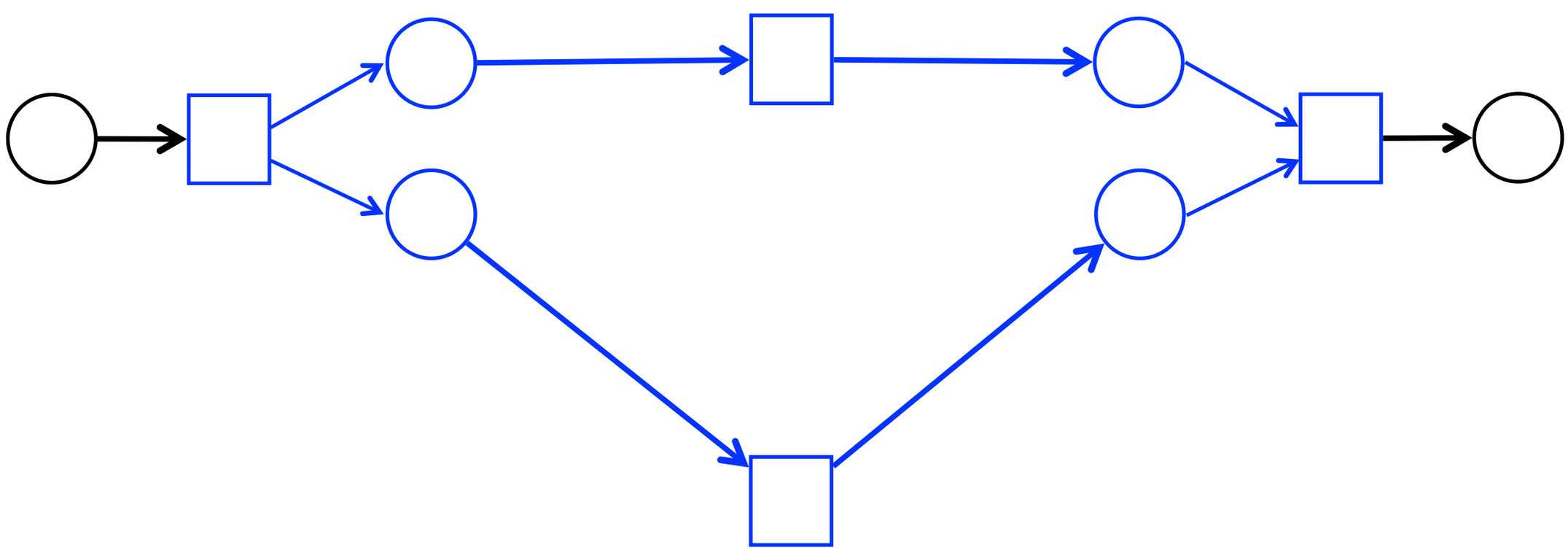

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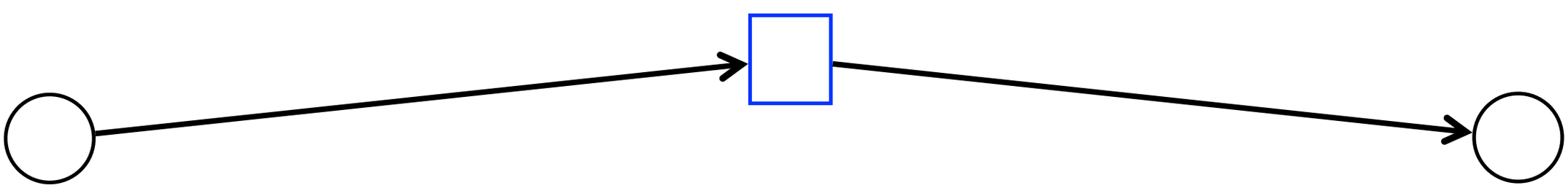
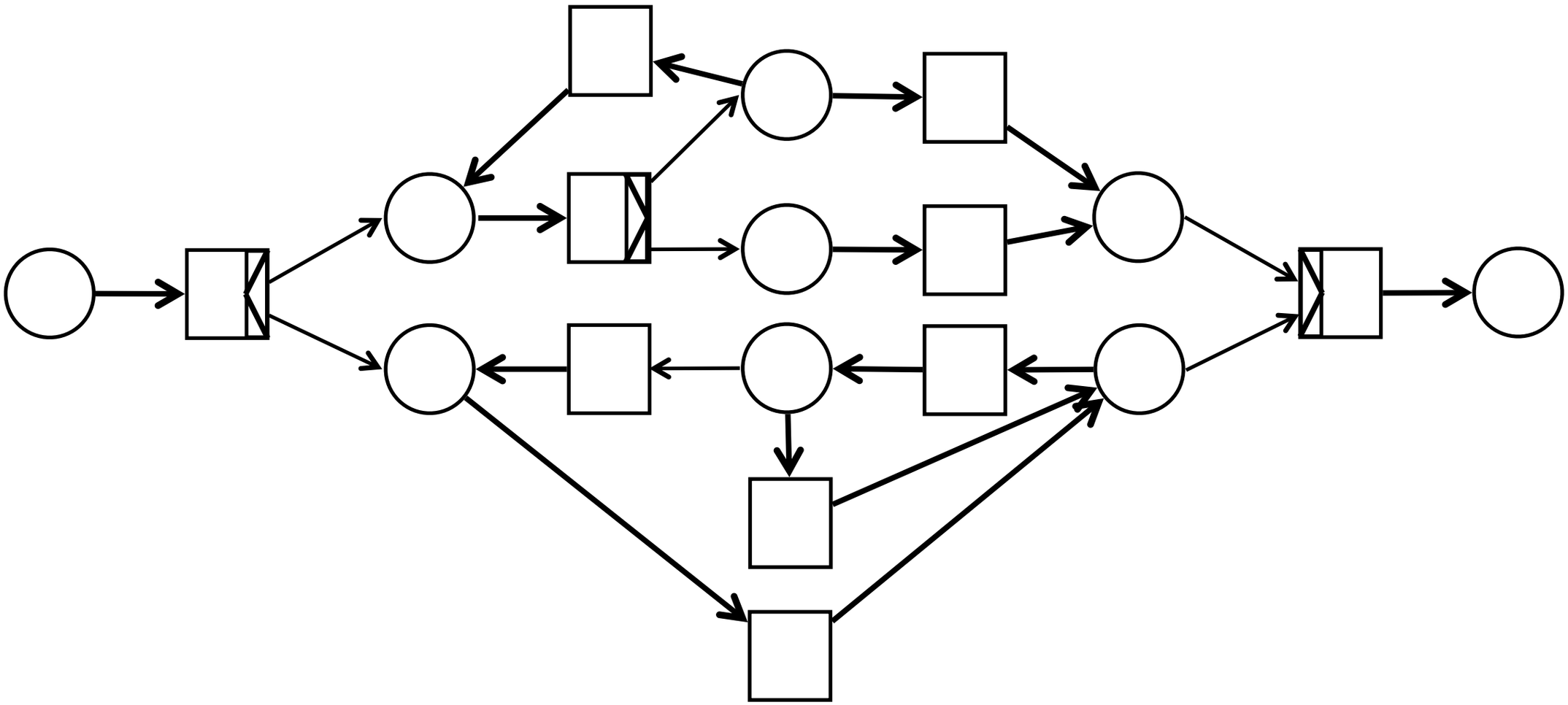
a safe and sound workflow net



Exercise

Prove that the net below is
a safe and sound workflow net (hint: "desugar" it)



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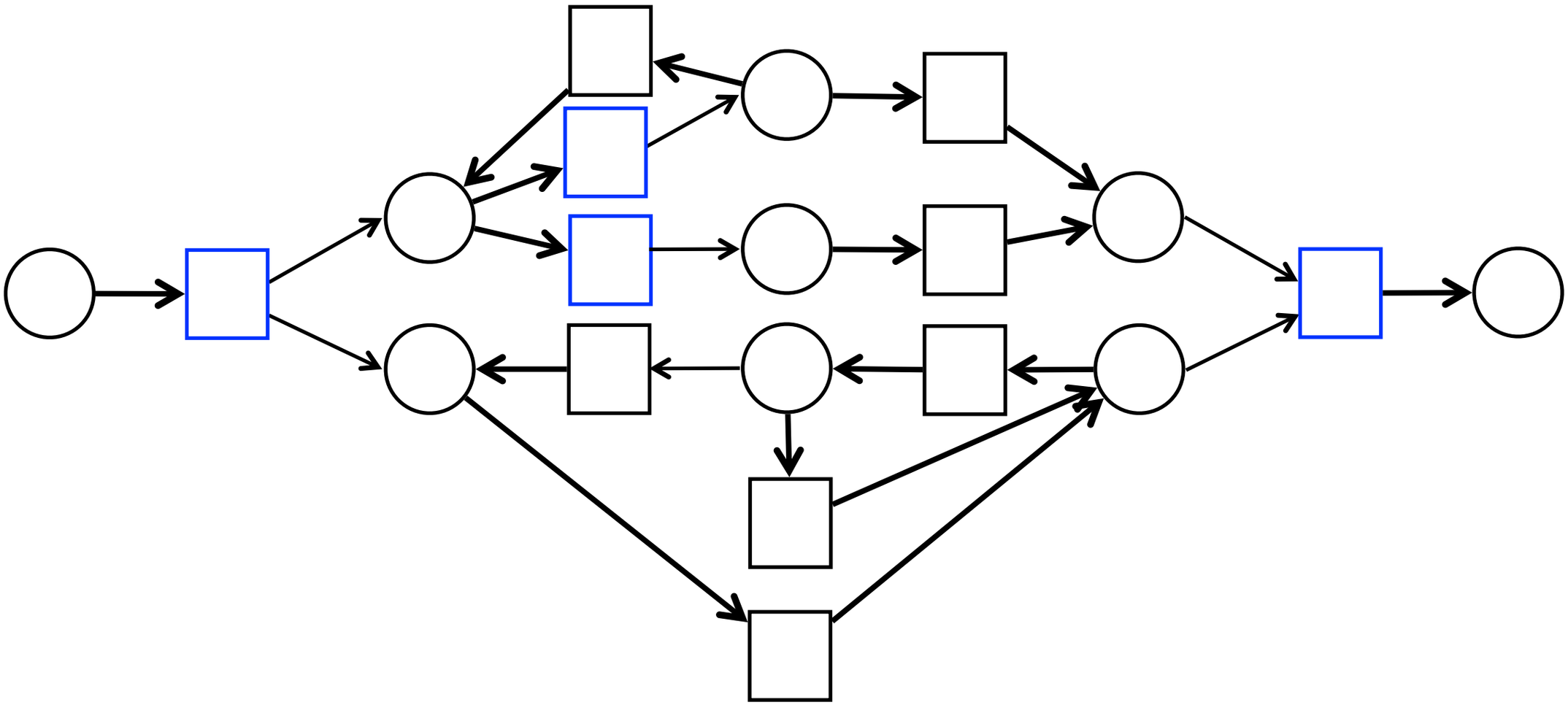

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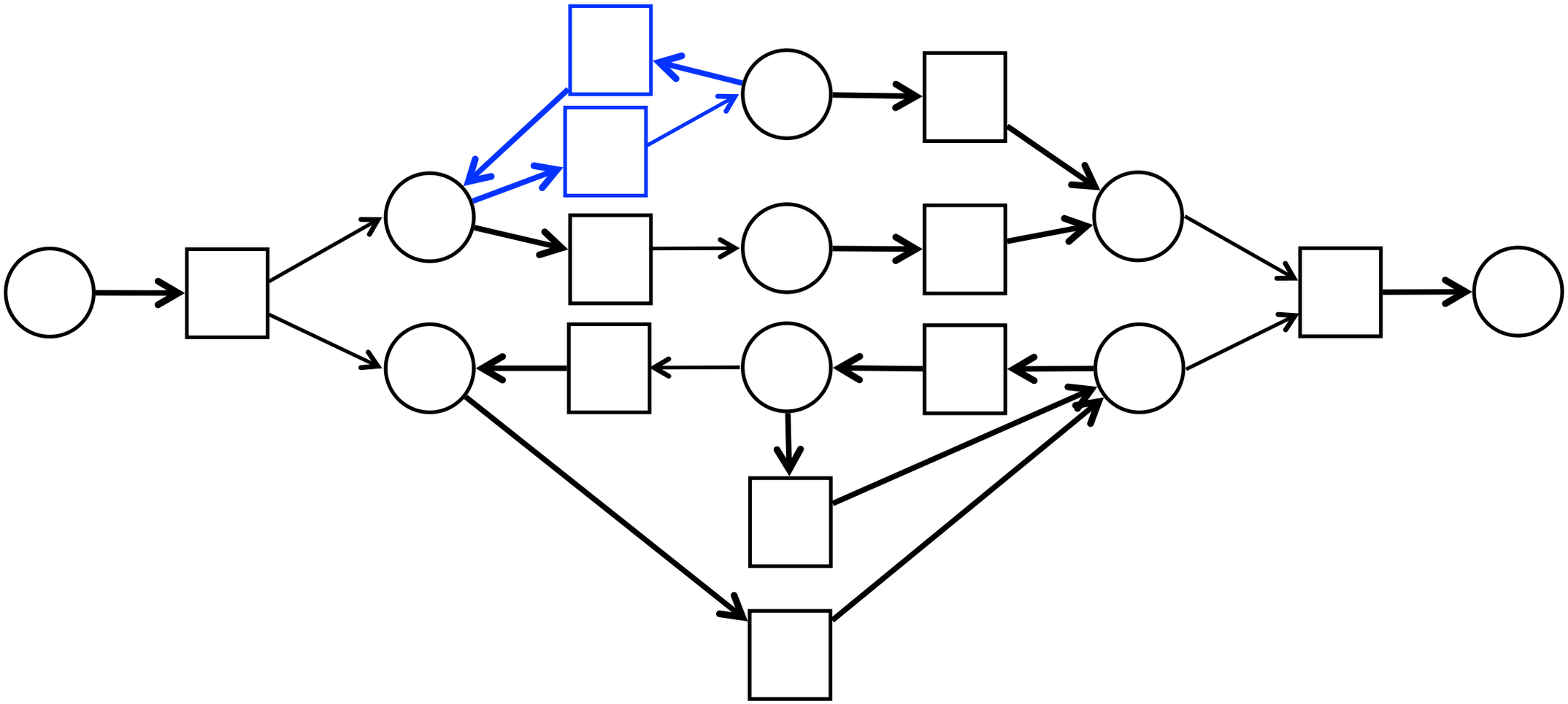
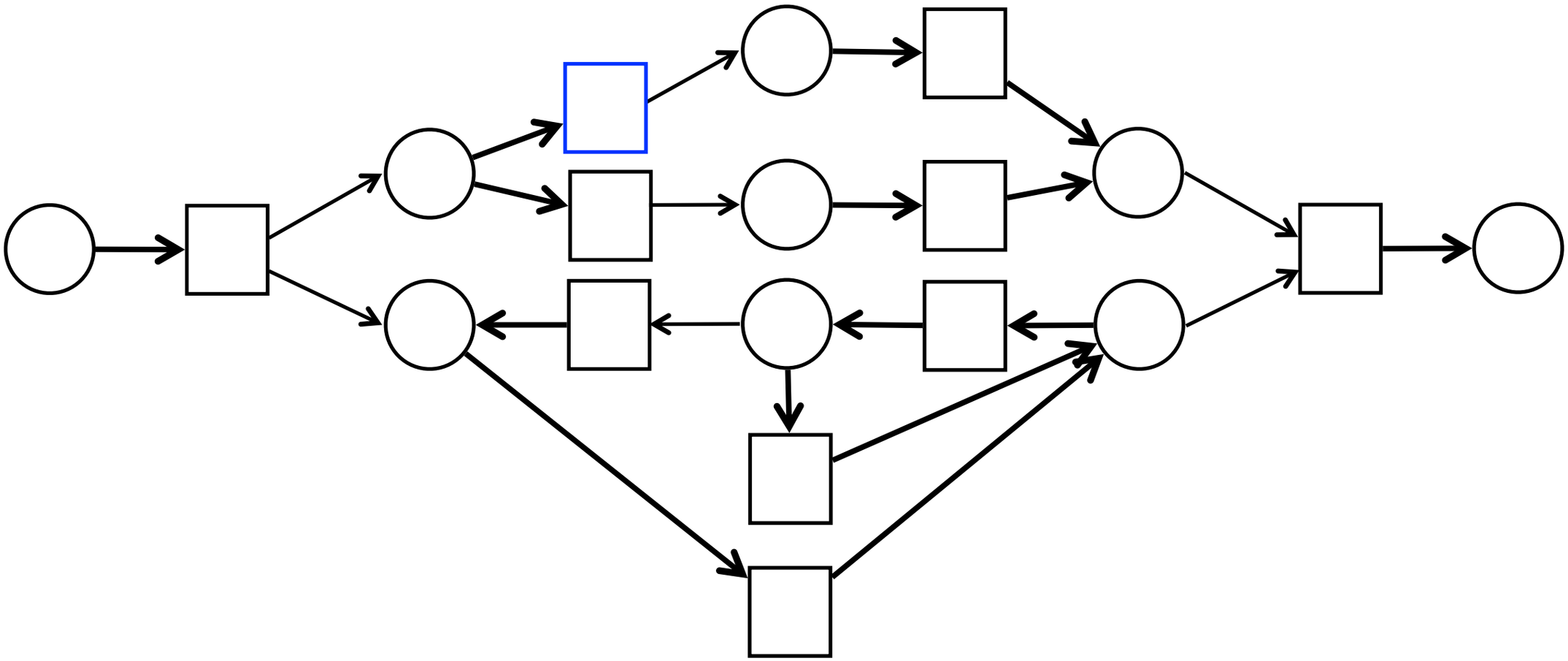


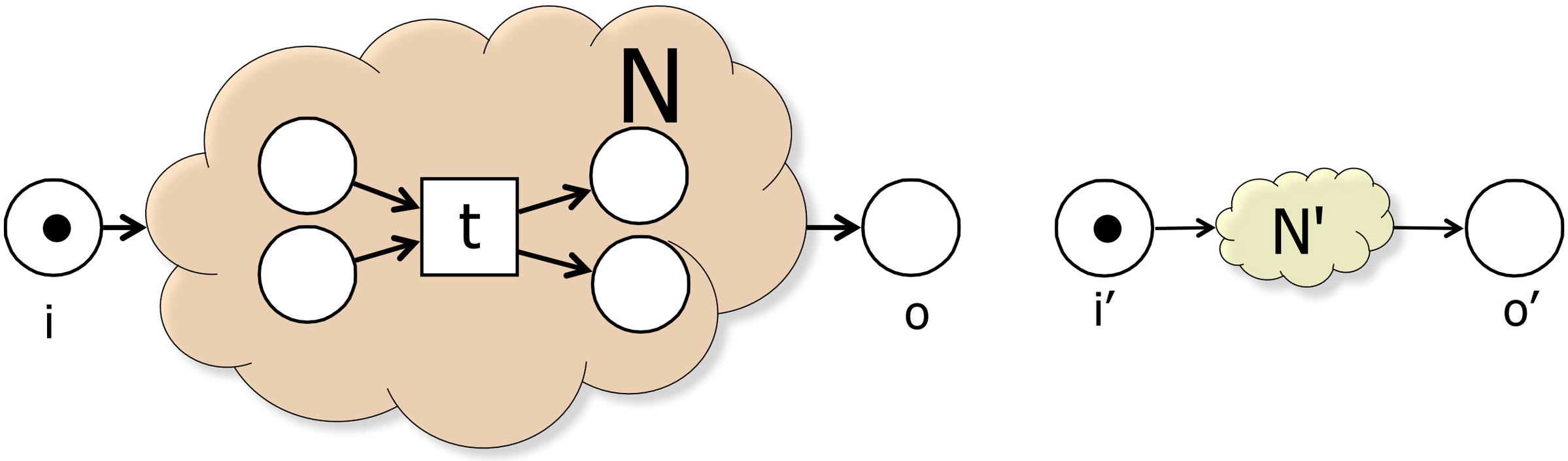
Exercise

This is the same net we have examined before

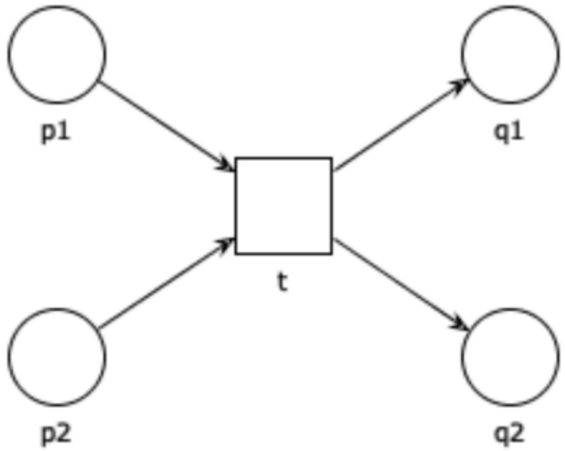


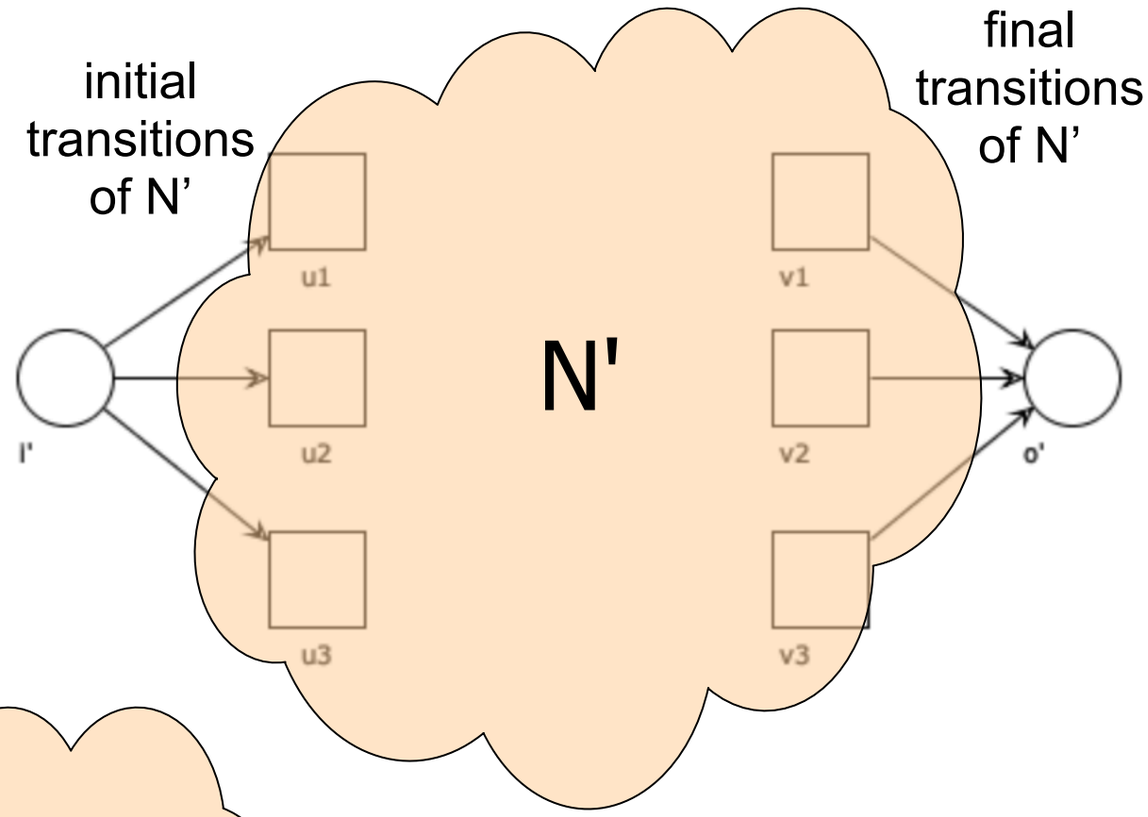
Generalization

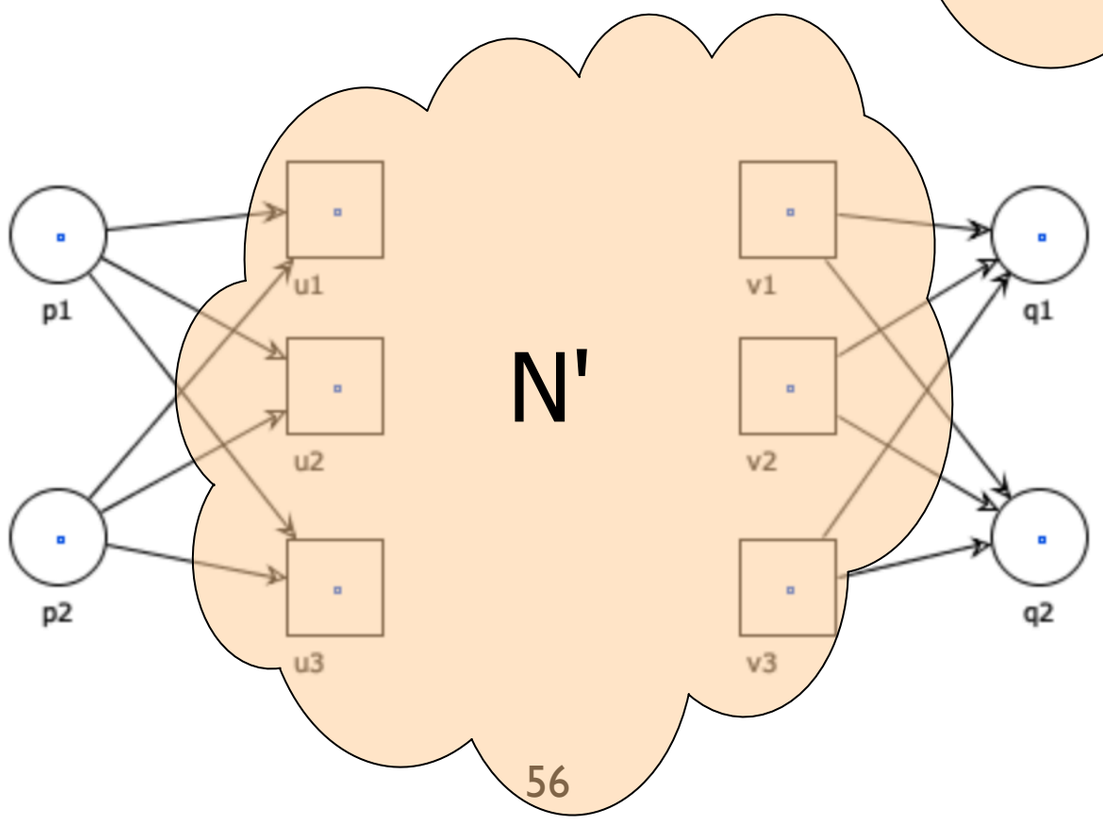
We would like to progressively refine transitions with multiple incoming and outgoing arcs



Sketching the idea





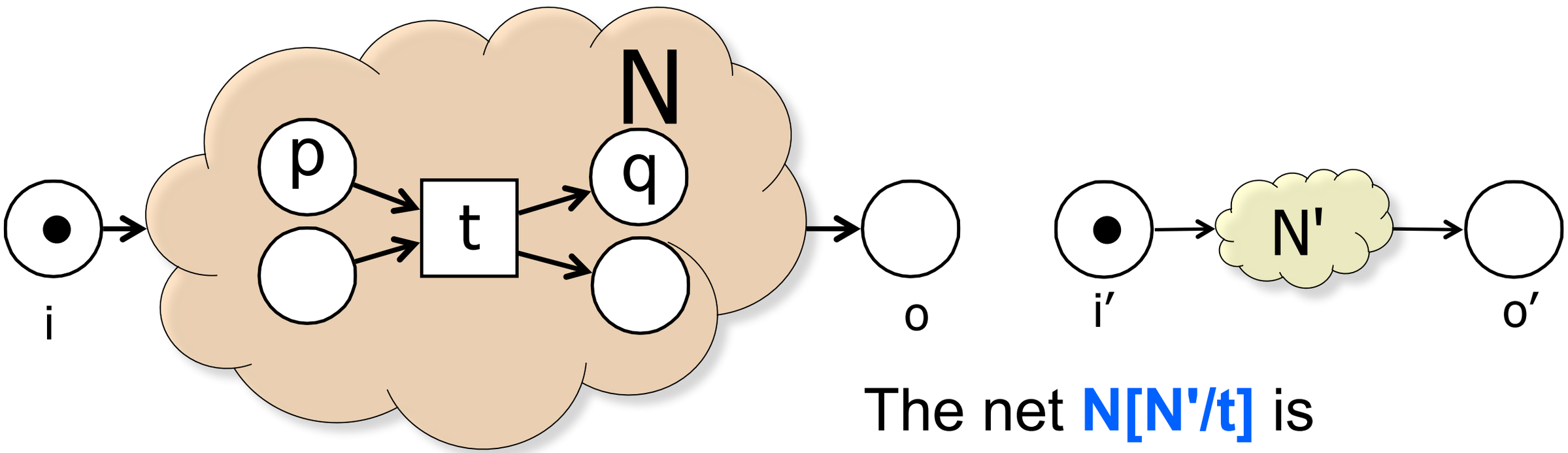


General replacement

Let $T_{i'} = \{\, u \mid \bullet u = \{i'\} \,\}$. (initial transitions of N')
Let $T_{o'} = \{\, v \mid v \bullet = \{o'\} \,\}$. (final transitions of N')

If $(p,t) \in F_N, u \in T_{i'}$ then $(p,u) \in F_{N[N'/t]}$

If $(t,q) \in F_N, v \in T_{o'}$ then $(v,q) \in F_{N[N'/t]}$



The net **N[N'/t]** is
a **sound** and **safe workflow net**

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Let $T_{i'} = \{\, u \mid \bullet u = \{i'\} \,\}$. (initial transitions of N')
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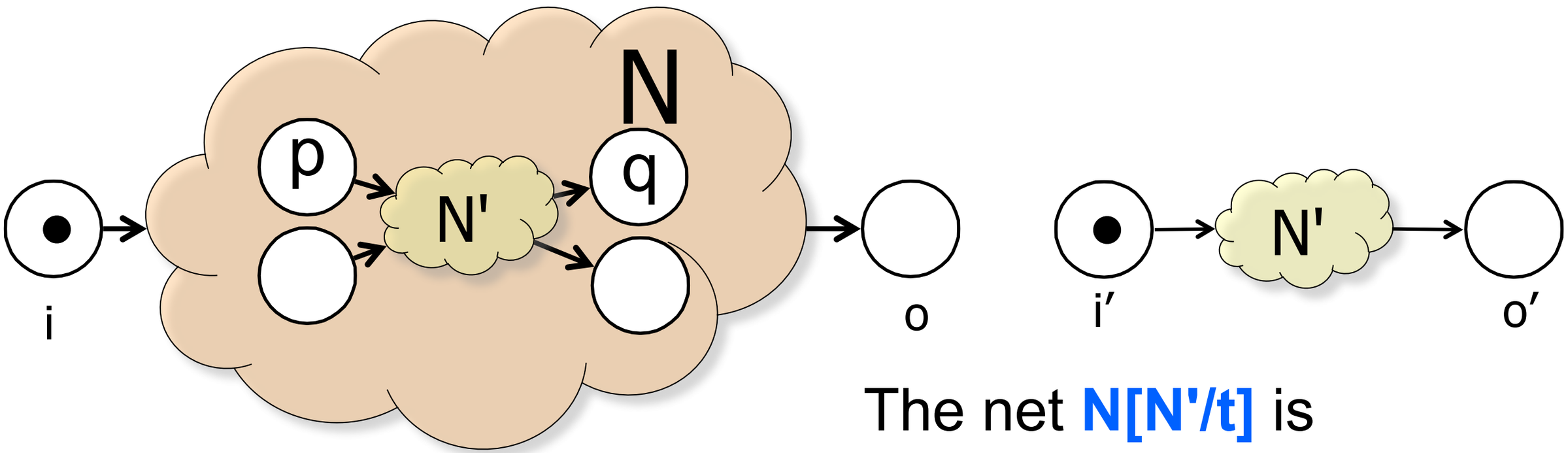

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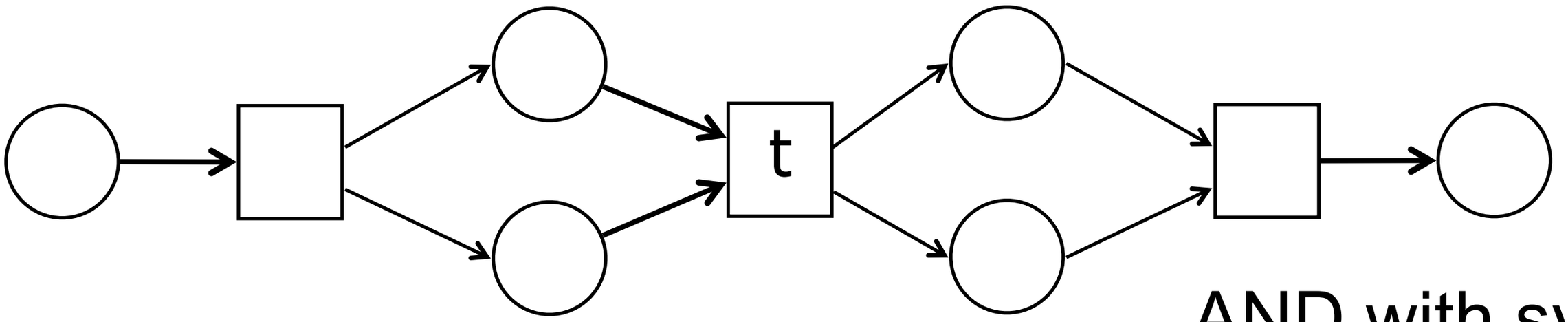
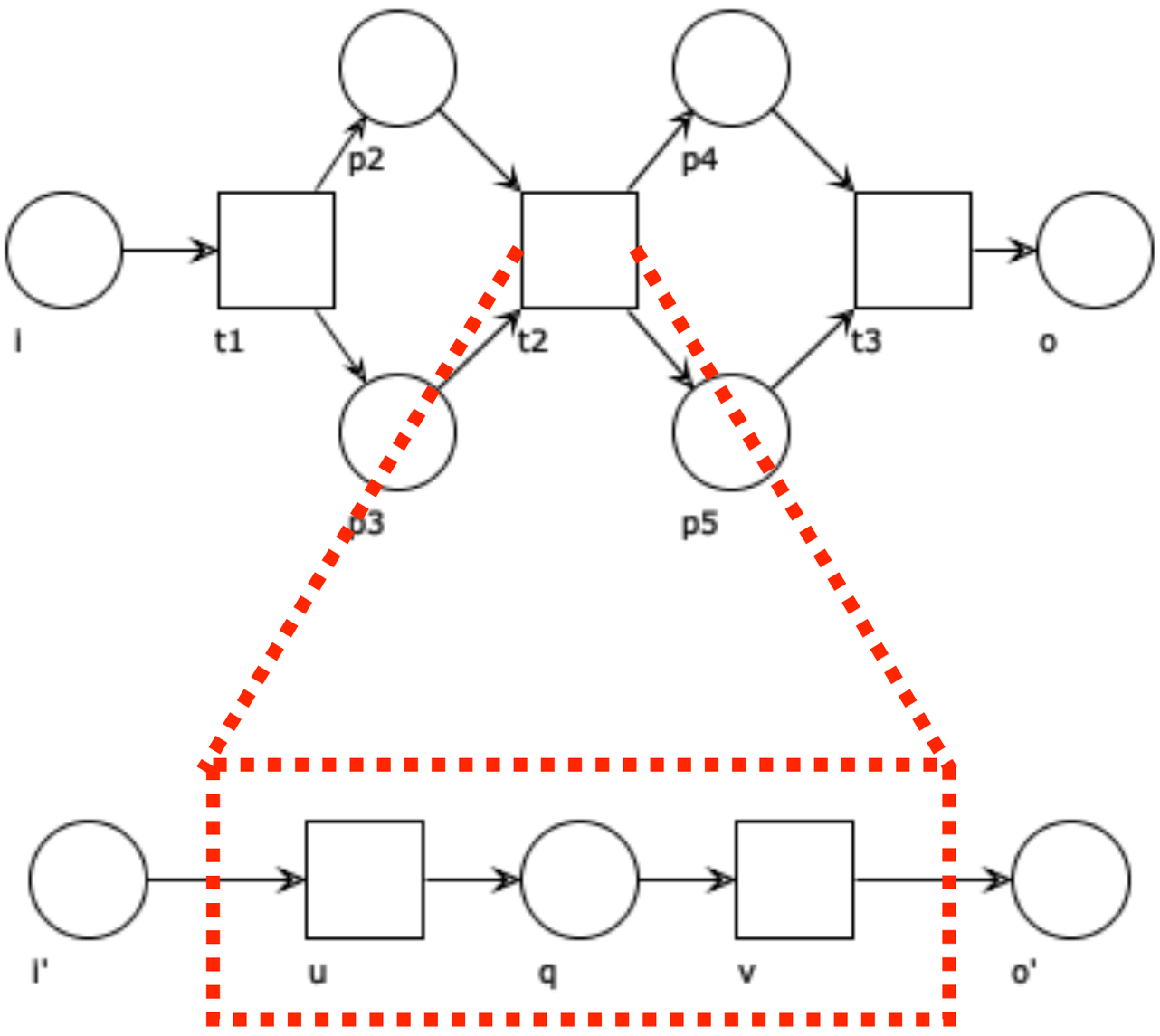
Some Building Blocks 5



AND with sync

But you can define more blocks on your own

Example



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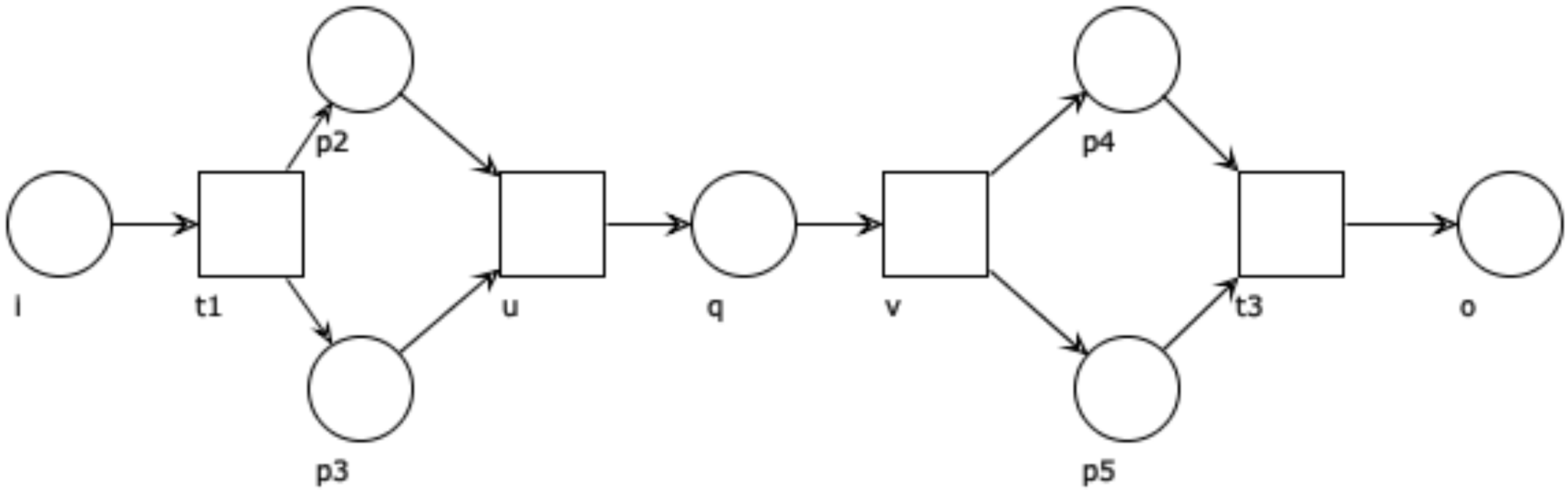

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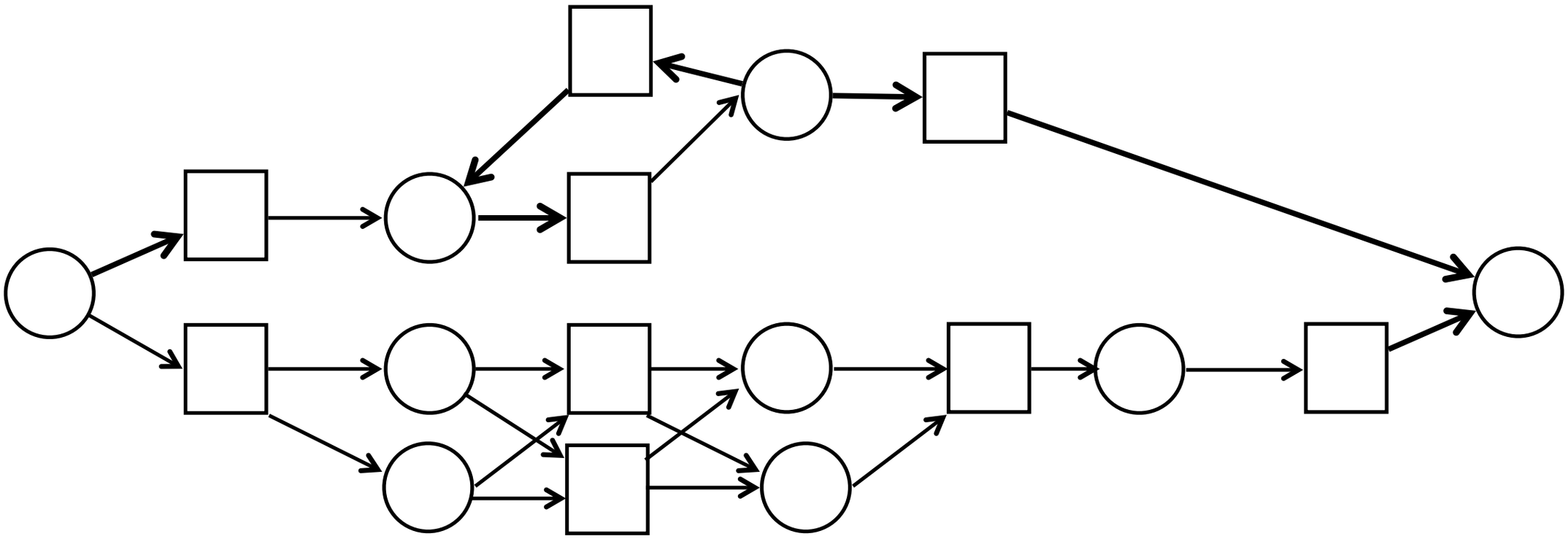

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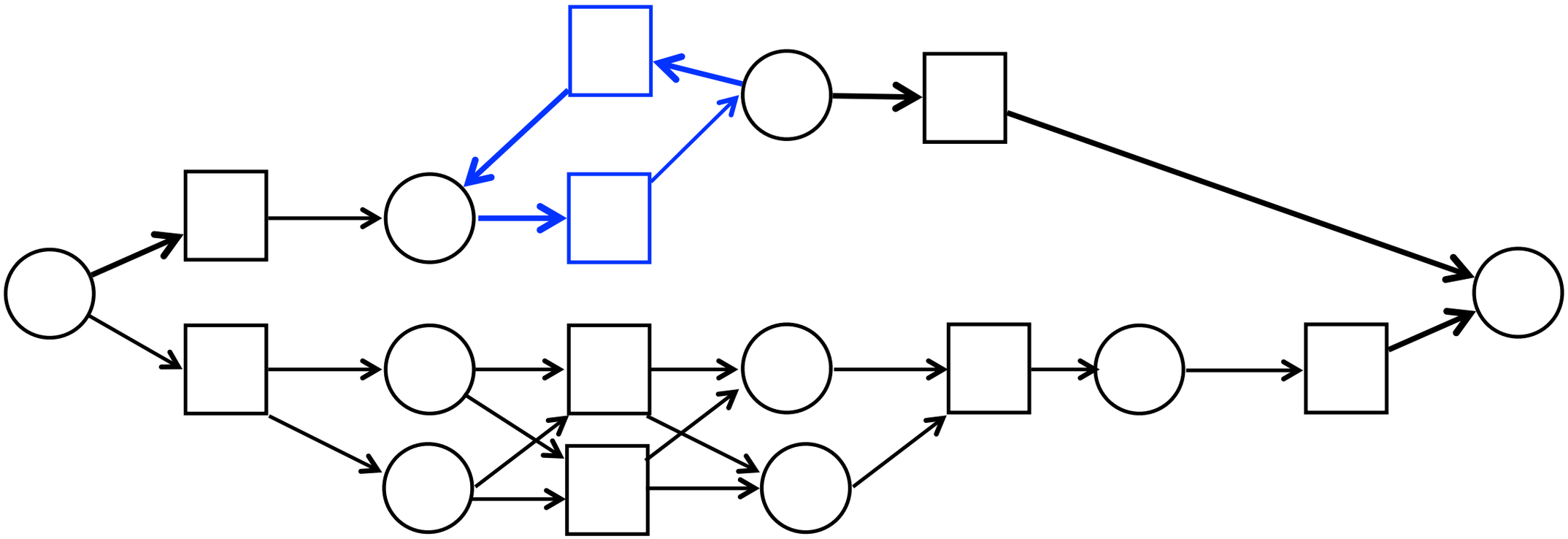

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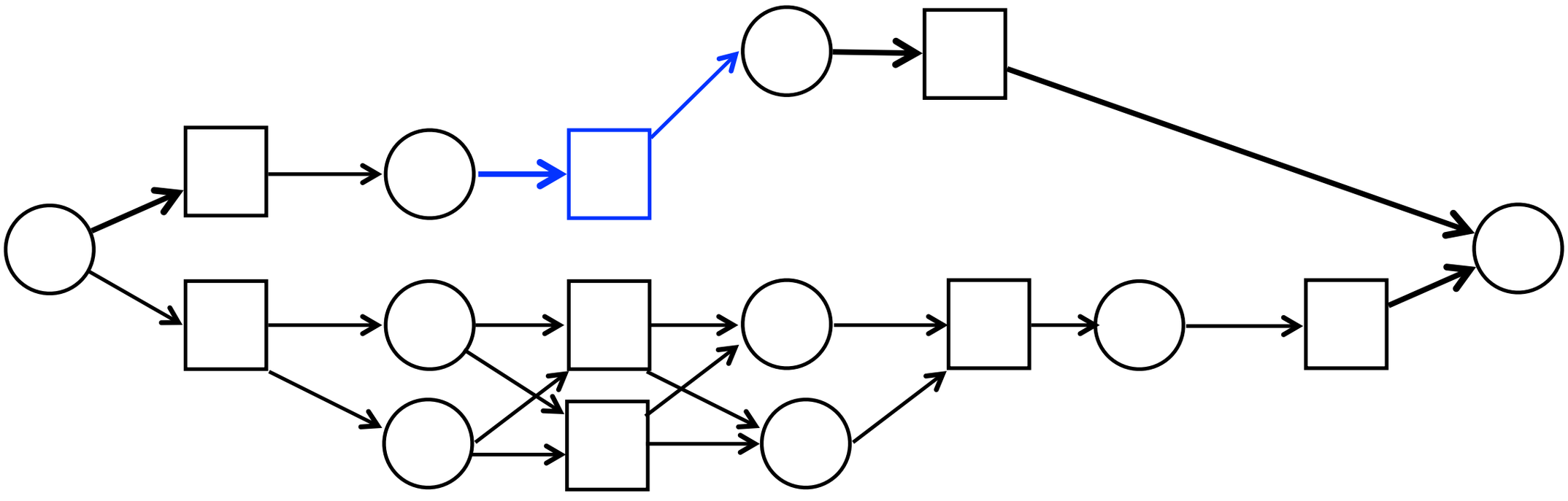

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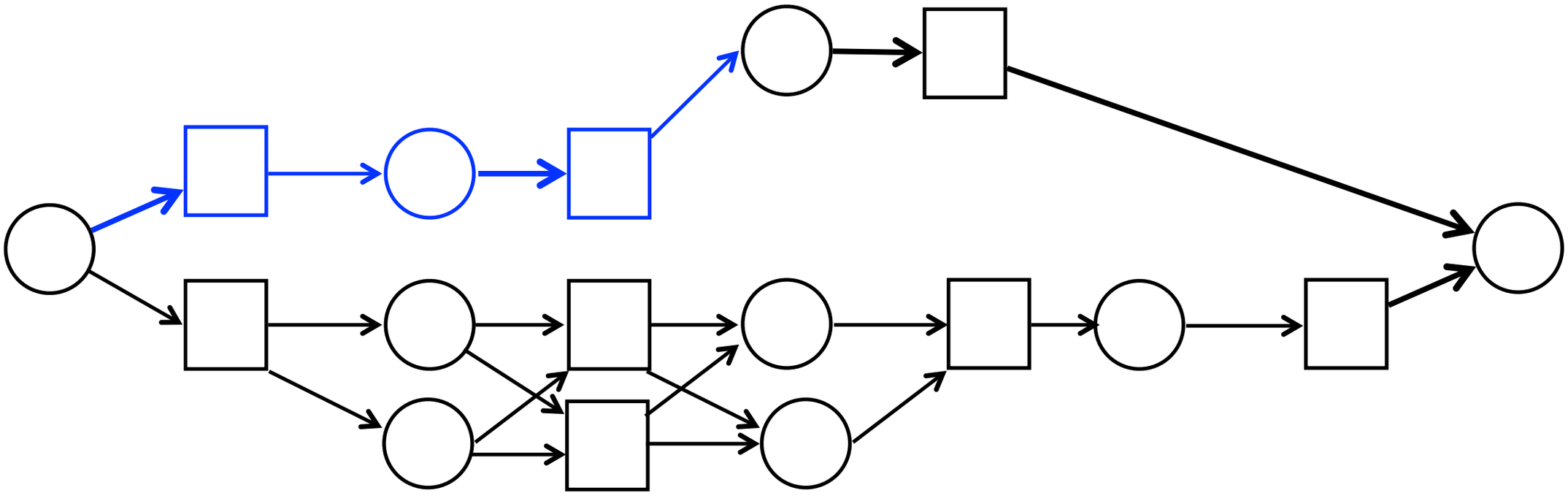

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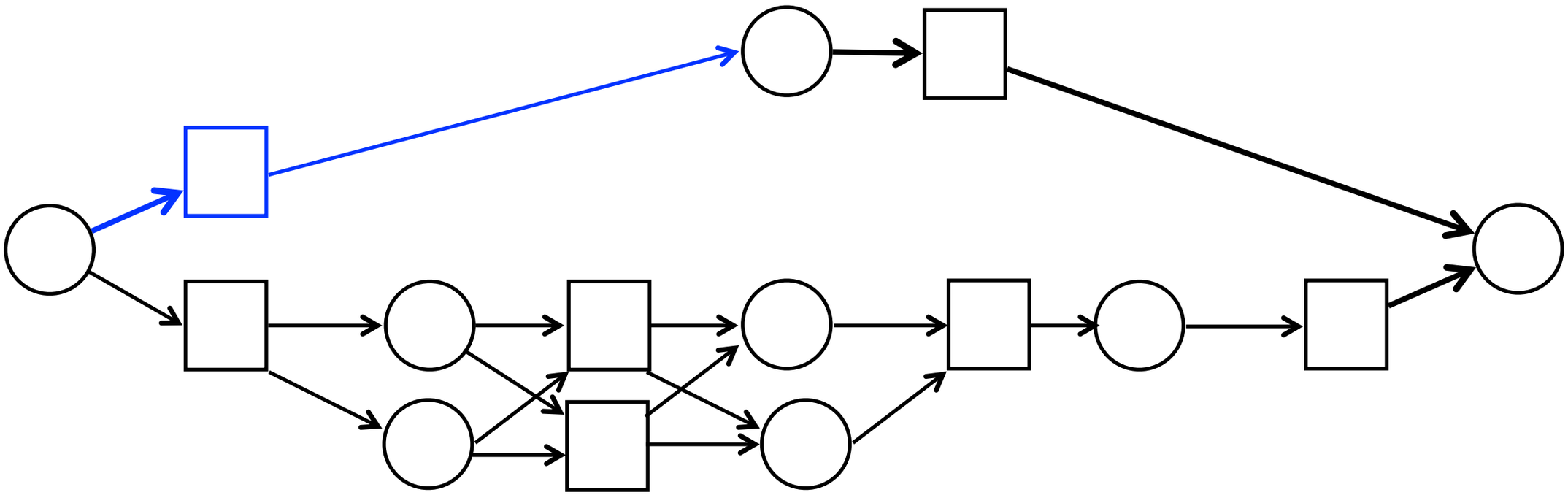

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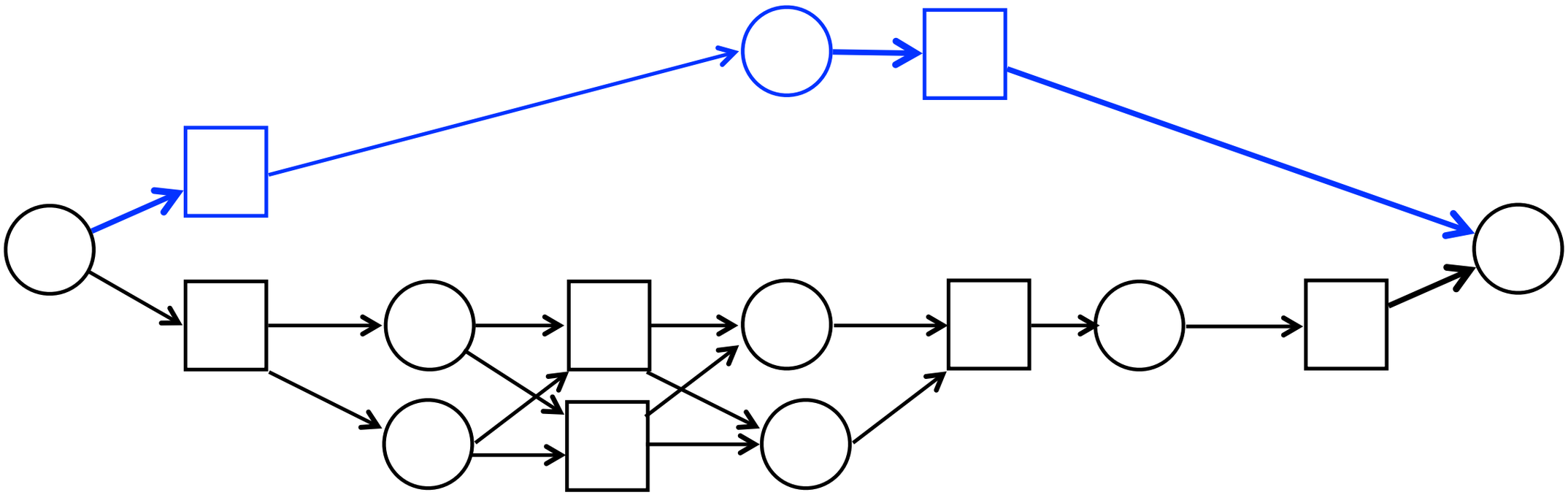

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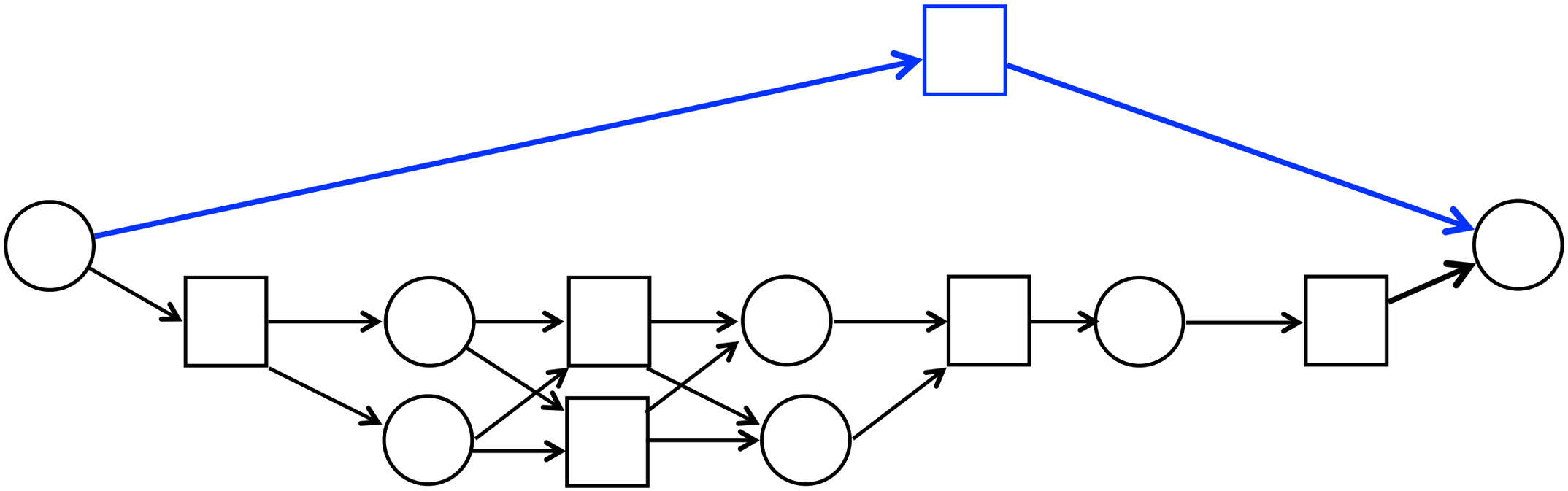

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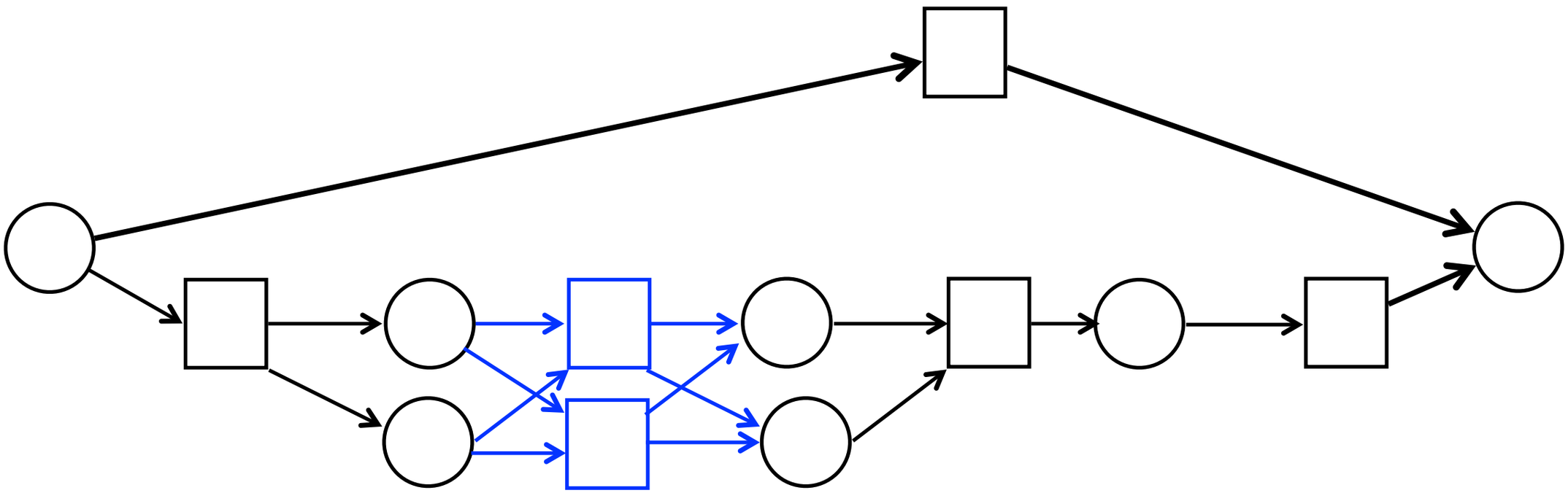

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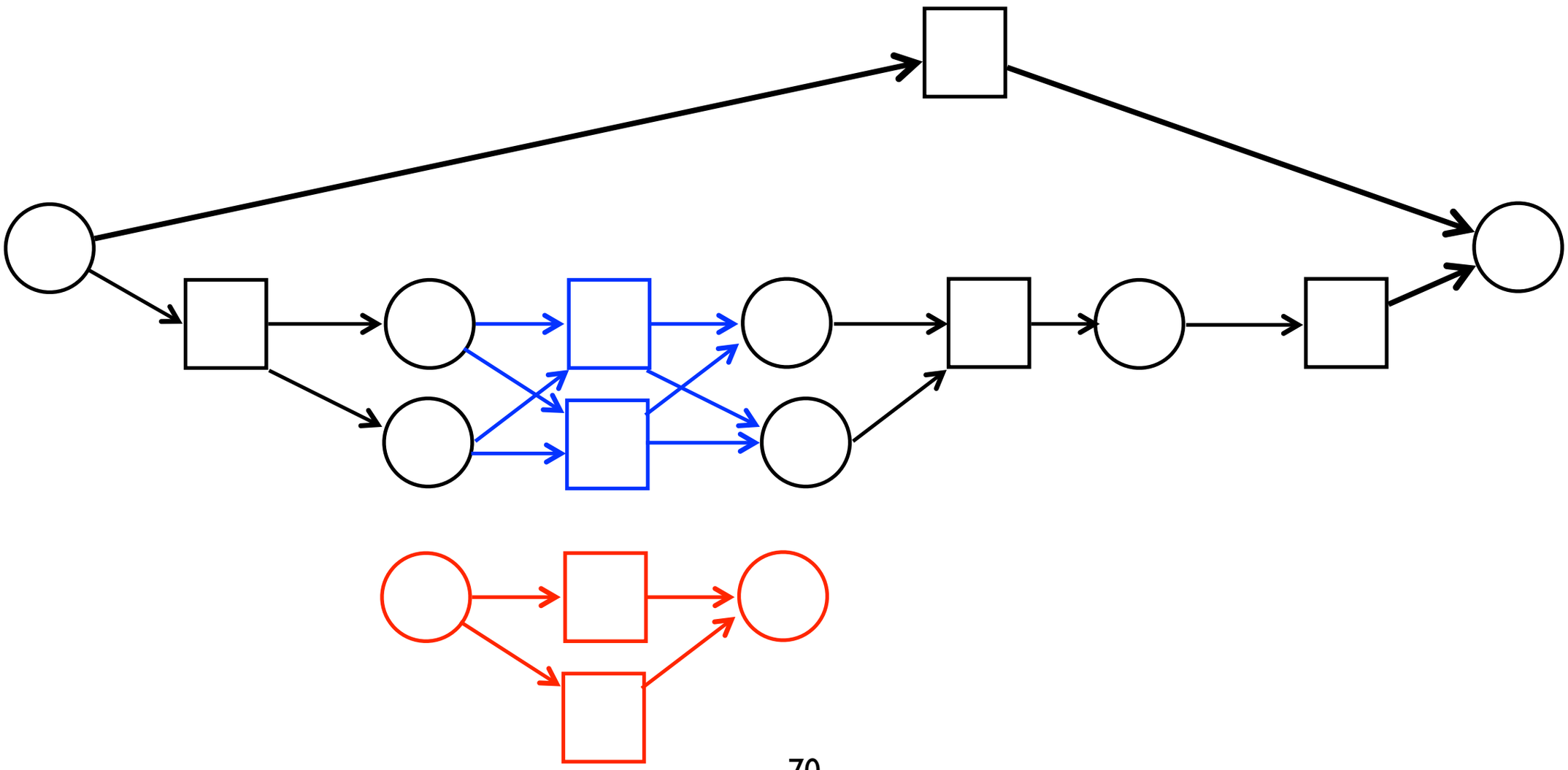

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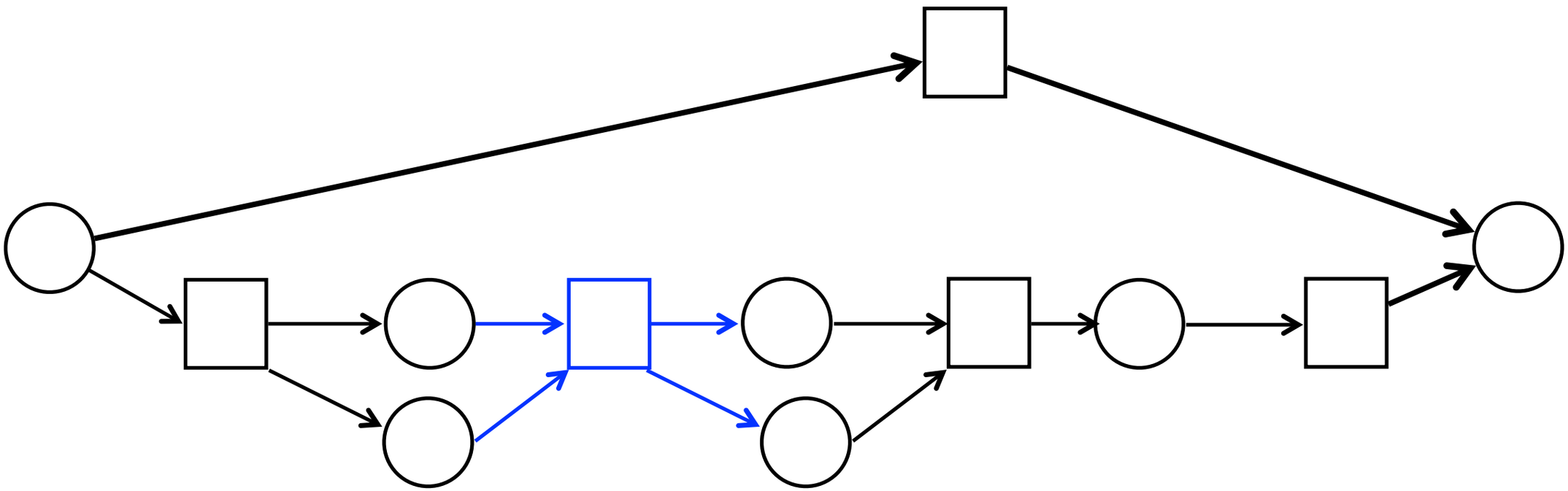

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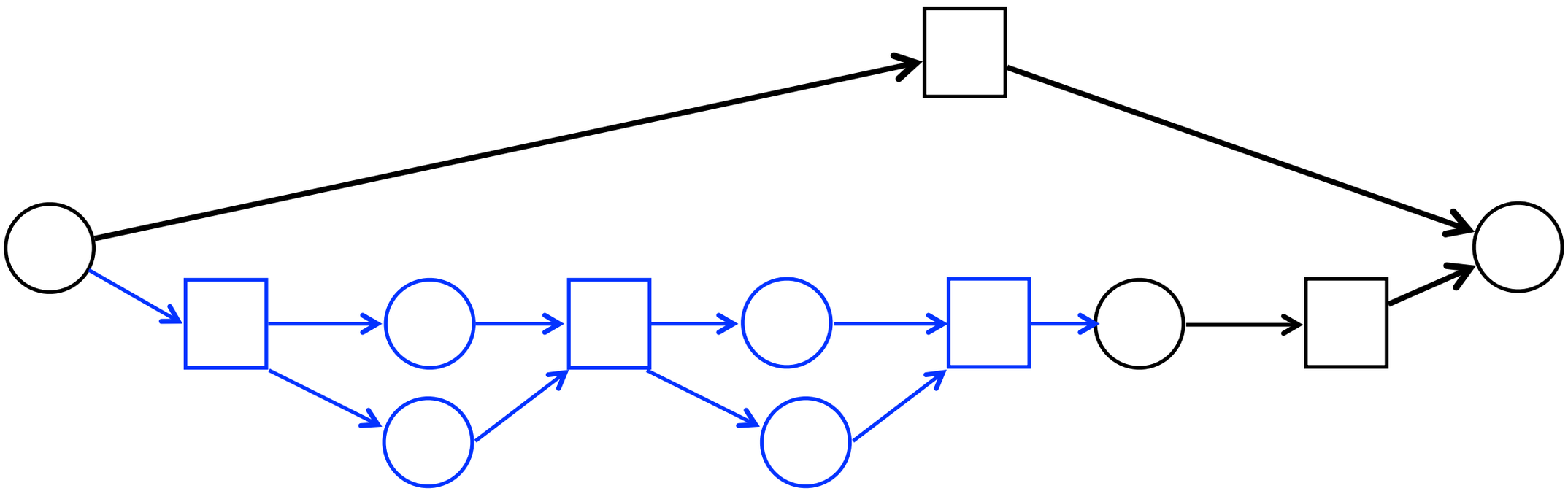

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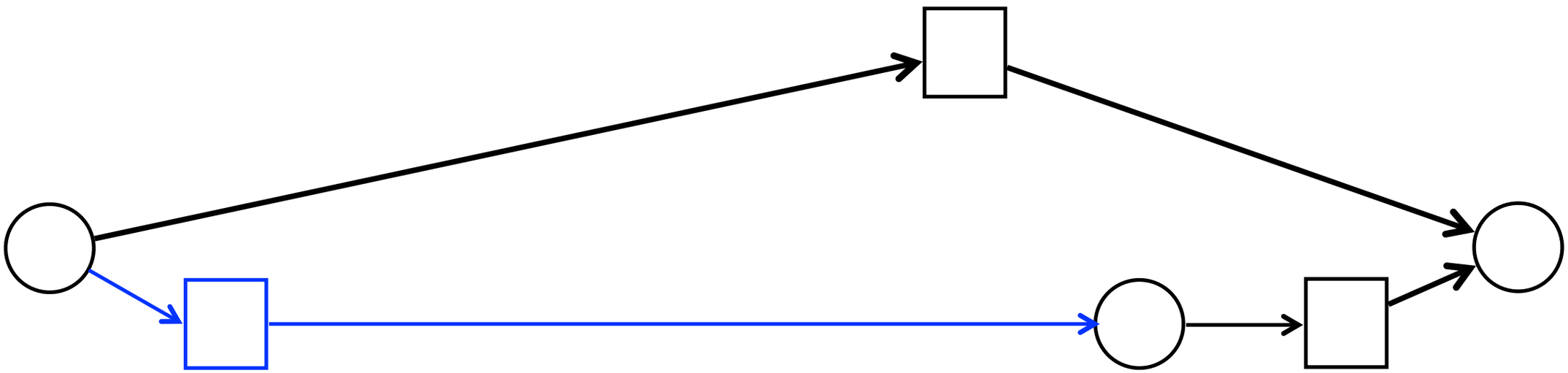

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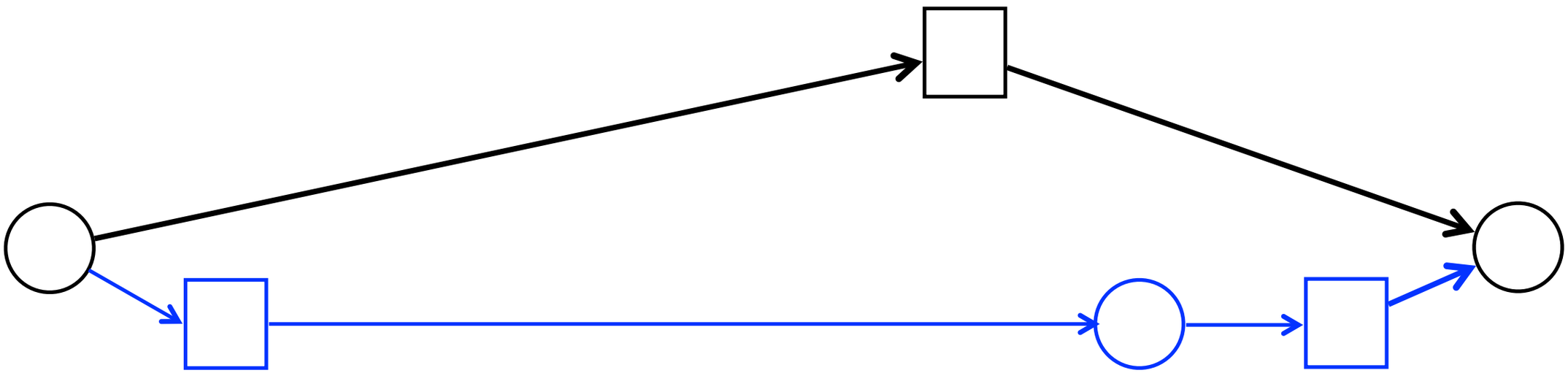

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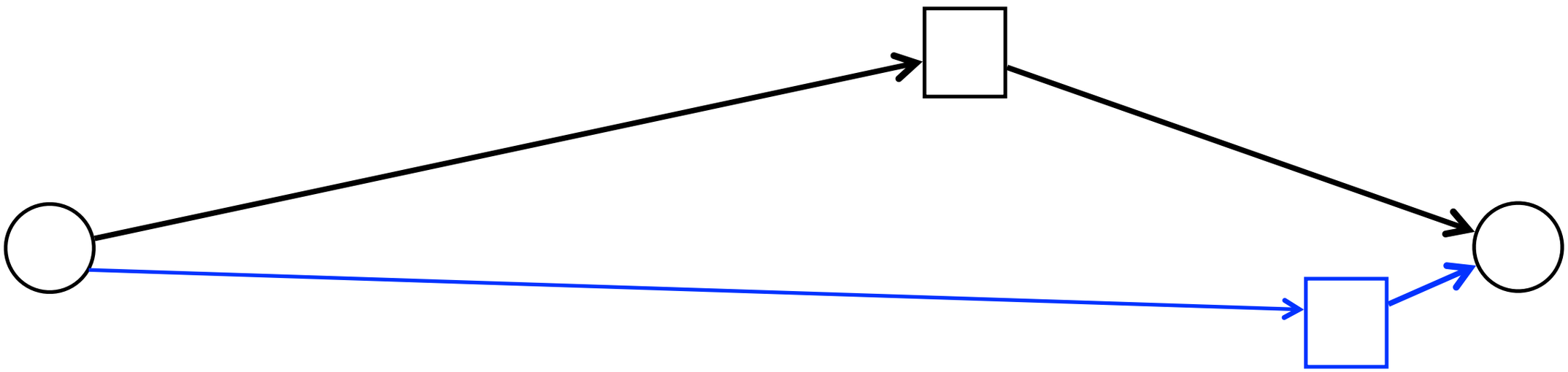

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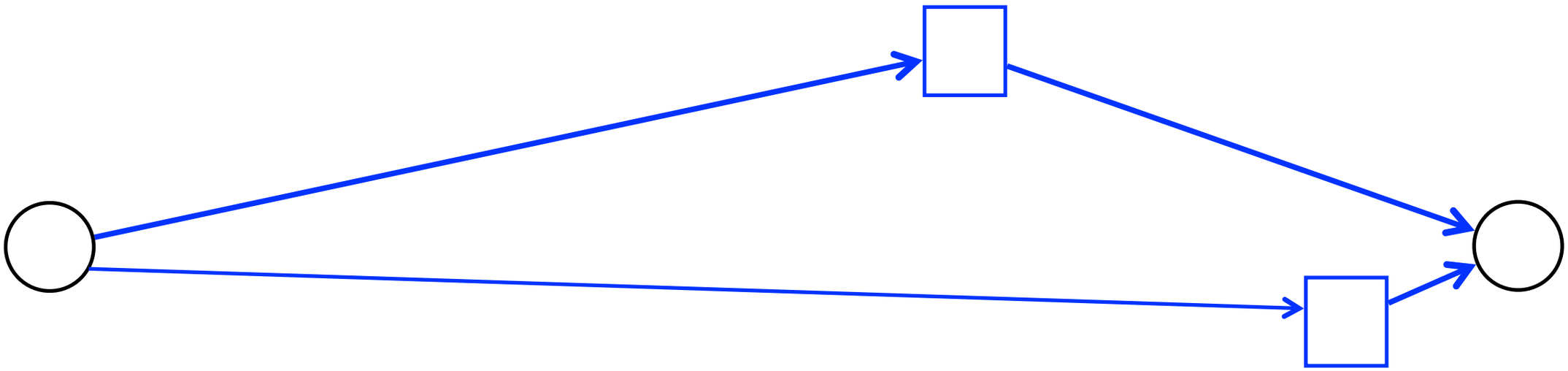

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