

Business Processes Modelling

MPB (6 cfu, 295AA)

Roberto Bruni

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

15 - Sound by construction



Object



We show a technique to build sound
Workflow nets

Soundness proof by construction

Idea

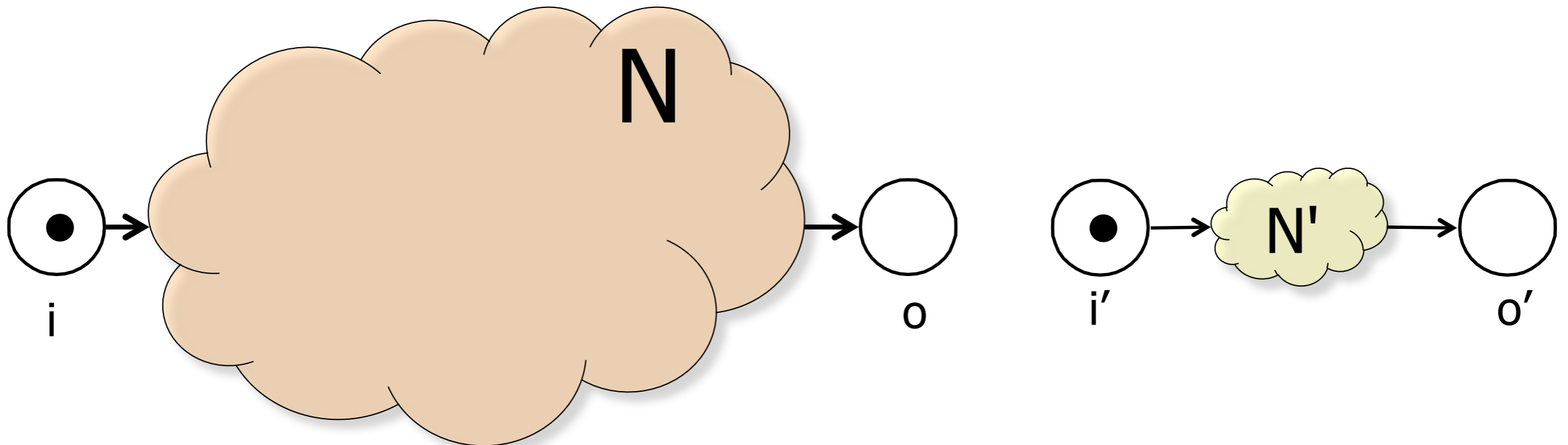
1. Find a suitable set of "building blocks"

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

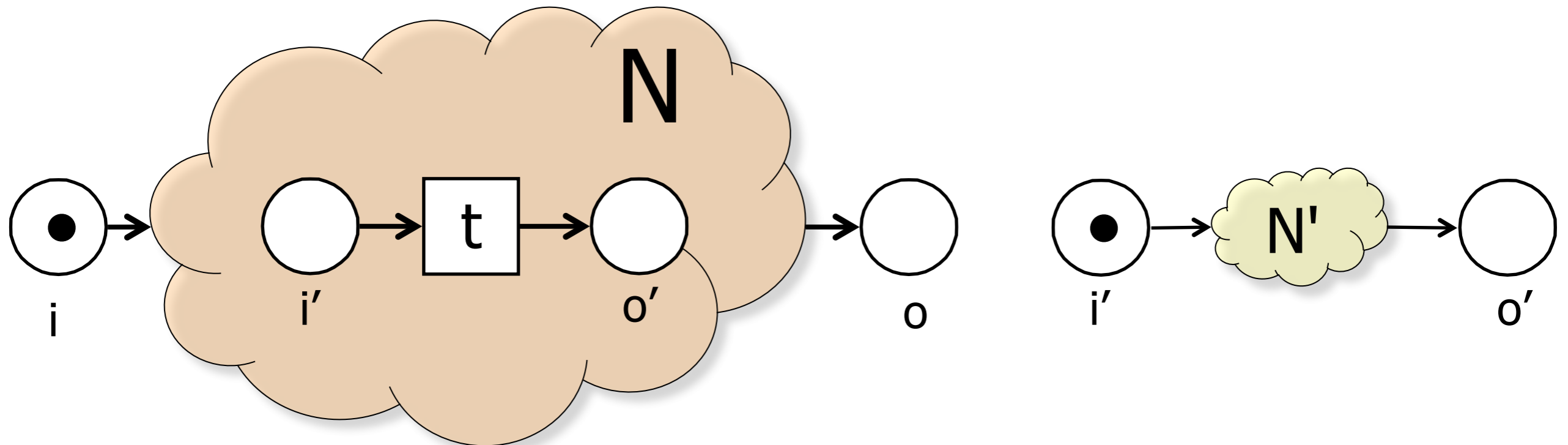
Sound and safe by composition

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



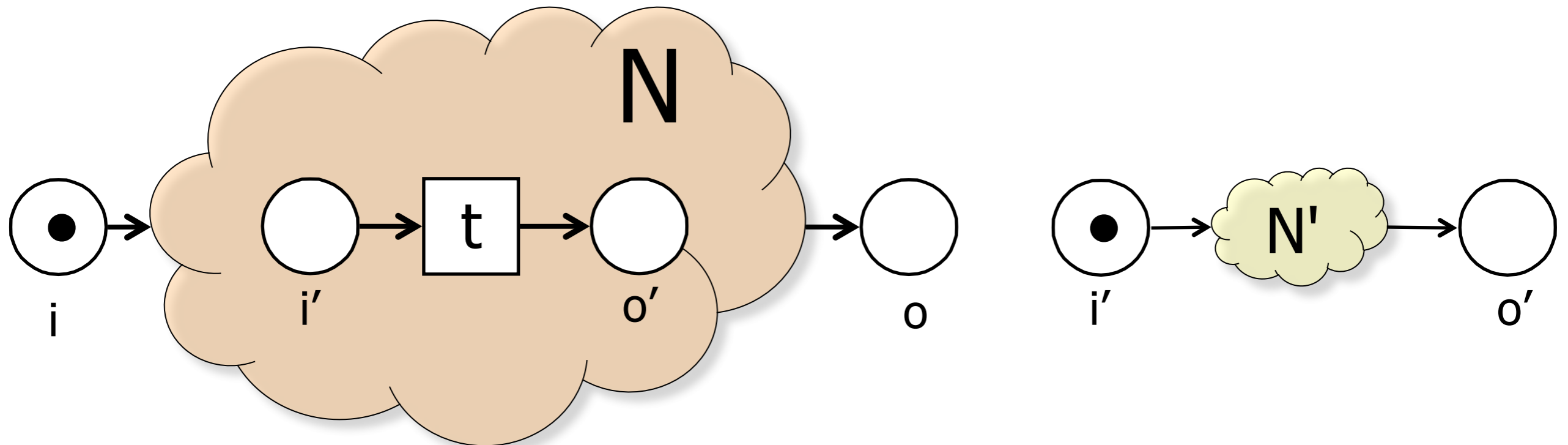
Sound and safe by composition

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



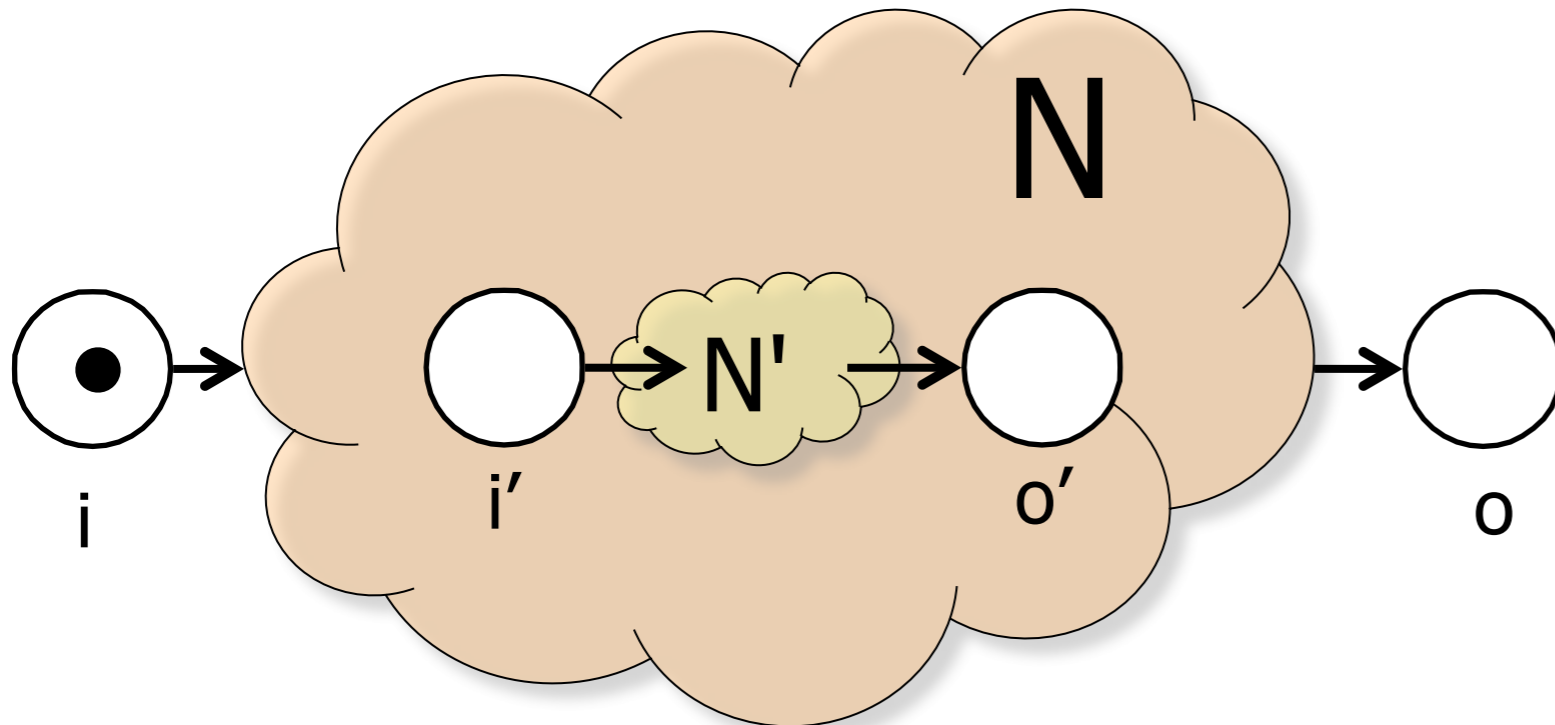
Sound and safe by composition

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



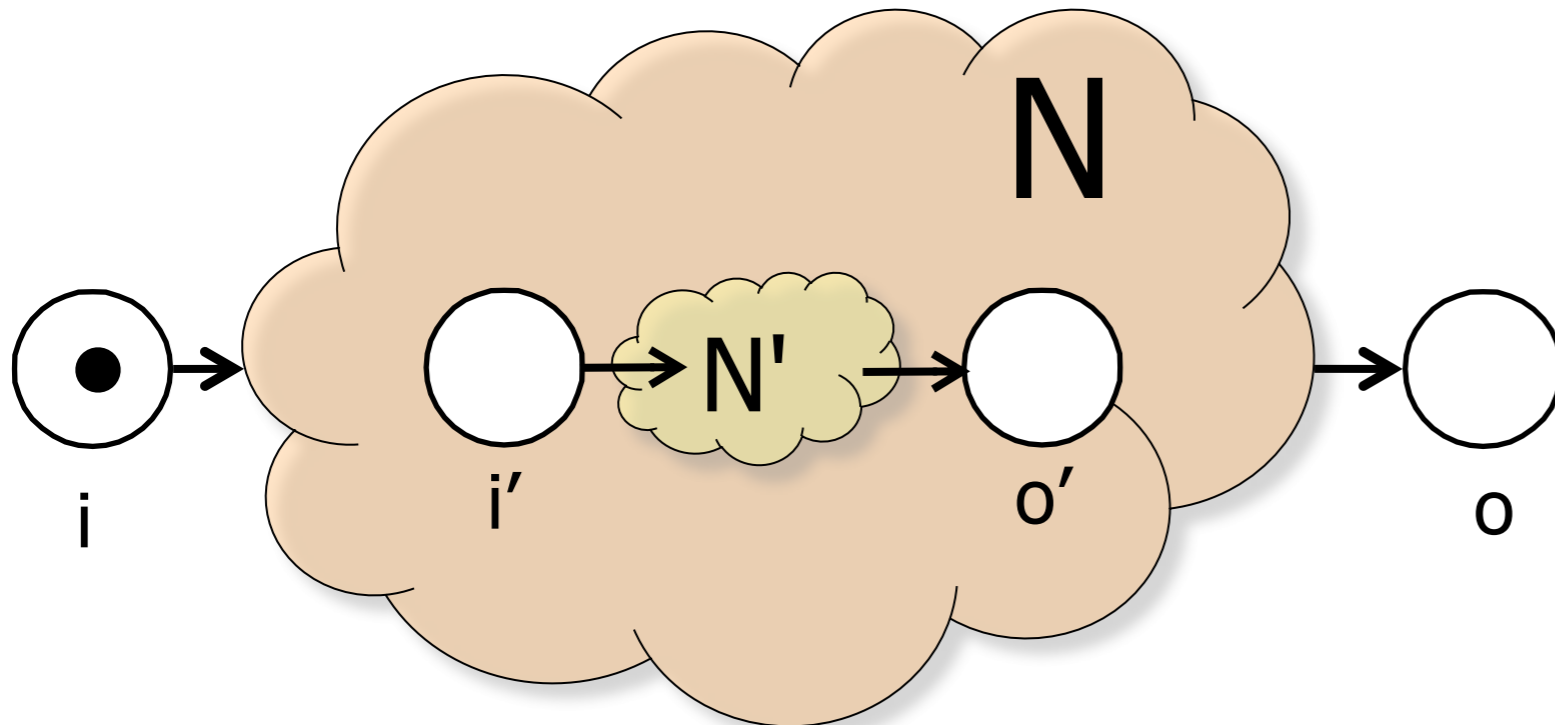
Sound and safe by composition

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)



Proof sketch

Intuitively

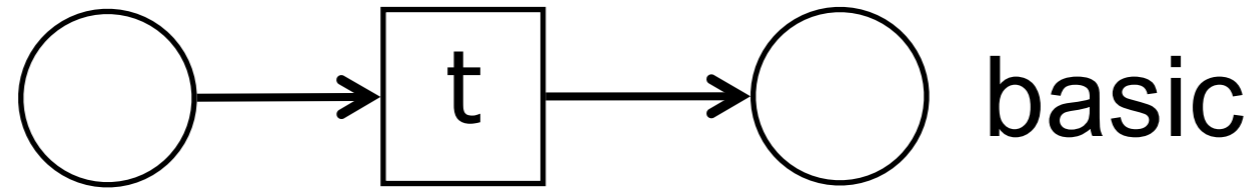
a sound workflow net behaves as a transition:
it takes one token from its input place and
it produces one token to its output place
(but not atomically)

Formally

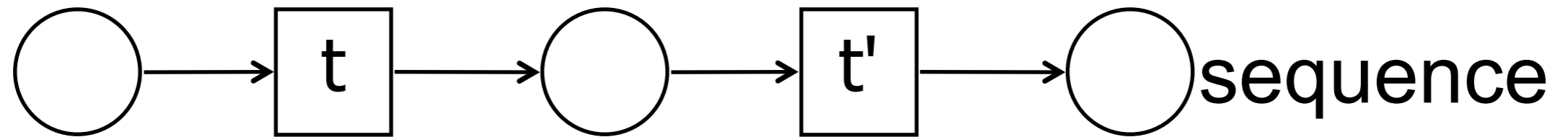
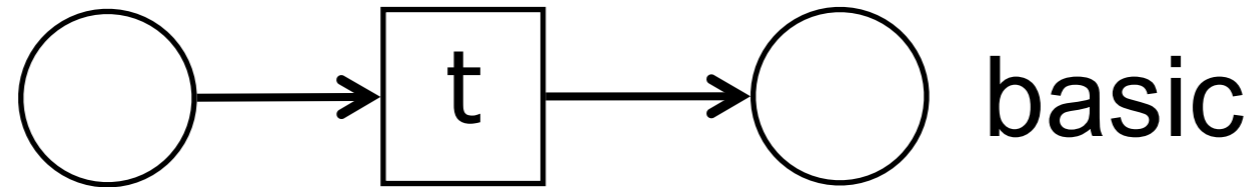
the crux of the proof is showing a bijective correspondence
between

markings of the composed net $N[N'/t]$
and the pairs of markings in N and N'

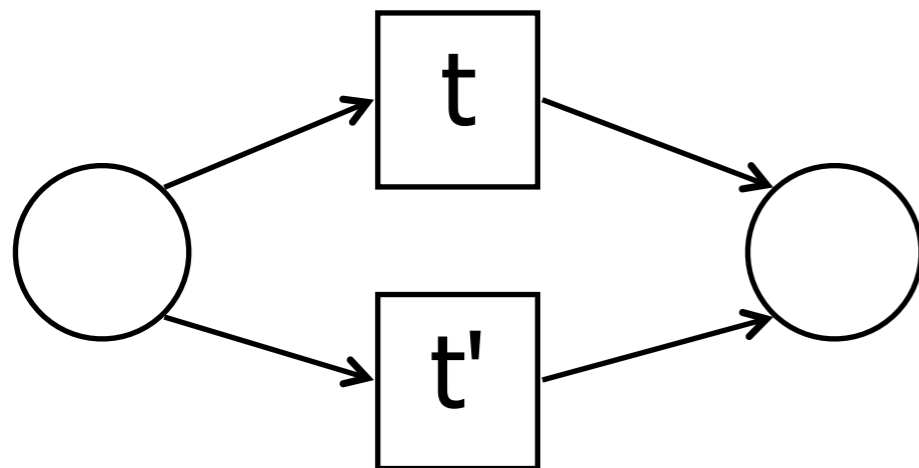
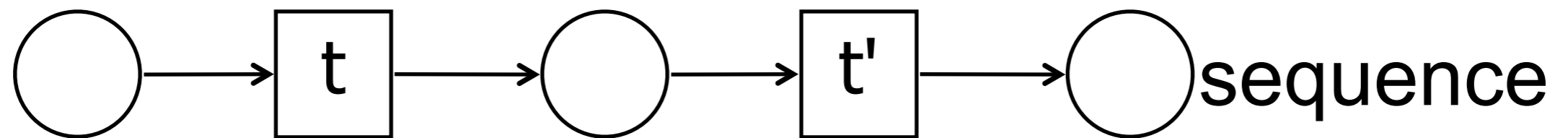
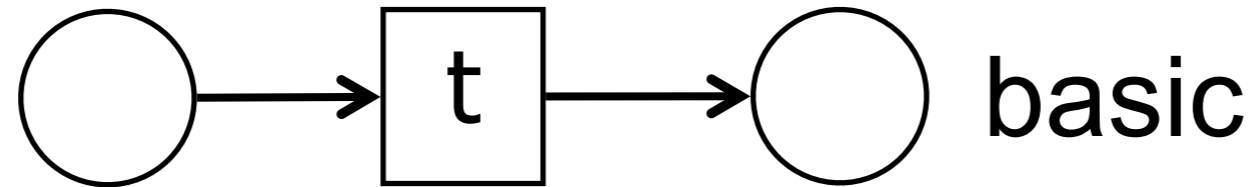
Some Building Blocks 1



Some Building Blocks 1

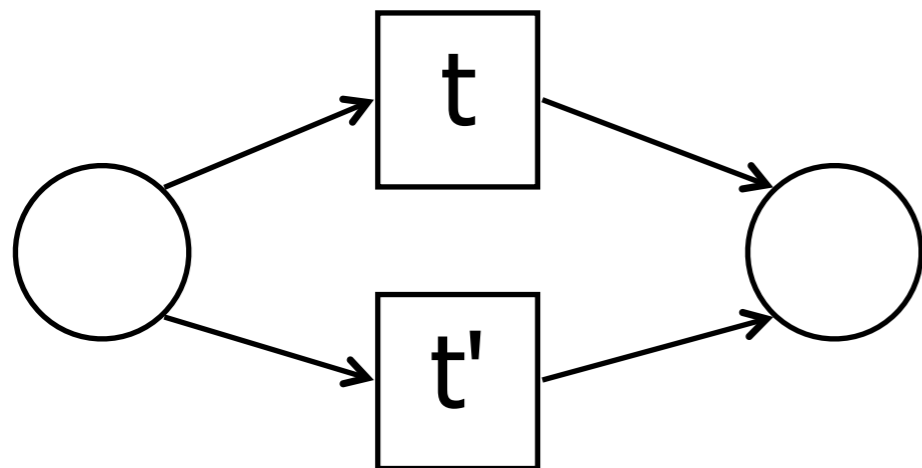
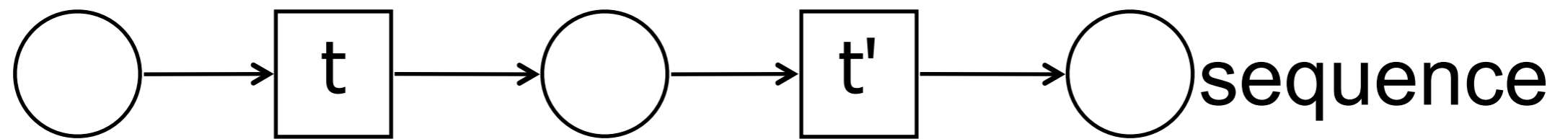
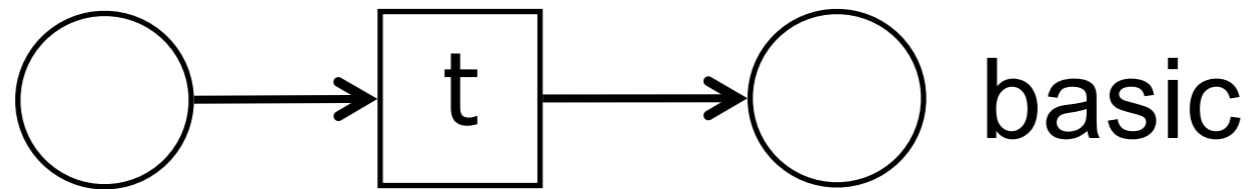


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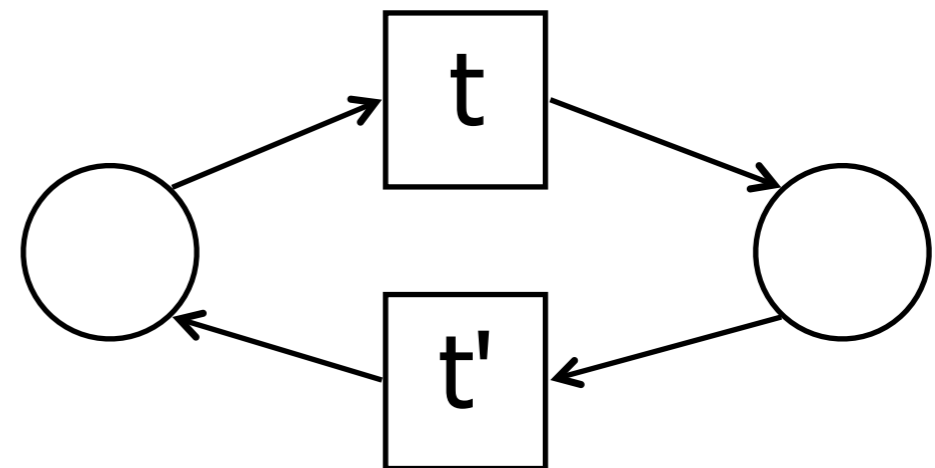


implicit XOR

Some Building Blocks 1

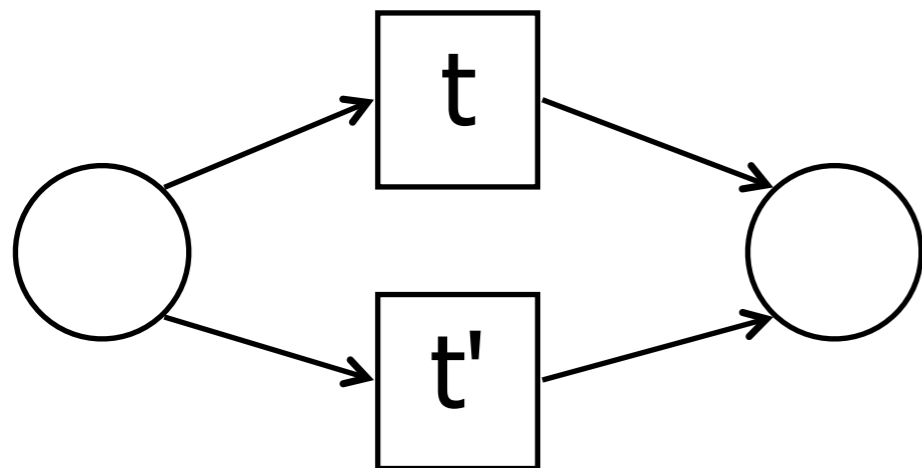
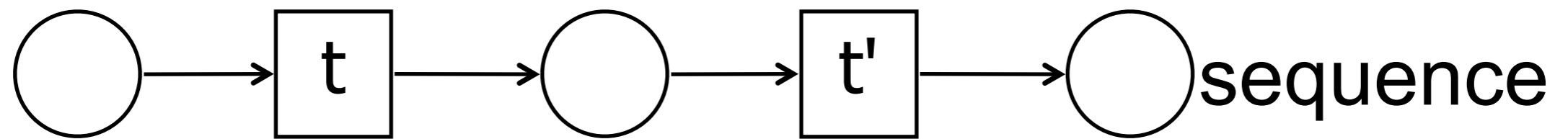
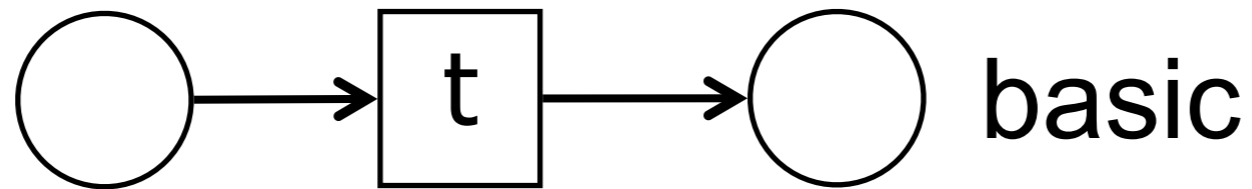


implicit XOR

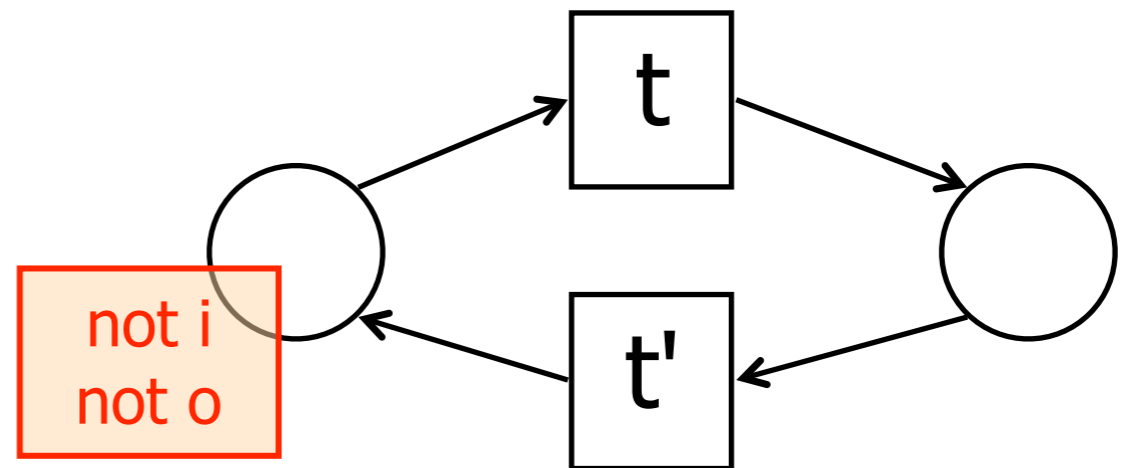


iteration

Some Building Blocks 1

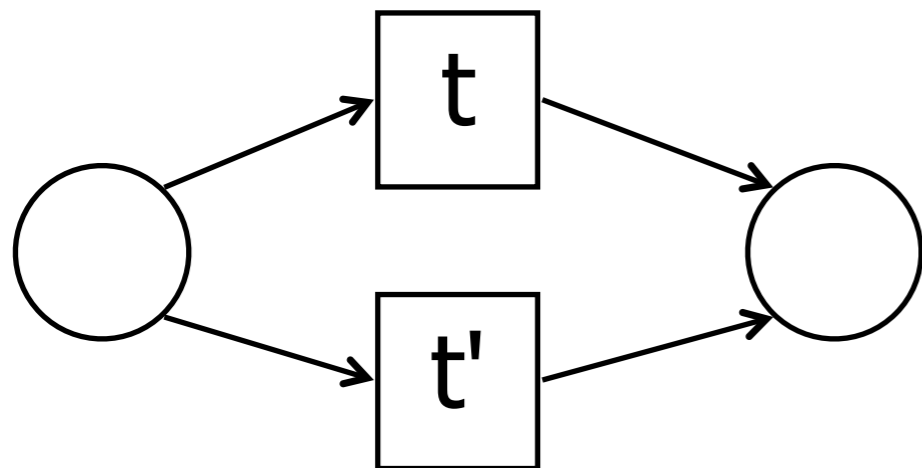
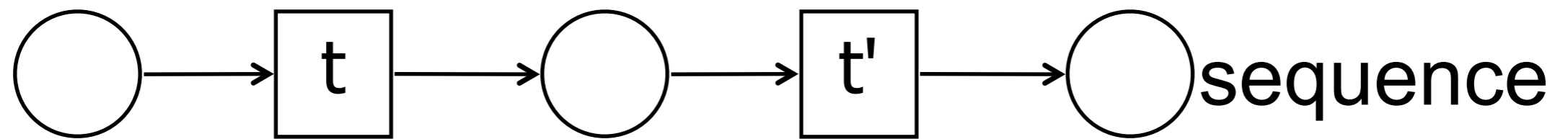
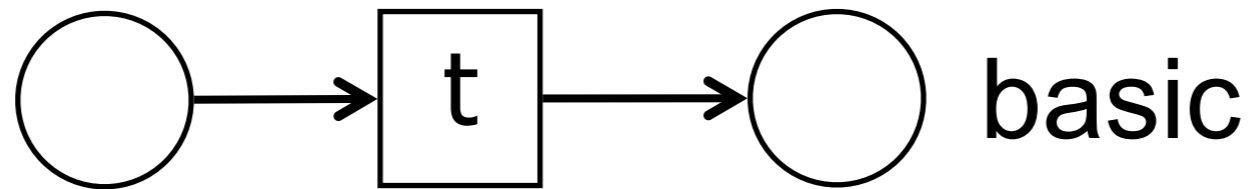


implicit XOR

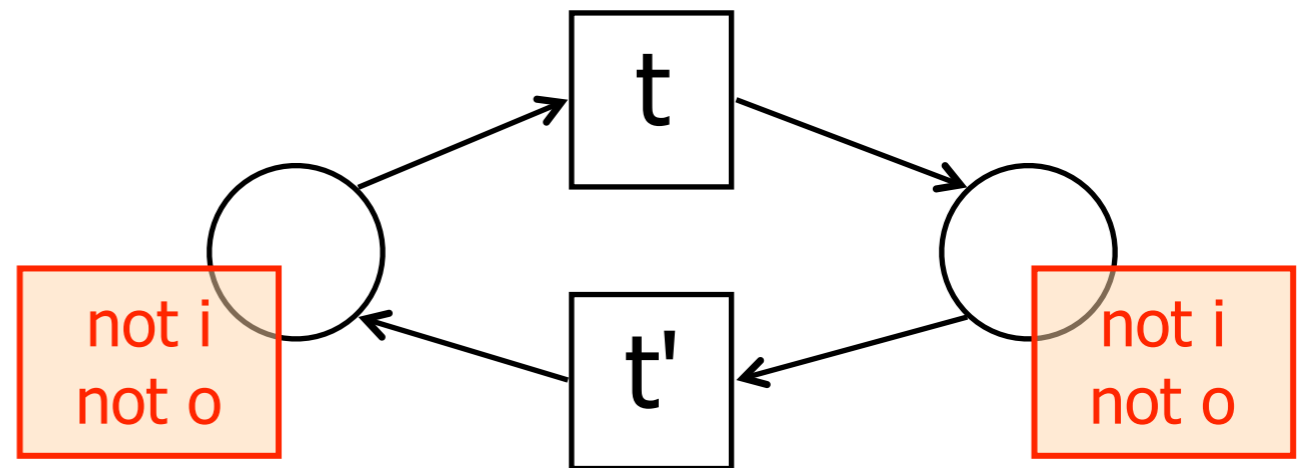


iteration

Some Building Blocks 1

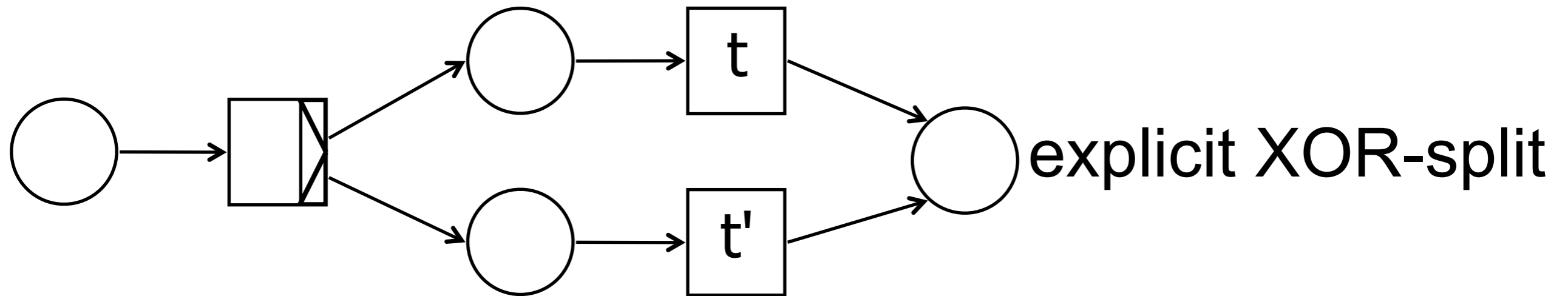


implicit XOR

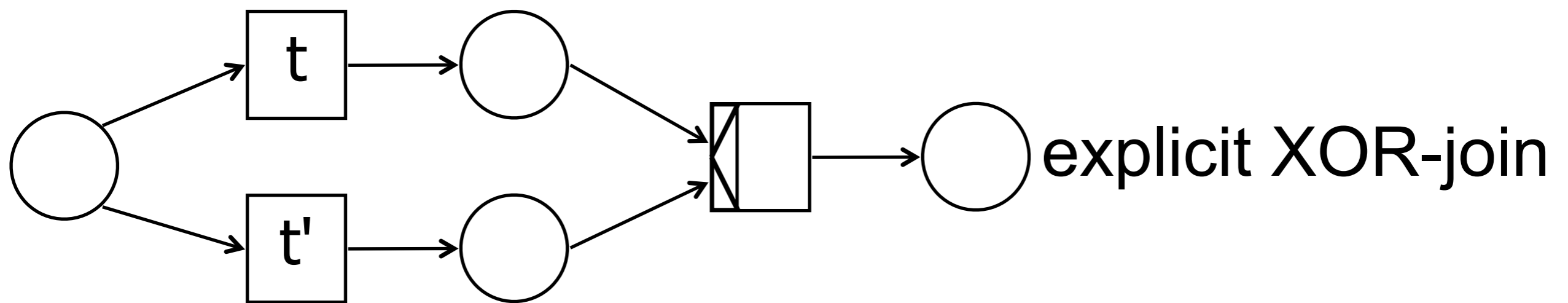
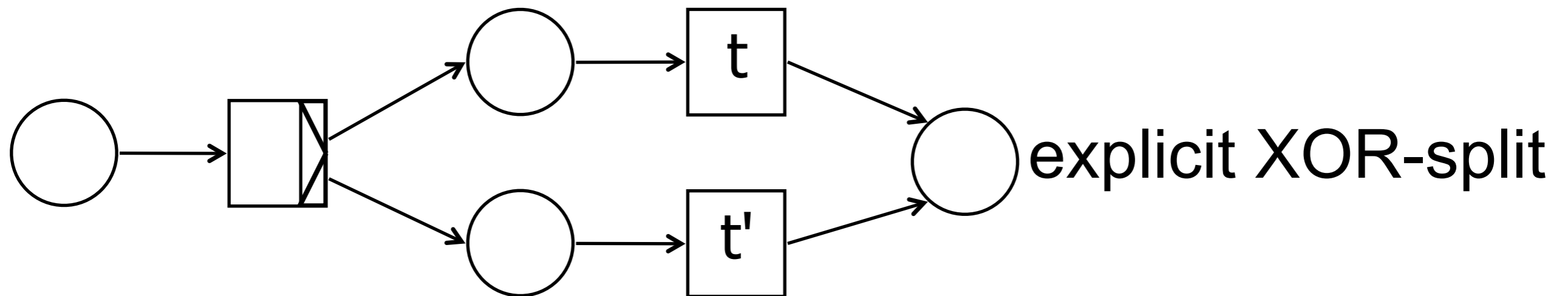


iteration

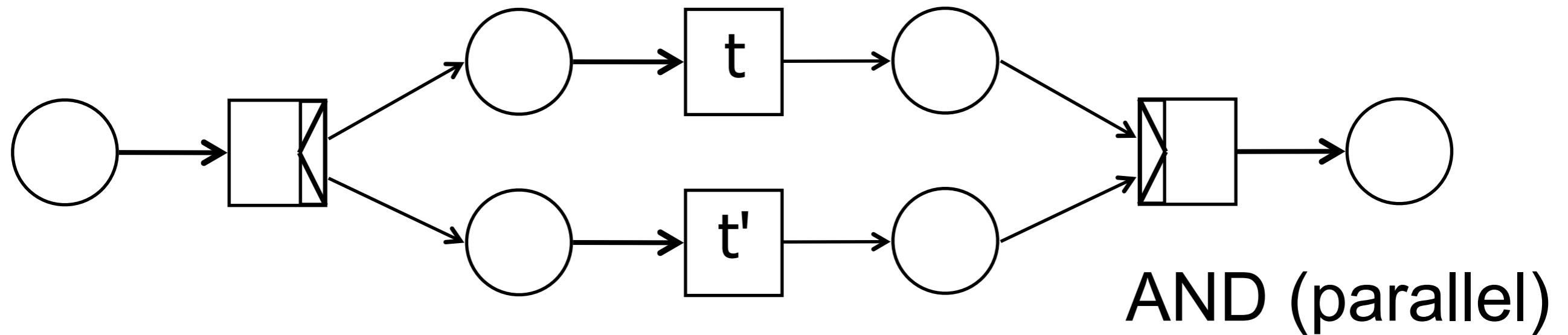
Some Building Blocks 2



Some Building Blocks 2

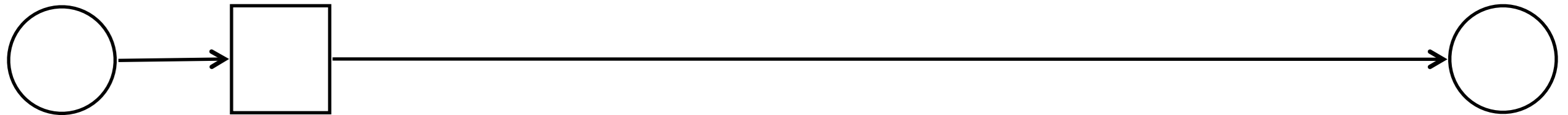


Some Building Blocks 3

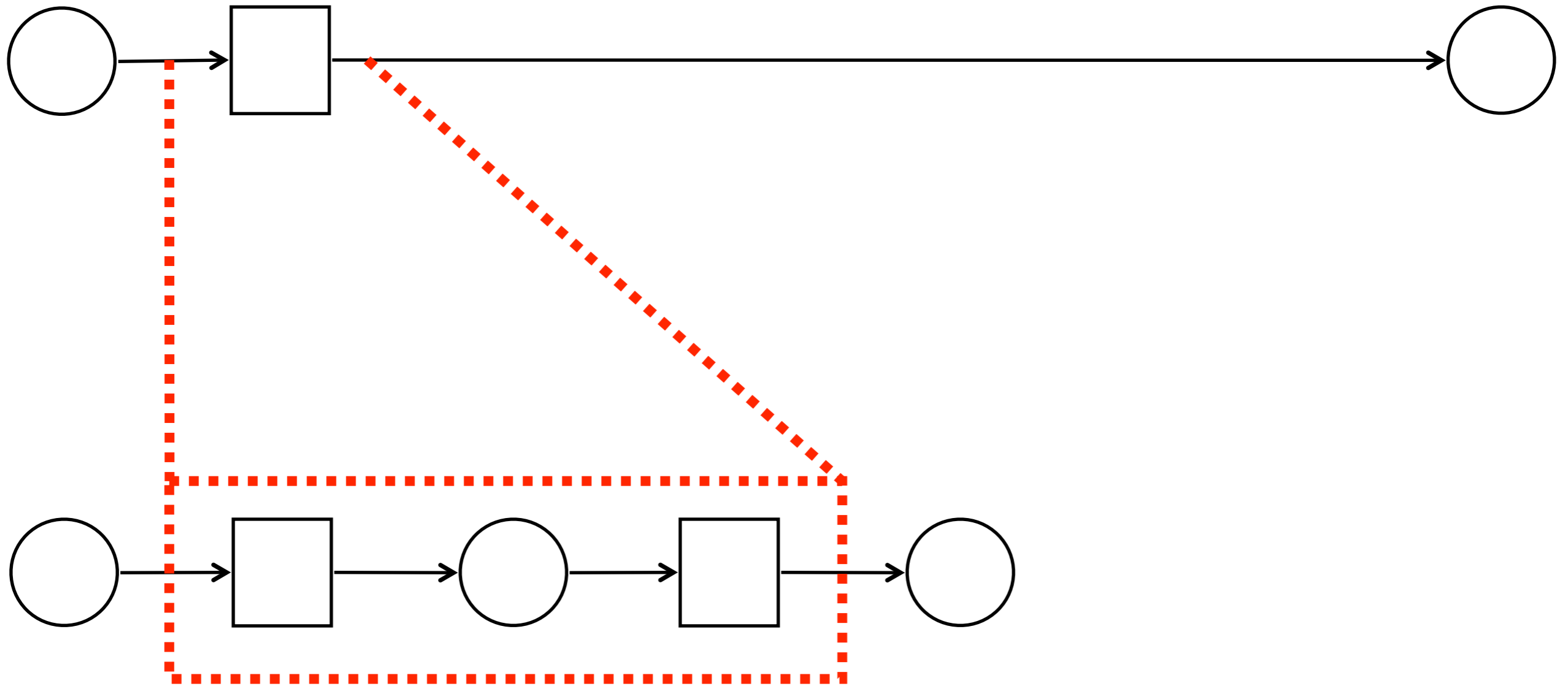


But you can define more blocks on your own

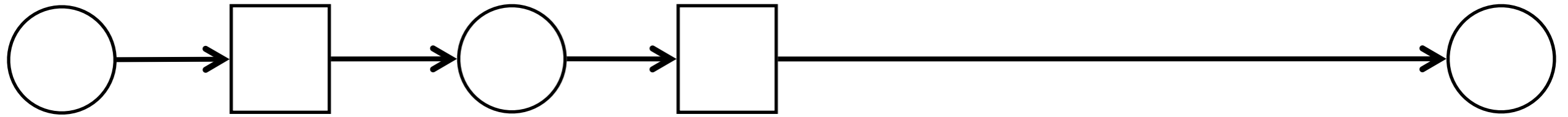
Example: refinement



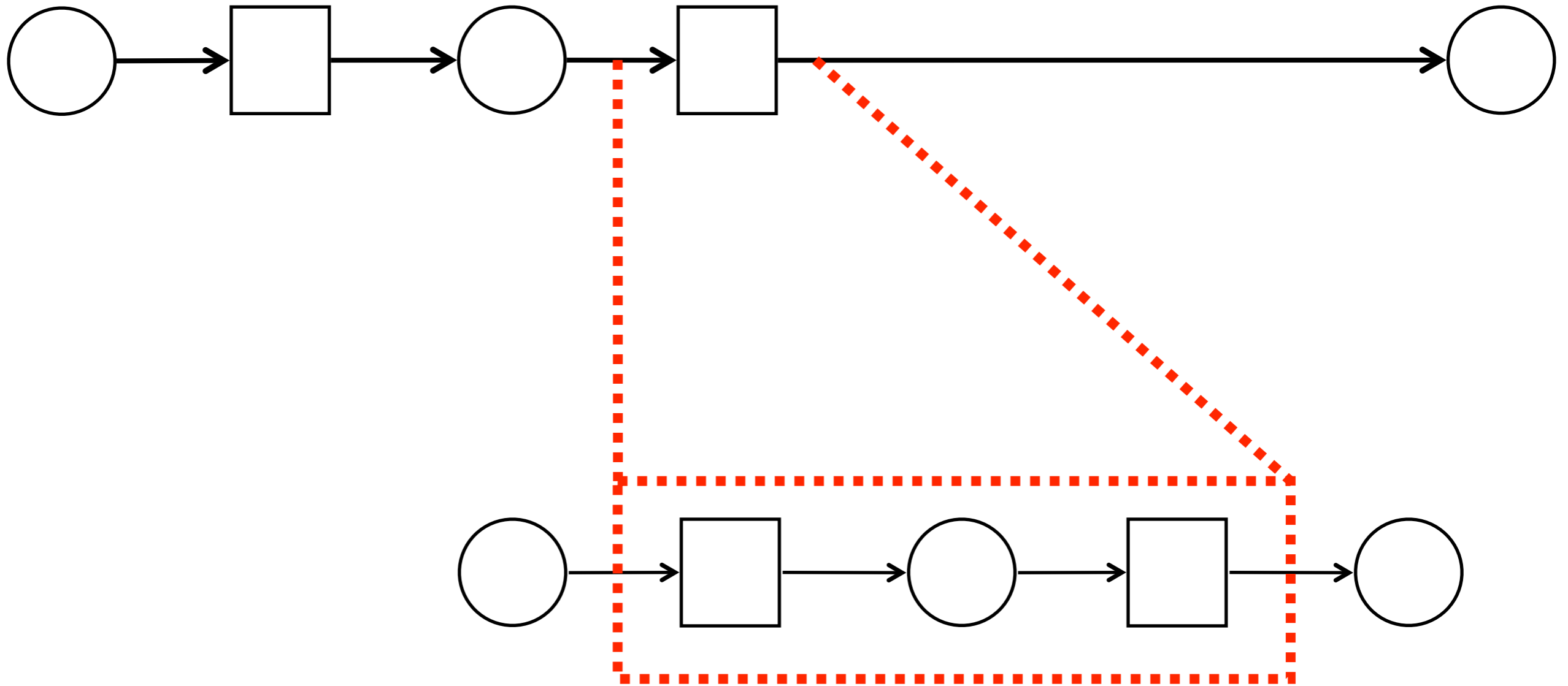
Example: refinement



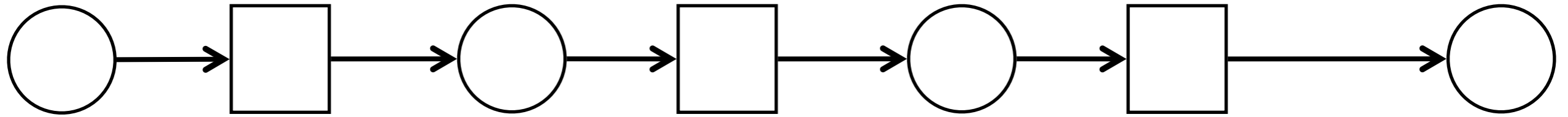
Example: refinement



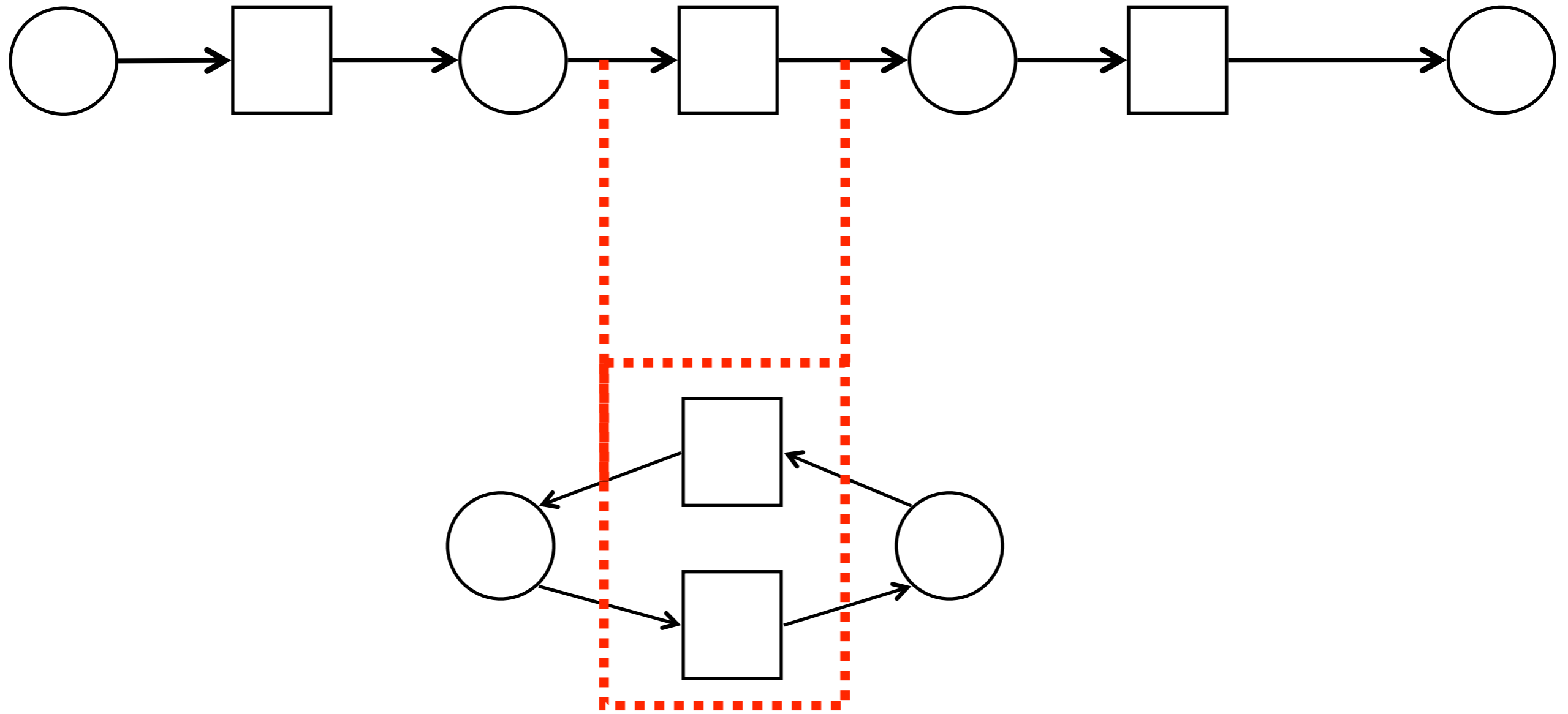
Example: refinement



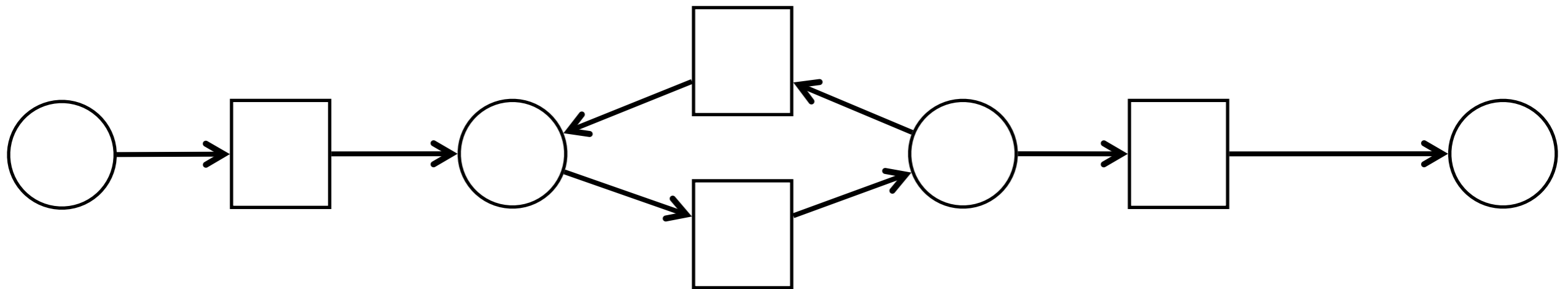
Example: refinement



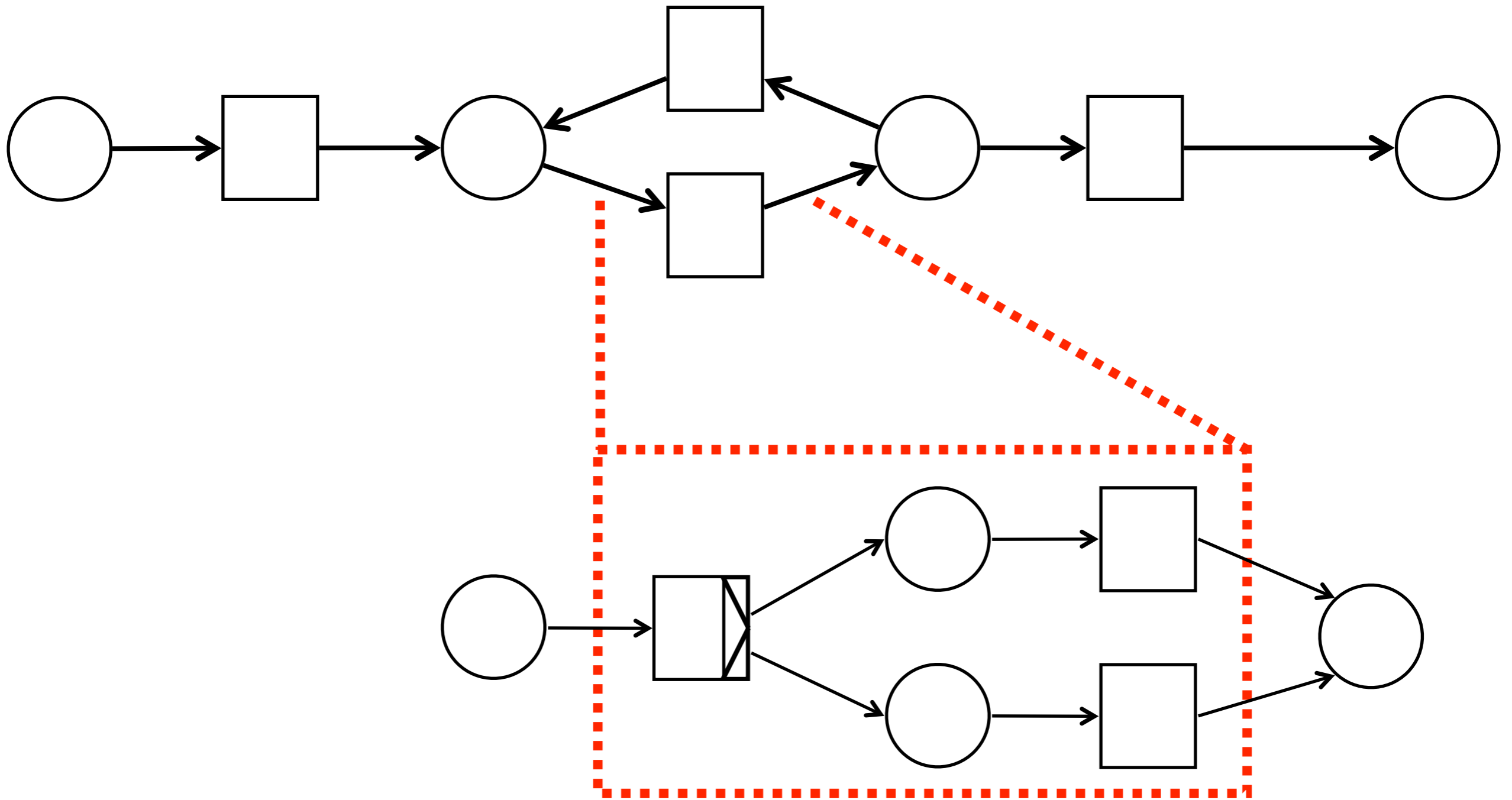
Example: refinement



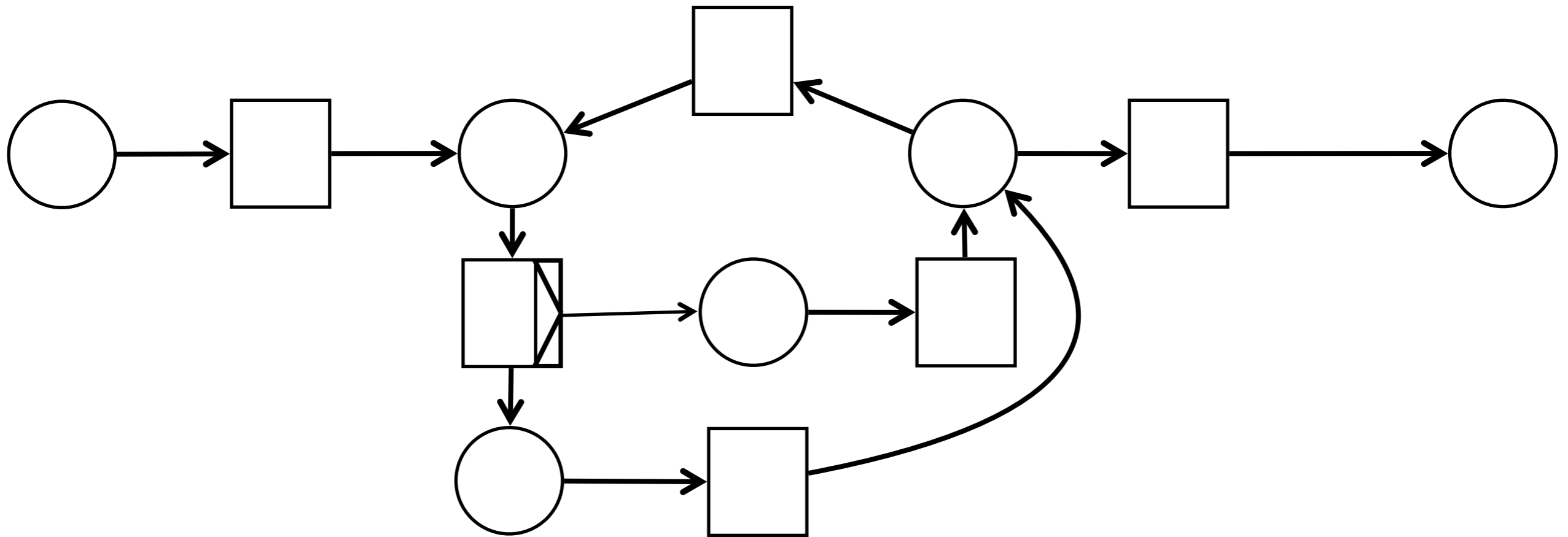
Example: refinement



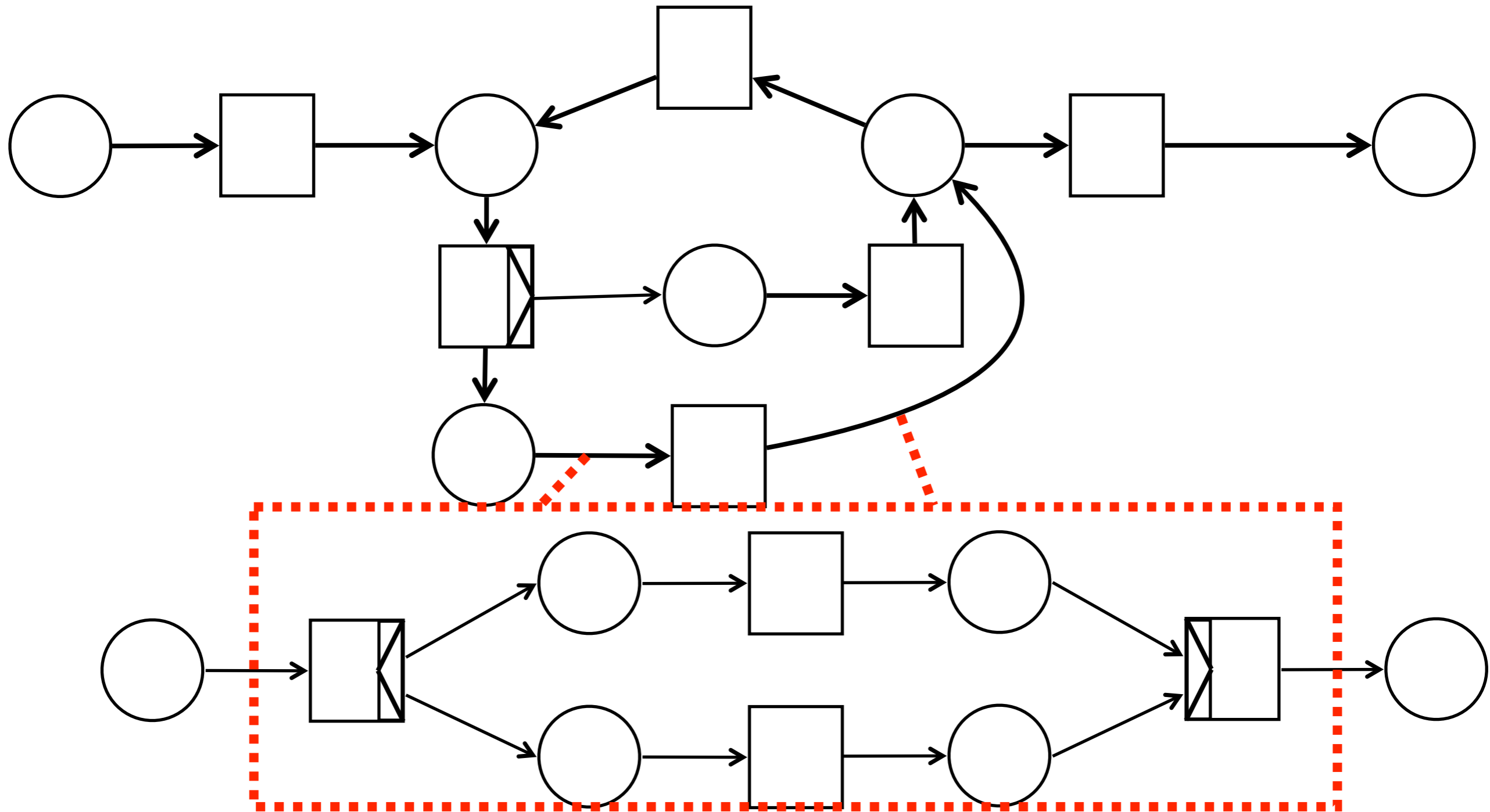
Example: refinement



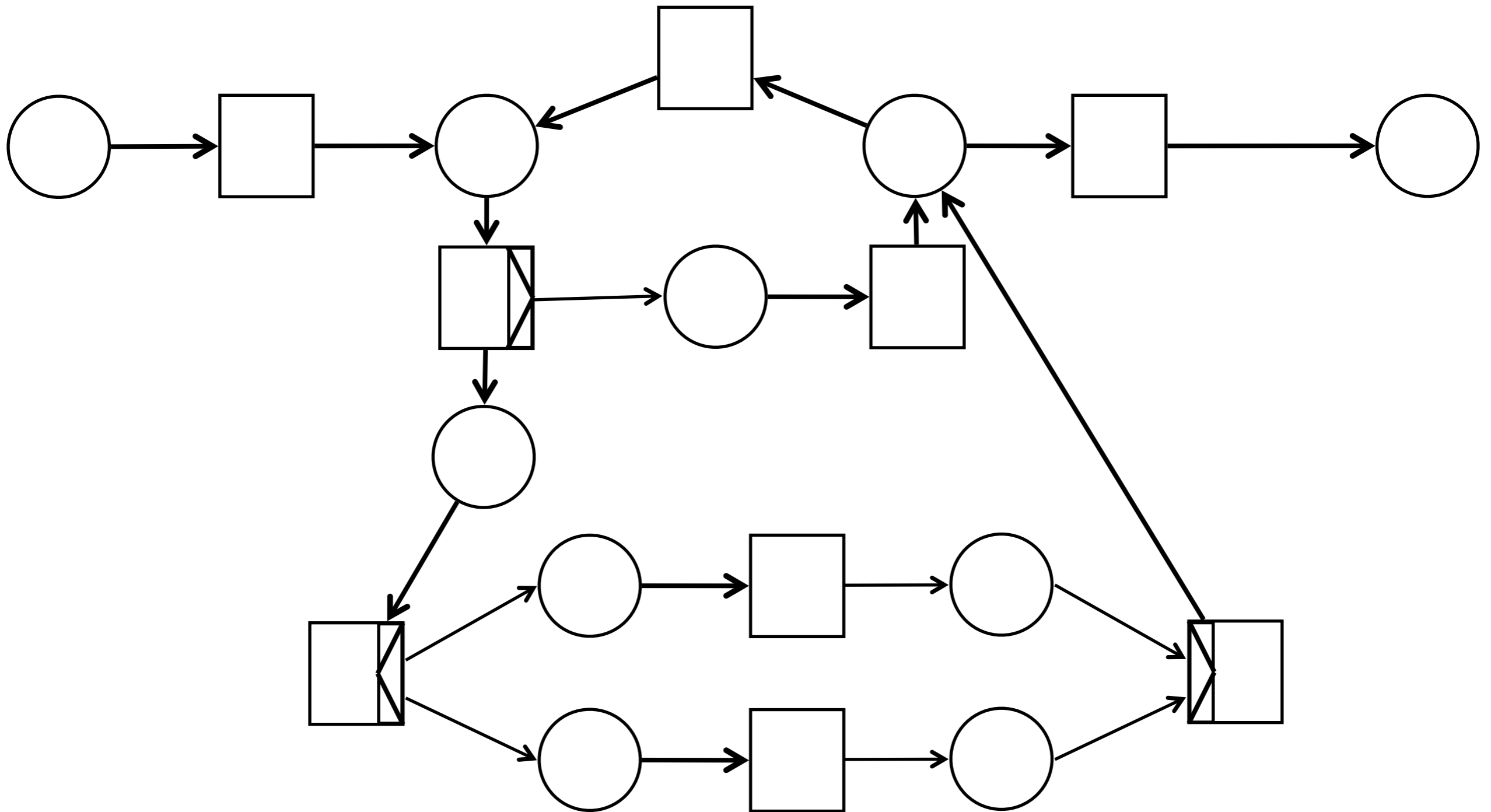
Example: refinement



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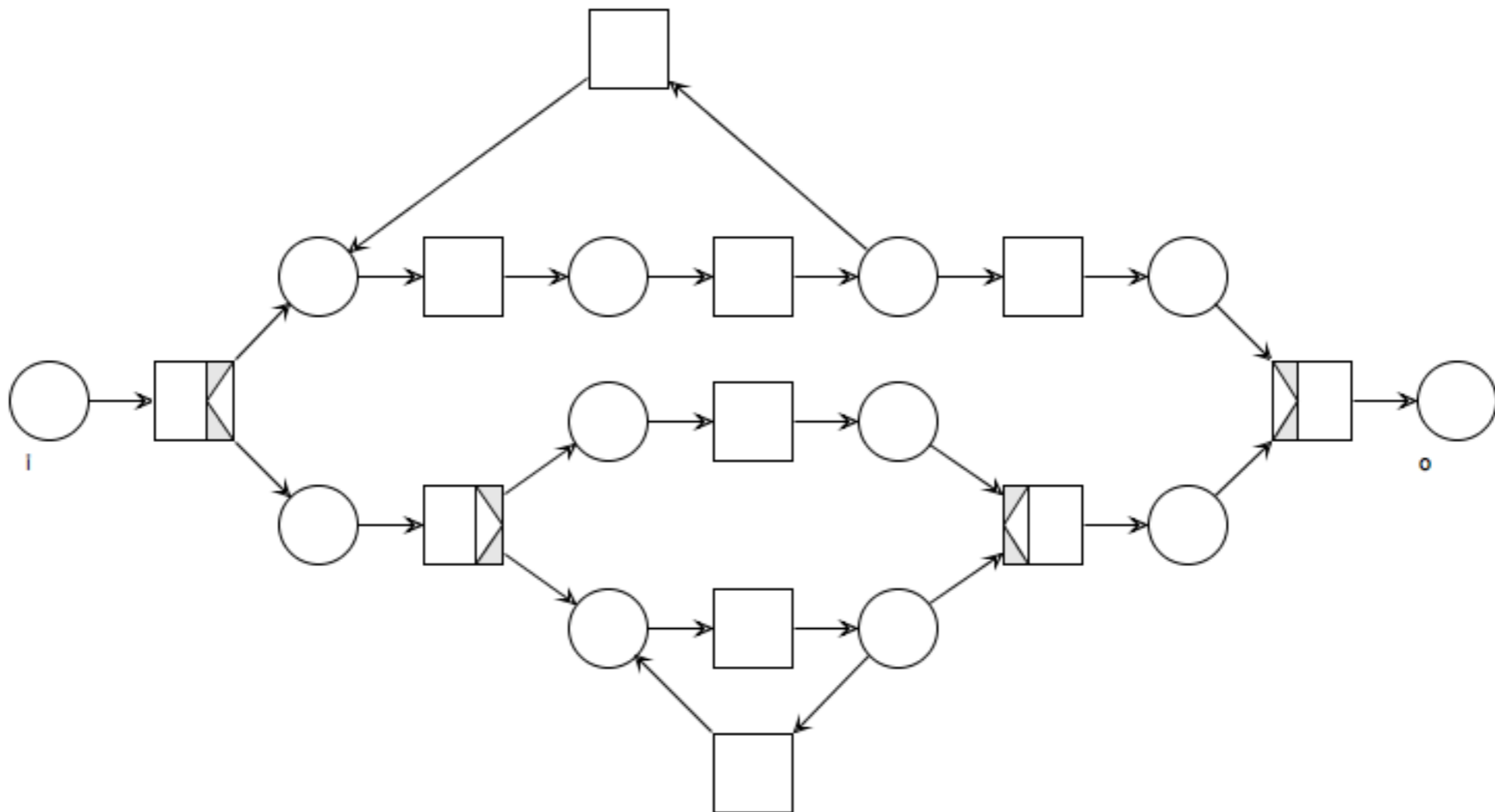


Example: refinement



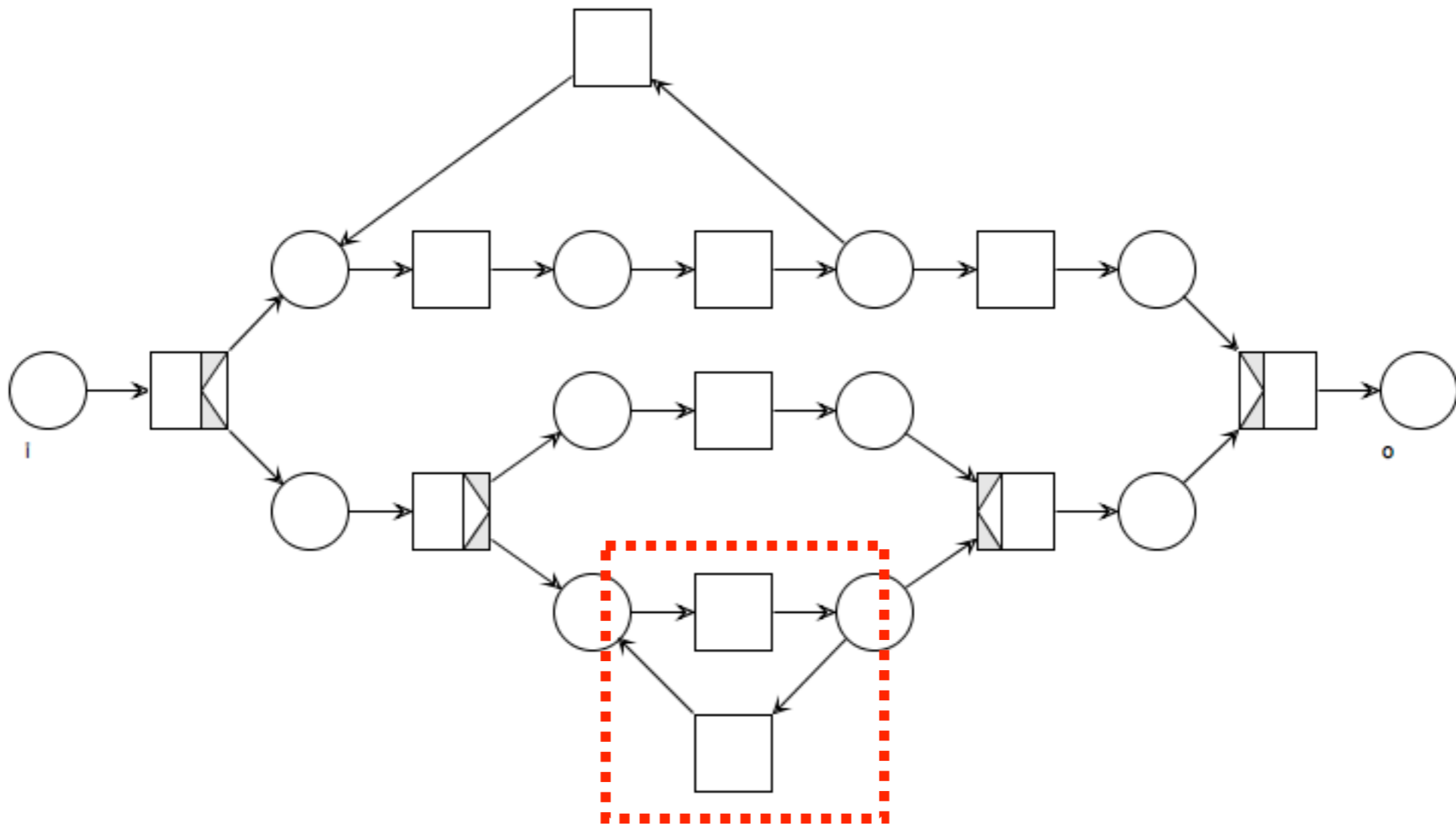
Example: abstraction

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



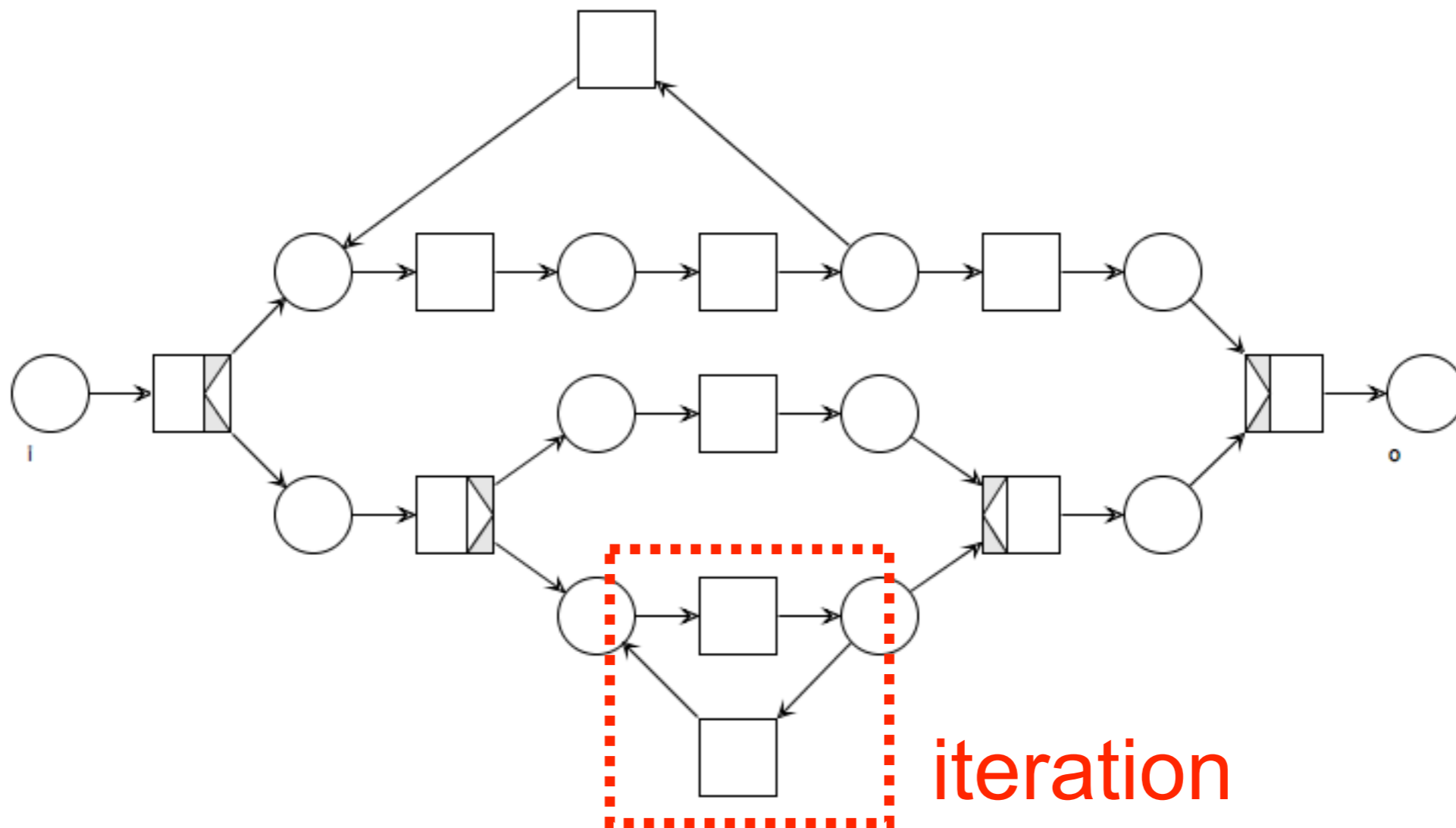
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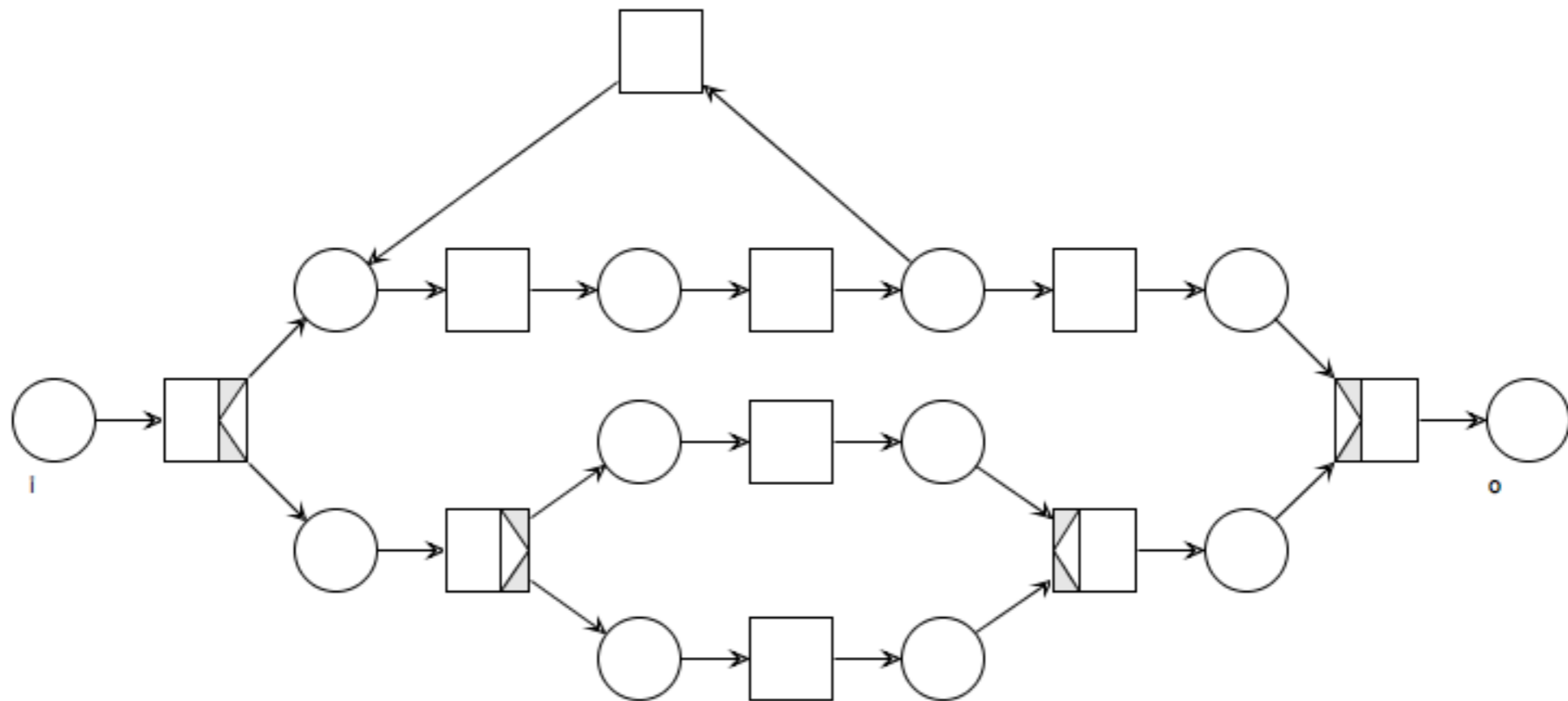
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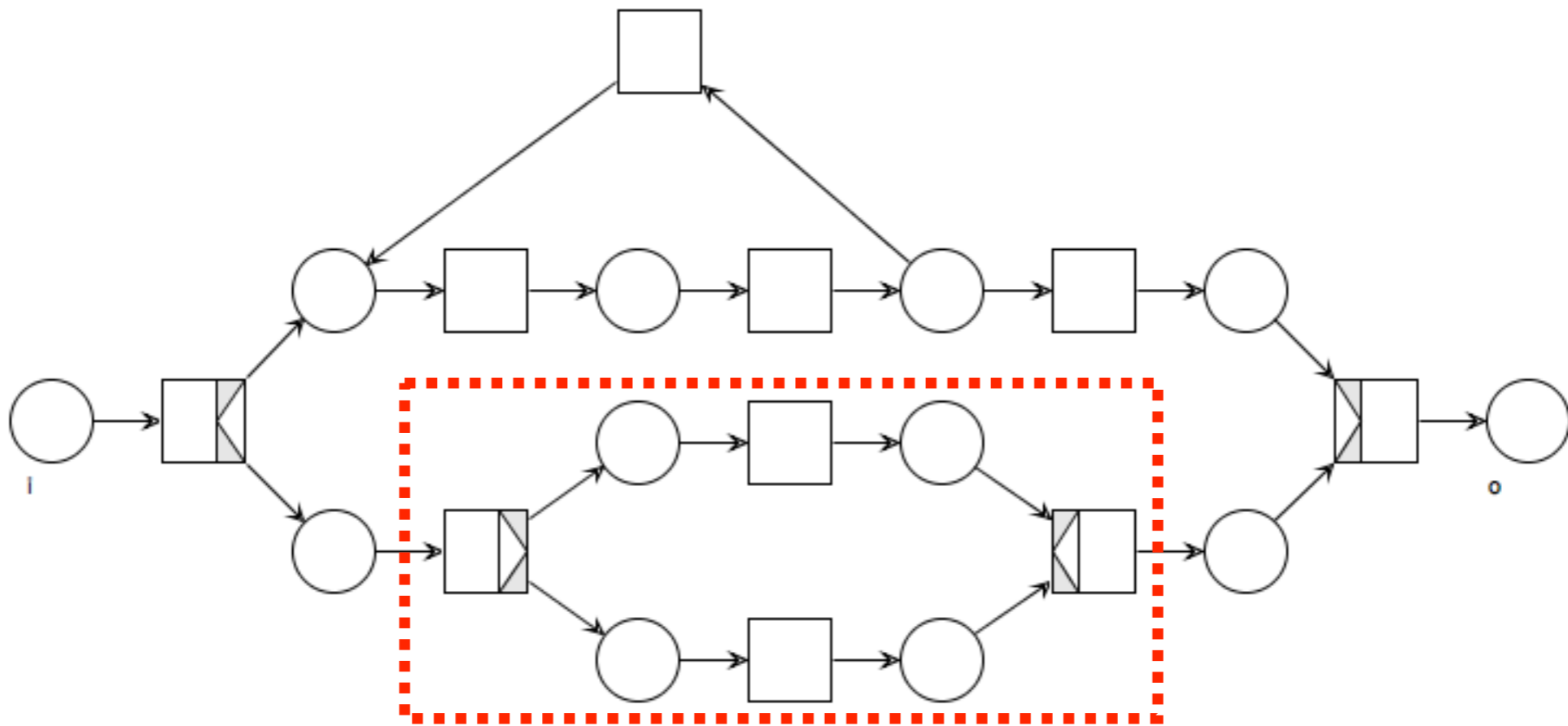
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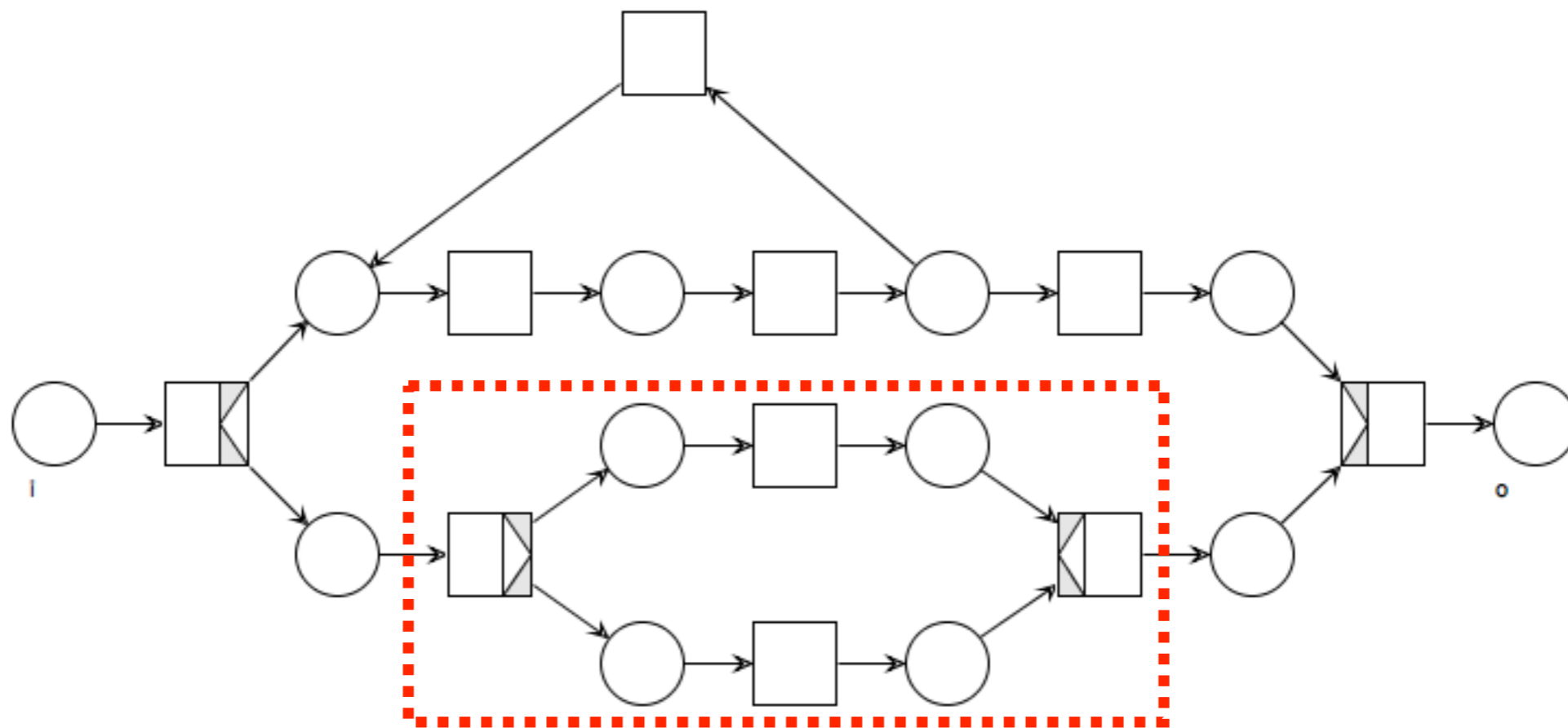
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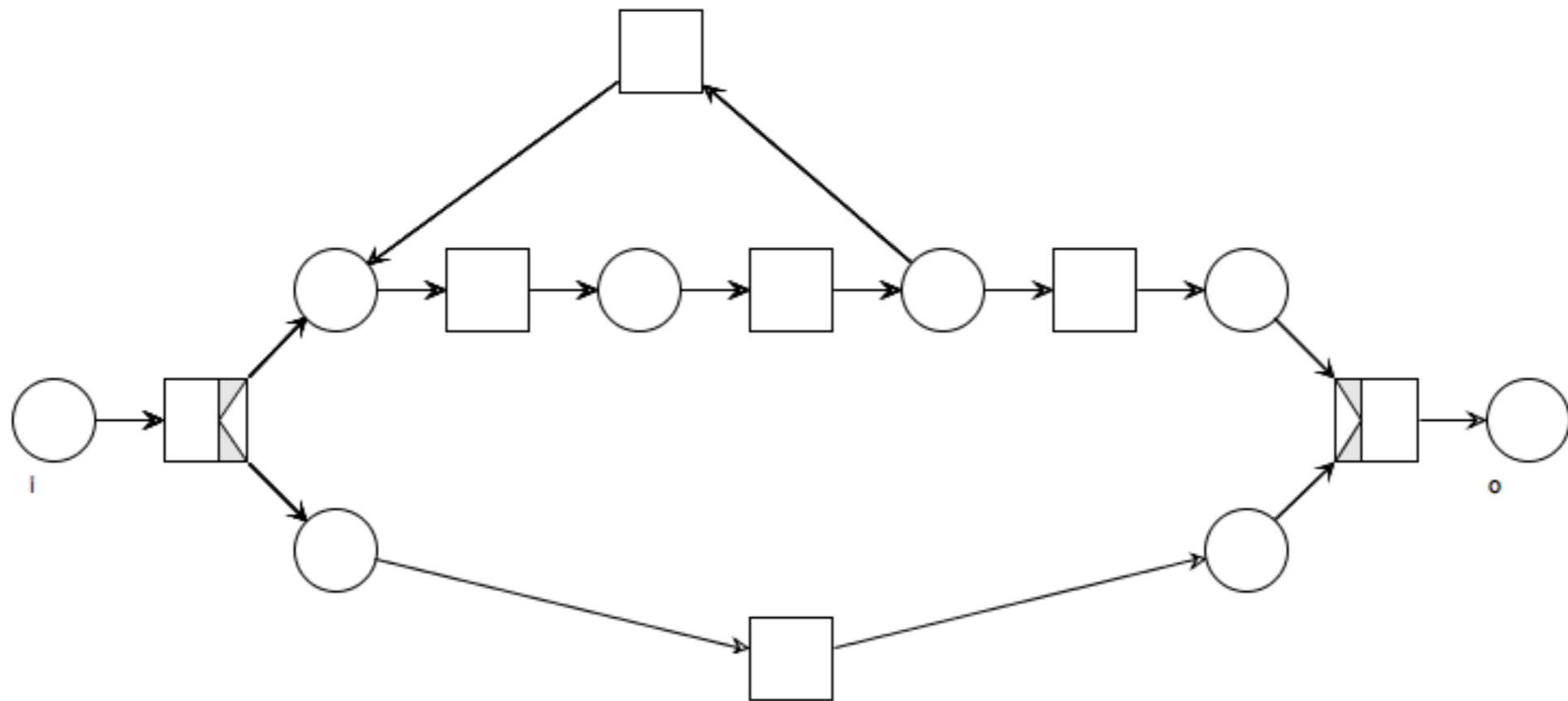
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explicit XOR block

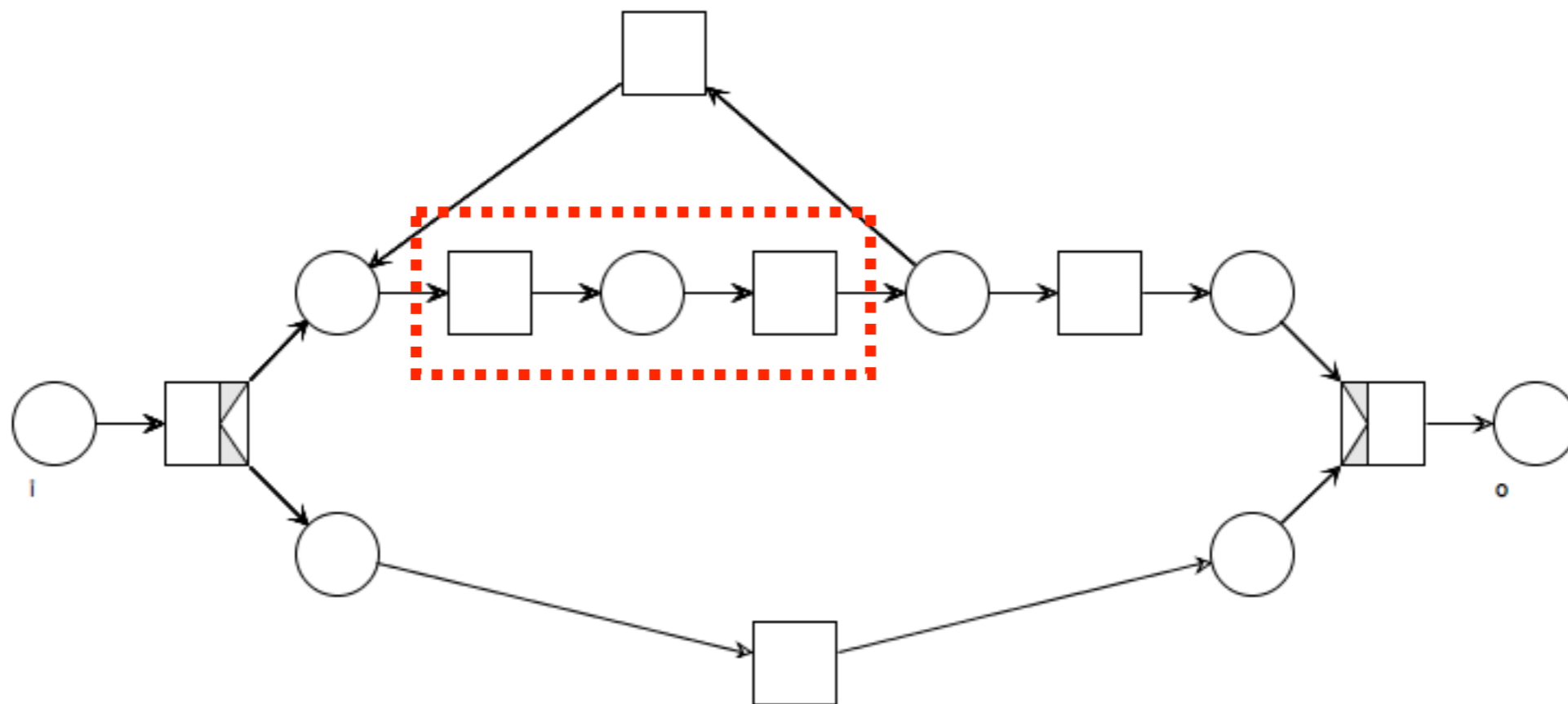
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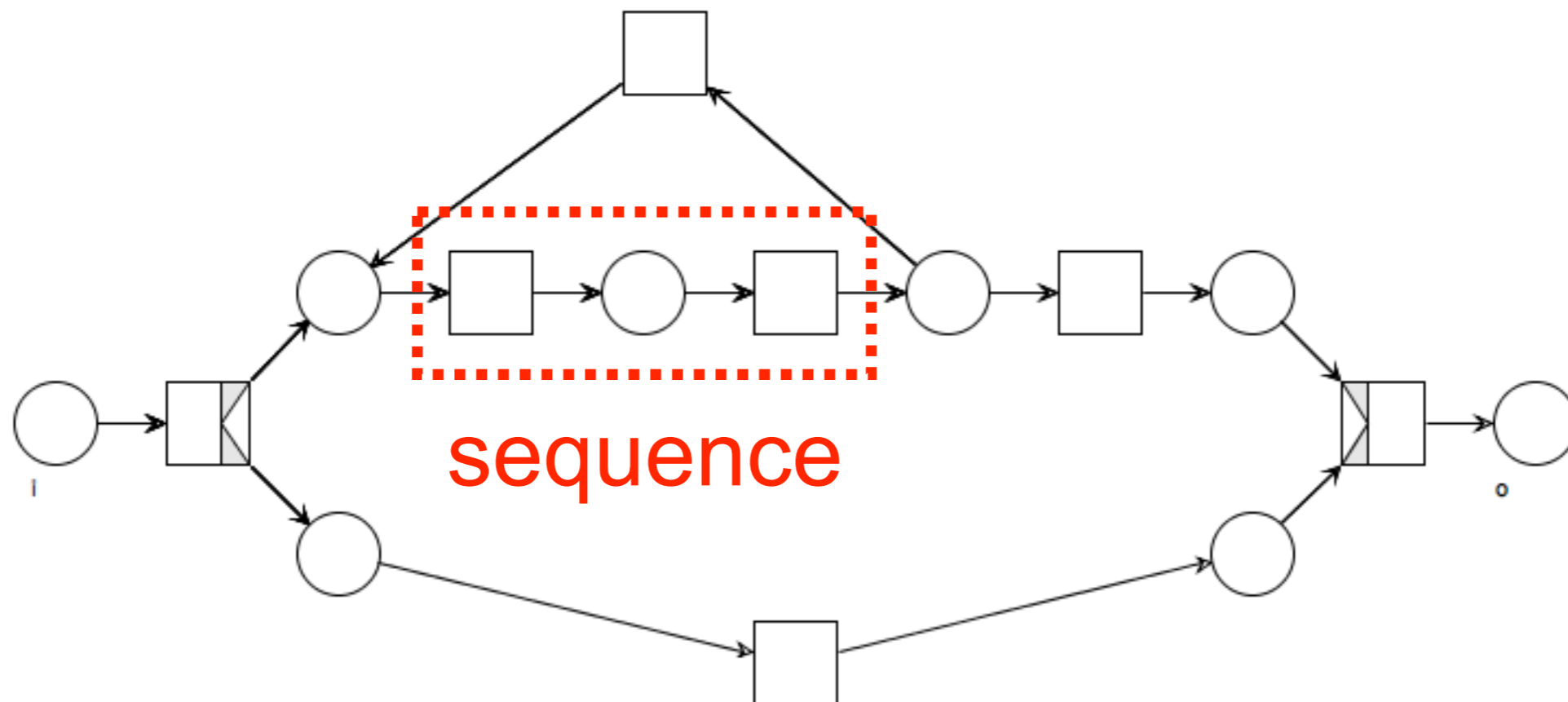
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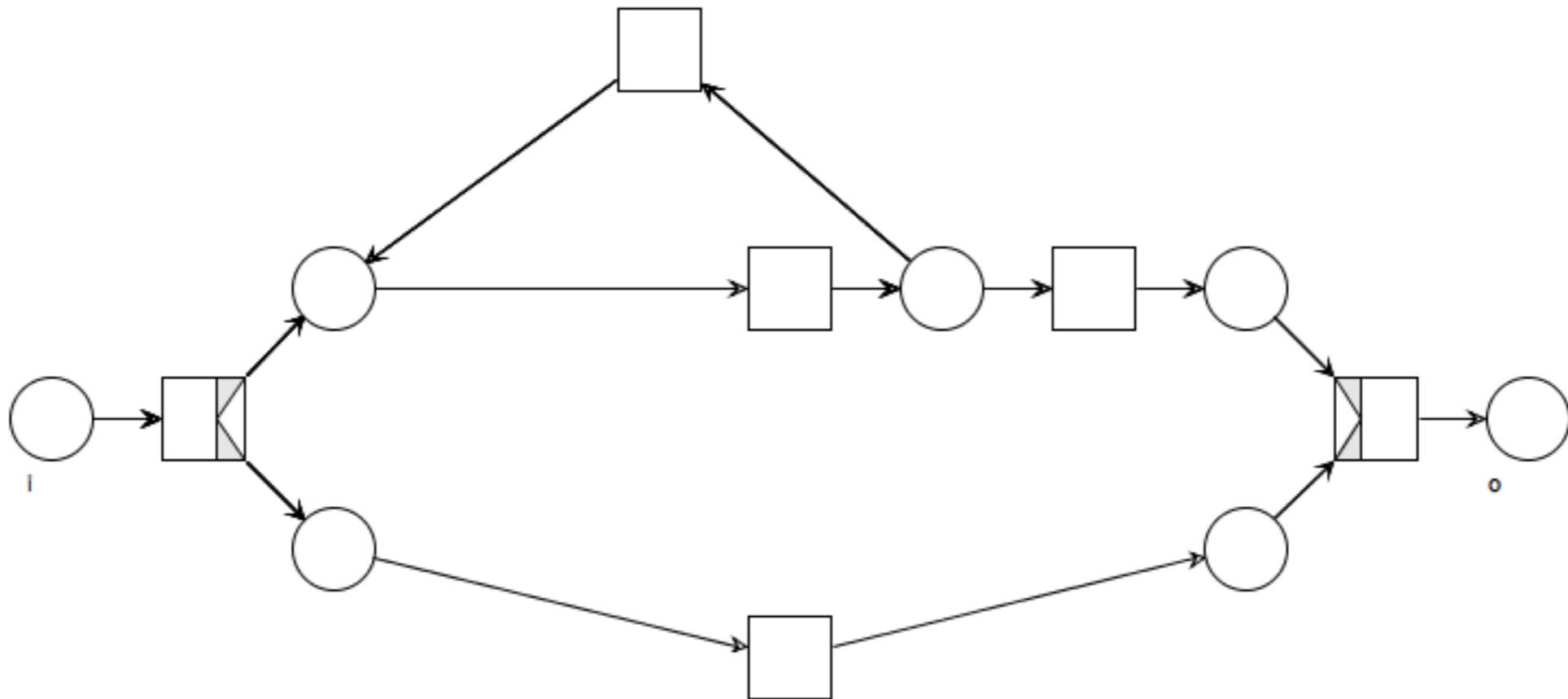
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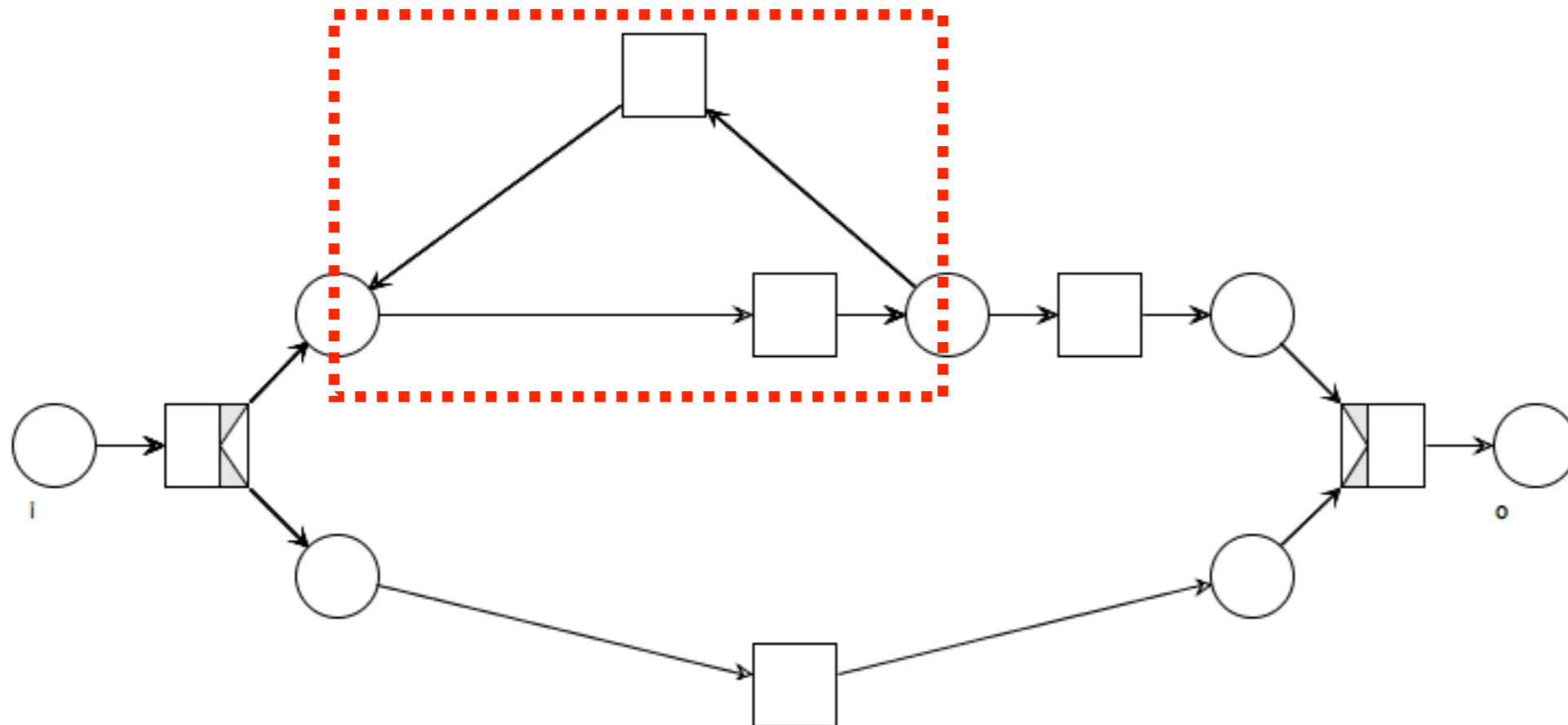
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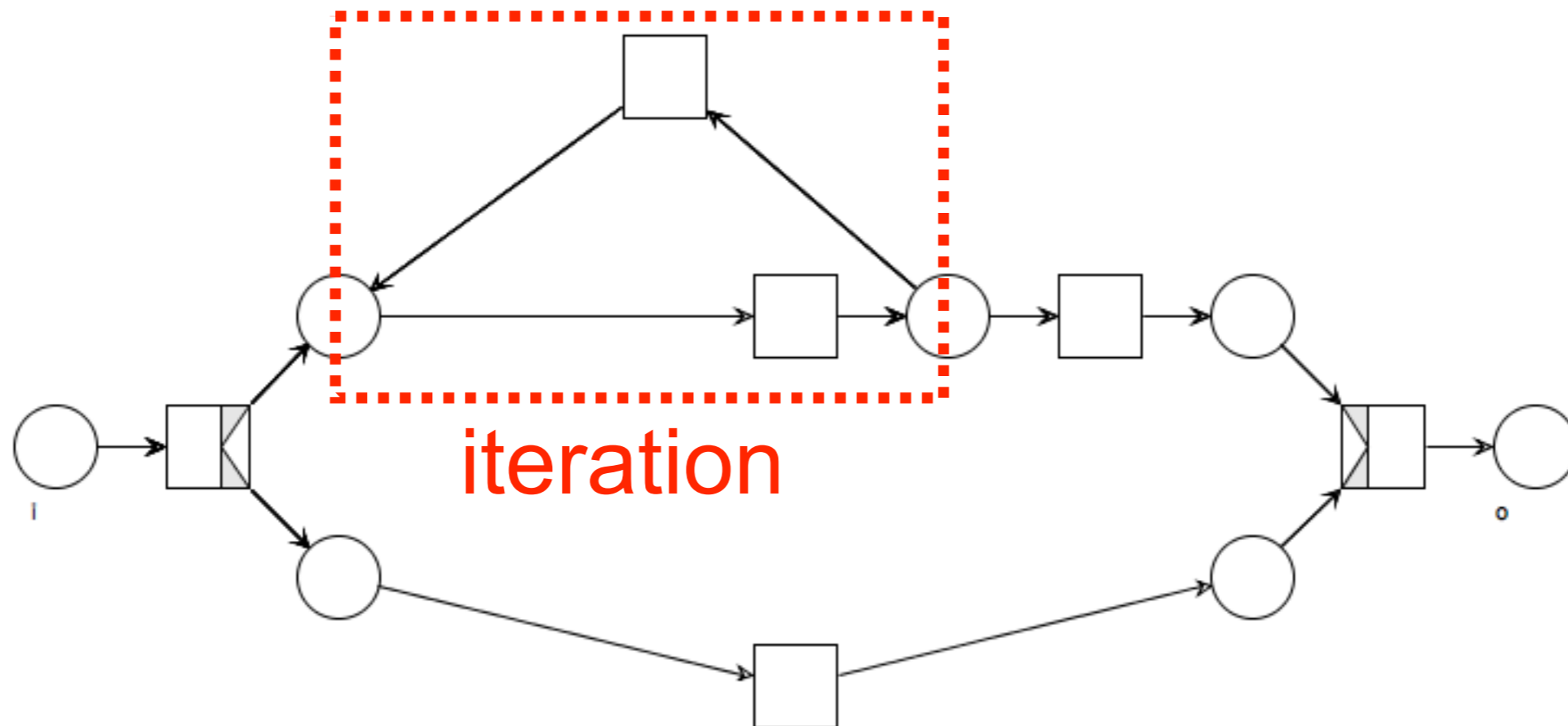
Example: abstraction

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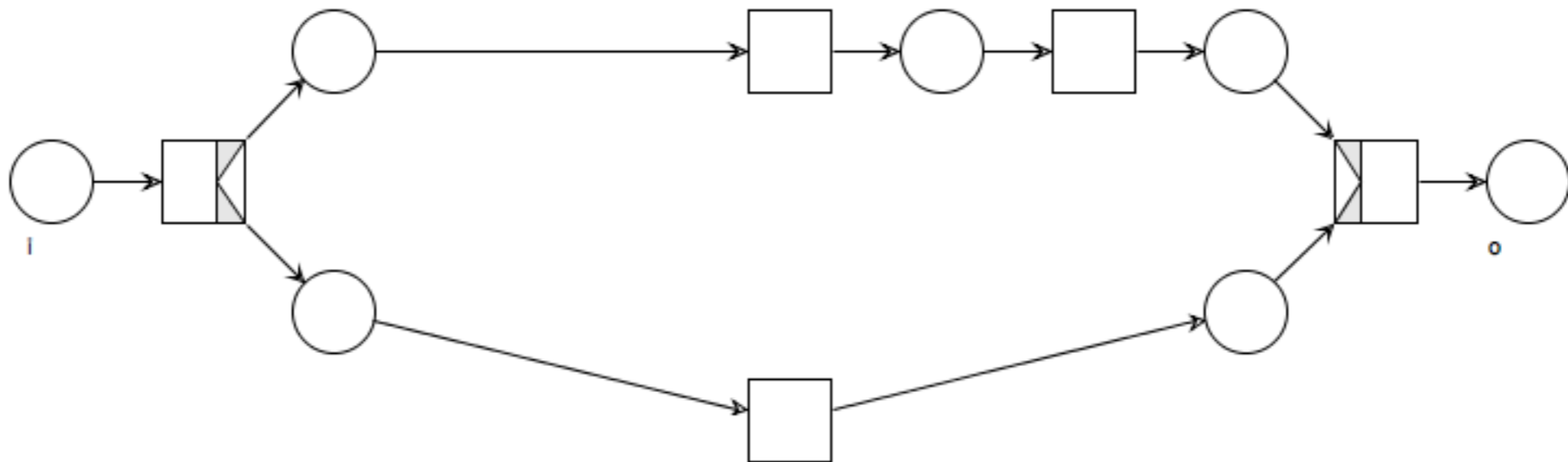
Example: abstraction

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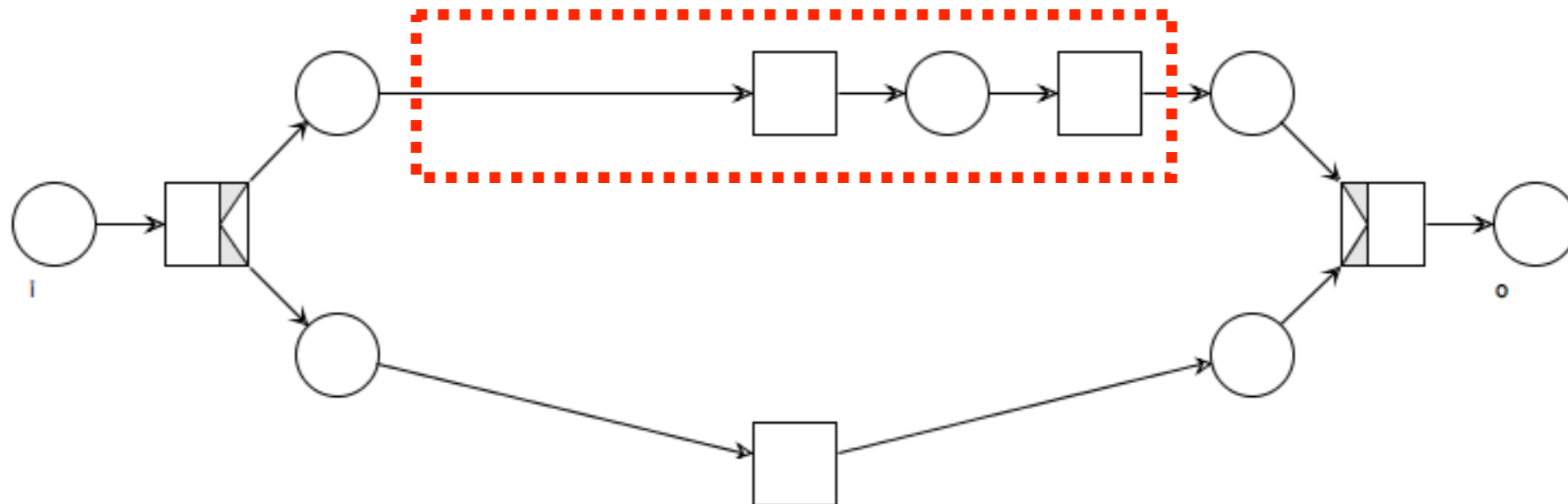
Example: abstraction

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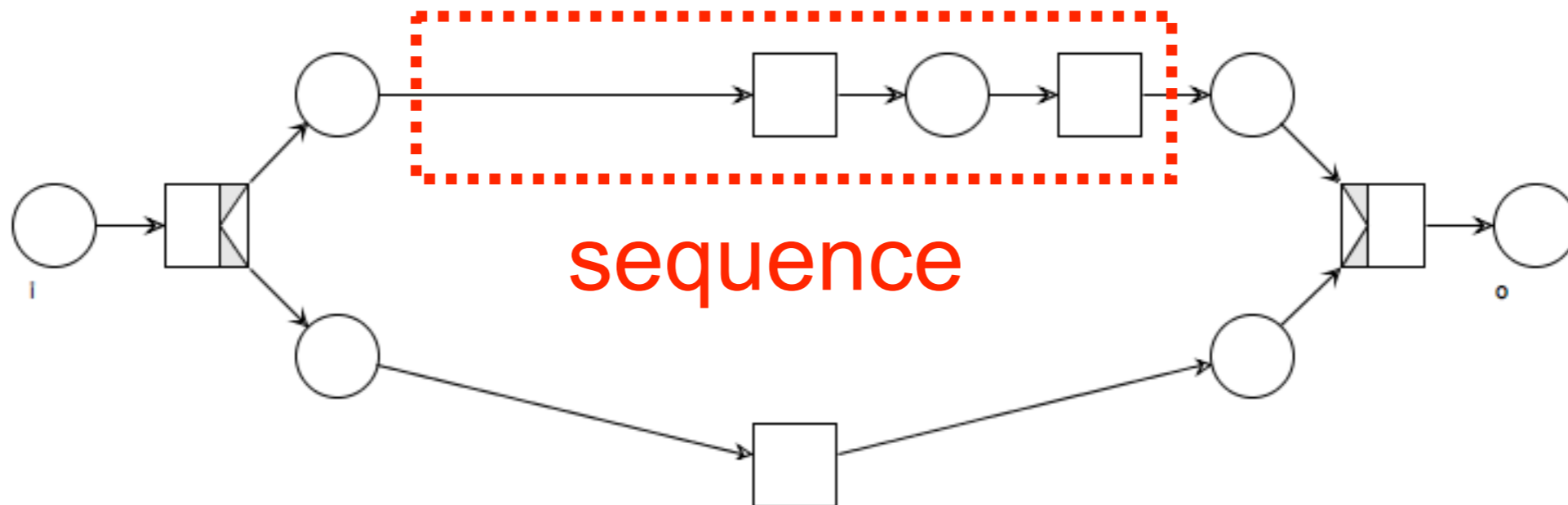
Example: abstraction

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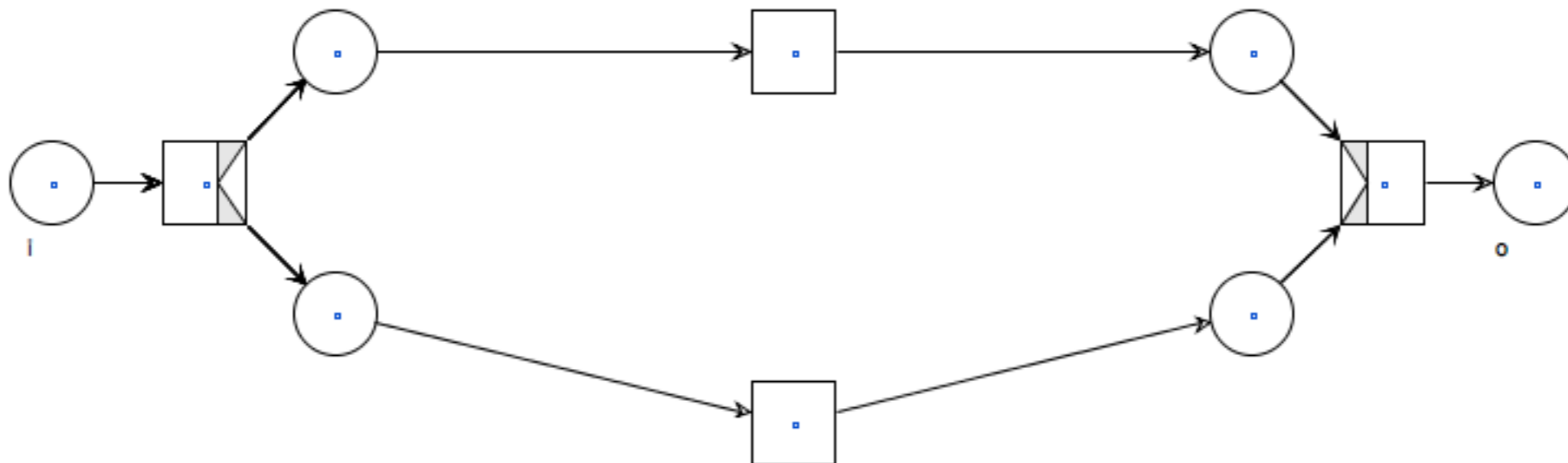
Example: abstraction

Prove that the net below is
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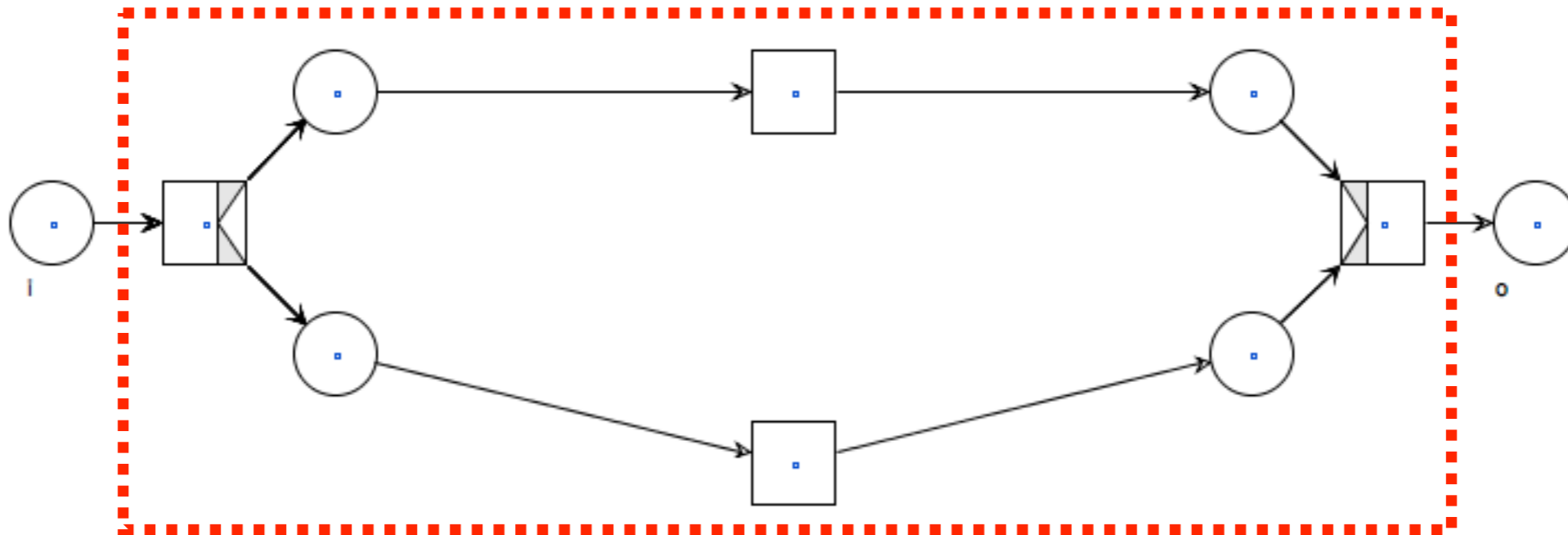
Example: abstraction

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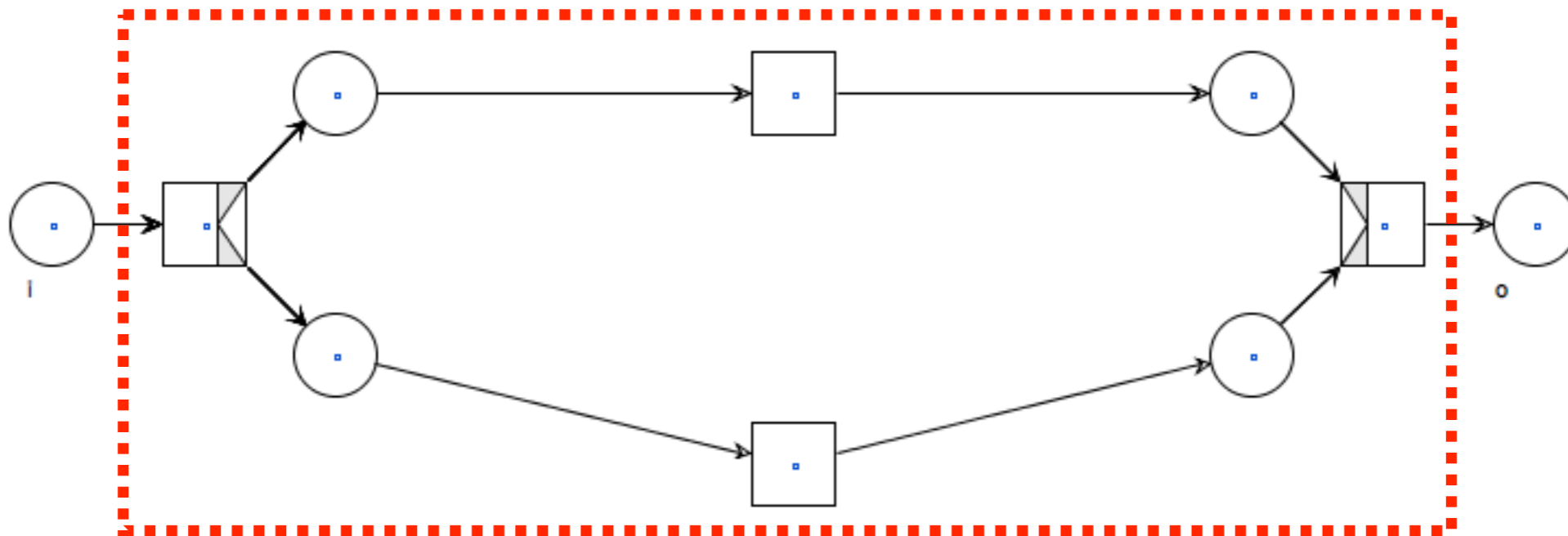
Example: abstraction

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Example: abstraction

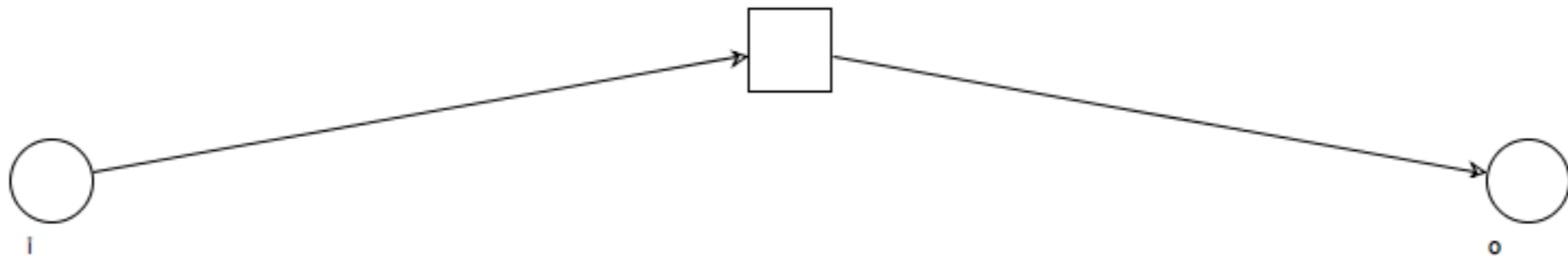
Prove that the net below is
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parallel (AND) block

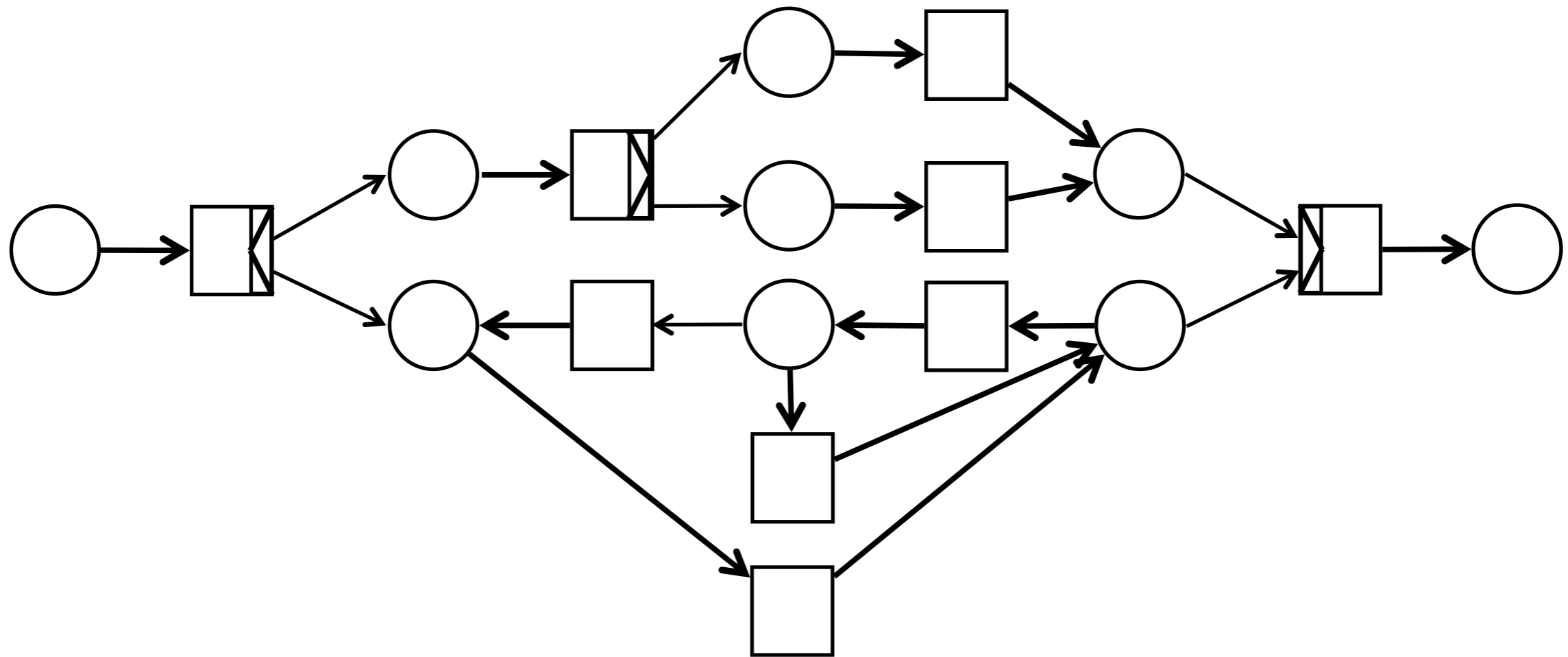
Example: abstraction

Prove that the net below is
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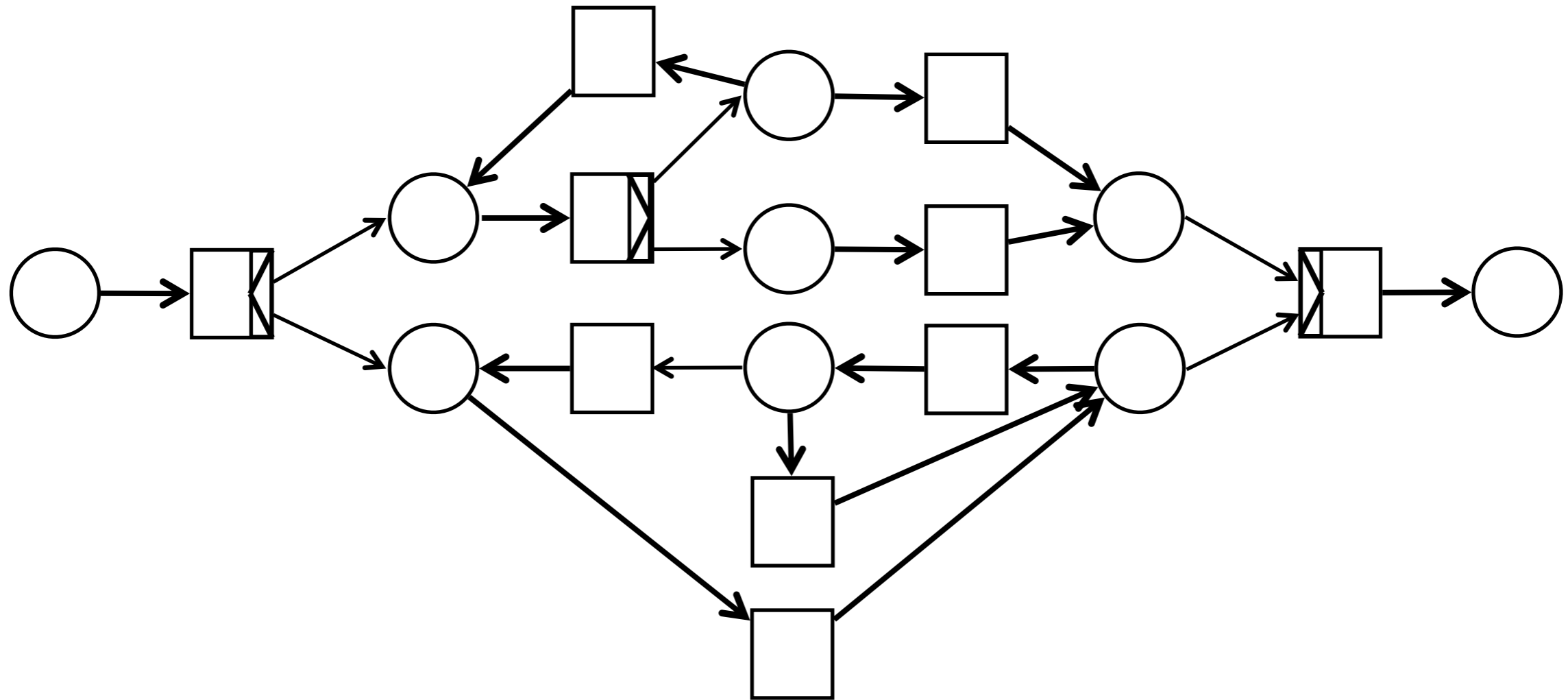
Exercise

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



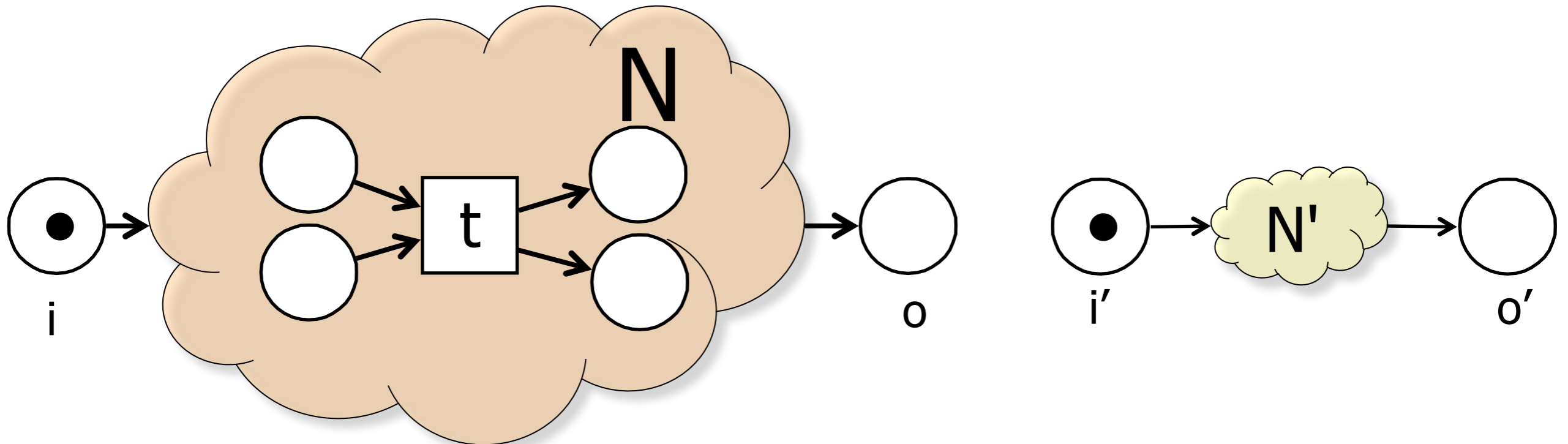
Exercise

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



Generalization

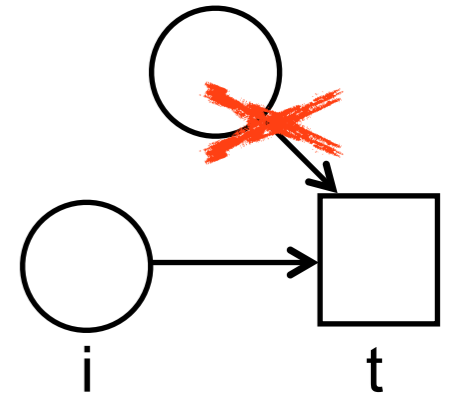
We would like to progressively refine transitions with multiple incoming and outgoing arcs



Two facts

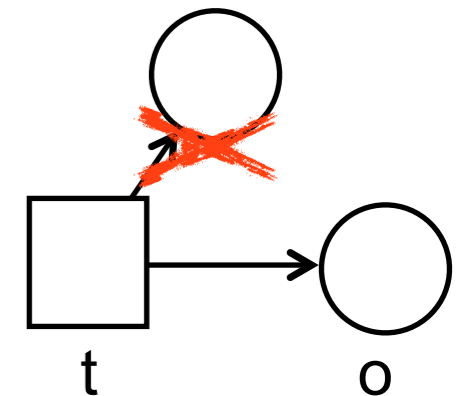
Lemma: Let N be a sound WF net.
If $(i,t) \in F$ then the pre-set of t is $\{i\}$

(otherwise t would be a dead transition)



Lemma: Let N be a sound WF net.
If $(t,o) \in F$ then the post-set of t is $\{o\}$

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



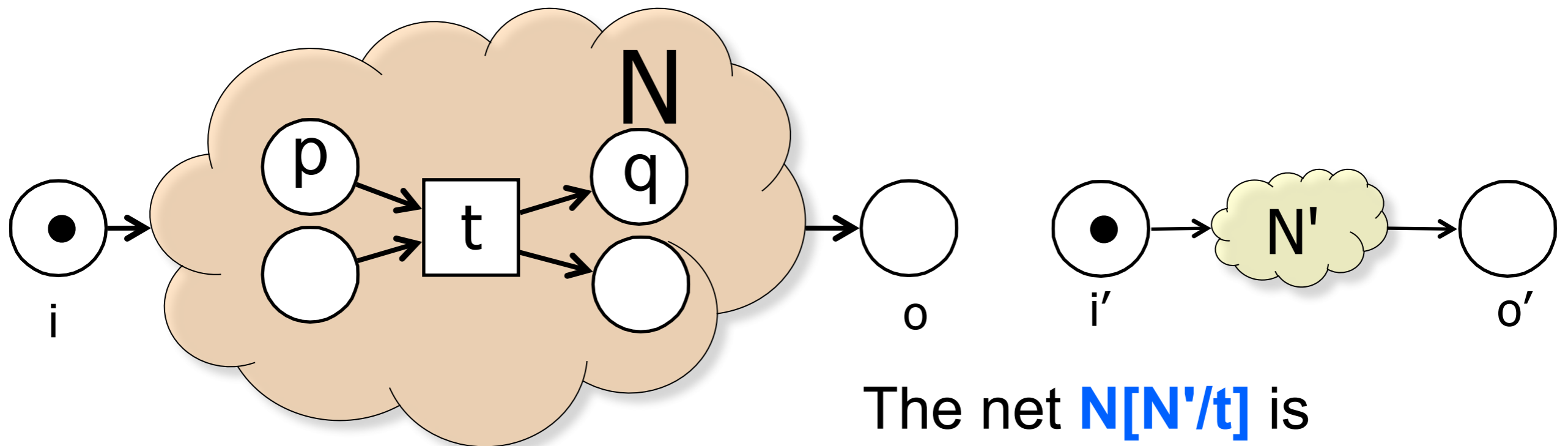
General replacement

Let $T_{i'} = \{ u \mid \bullet u = \{i'\} \}$.

Let $T_{o'} = \{ v \mid v\bullet = \{o'\} \}$.

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**

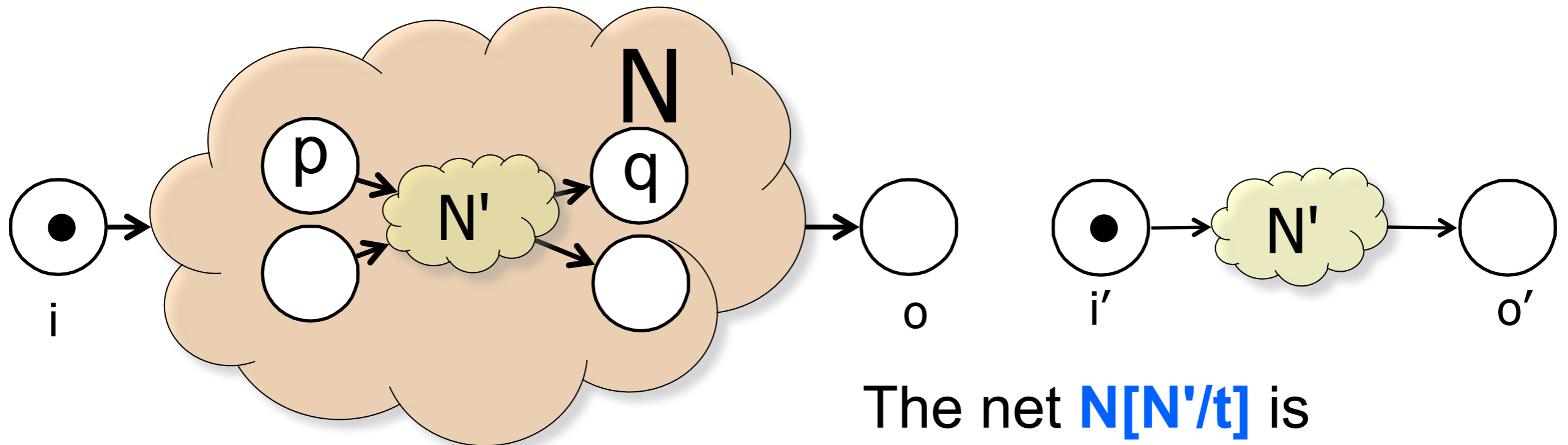
General replacement

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

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

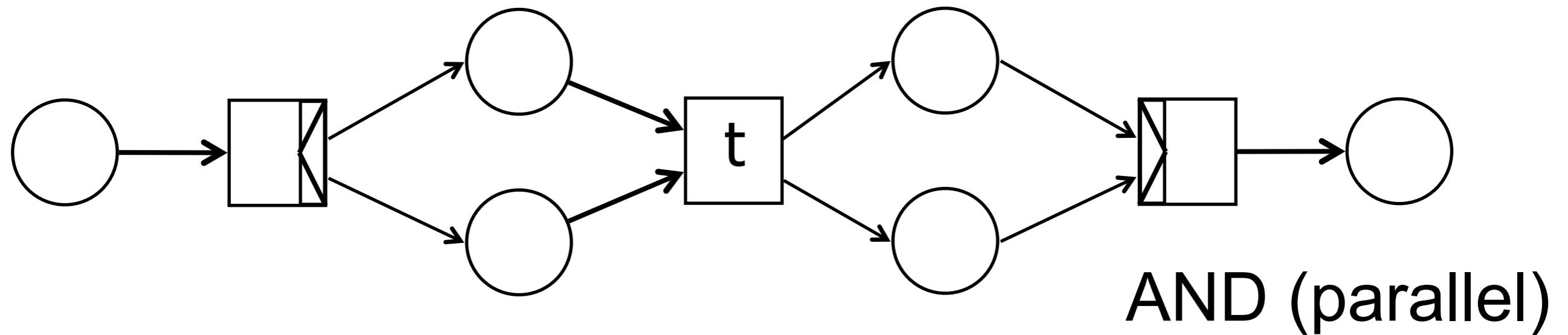
If $(p, t) \in F_N, u \in T_{i'}$ then $(p, u) \in F_{N[N'/t]}$

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**

Some Building Blocks 4



But you can define more blocks on your own

Exercise

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

