Stability of Certainty and Opinion on Influence Networks

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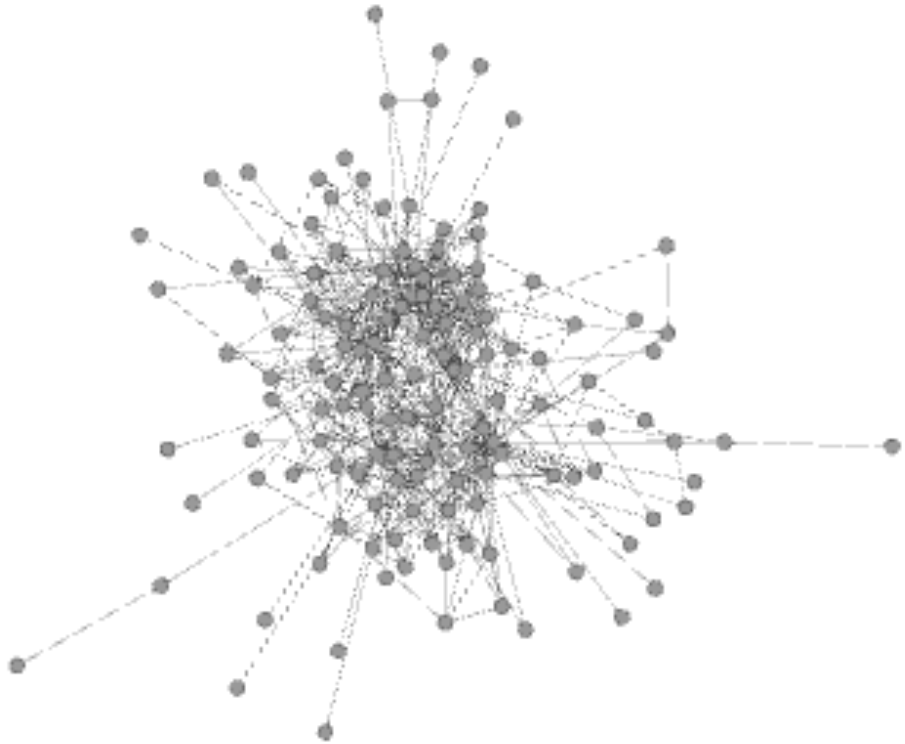
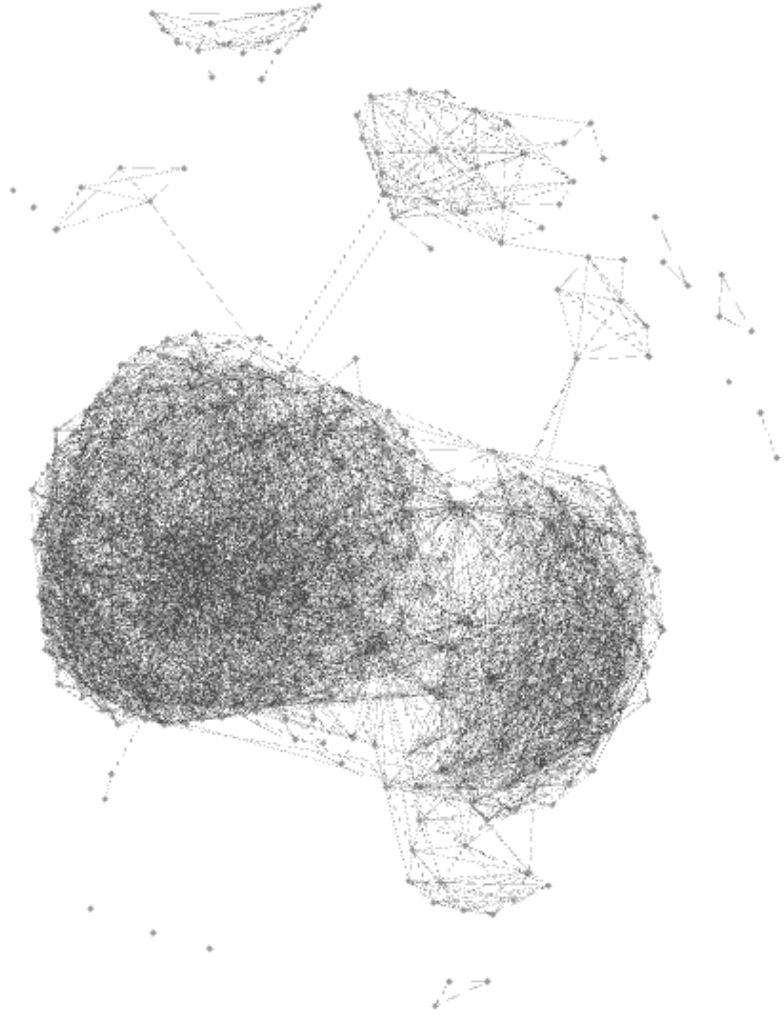




Background

1. Networks Change

2. Opinion Change

Opinion Change

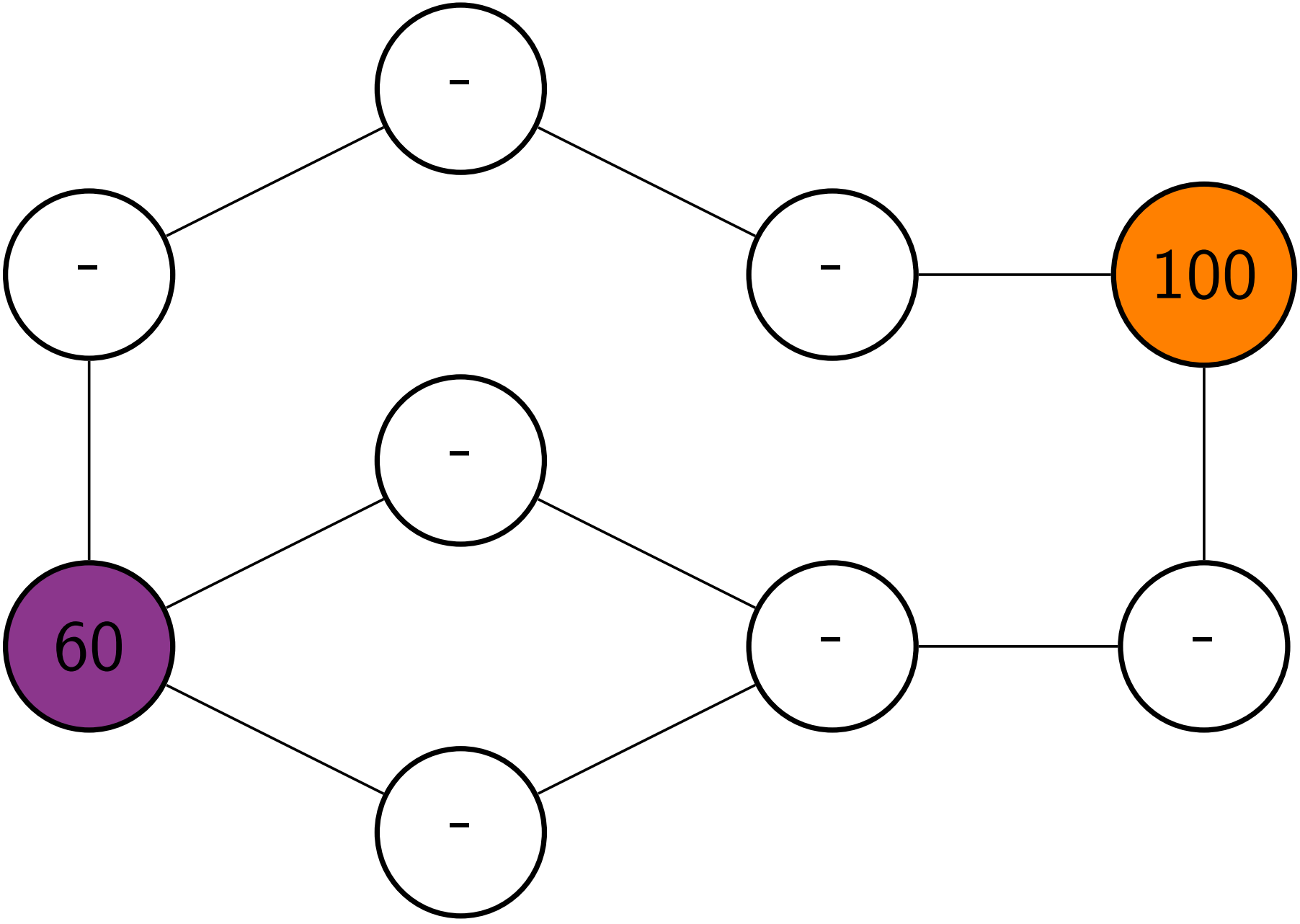
- Type of Spread
  - John French, 1956
  - Morris DeGroot, 1974
  - Robert Axelrod, 1997 and Deffuant-Weisbuch model, 2000
  - Serge Galam, 2004

- Weight of Influence
  1. Conformity
  2. Compromise
  3. Stubbornness
     - Yildiz, 2010

Initialization

- Assignment
- Cascade

Certainty Model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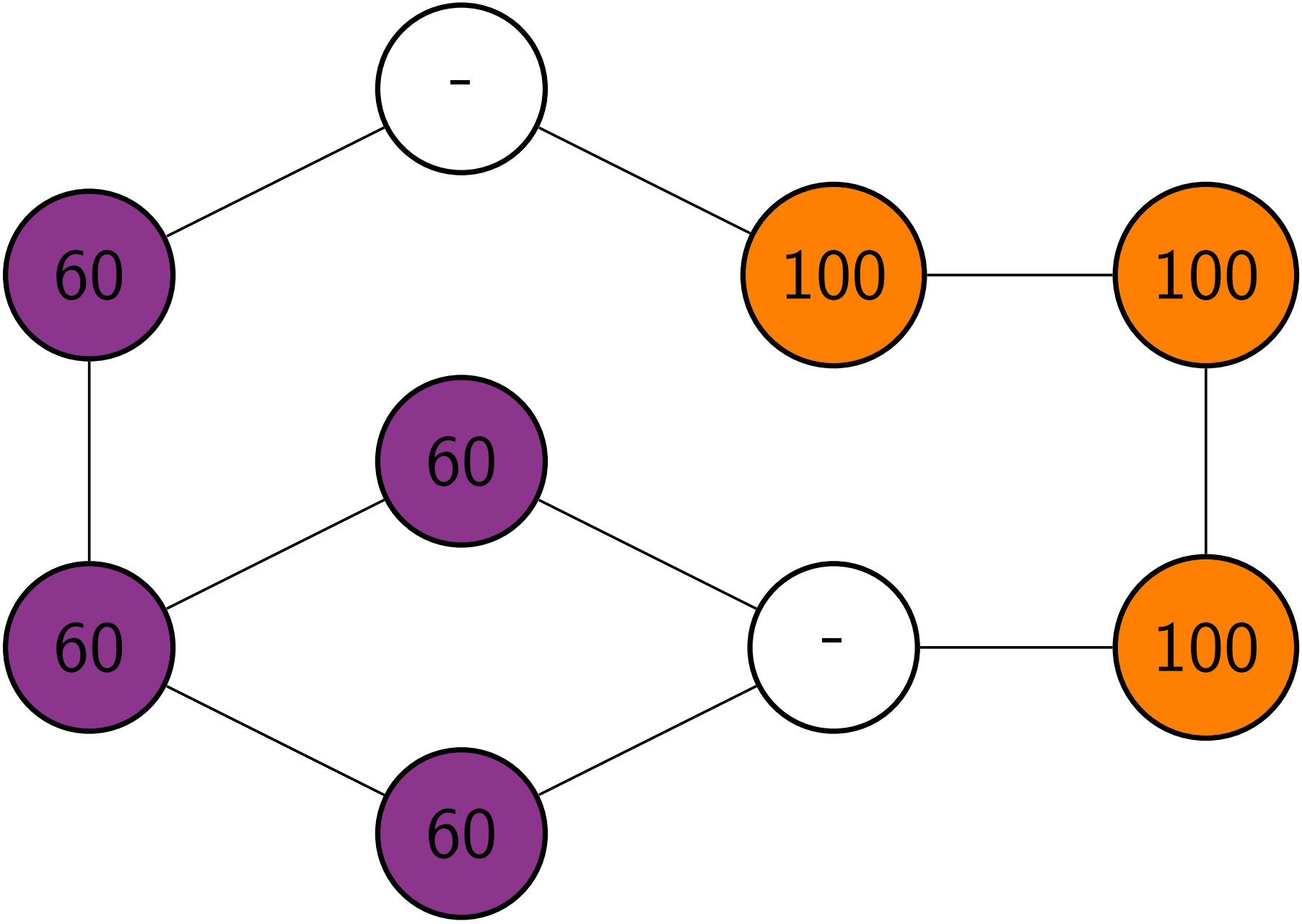
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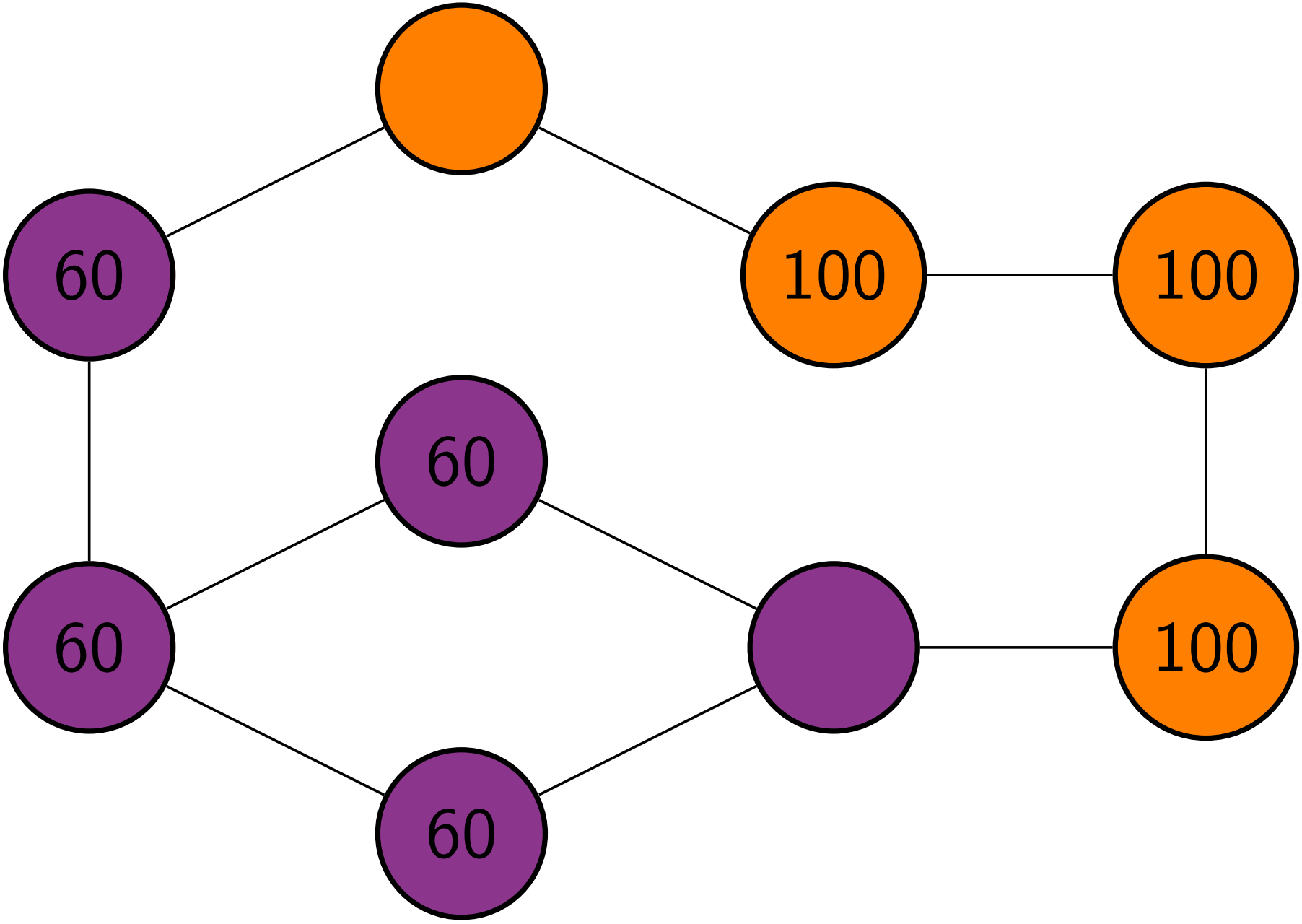
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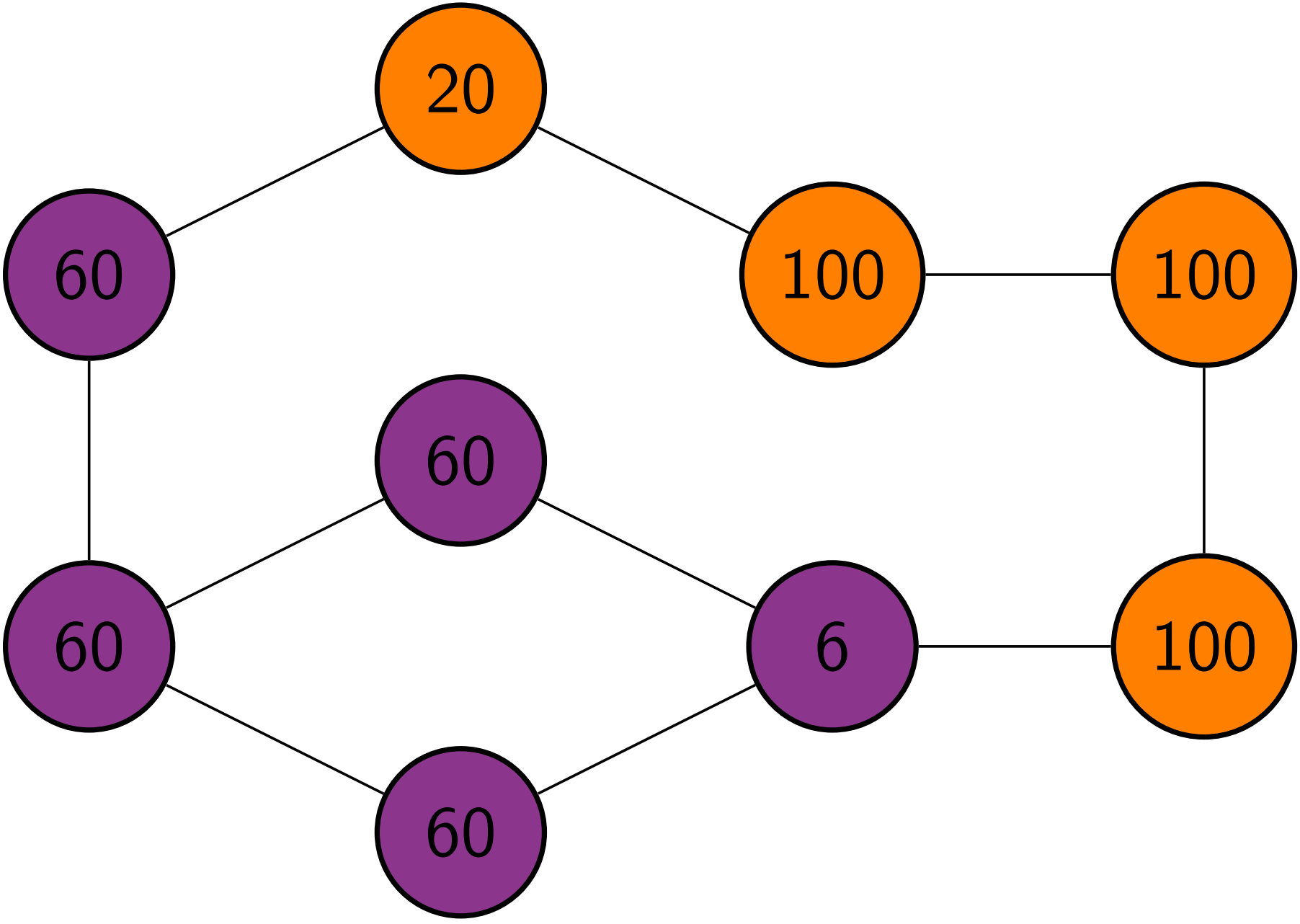
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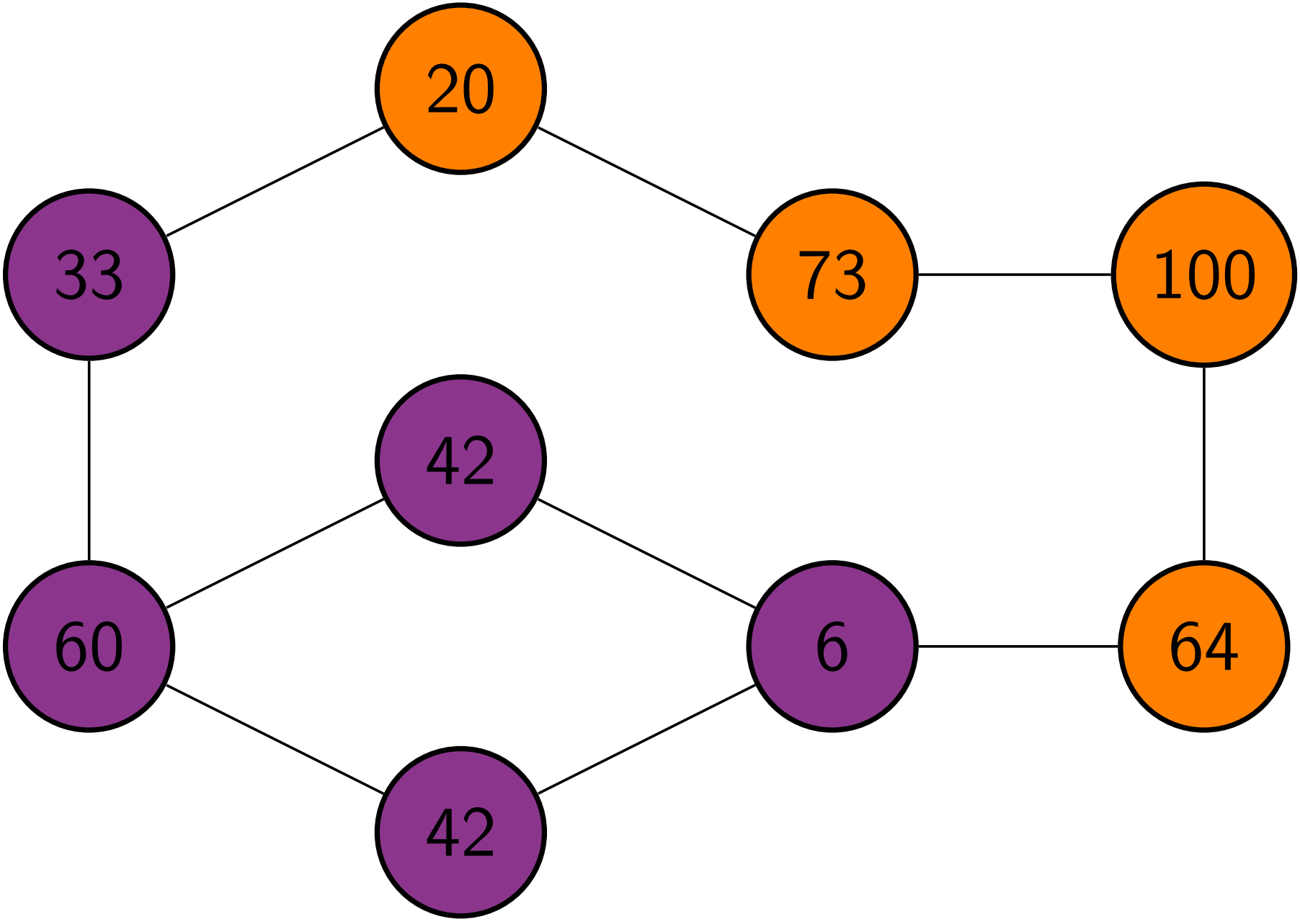
60
100
100
60
60
6
100
60

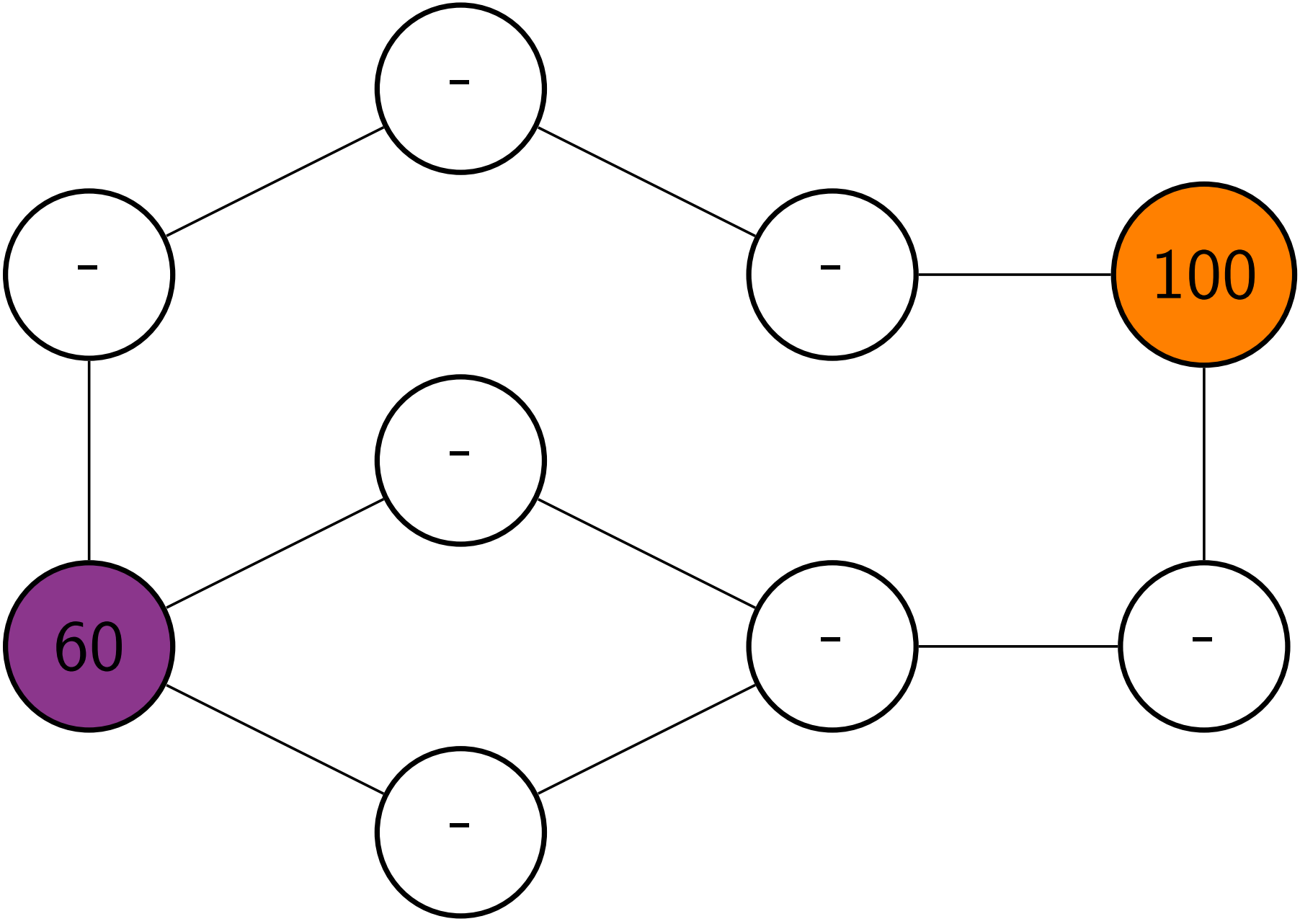

20
33
73
100
42
60
6
64
42

Stability

- Number
- Opinion - O(d)
- Certainty - O(d)

Stability

- Number - O(n)
- Opinion - O(d)
- Certainty - O(d)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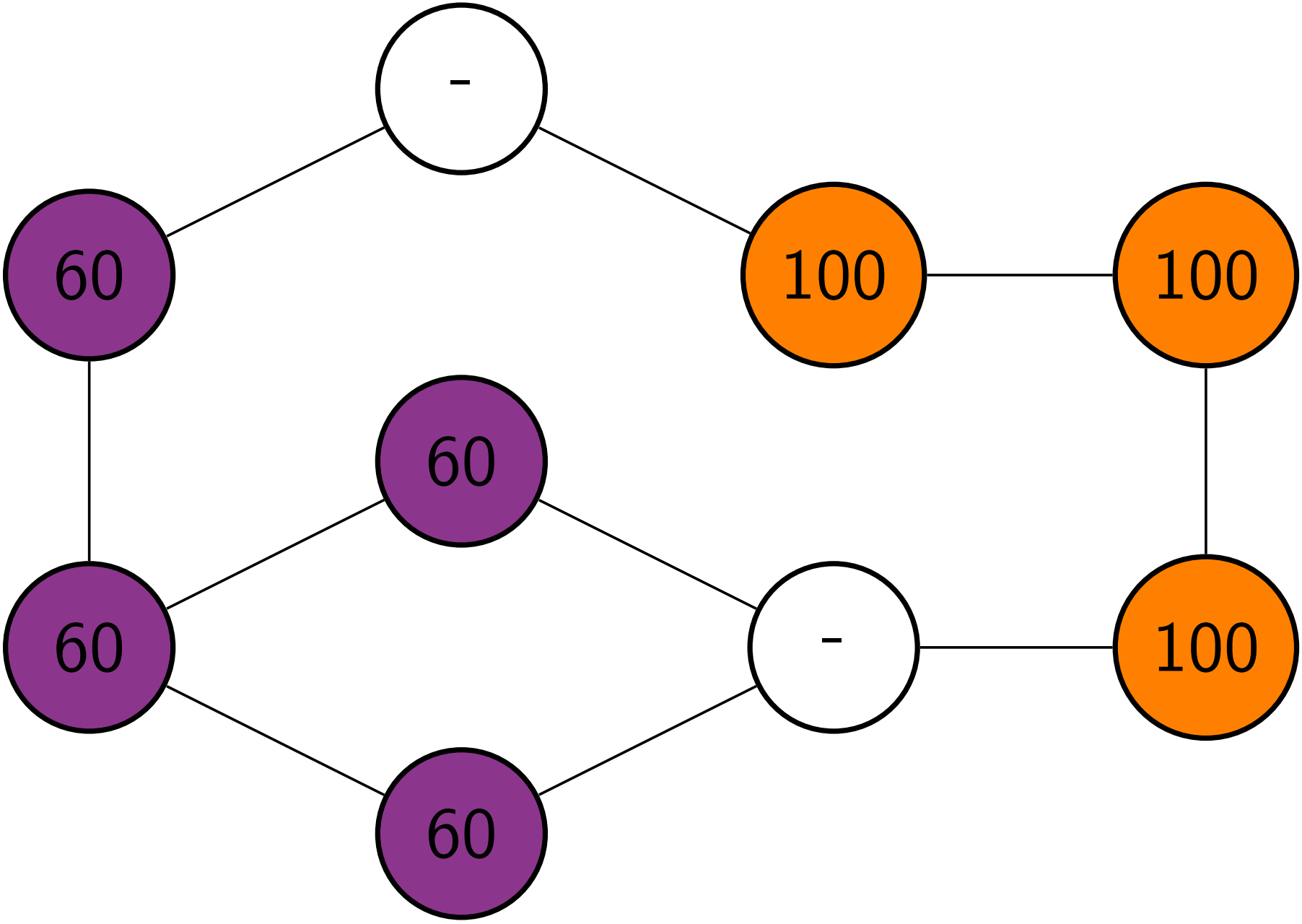
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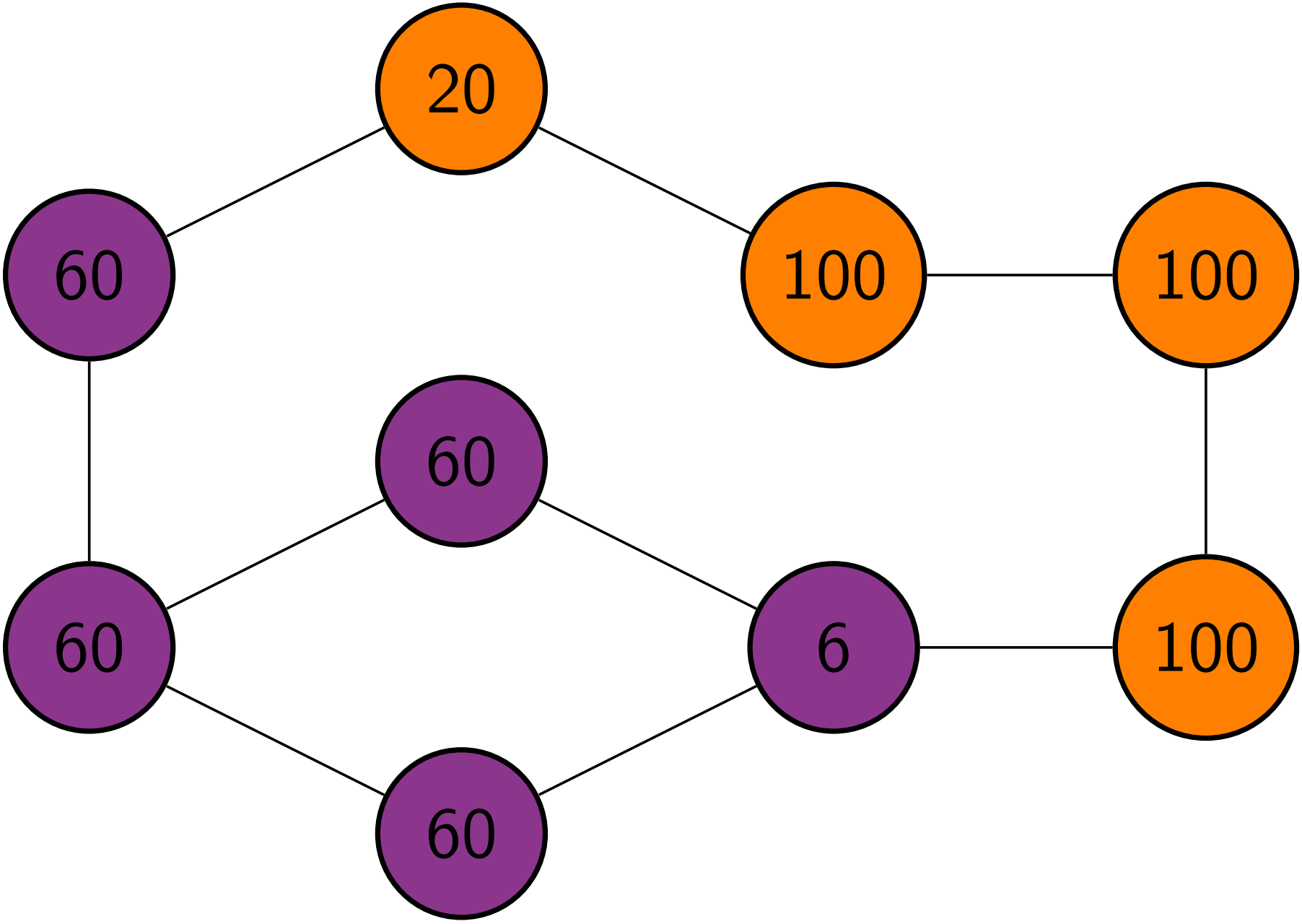
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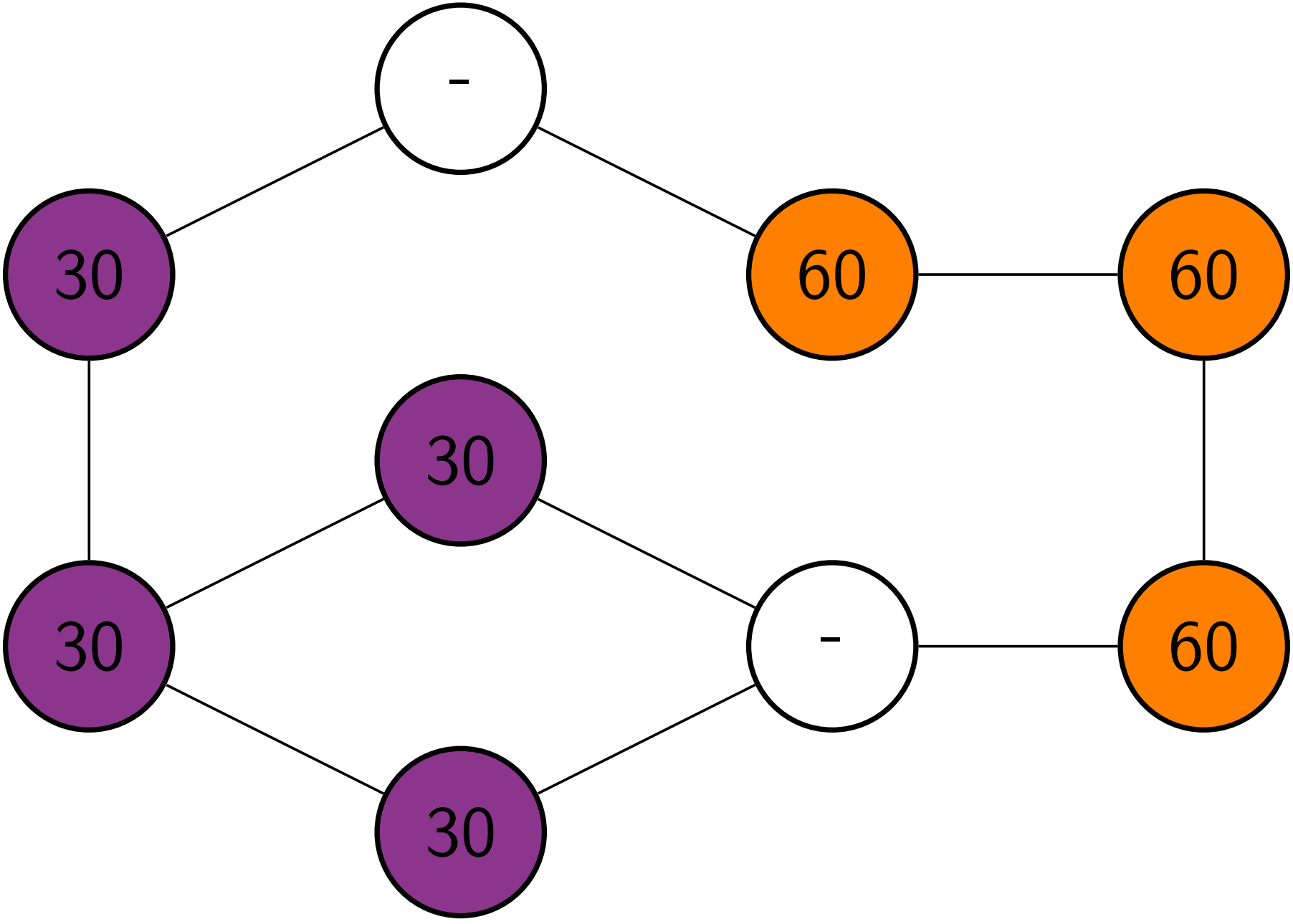
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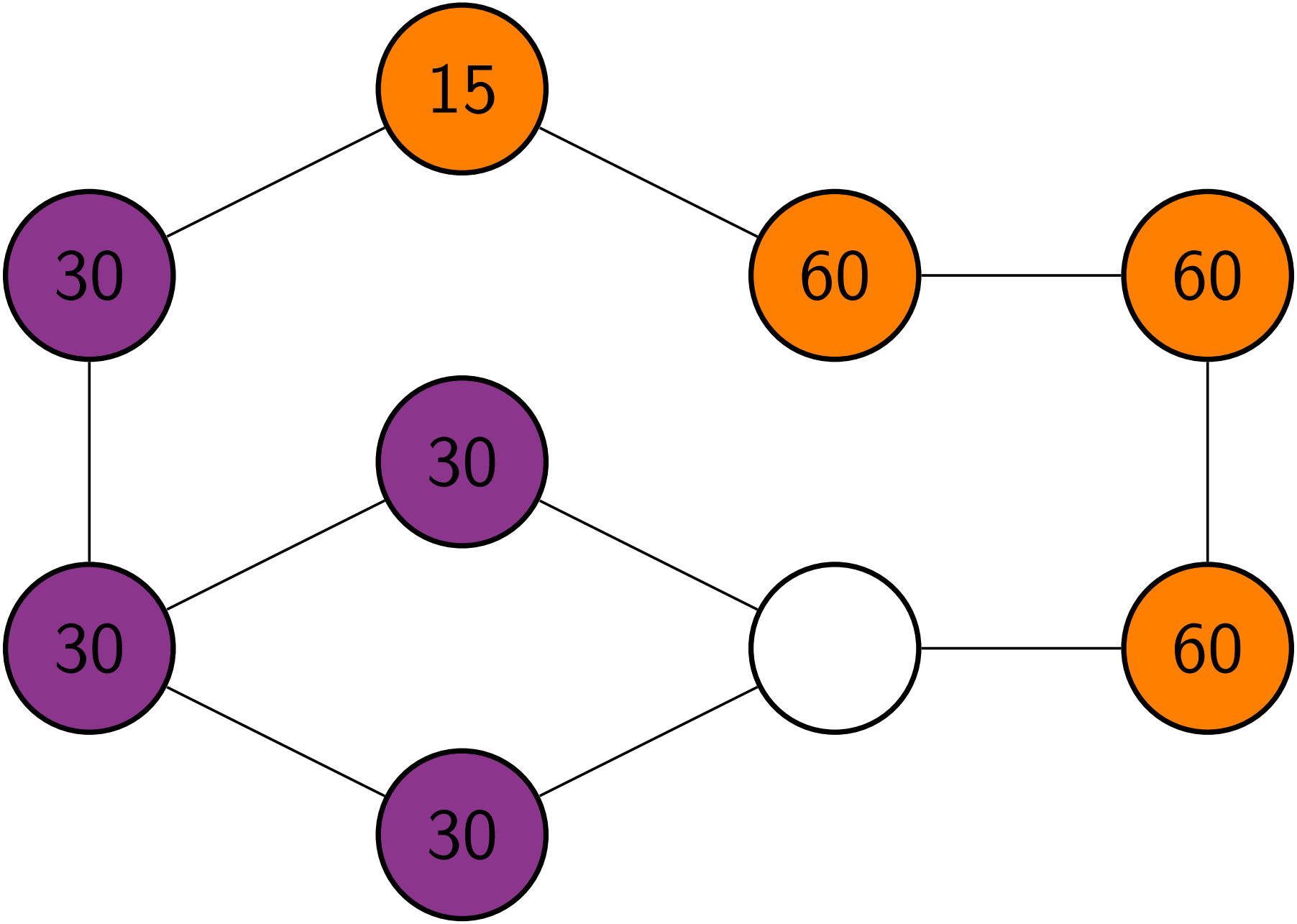
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60
60
30
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60
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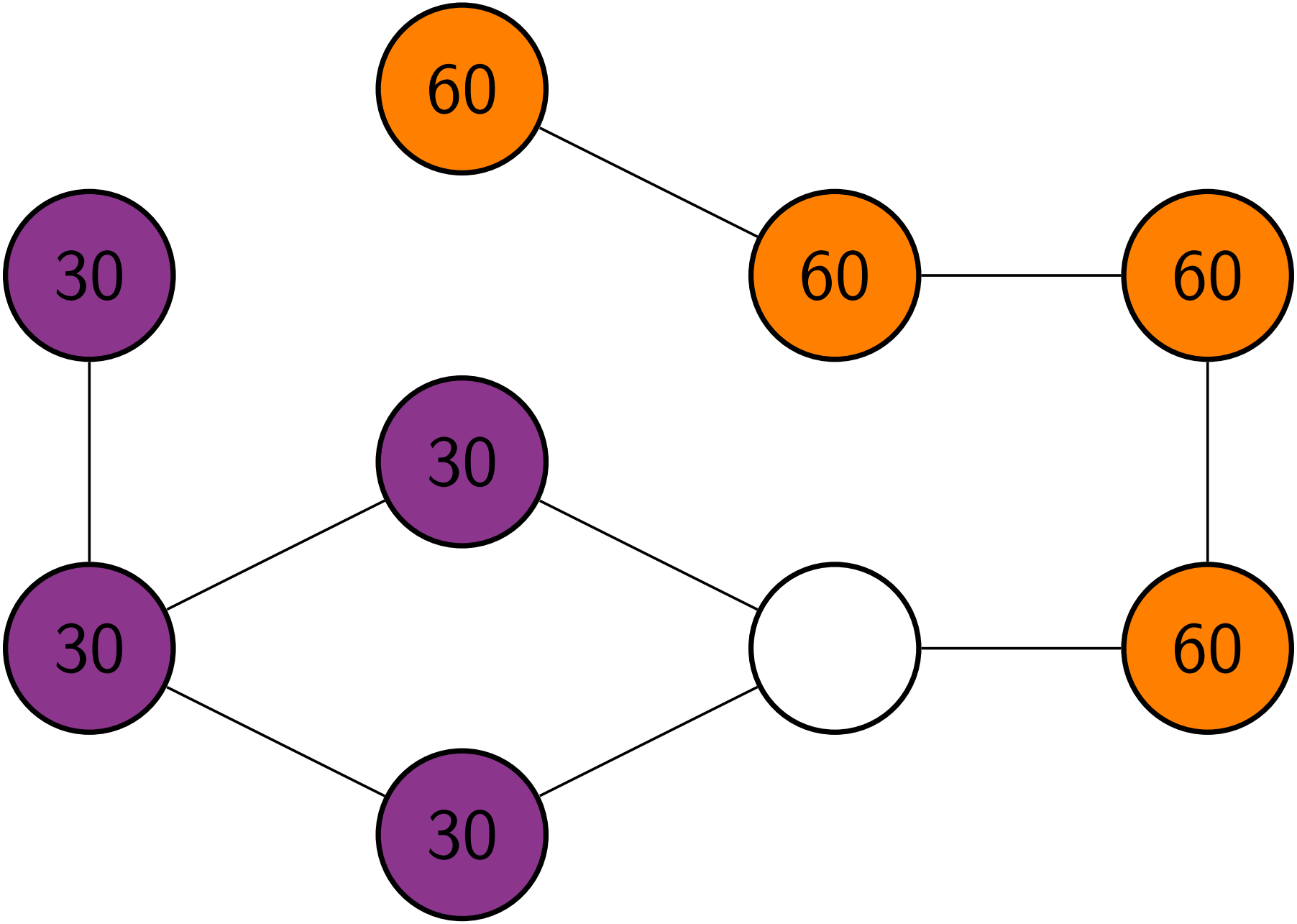
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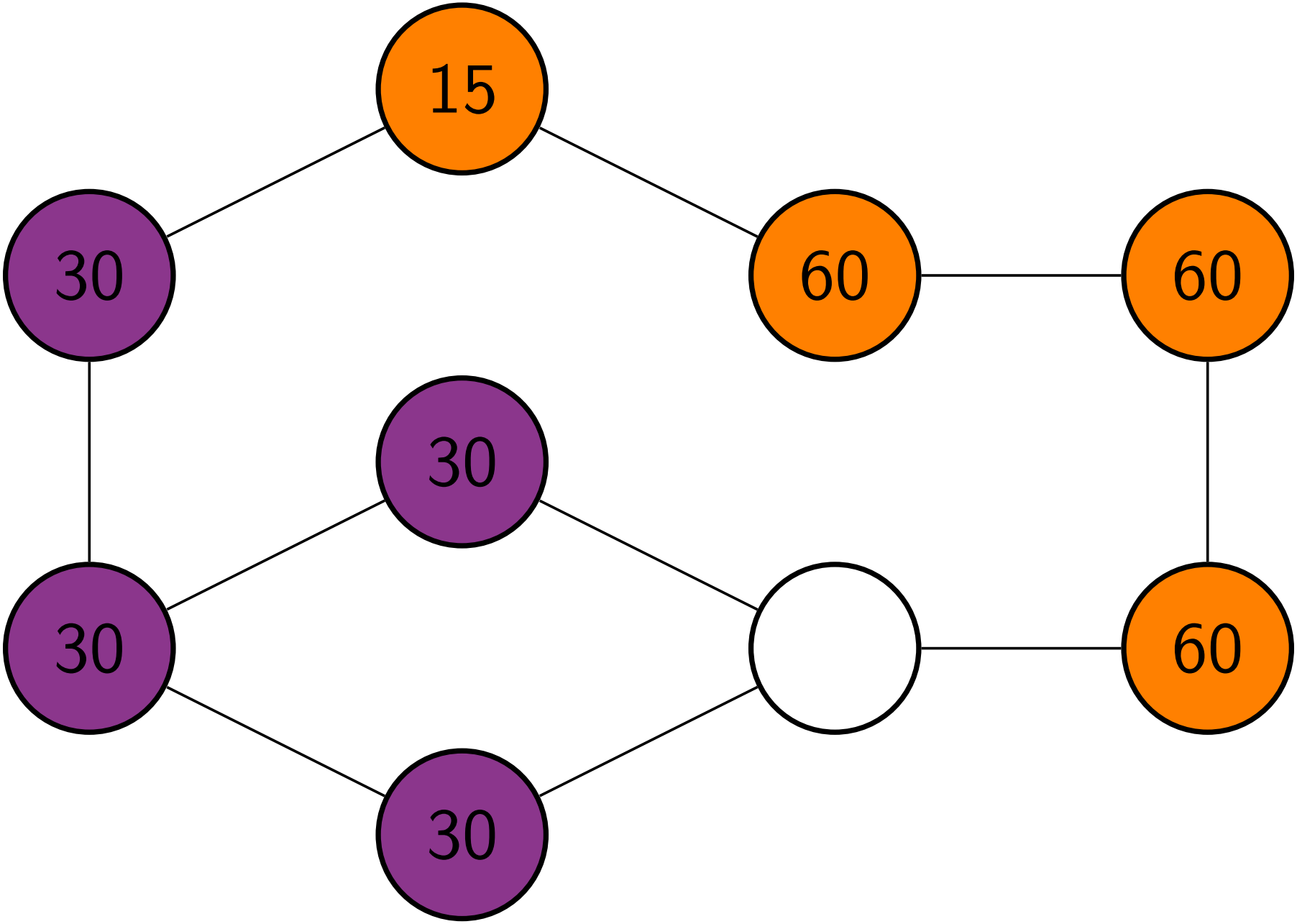
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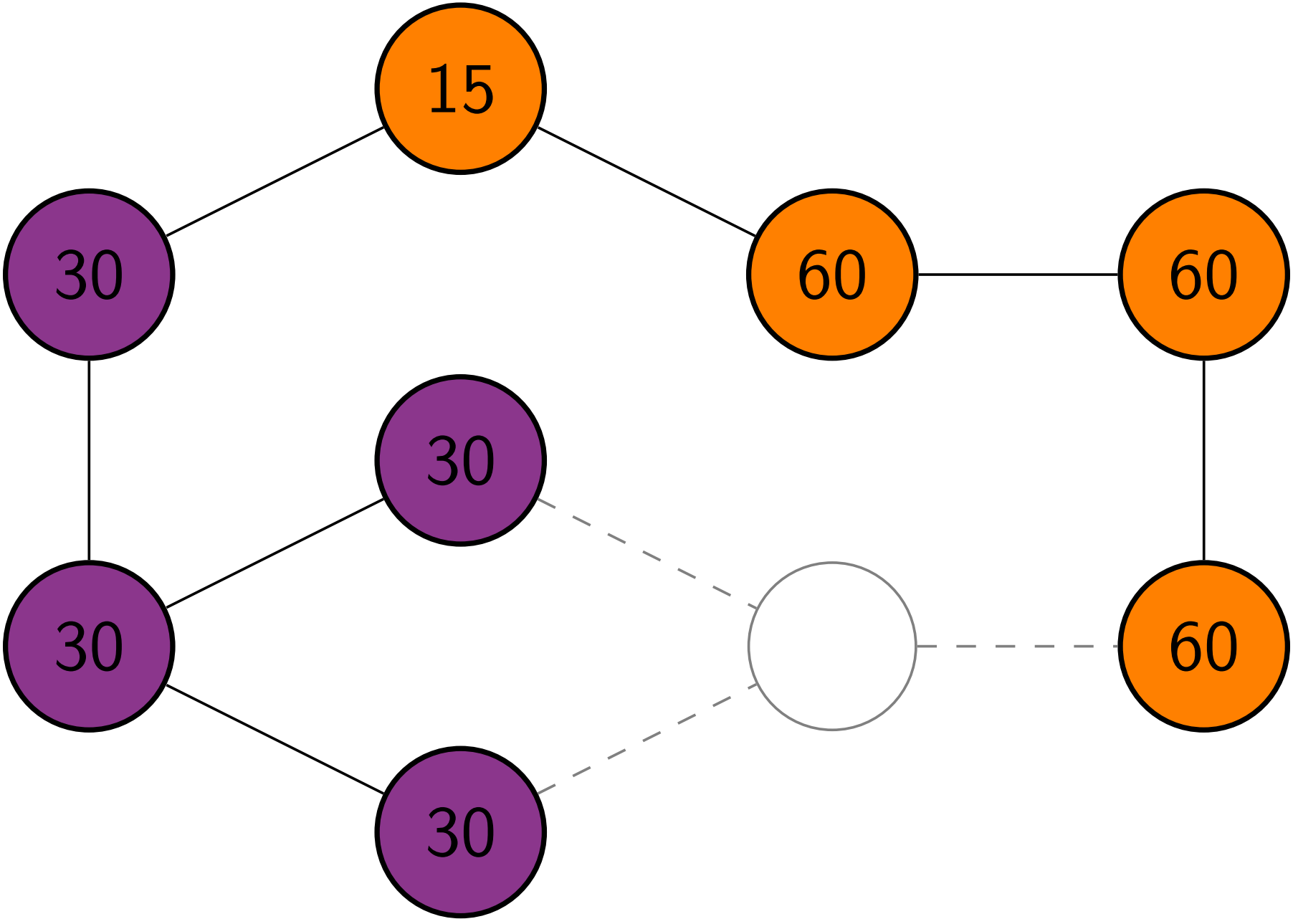
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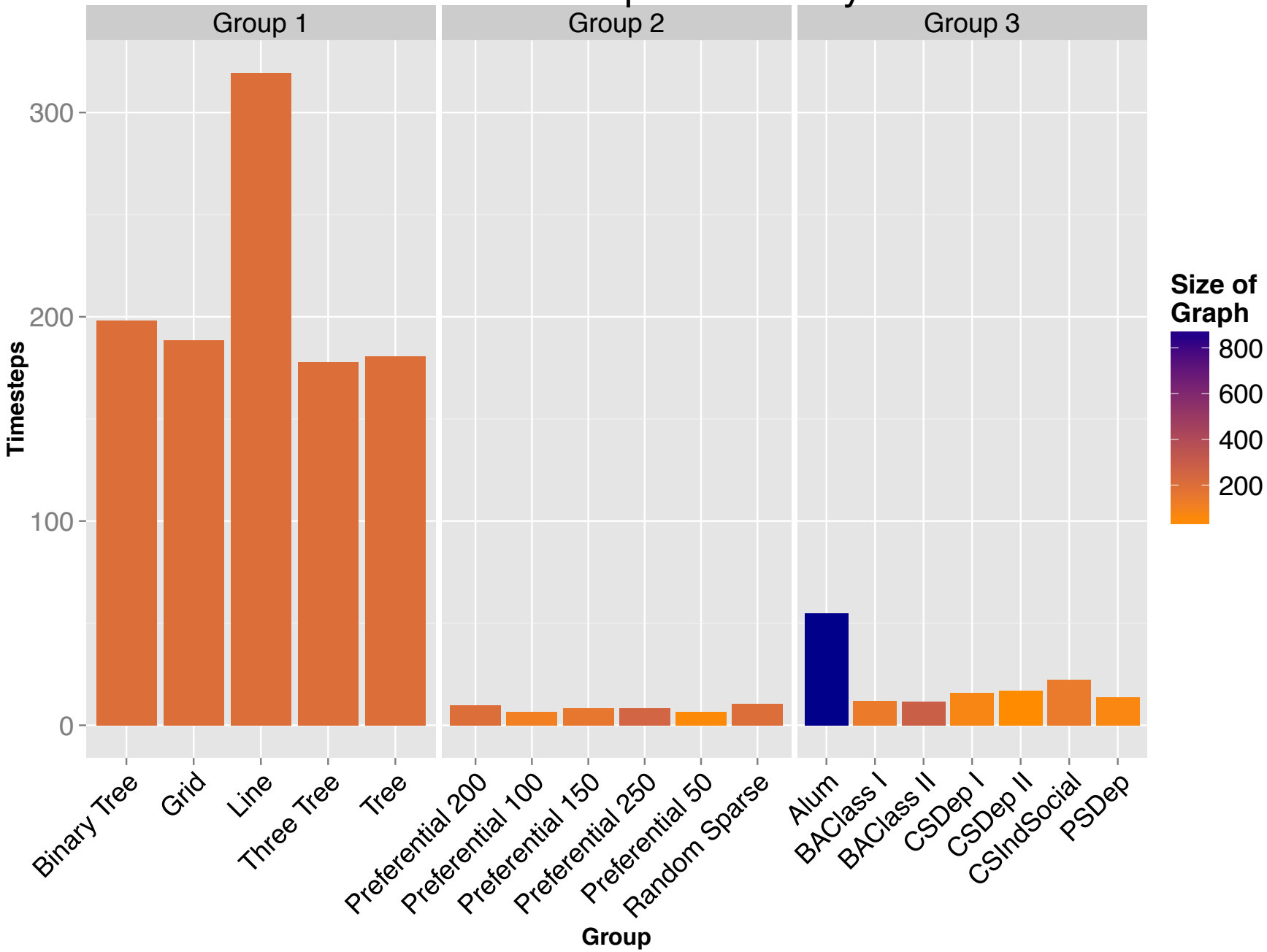
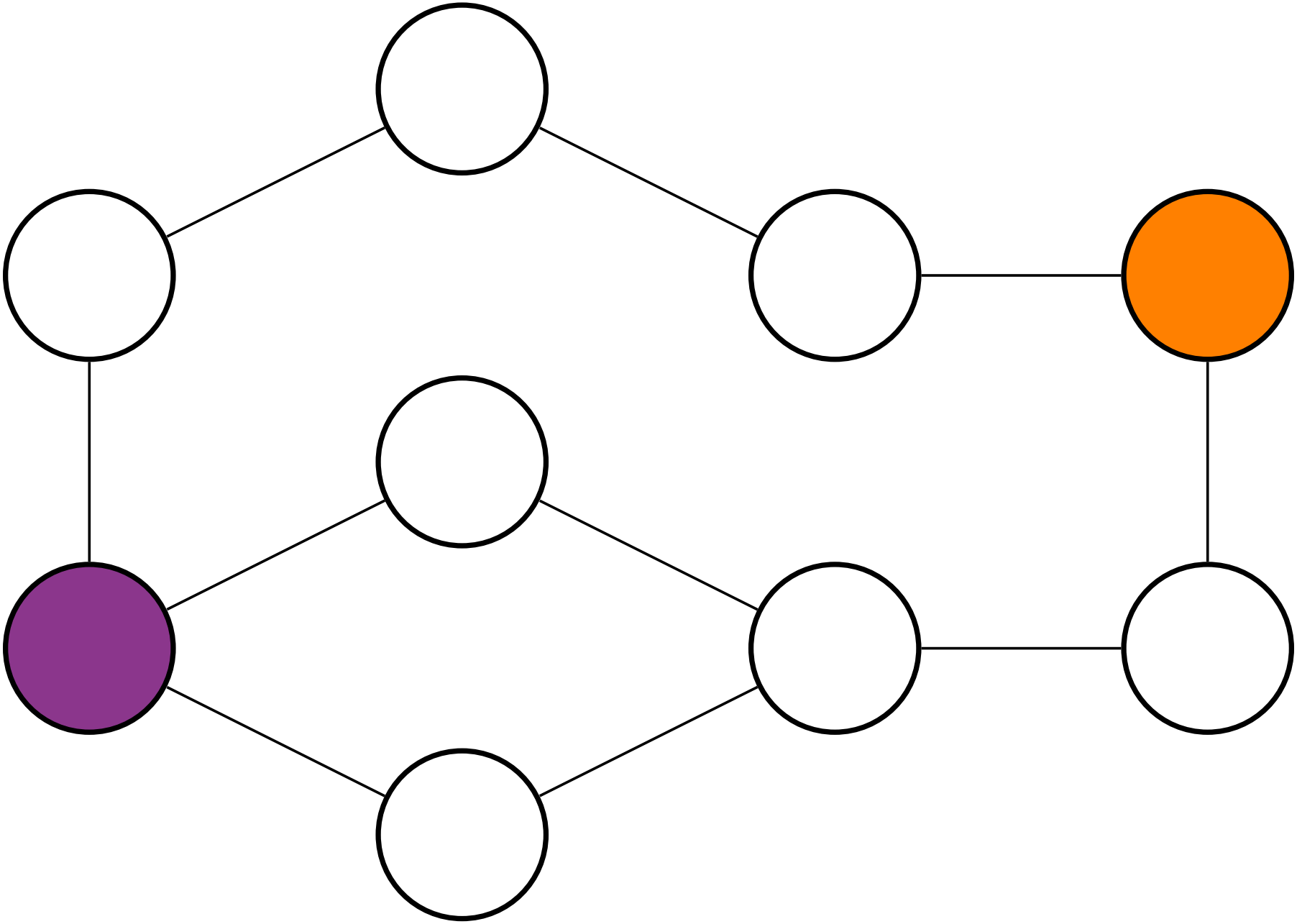
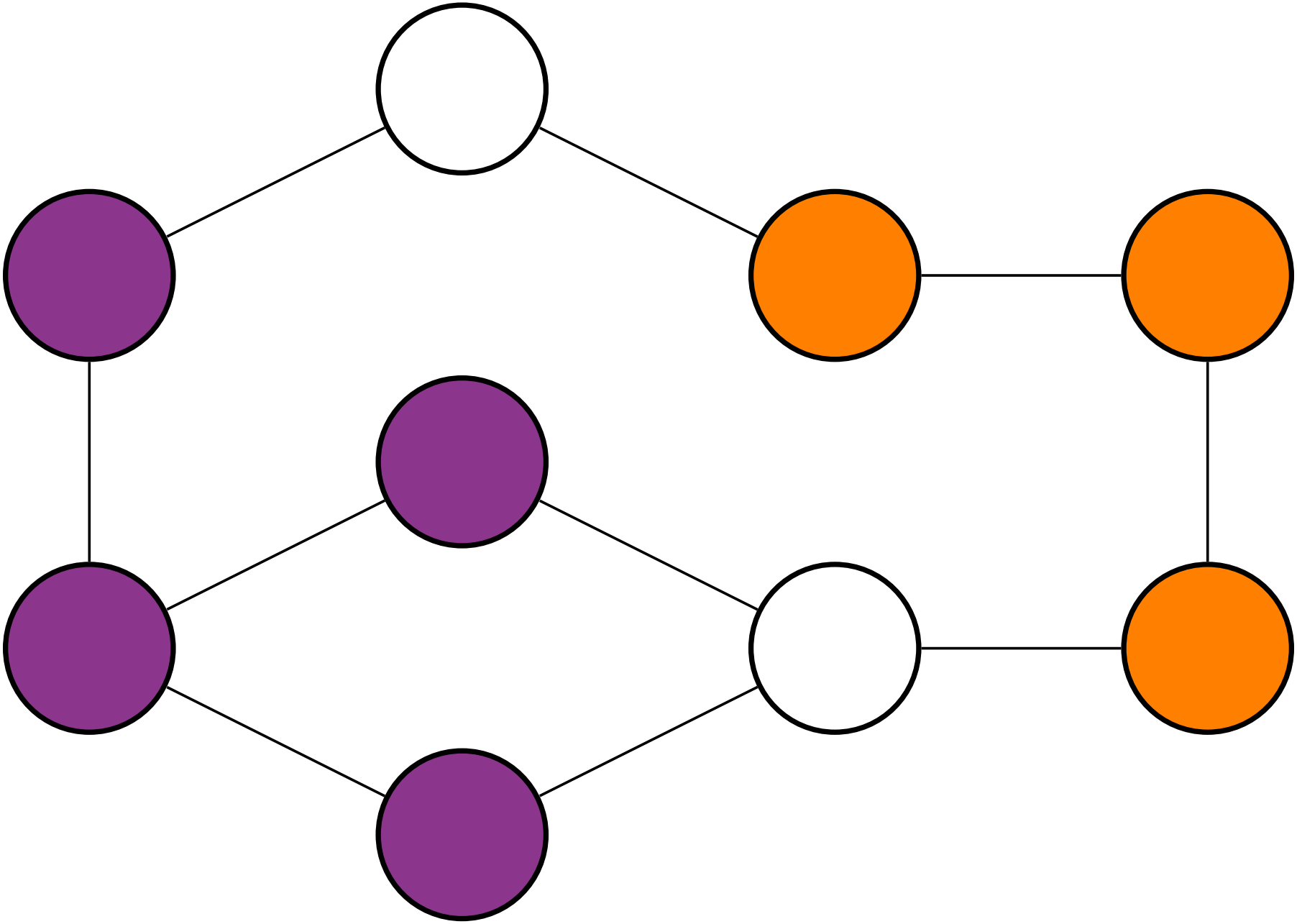
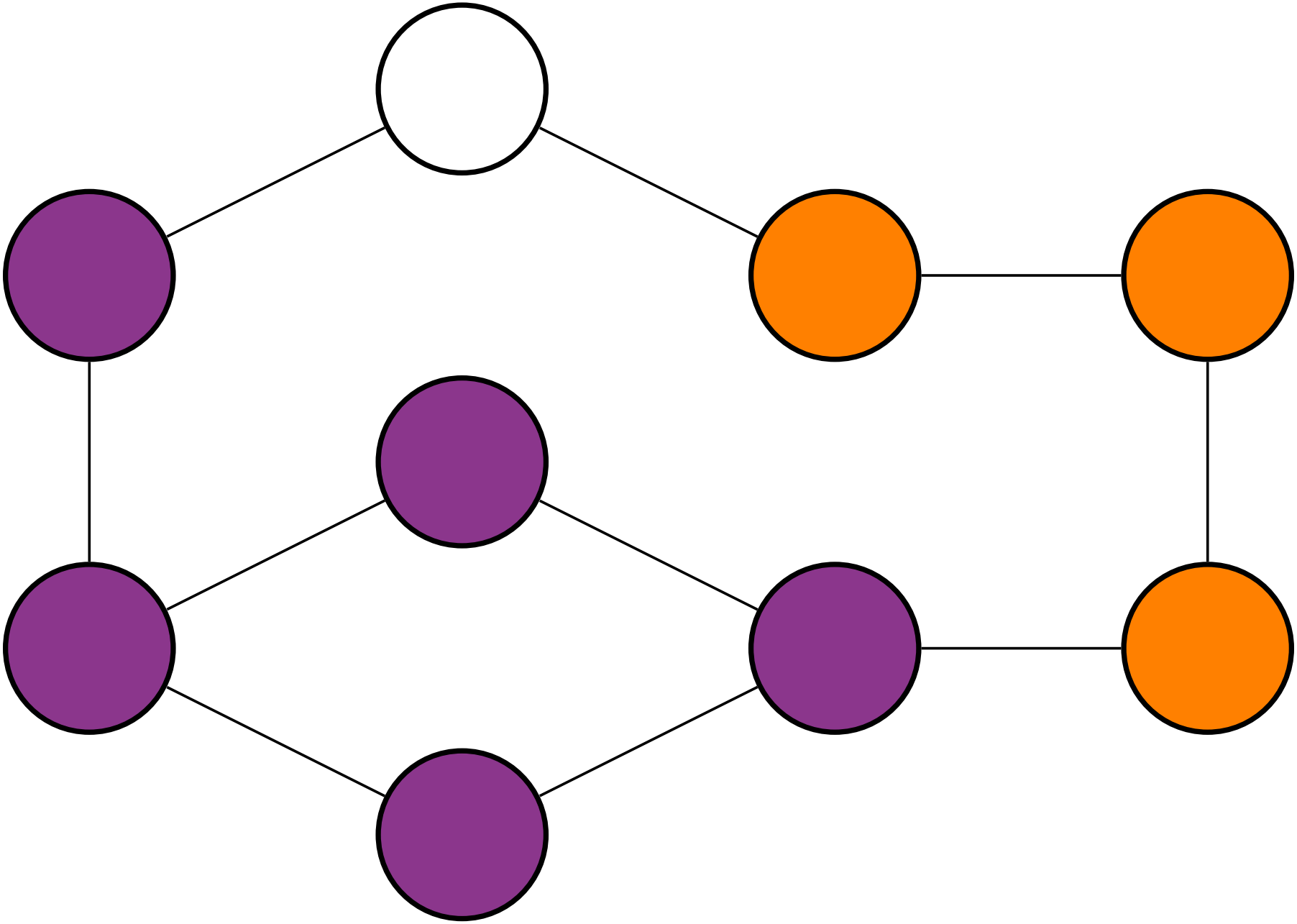

Mean Timesteps to Stability
Group 1
Group 2
Group 3
300
200
100
0
Timesteps
Size of Graph
800
600
400
200
Binary Tree
Grid
Line
Three Tree
Tree
Preferential 200
Preferential 100
Preferential 150
Preferential 250
Preferential 50
Random Sparse
Alum
BAClass I
BAClass II
CSDep I
CSDep II
CSIndSocial
PSDep
Group

Majority Model







Stability

- Number
- Opinion
- Certainty

Stability

- Number
- Opinion
- ~~Certainty~~

Period Stability

Democrats and Republicans Model

Frischknecht, Keller, and Wattenhofer Model, 2013

- Periodic Stability
- $\Omega(n^{\frac{3}{2}})$

Democrats and Republicans Model

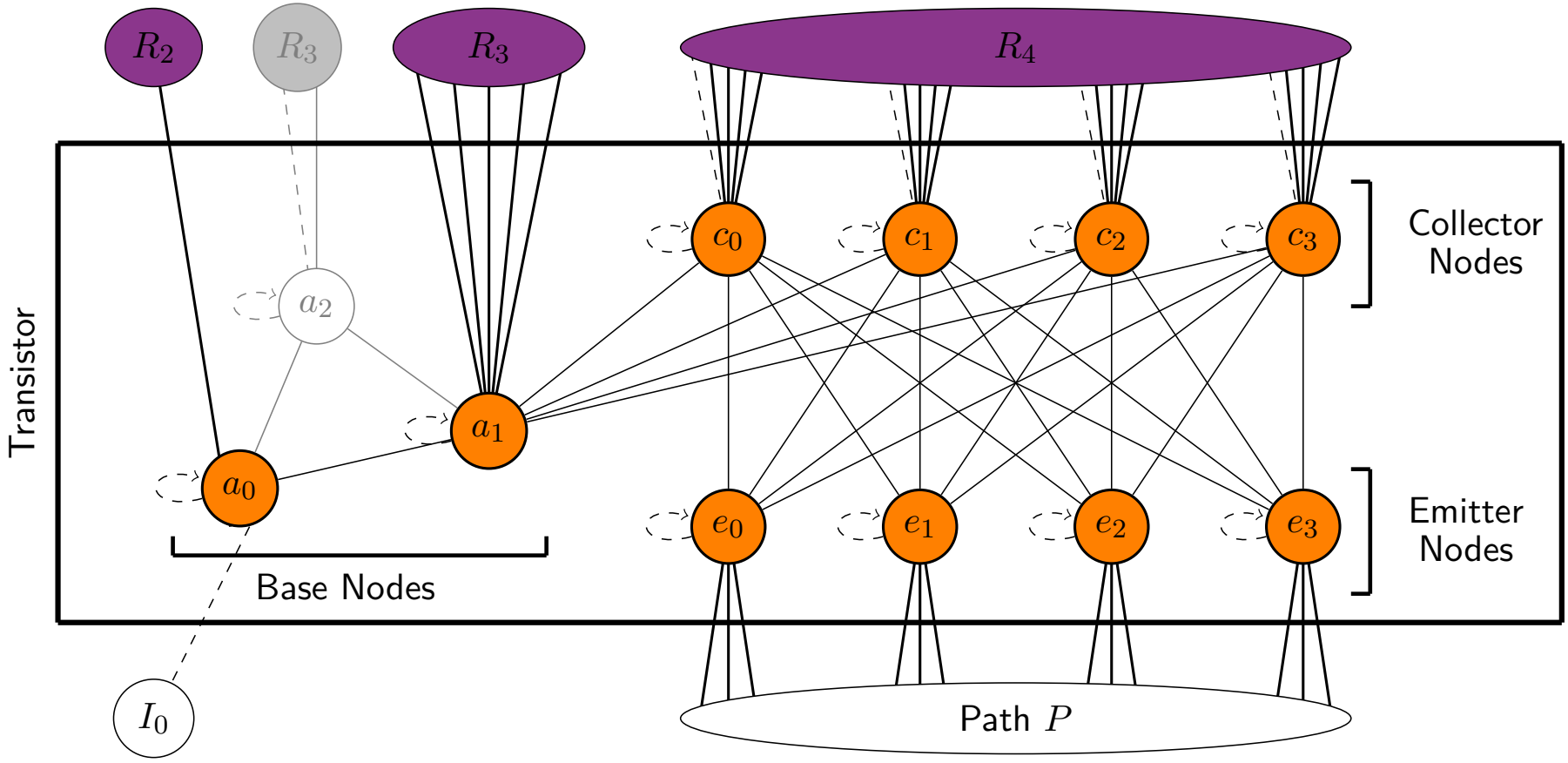
Frischknecht, Keller, and Wattenhofer Model, 2013

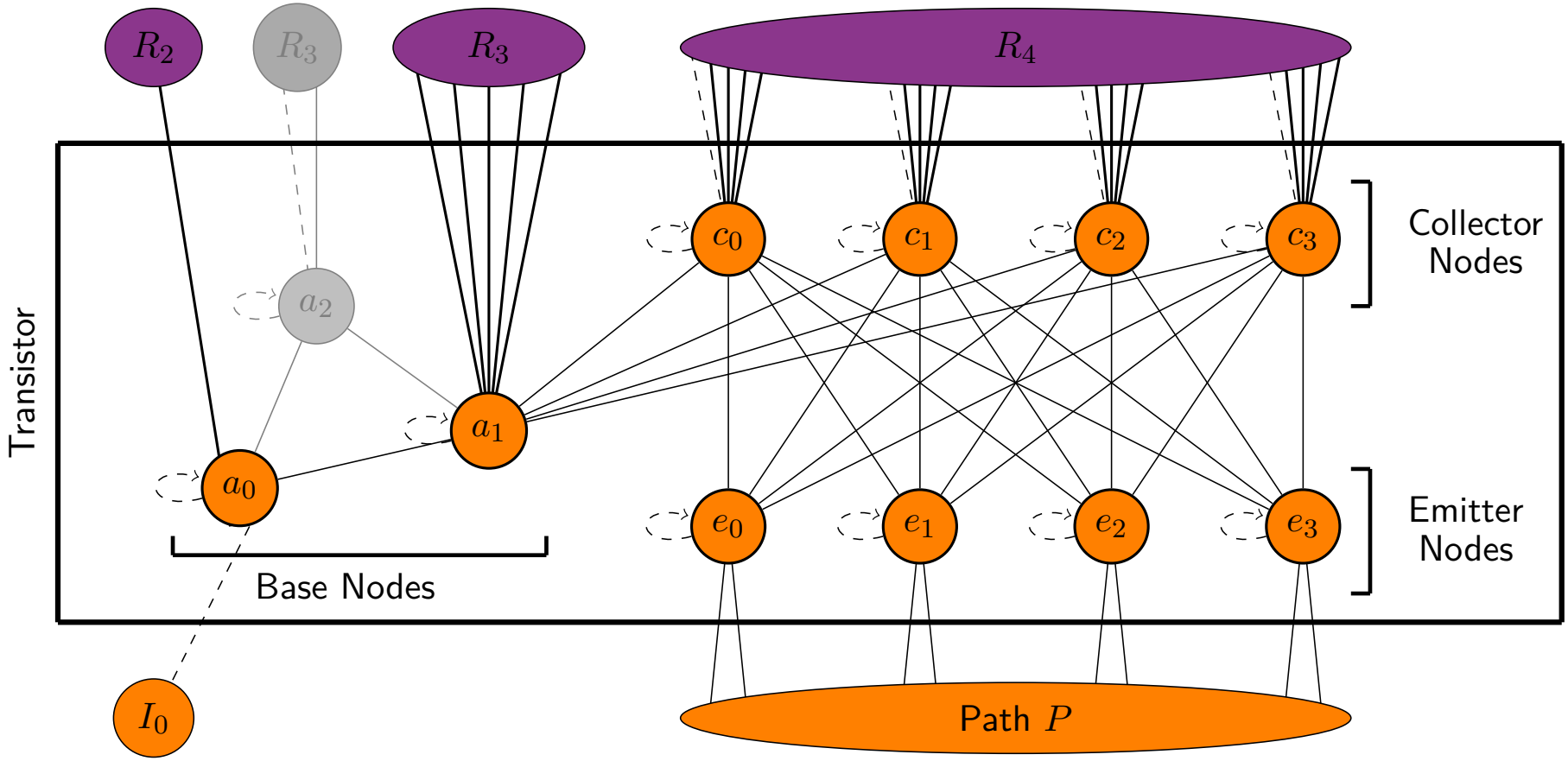
A Transistor

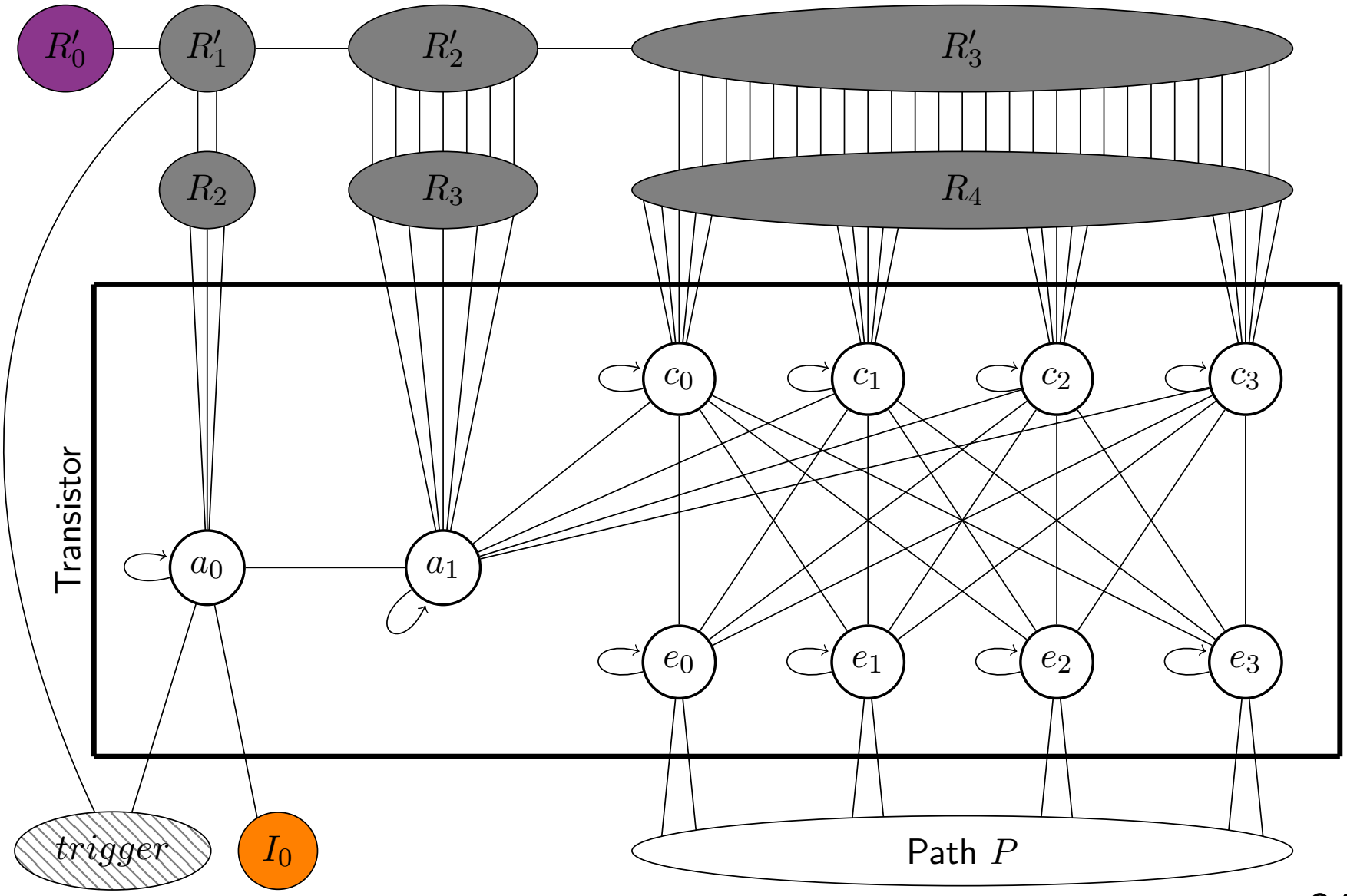
A transistor of size k can change $O(k^2)$ nodes in $O(k^2)$ timesteps.

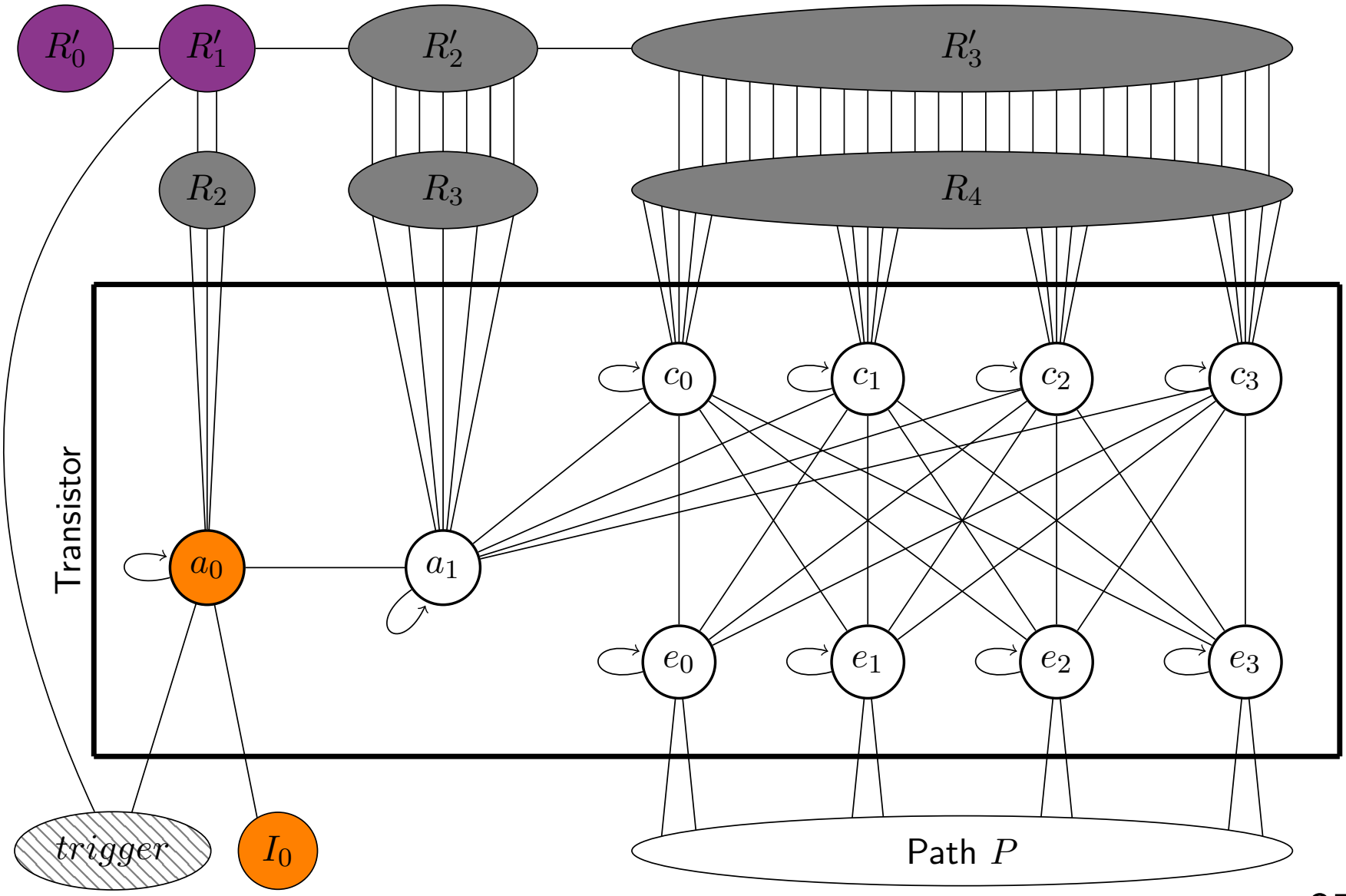
When there are k transistors the graph will stabilize in $\Omega(n^{\frac{3}{2}})$ timesteps.

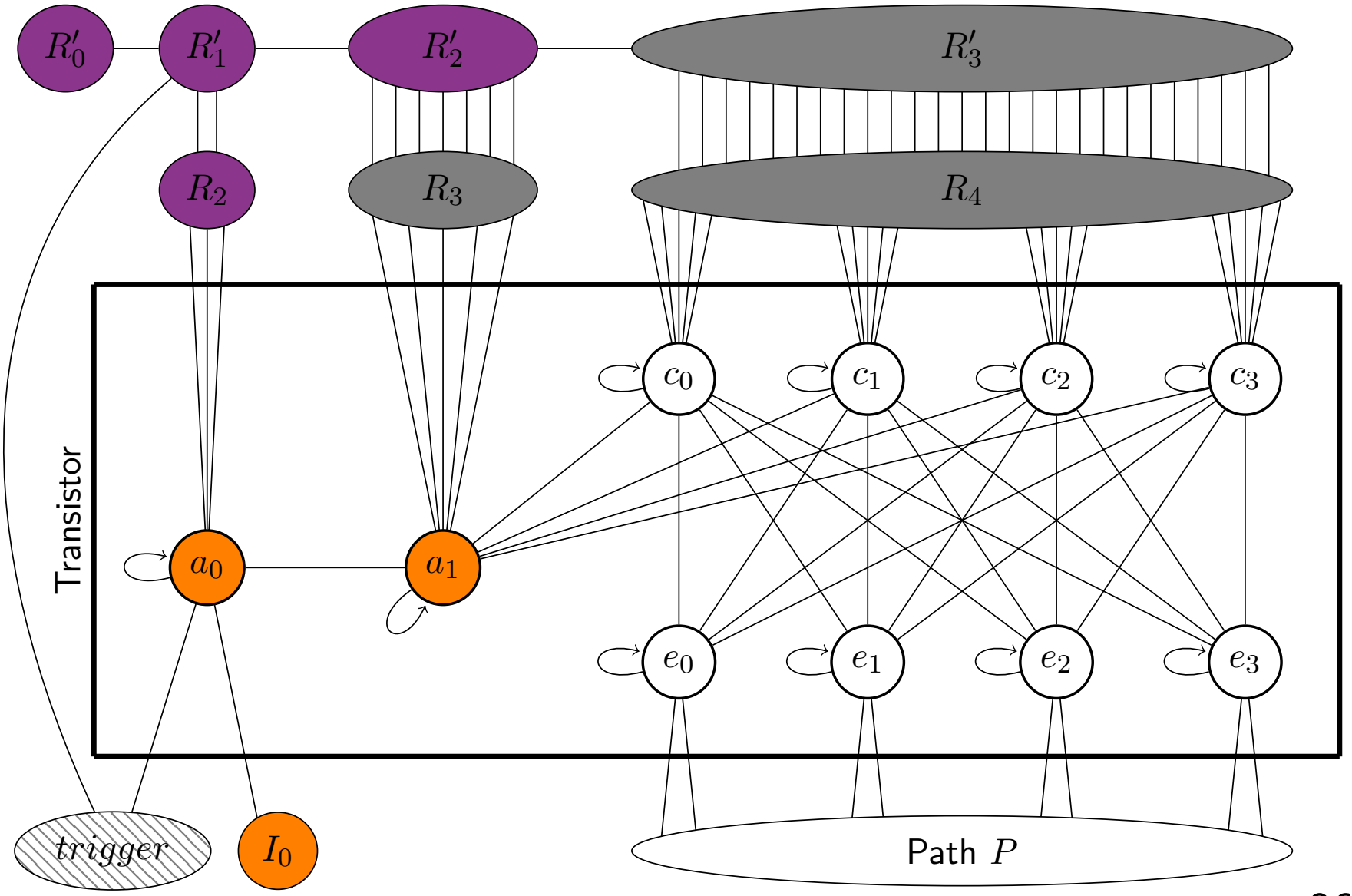
Transistor

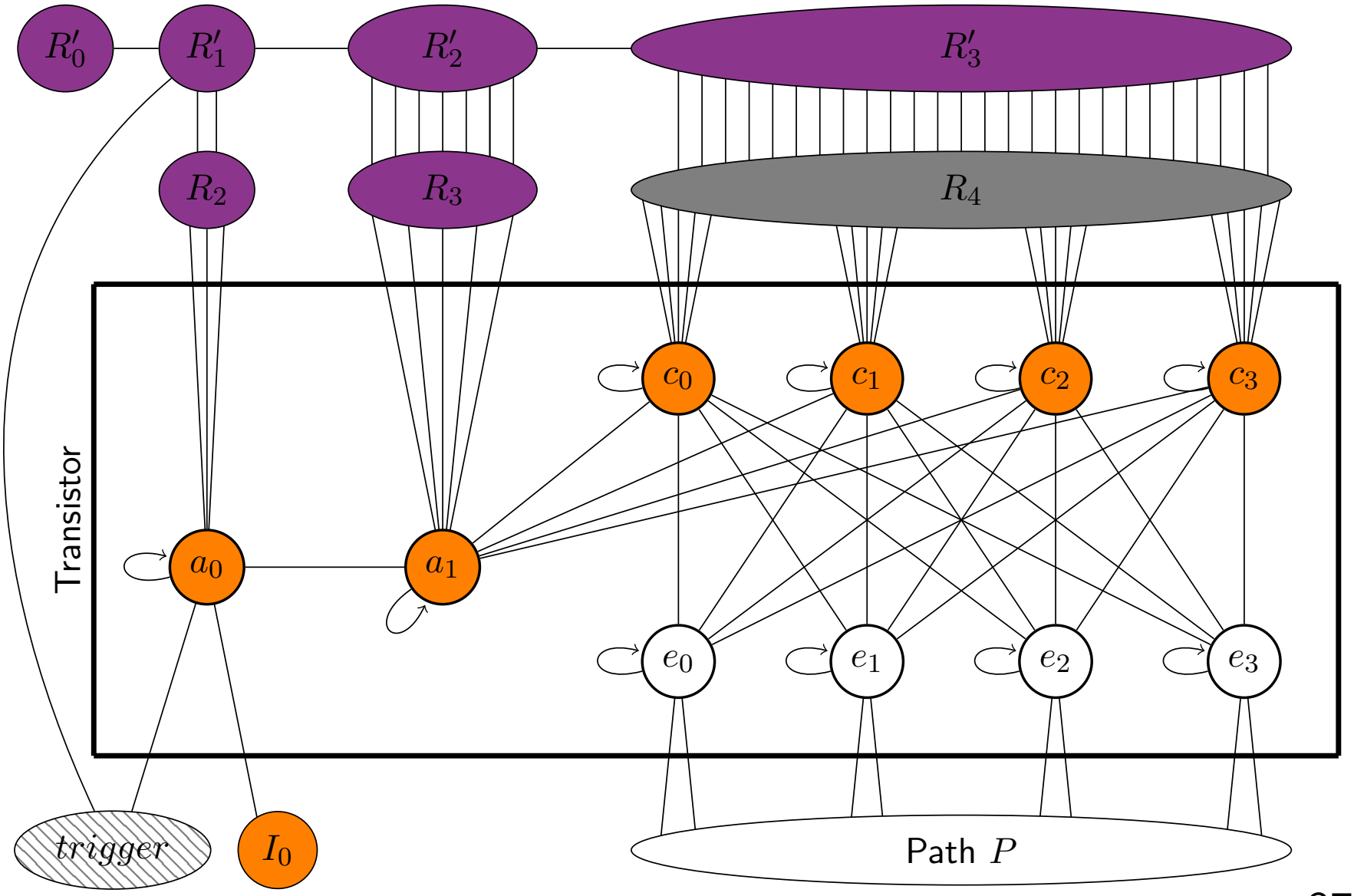

R_2
R_3
R_3
R_4
c_0
c_1
c_2
c_3
Collector Nodes
a_2
a_1
a_0
Transistor
e_0
e_1
e_2
e_3
Emitter Nodes
Base Nodes
I_0
Path P


R_2
R_3
R_3
R_4
c_0
c_1
c_2
c_3
Collector Nodes
a_2
a_1
a_0
e_0
e_1
e_2
e_3
Emitter Nodes
Transistor
Base Nodes
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P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R'_3
R_2
R_3
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Transistor
c_0
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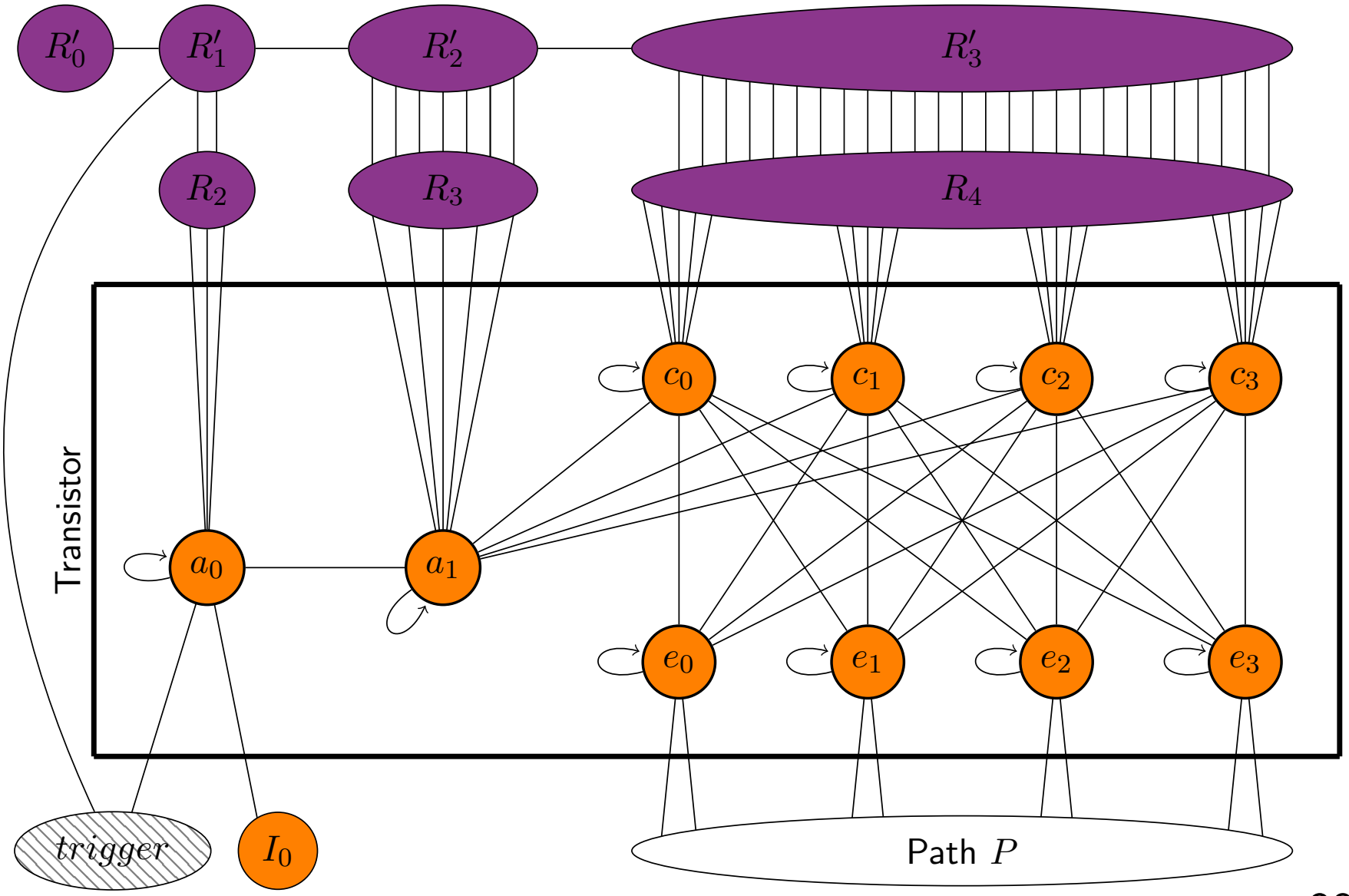
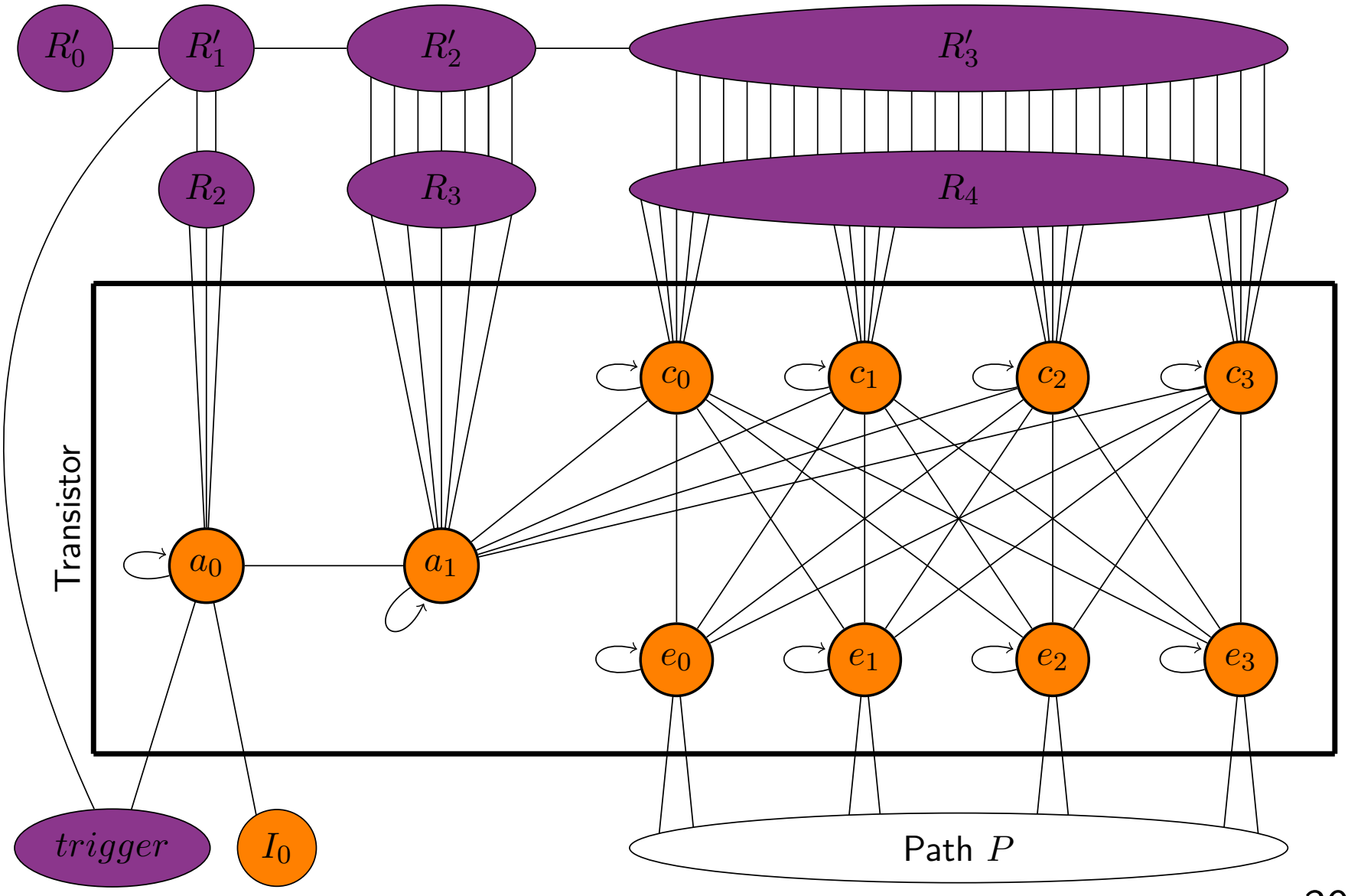
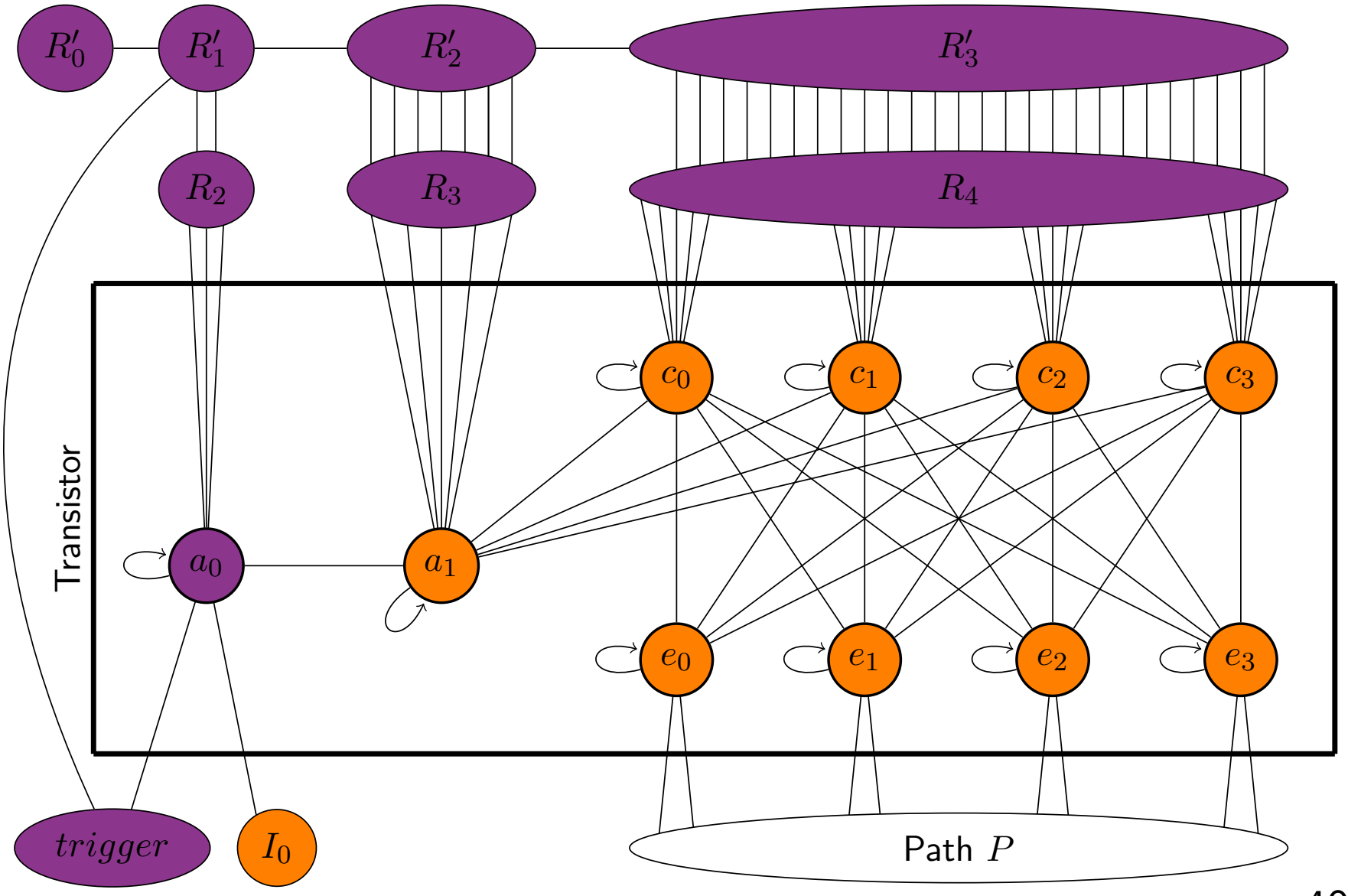
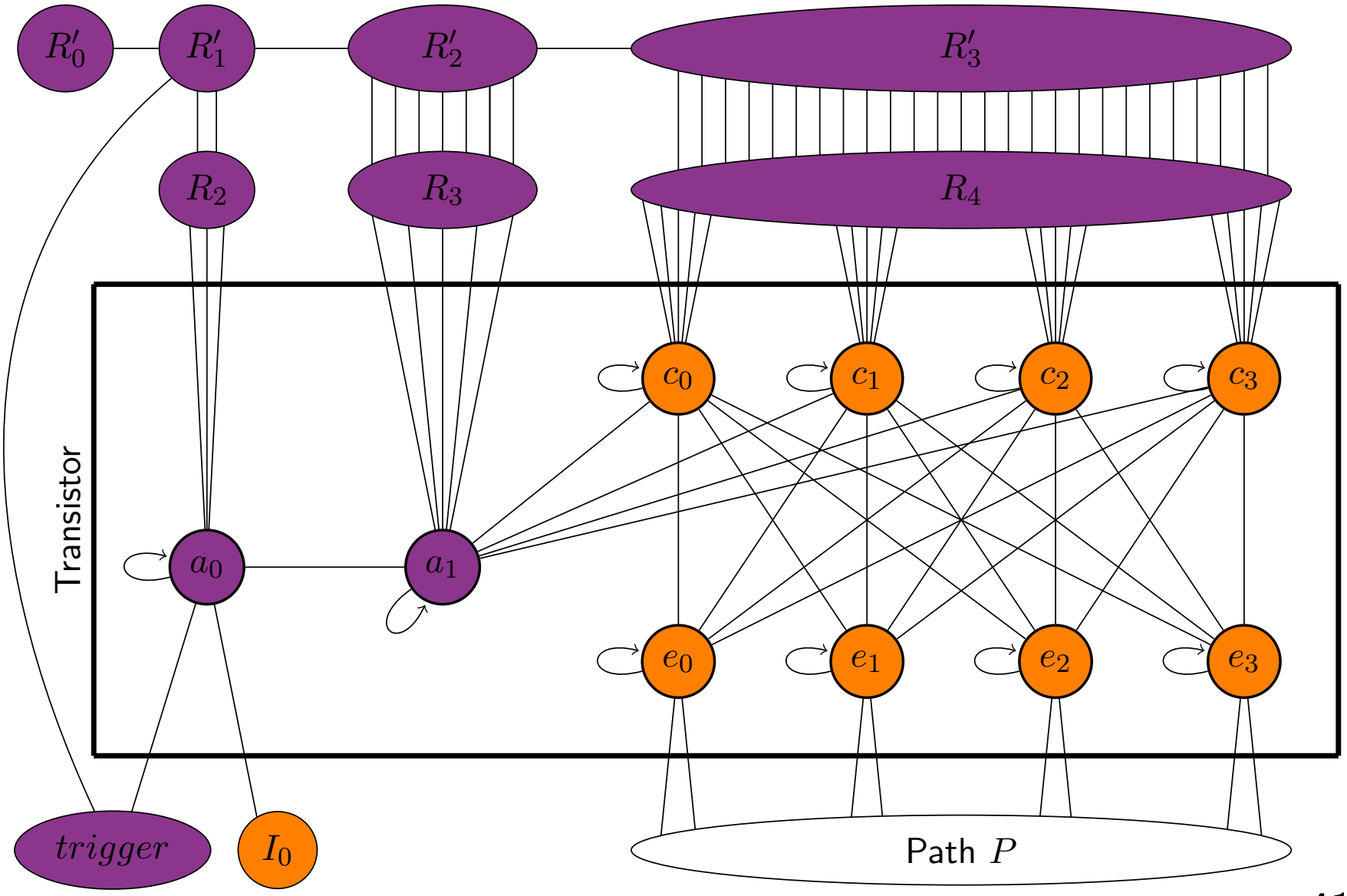
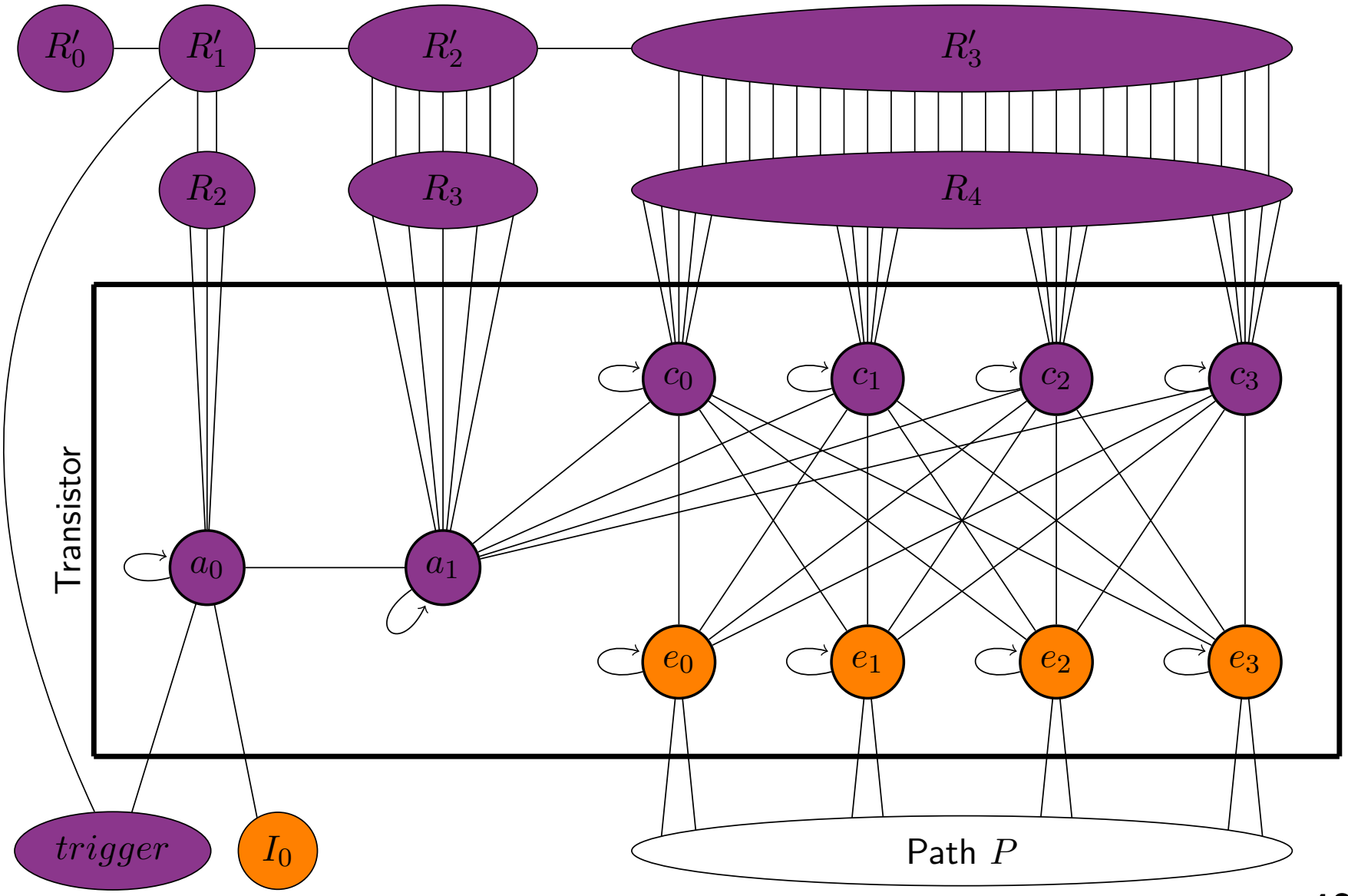
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P

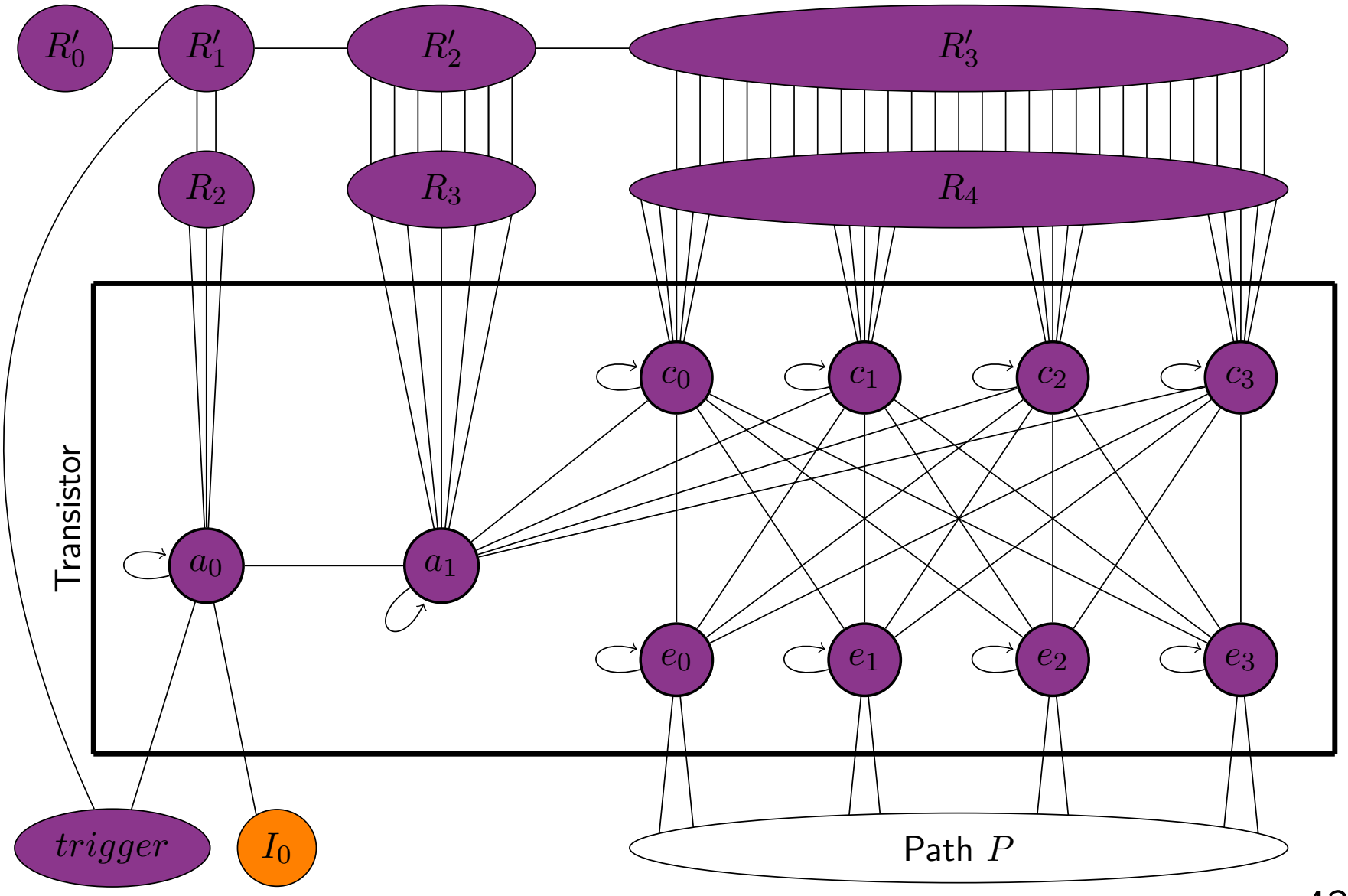

R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P

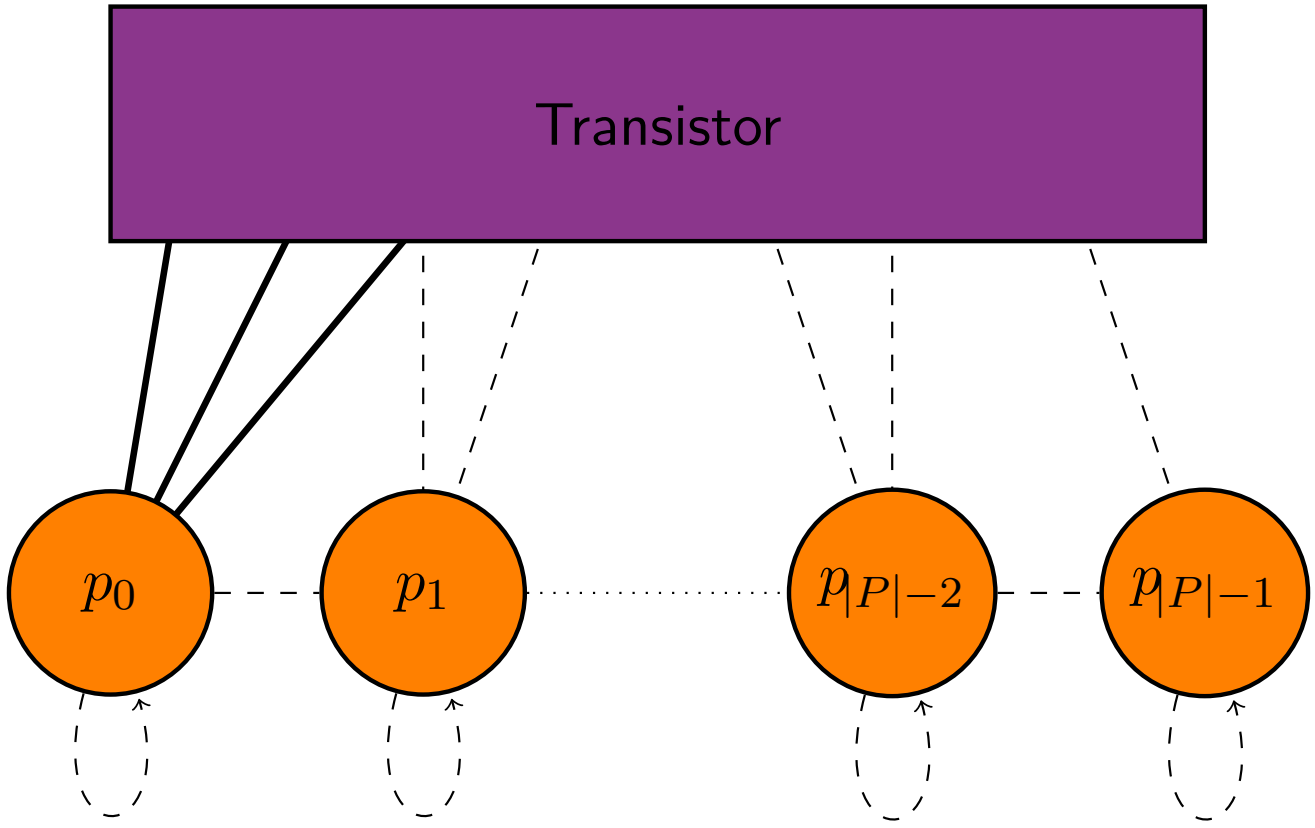

R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P

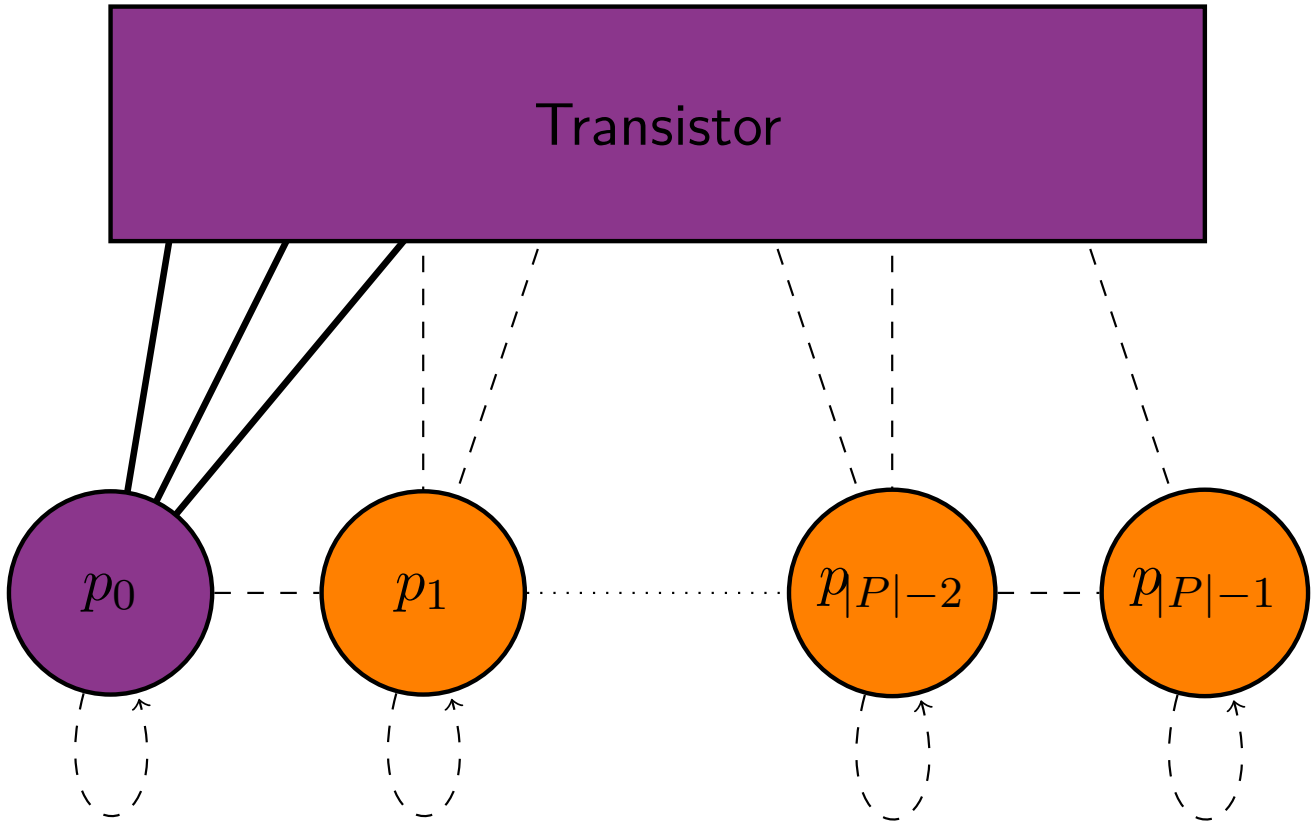

R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


R'_0
R'_1
R'_2
R'_3
R_2
R_3
R_4
Transistor
c_0
c_1
c_2
c_3
a_0
a_1
e_0
e_1
e_2
e_3
$trigger$
I_0
Path P


Transistor
p_0
p_1
$p_{|P|-2}$
$p_{|P|-1}$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p_0
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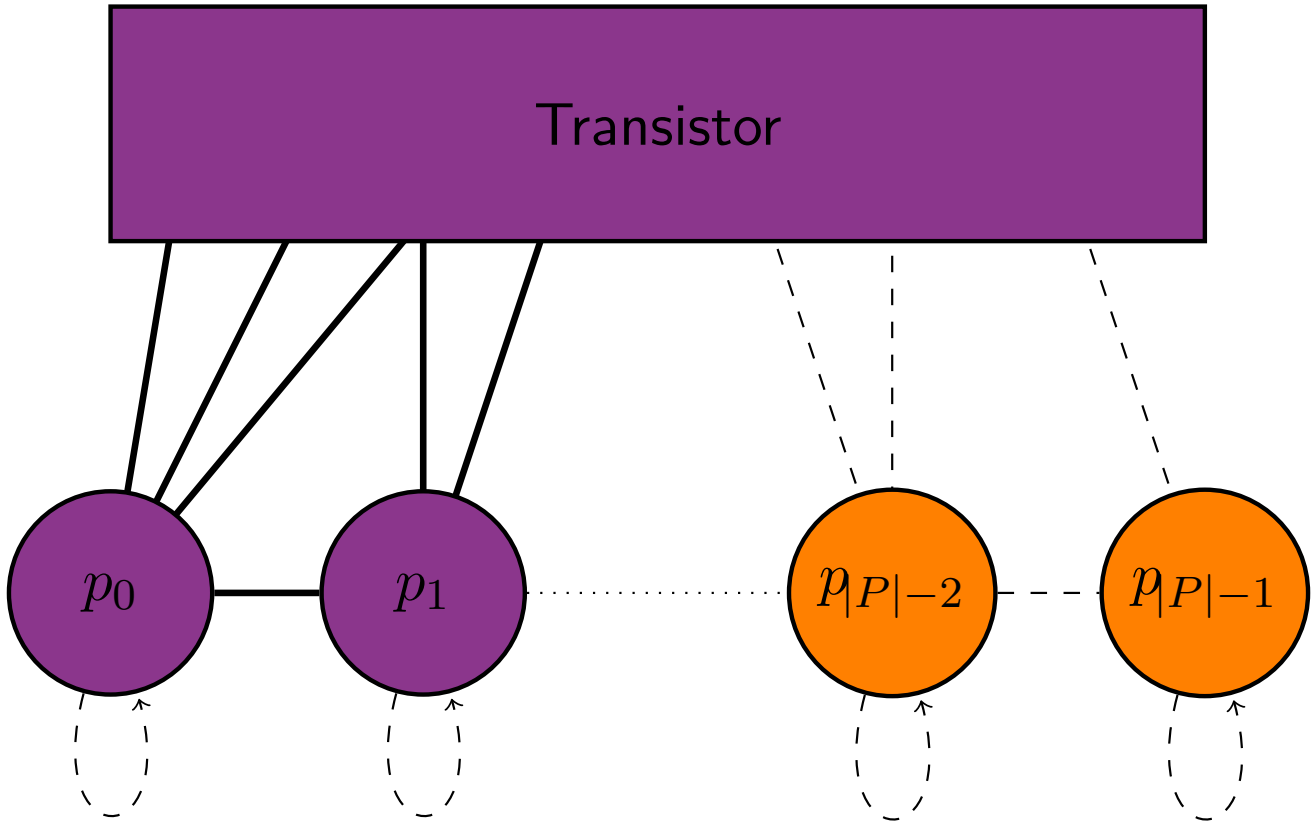
$p_{|P|-2}$
$p_{|P|-1}$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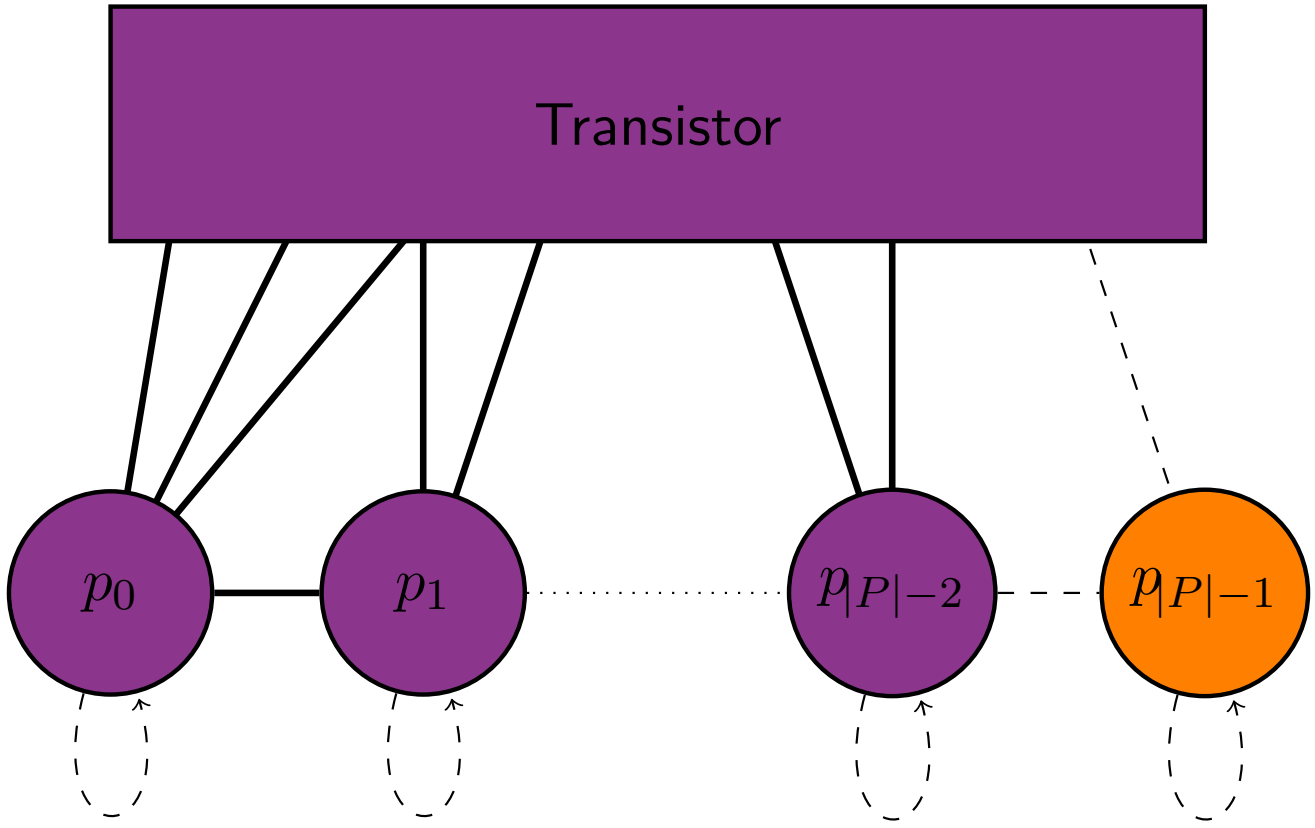
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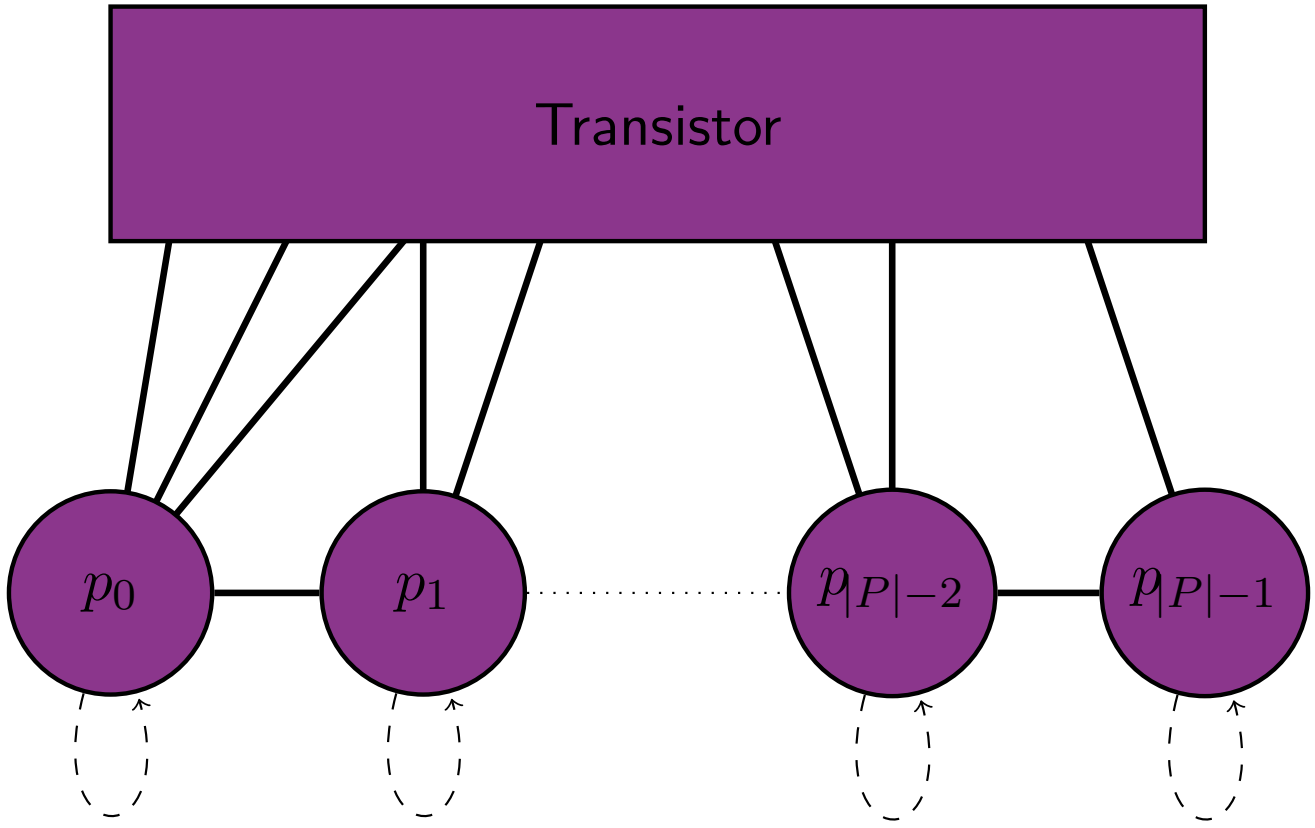
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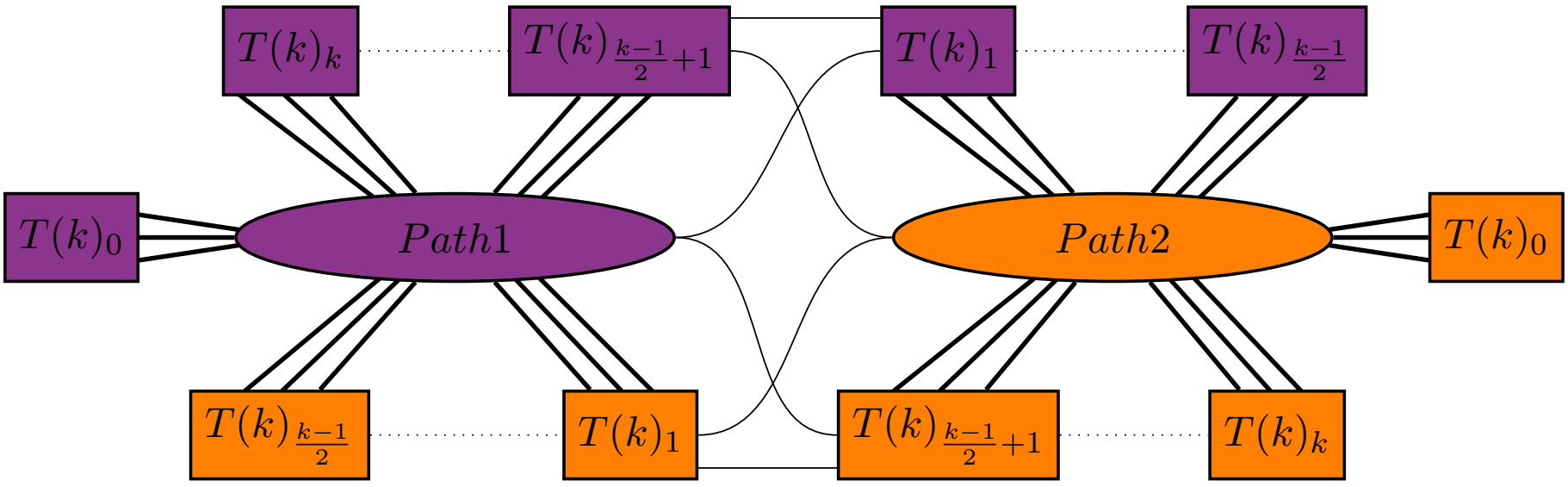
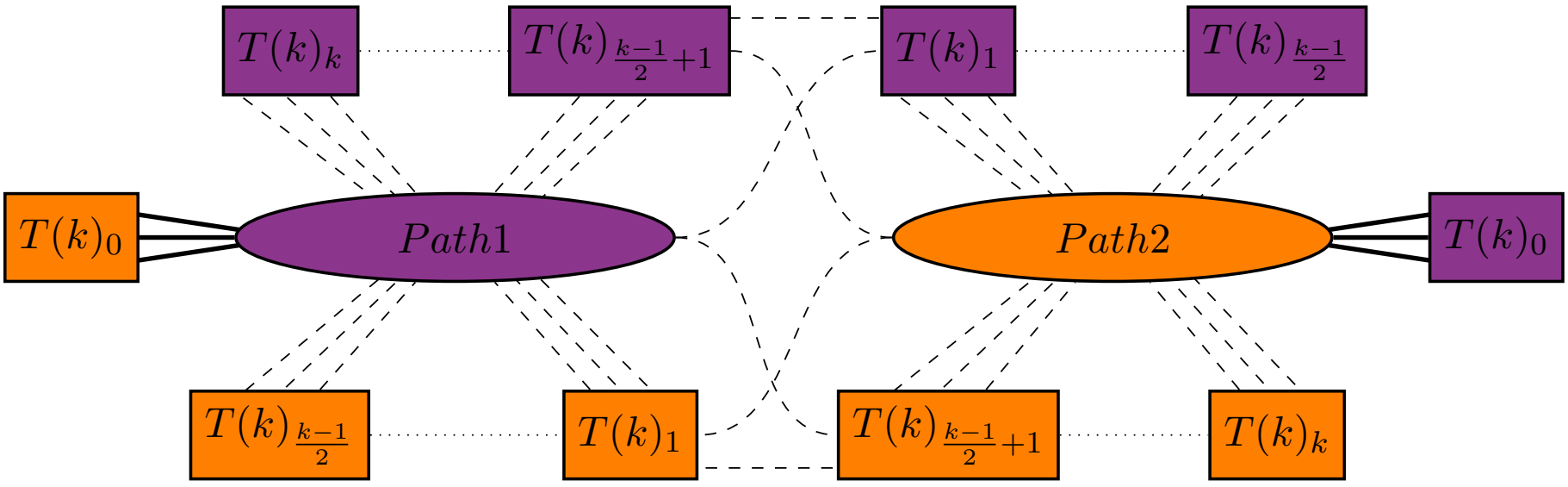
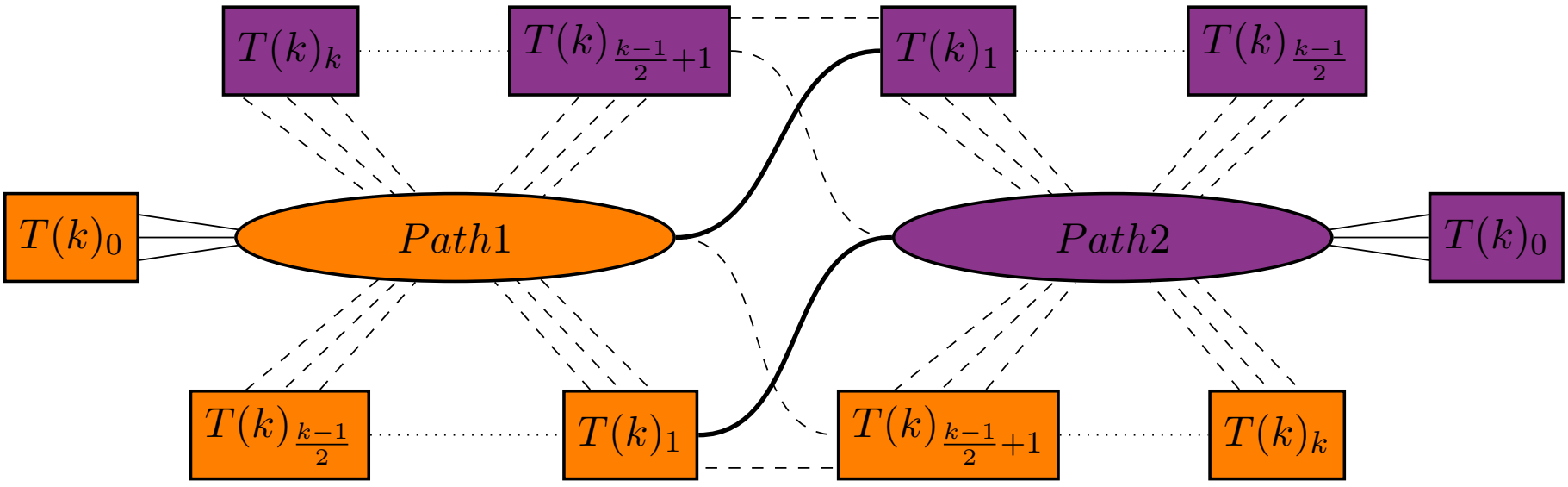
p_0
p_1
$p_{|P|-2}$
$p_{|P|-1}$


$T(k)_k$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$


$T(k)_k$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$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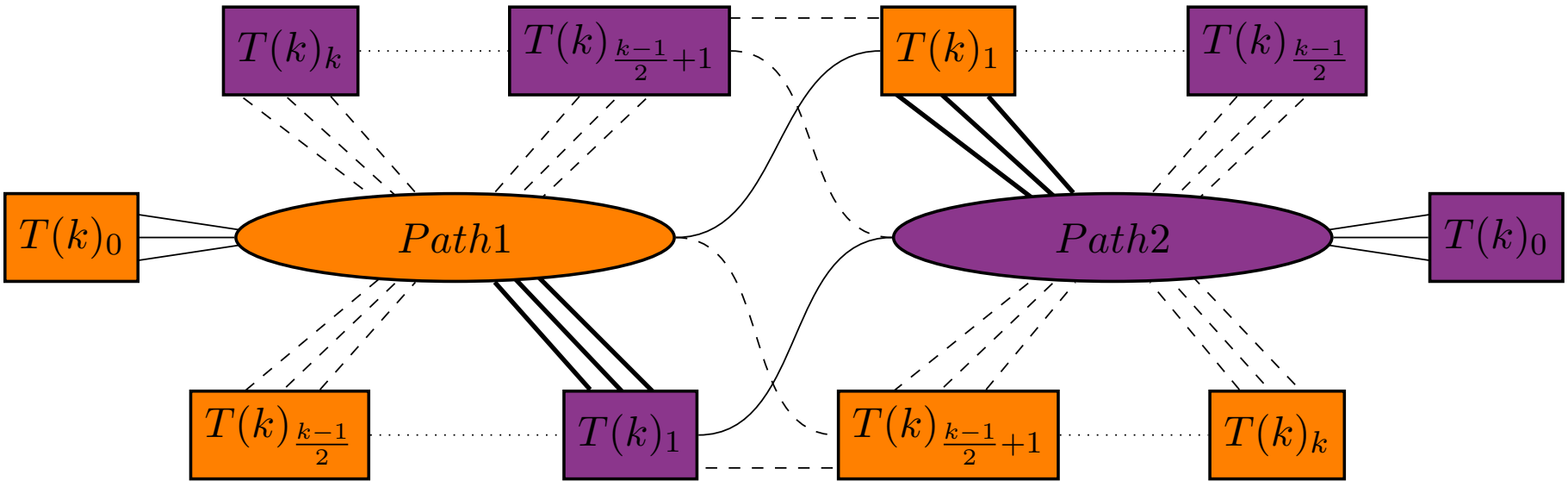
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$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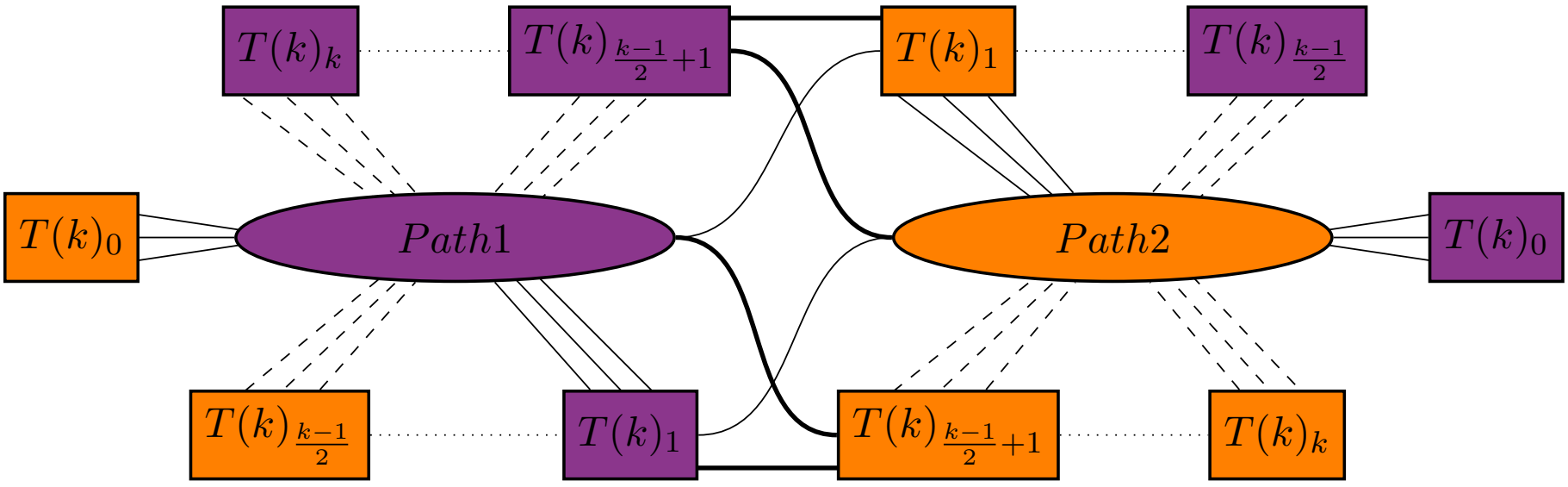
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$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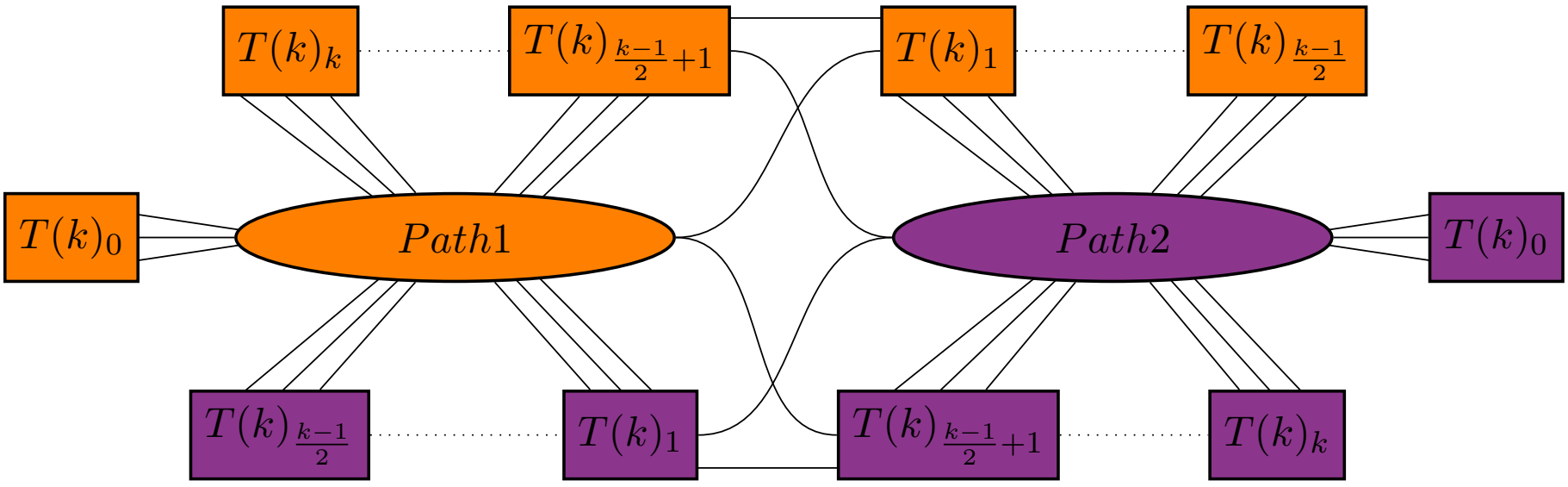
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$


$T(k)_k$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}}$
$T(k)_0$
$Path1$
$Path2$
$T(k)_0$
$T(k)_{\frac{k-1}{2}}$
$T(k)_1$
$T(k)_{\frac{k-1}{2}+1}$
$T(k)_k$

Future Work

- Periodic stability
- Increase certainty
- More than two experts

Questions?