Gracefully Degrading Gathering in Dynamic Rings

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Models

Models

Models

Indulgent Algorithms [AGGT12]

Synchronous

Asynchronous

Models with synchrony assumptions

Consensus (with termination) with crashes ✓

~~Consensus (with termination) with crashes~~

Indulgent Algorithms [AGGT12]

Synchronous

Asynchronous

Models with synchrony assumptions

Consensus (with termination) with crashes ✓

Consensus **without** termination with crashes ✓

Gracefully Degrading Algorithms [BRSSW18]

Weak dynamicity

Strong dynamicity

Models with dynamicity assumptions

Problem P

Problem P

Gracefully Degrading Algorithms [BRSSW18]

Weak dynamicity

Strong dynamicity

Models with dynamicity assumptions

Problem P ✓

Problem **P'<P** ✓

Gracefully Degrading Algorithms [BRSSW18]

Weak dynamicity

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Problem **P'<P** ✓

Problem P' ✗

Gracefully Degrading Algorithms [BRSSW18]

Weak dynamicity

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Models with dynamicity assumptions

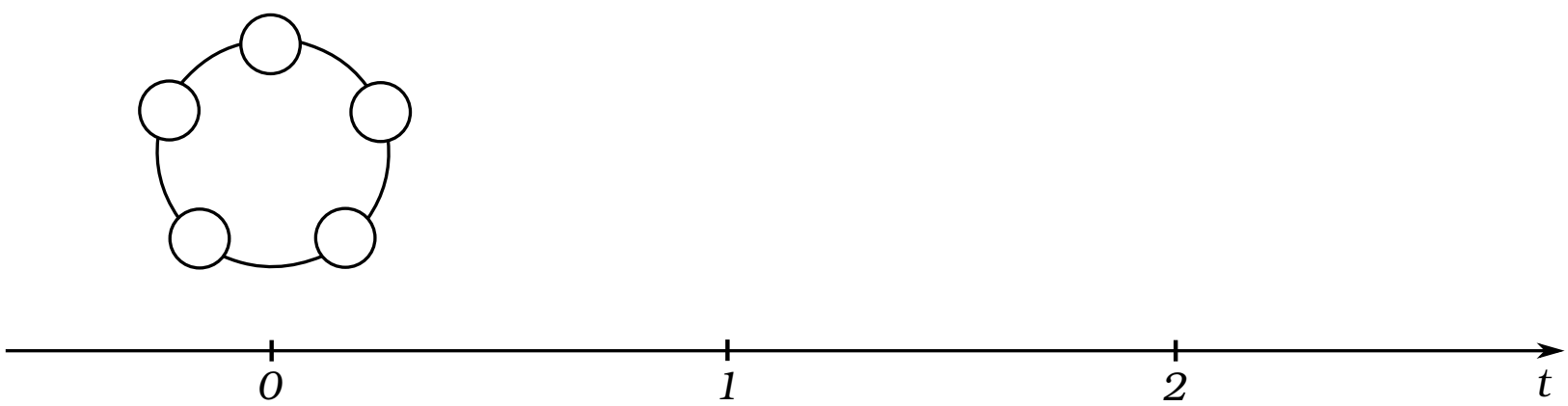
Problem P

Problem **P'<P**

Problem **P"<P'**

Plan

Evolving Graphs [XFJ03]



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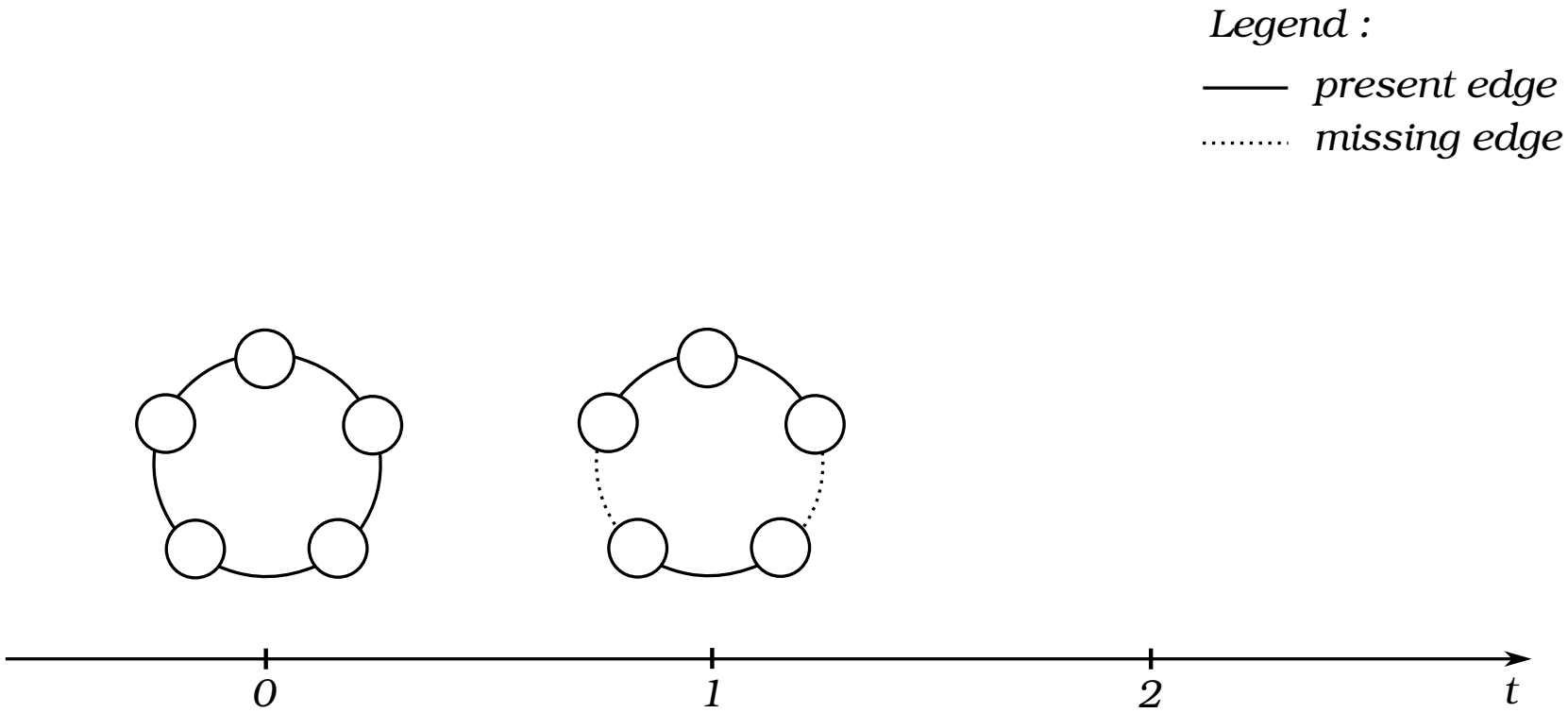

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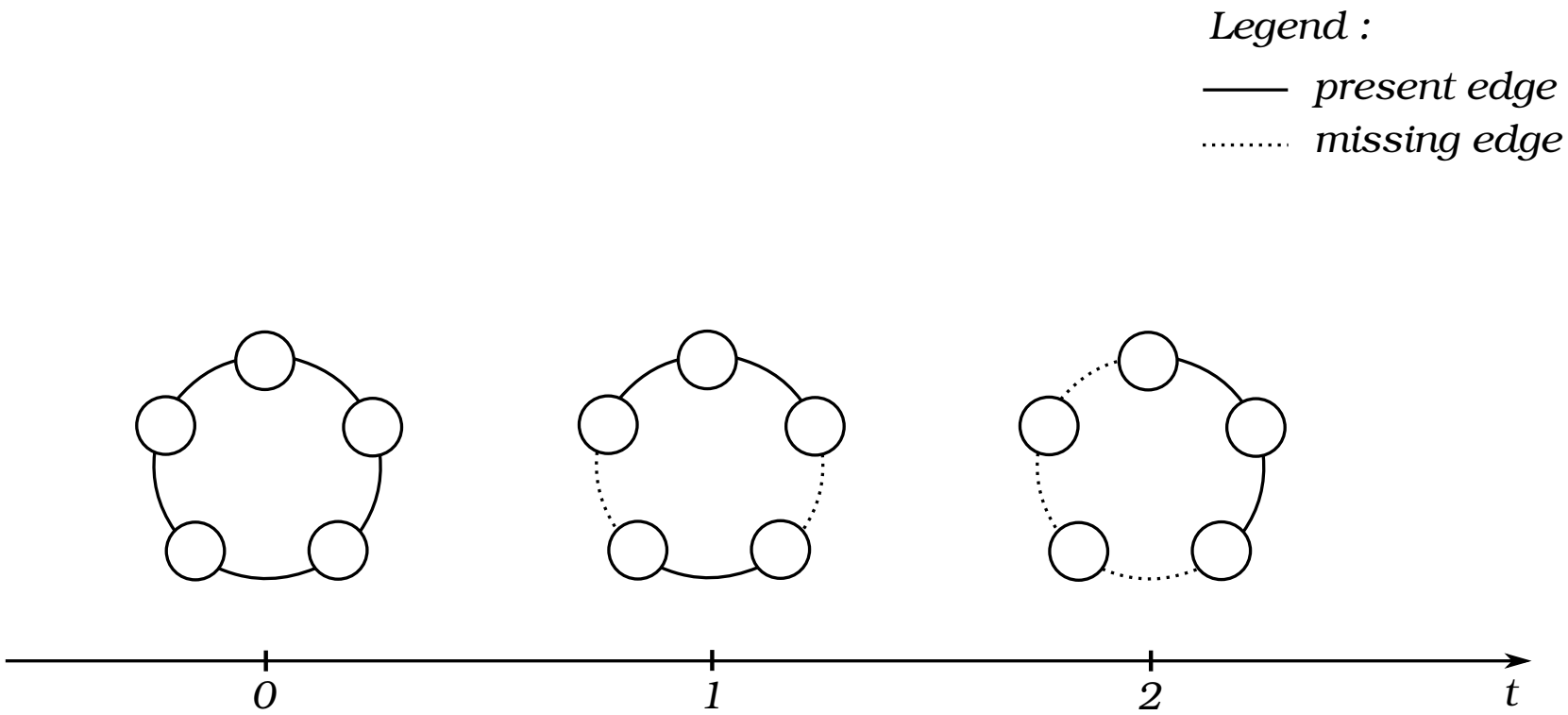

Classes of Dynamic Graphs [CFQS12]

Static

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Time-bounded recurrent-edges

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Classes of Dynamic Graphs [CFQS12]

Time-bounded recurrent-edges ⟶ *Recurrent-edges*

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Time-bounded recurrent-edges ⟶ *Recurrent-edges*

Static

1-interval-connected

Classes of Dynamic Graphs [CFQS12]

Time-bounded recurrent-edges → *Recurrent-edges*

Static

Connected-over-time

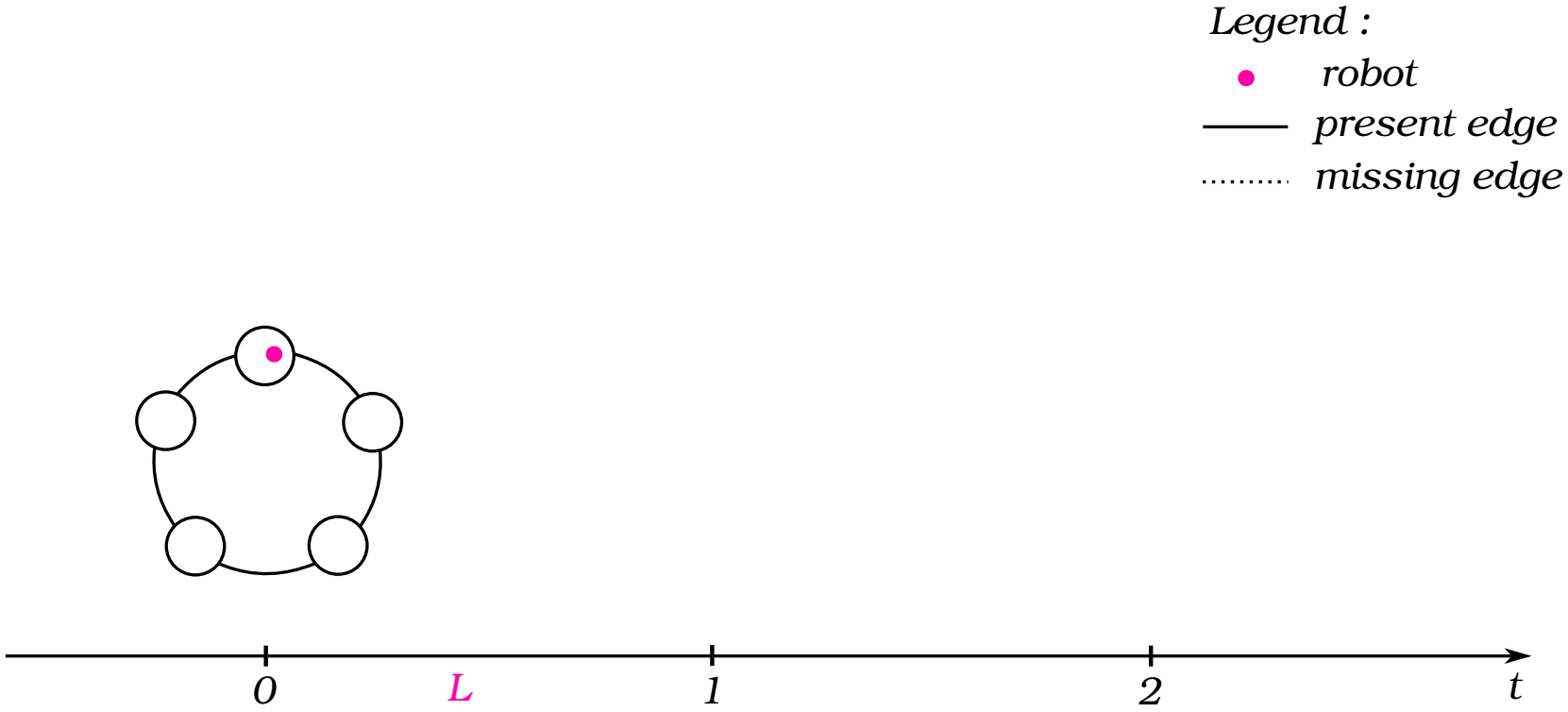
1-interval-connected

Classes of Dynamic Graphs [CFQS12]

Time-bounded recurrent-edges ⊂ *Recurrent-edges* ⊂ *Connected-over-time*

Static ⊂ *1-interval-connected* ⊂ *Connected-over-time*

Robots and Evolving Graphs



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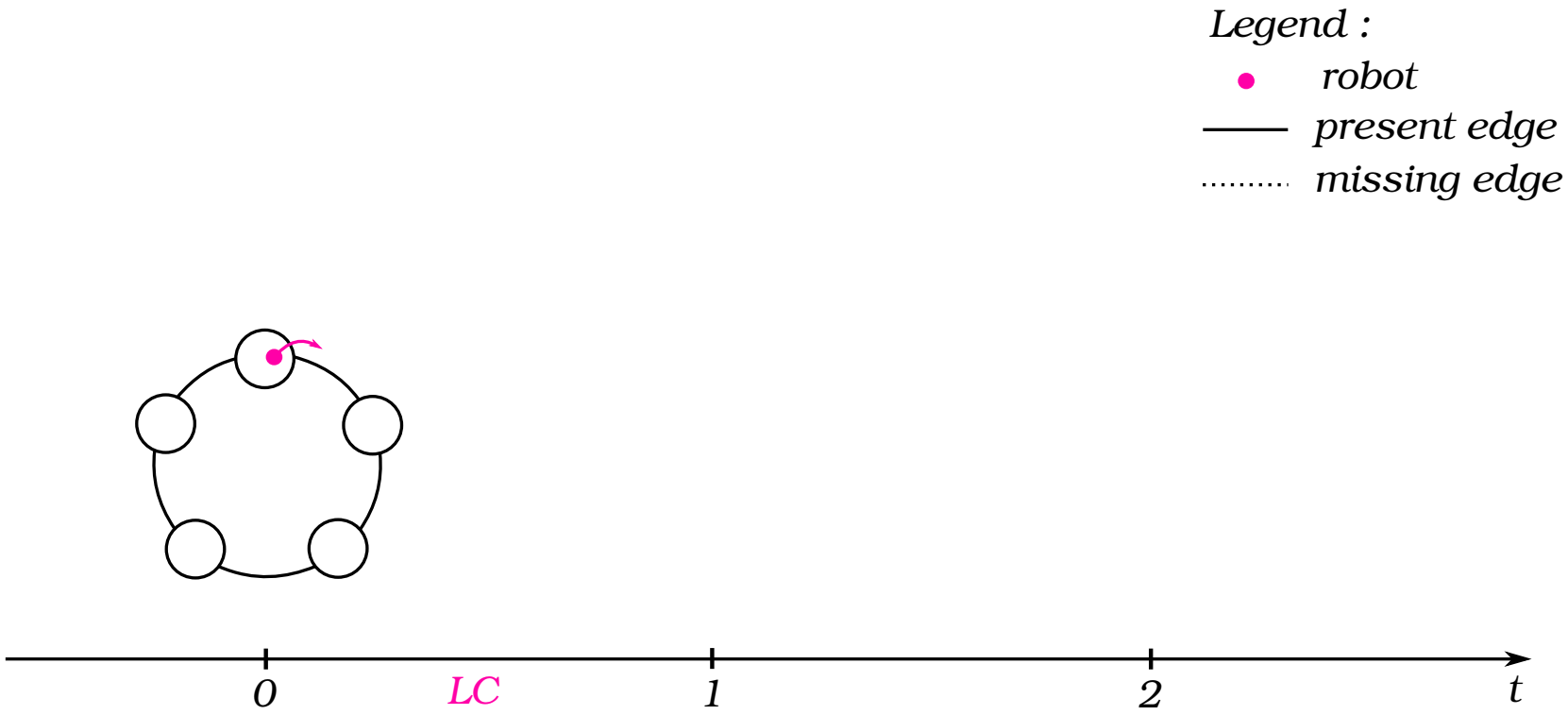

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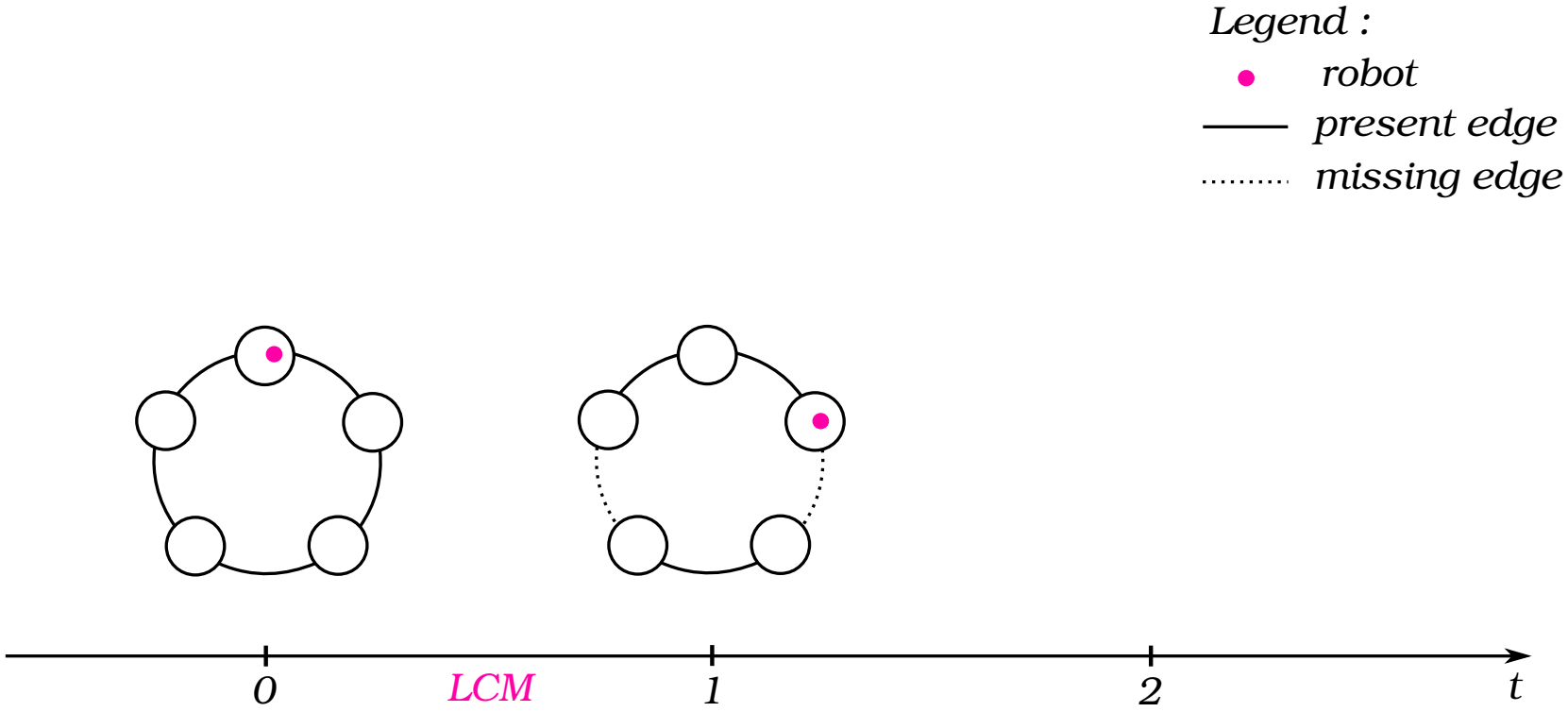

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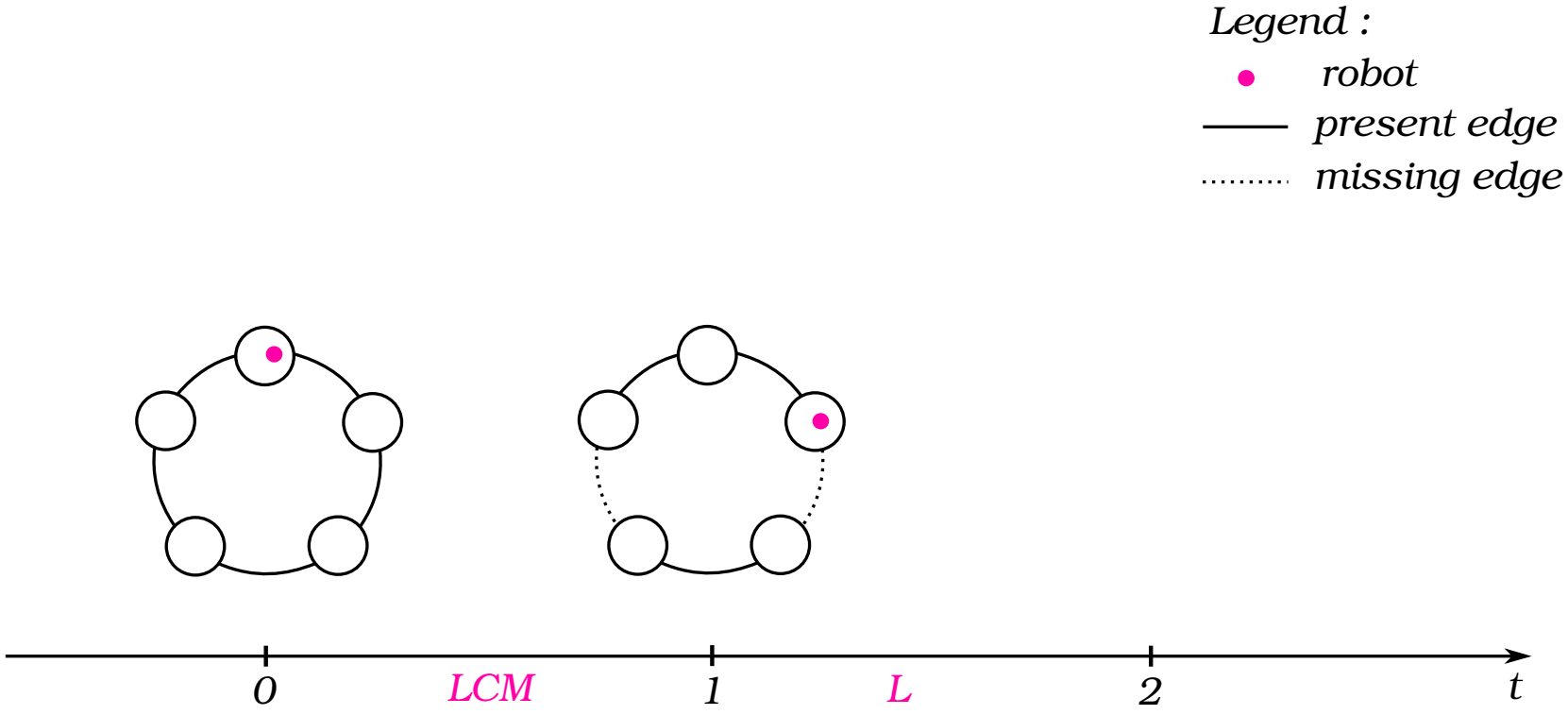

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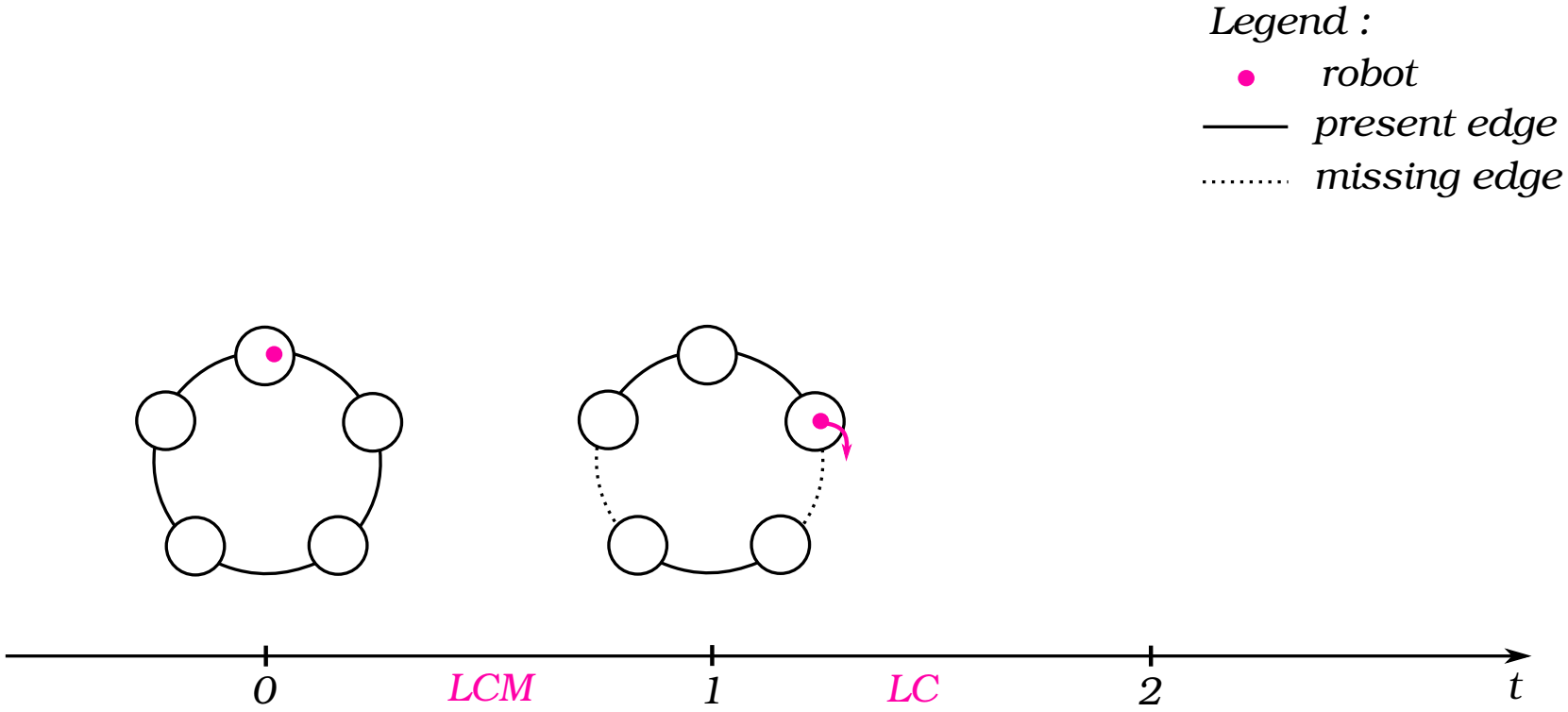

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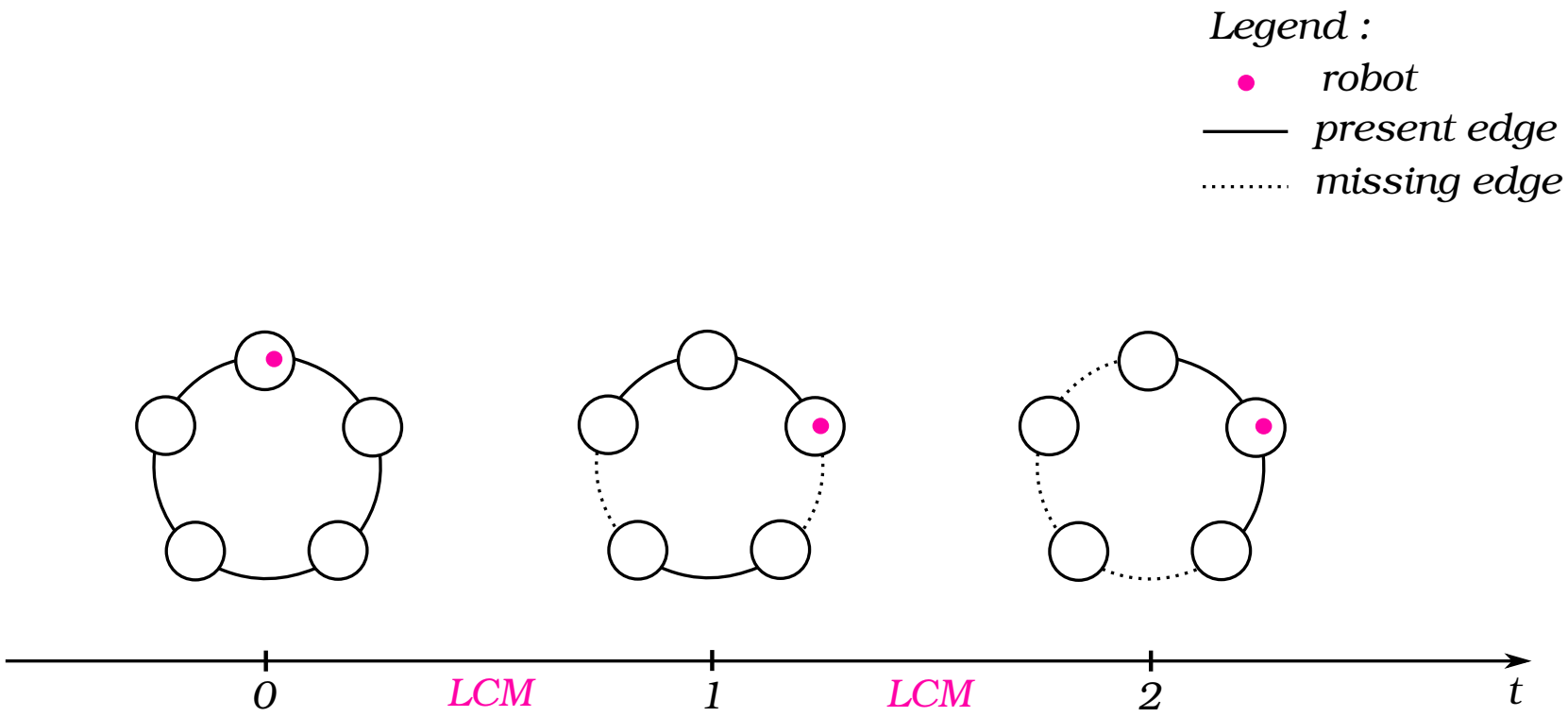
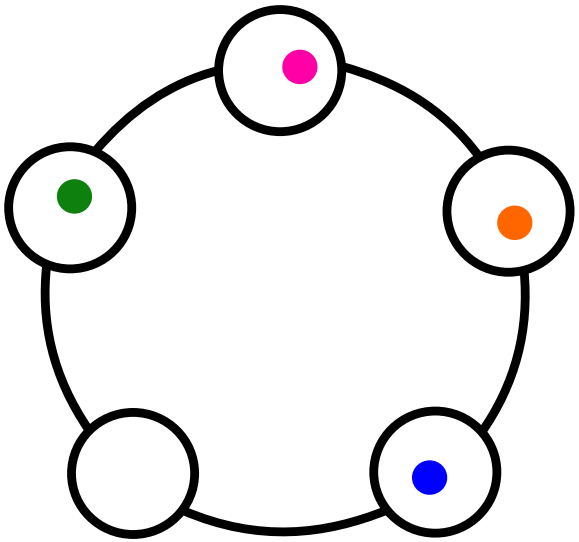


Plan

Gathering [KMP06]



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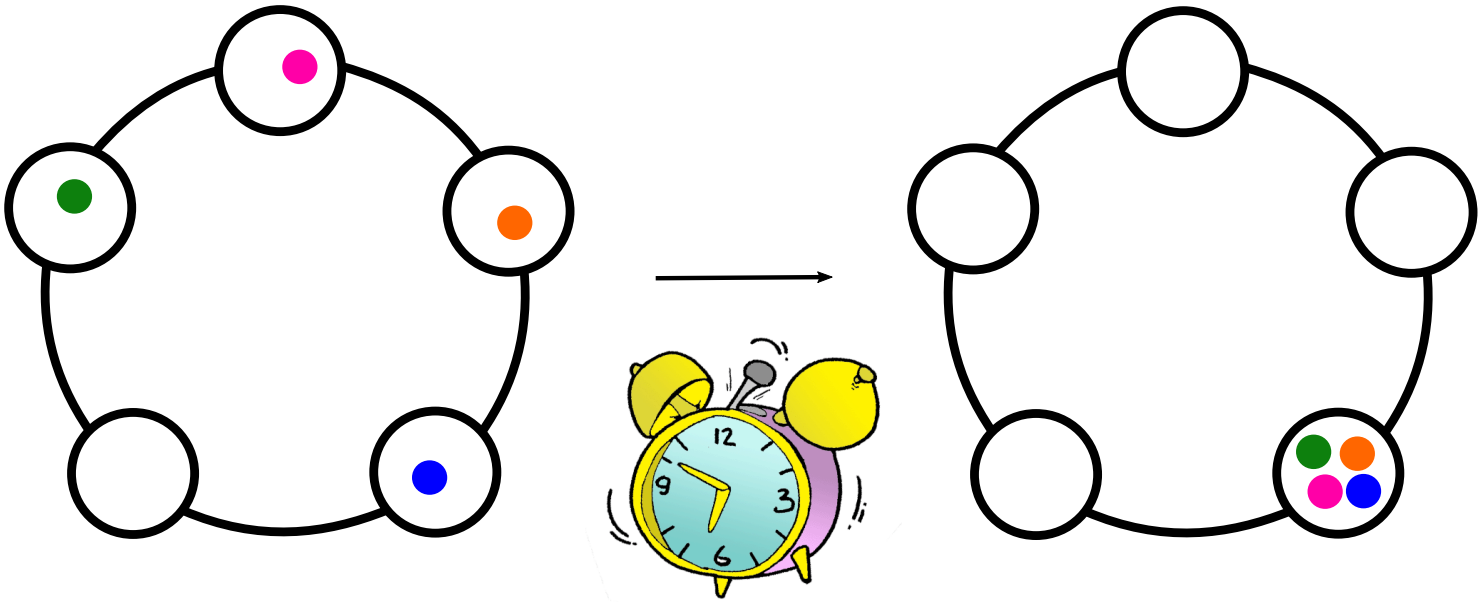
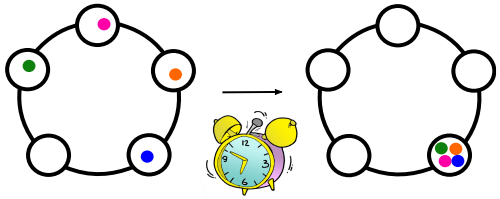
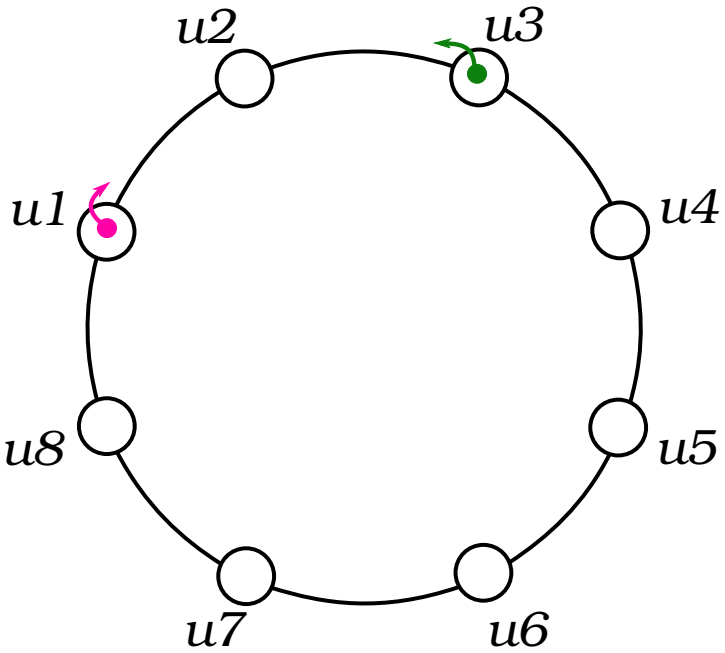


Impossibility Result

1-interval-connected





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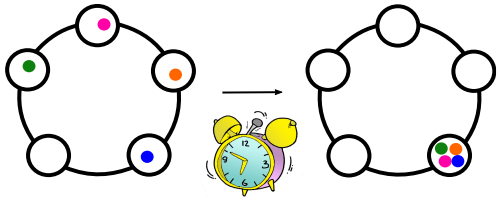

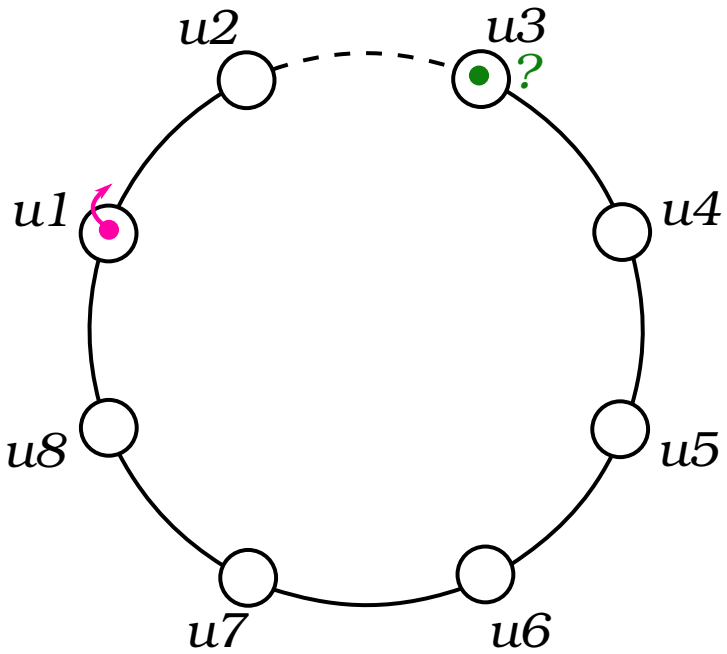

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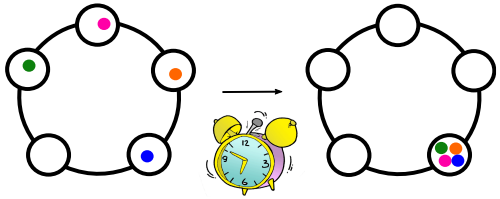

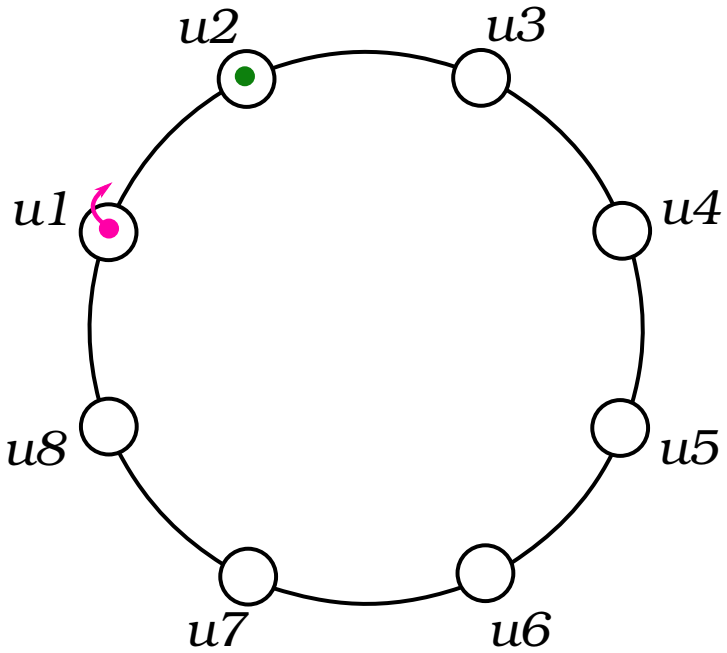

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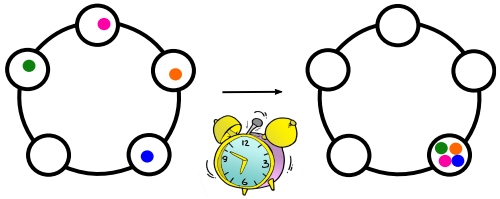
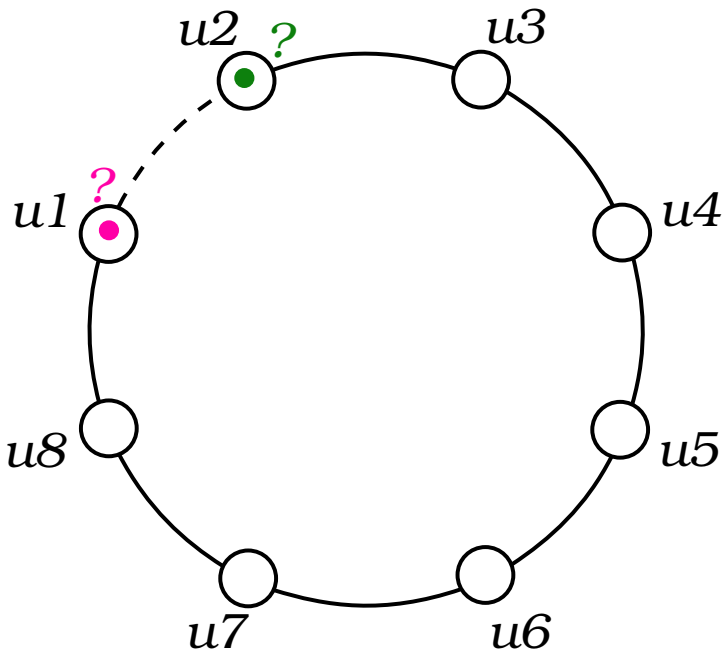
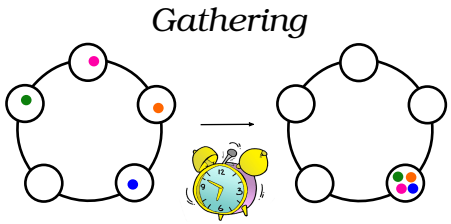




Weakening Gathering Problem



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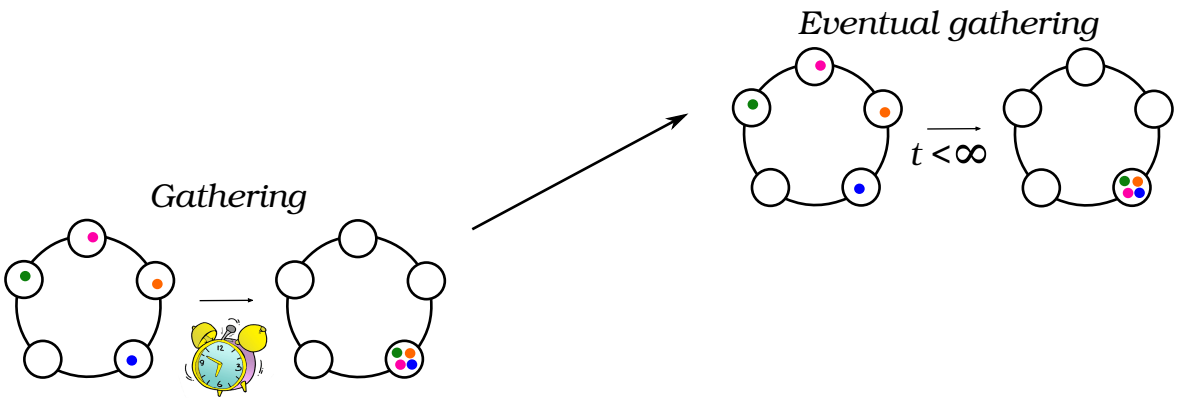

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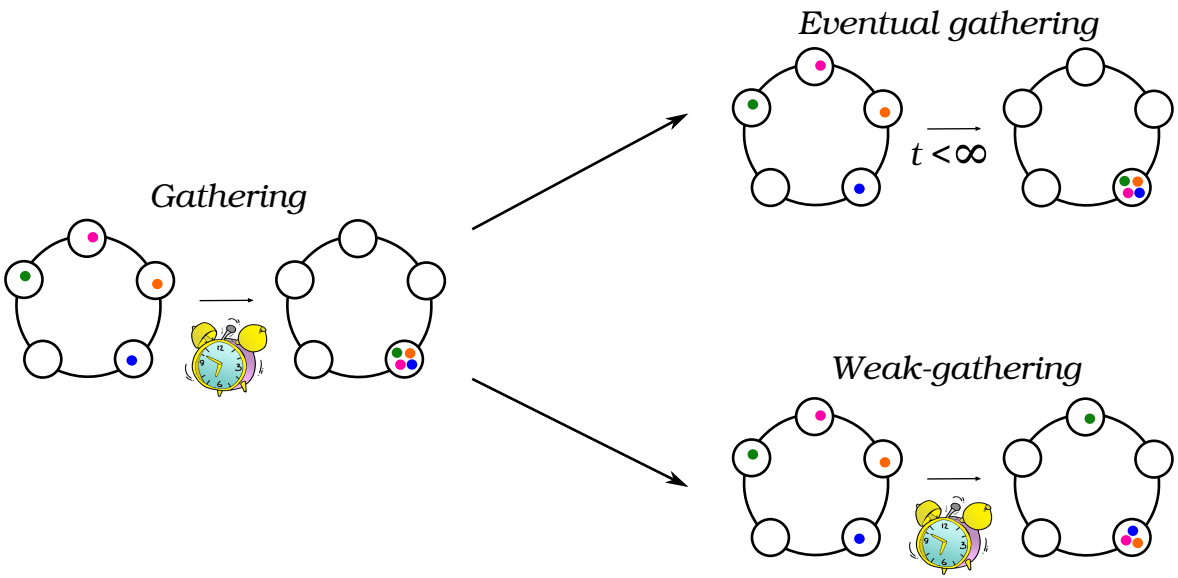

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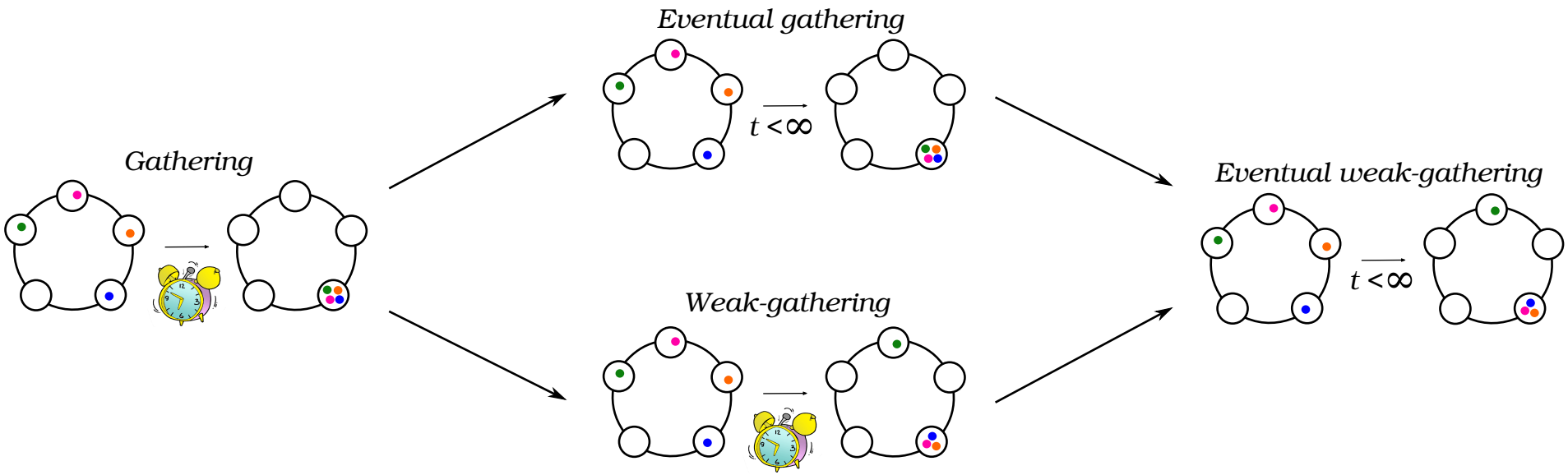
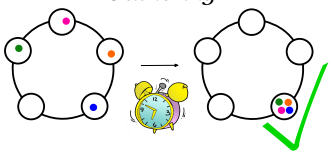


Our Contribution

Static

Gathering



Our Contribution

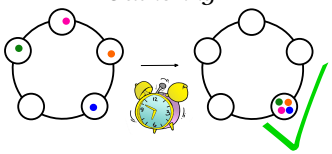
Time-bounded recurrent-edges

Static

Gathering

?

Gathering



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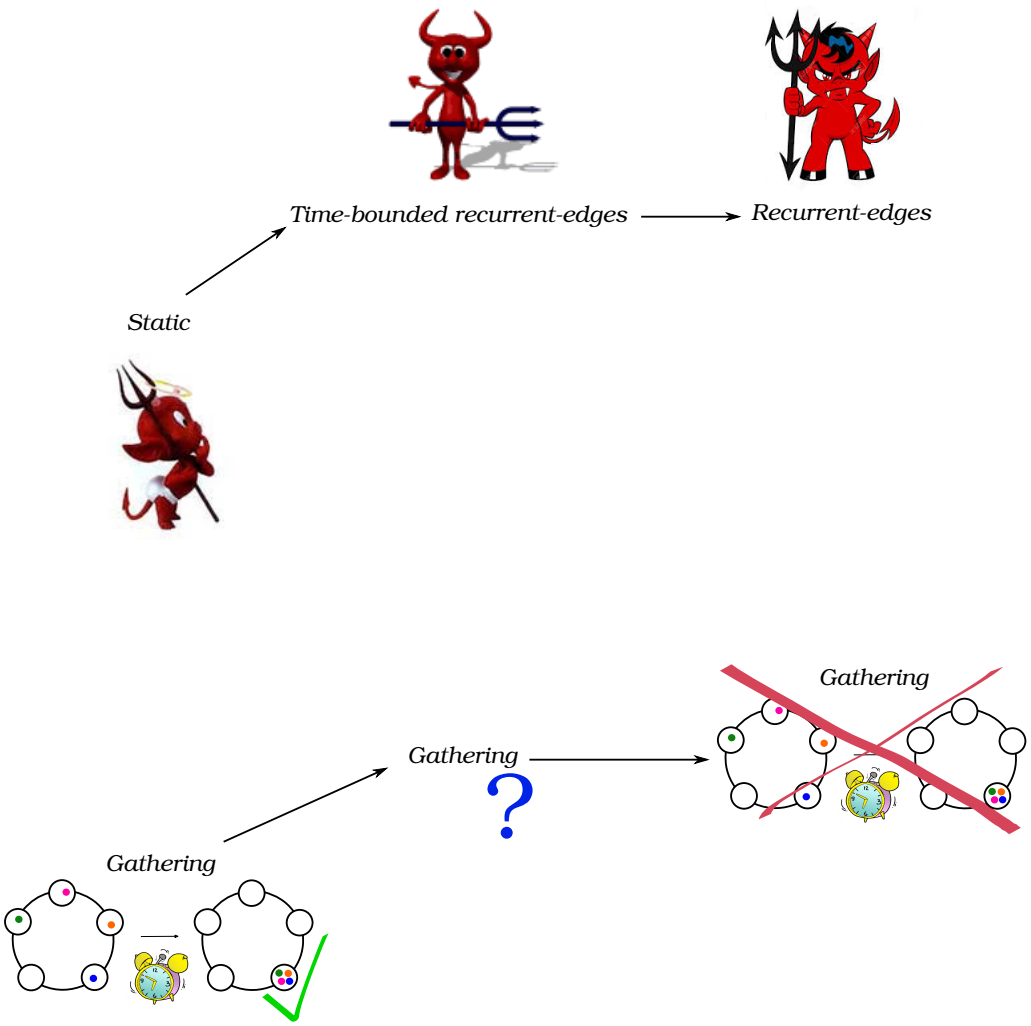

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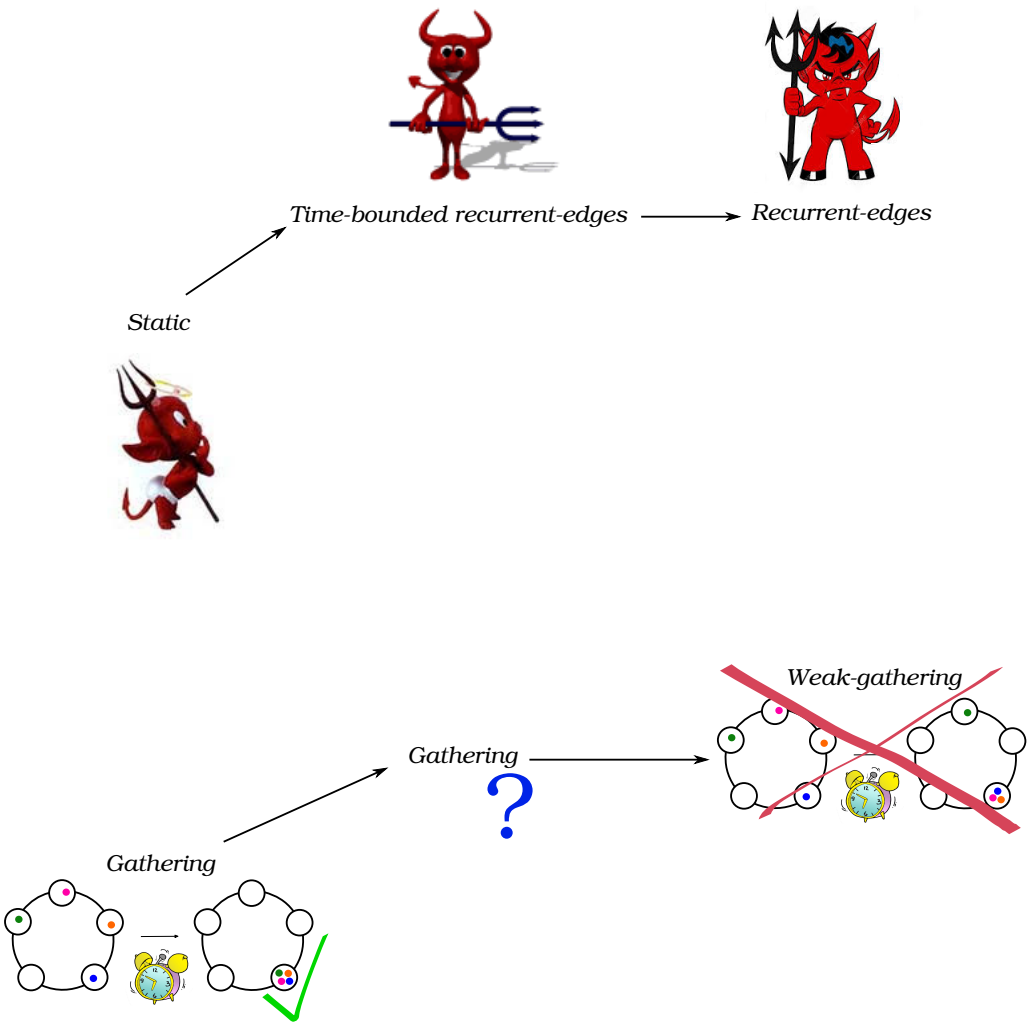

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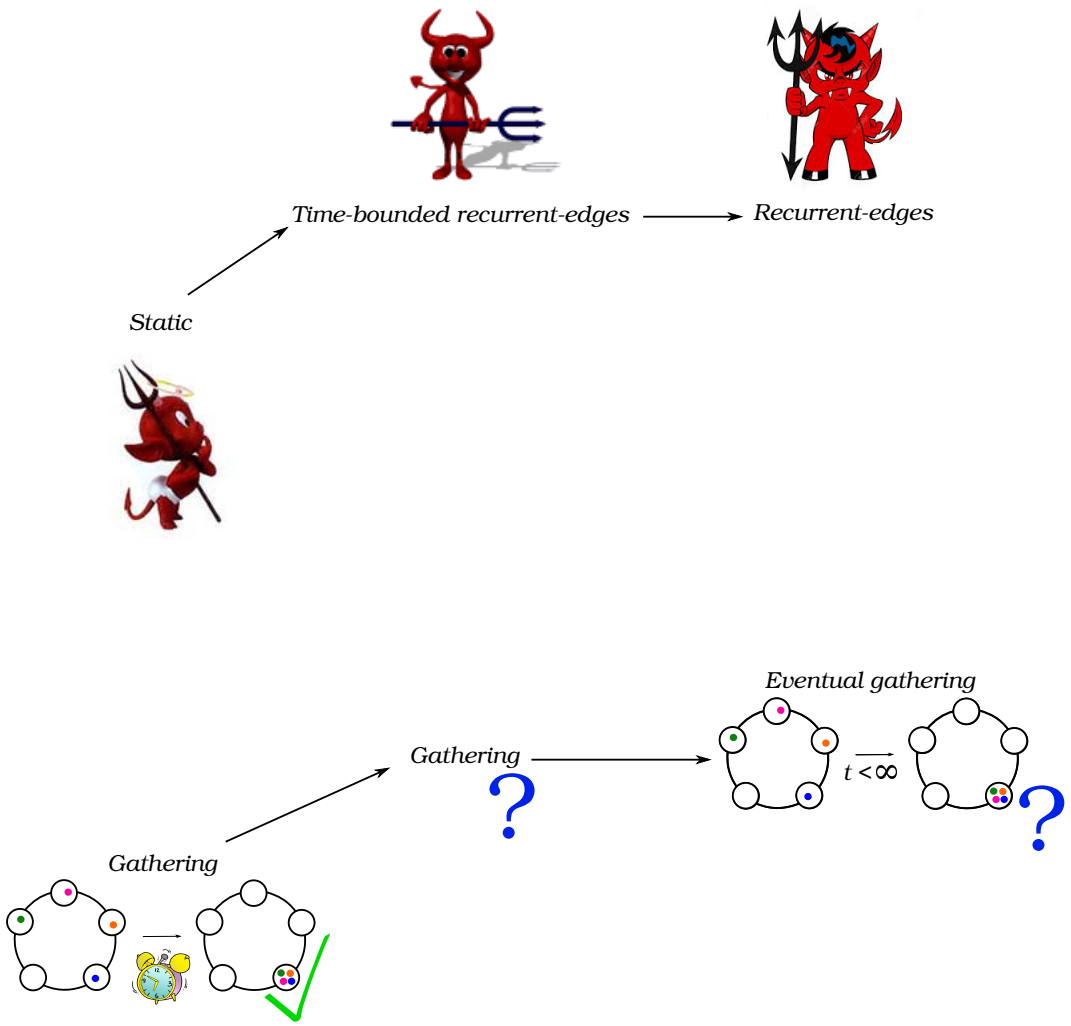

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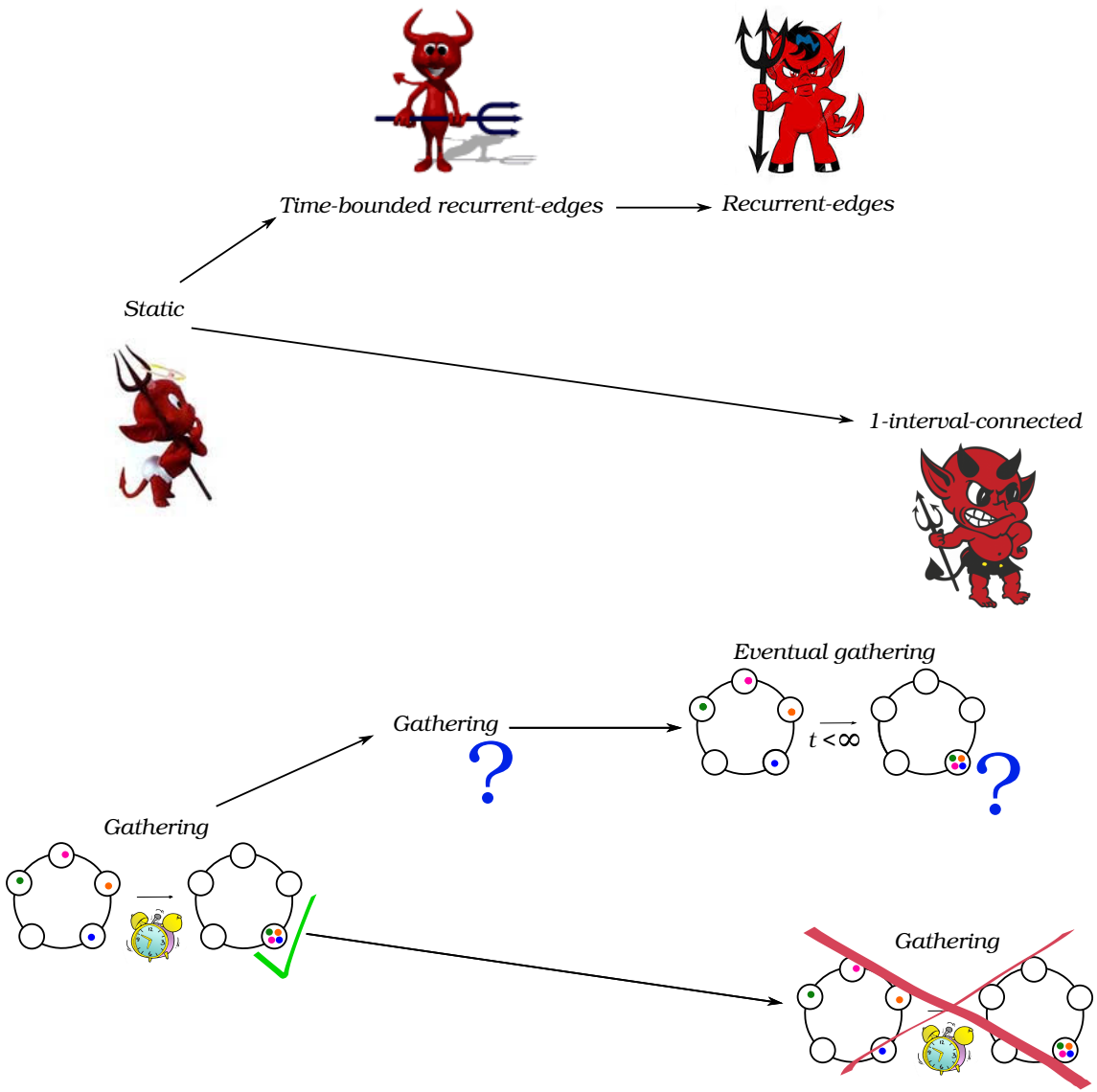

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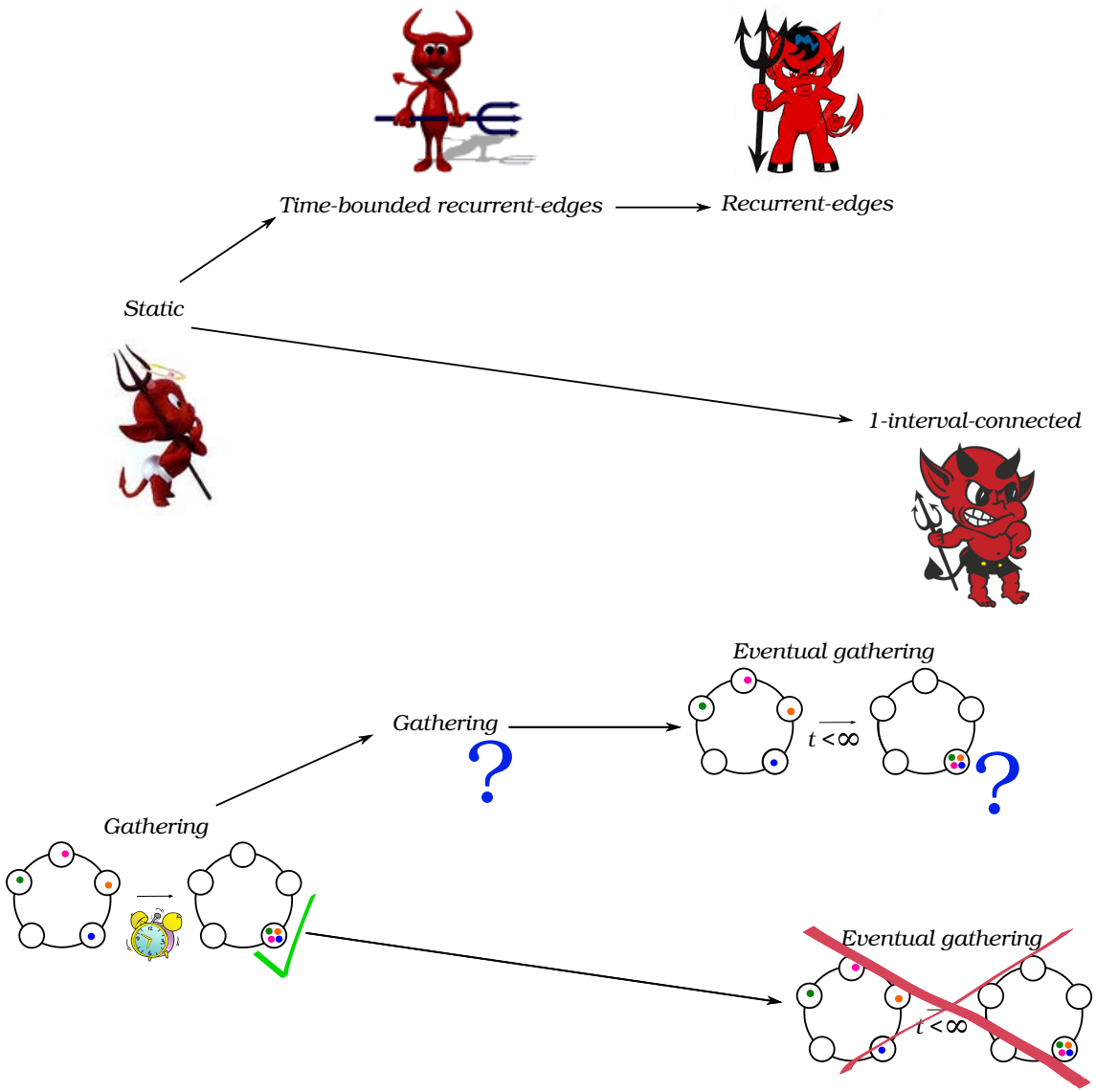

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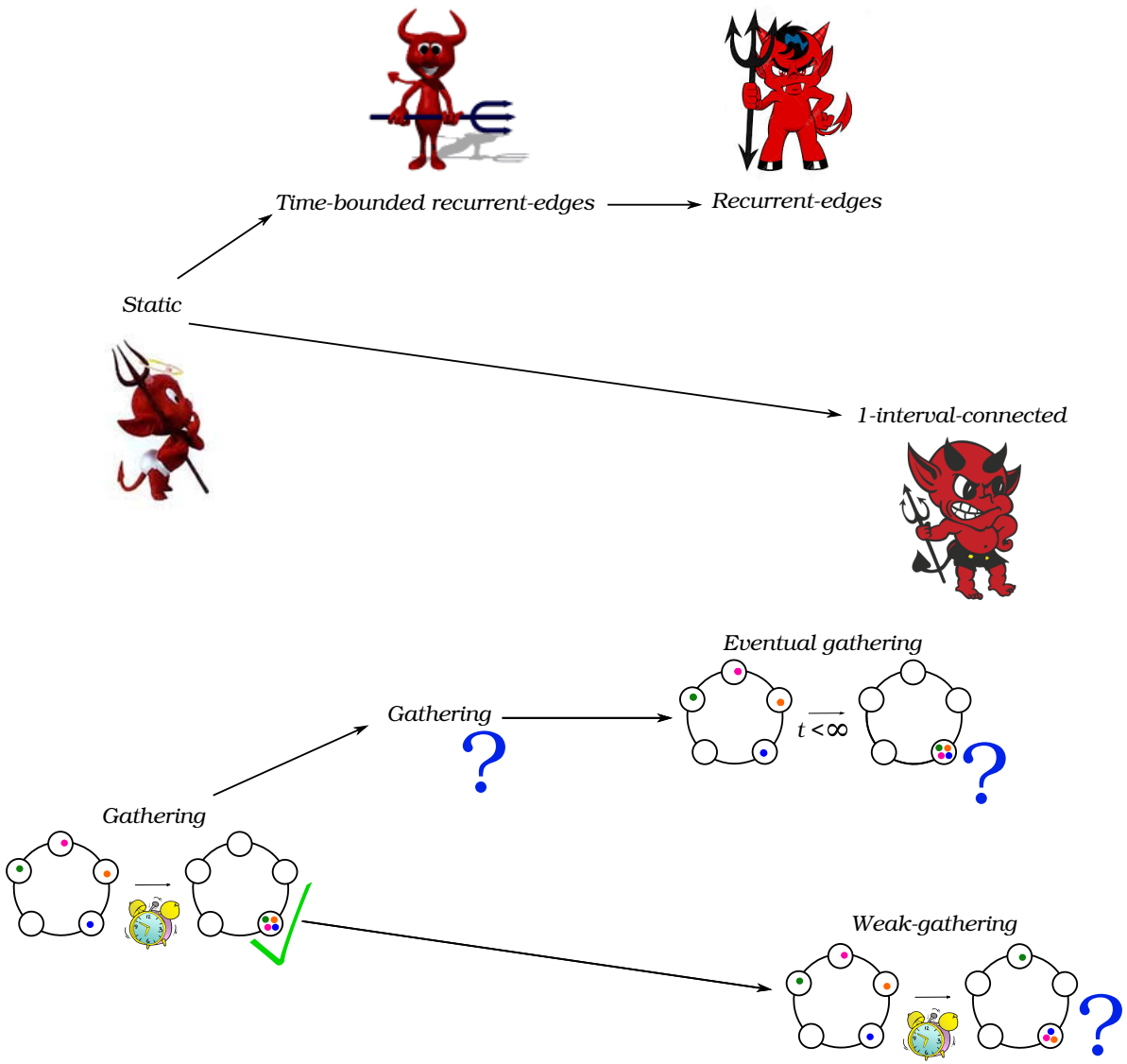

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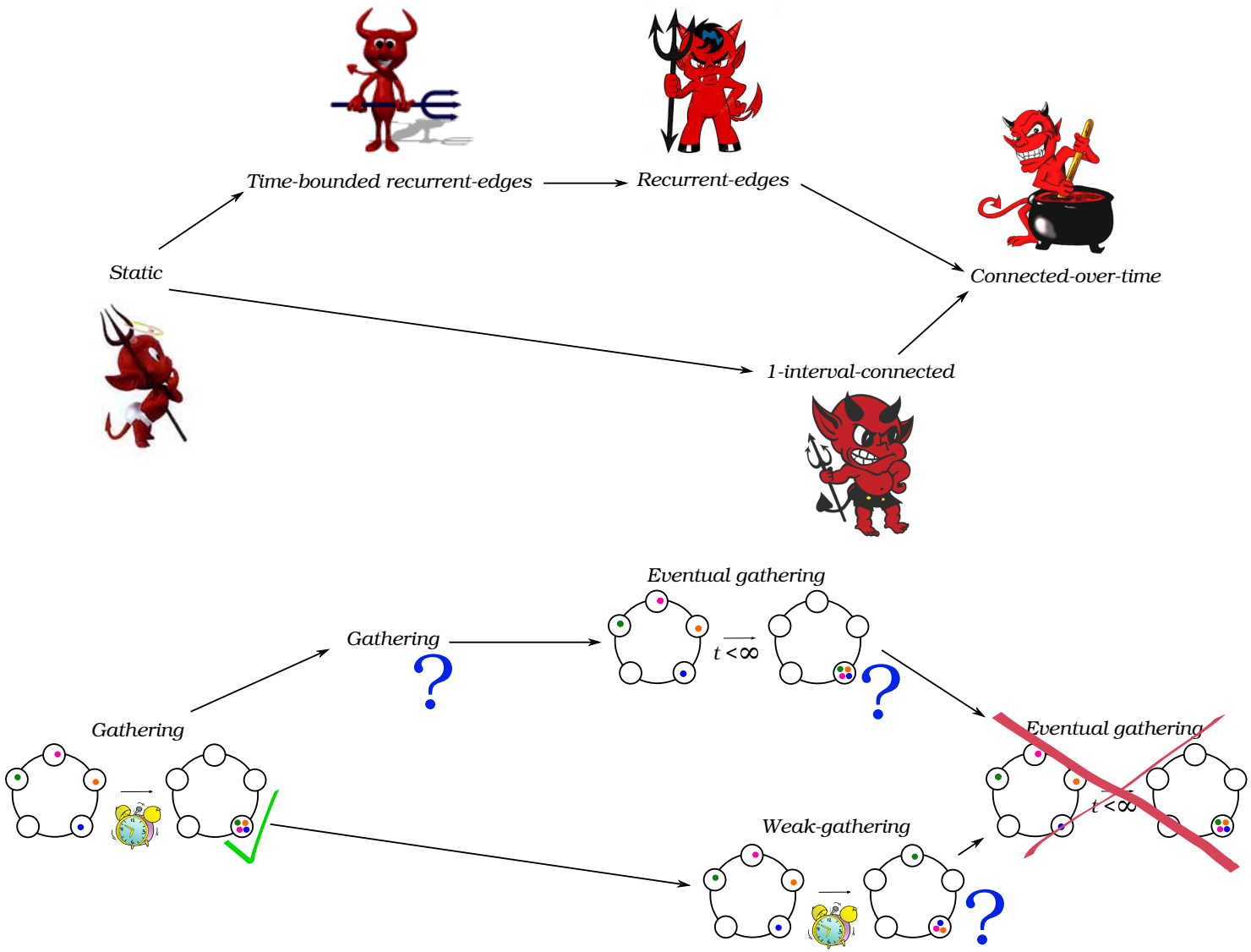

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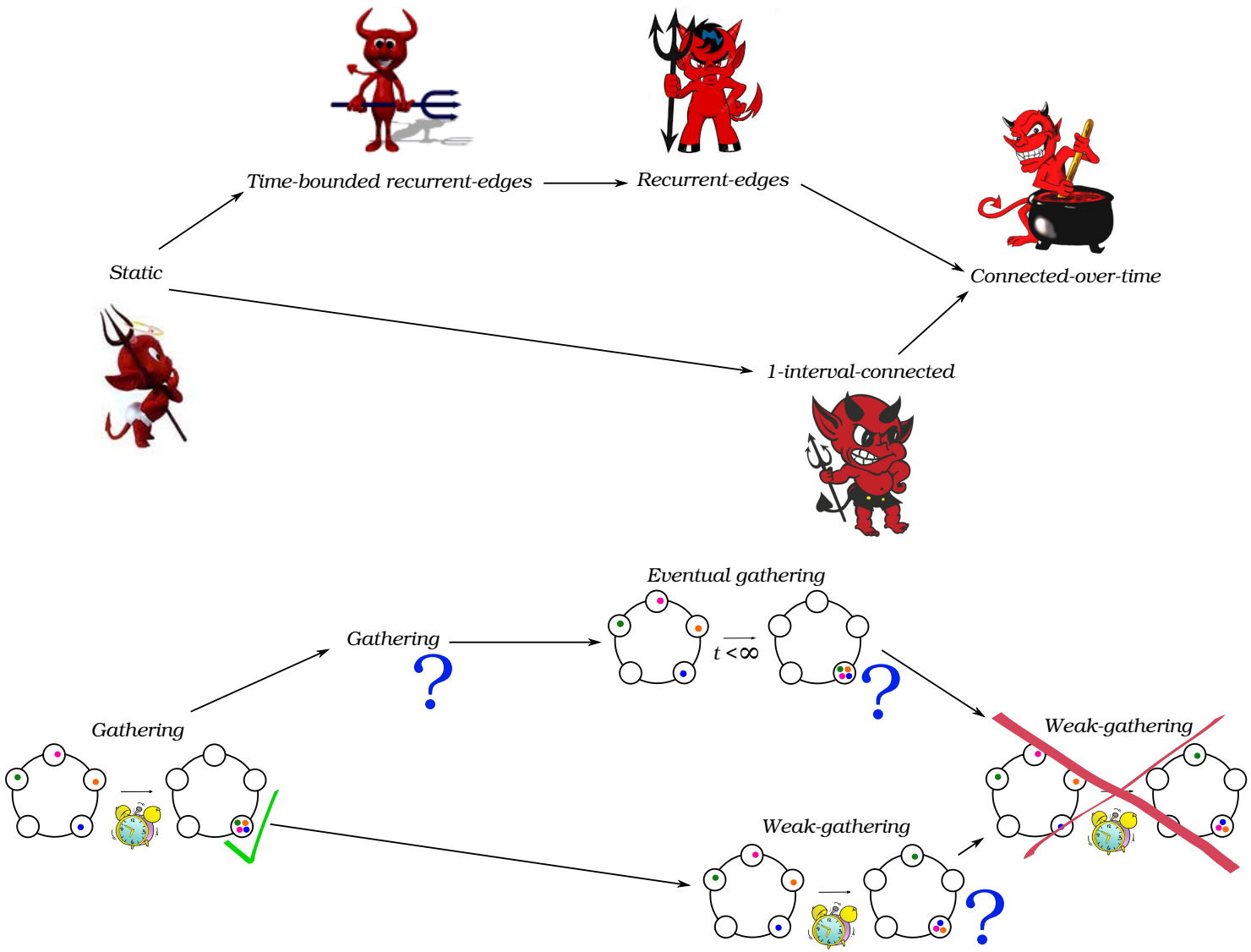

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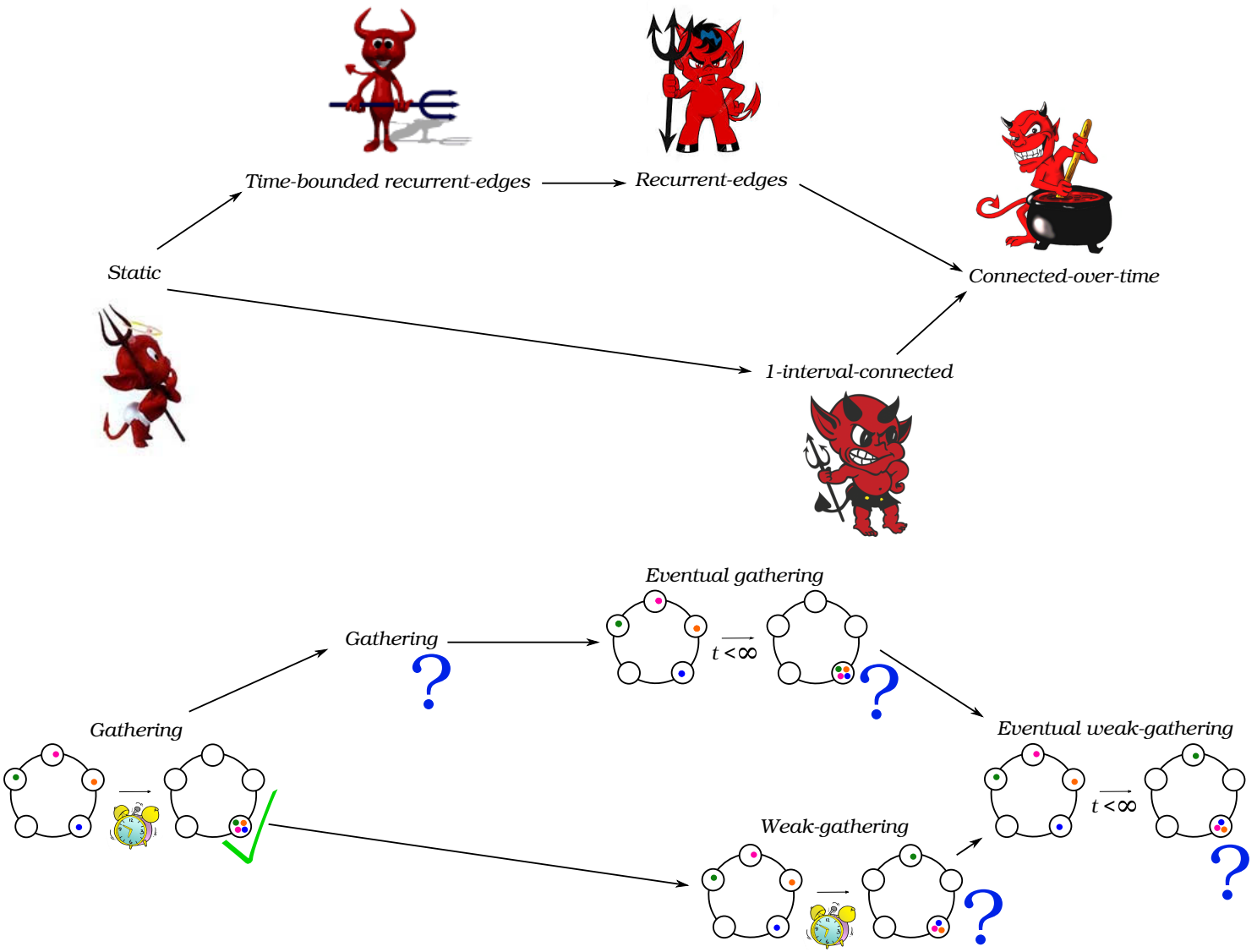

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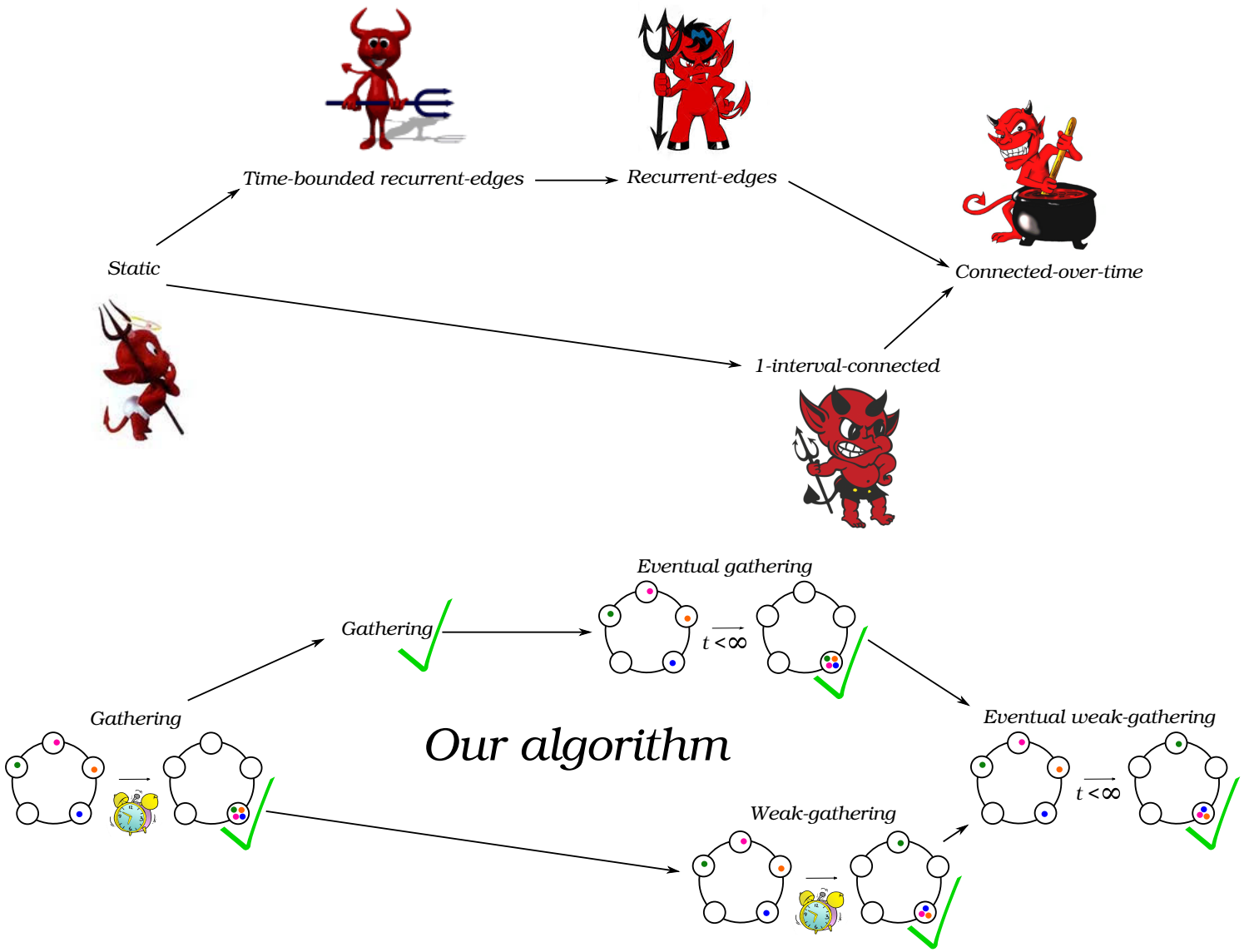

Plan

Assumptions

Goal: gracefully degrading gathering in dynamic rings

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Assumptions on the Graph:

- Dynamic ring
- Anonymous nodes

Assumptions

Goal: gracefully degrading gathering in dynamic rings

Assumptions on the Graph:

- Dynamic ring
- Anonymous nodes

Assumptions on the robots:

- FSYNC
- strictly greater than 3
- With distinct identifiers (unknown from the other robots)
- With local vision
- With persistent memory (# of robots and size of the ring known)
- Able to communicate when they are located on a same node
- With strong multiplicity detection
- With chirality/handedness

Our Algorithm

Main idea: make the robots gather on the node of the robot with the minimum identifier

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Phase I: The robot with the minimum identifier discovers that it possesses the minimum identifier

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Phase III: These $\mathcal{R} - 3$ robots and the minimum execute a special walk

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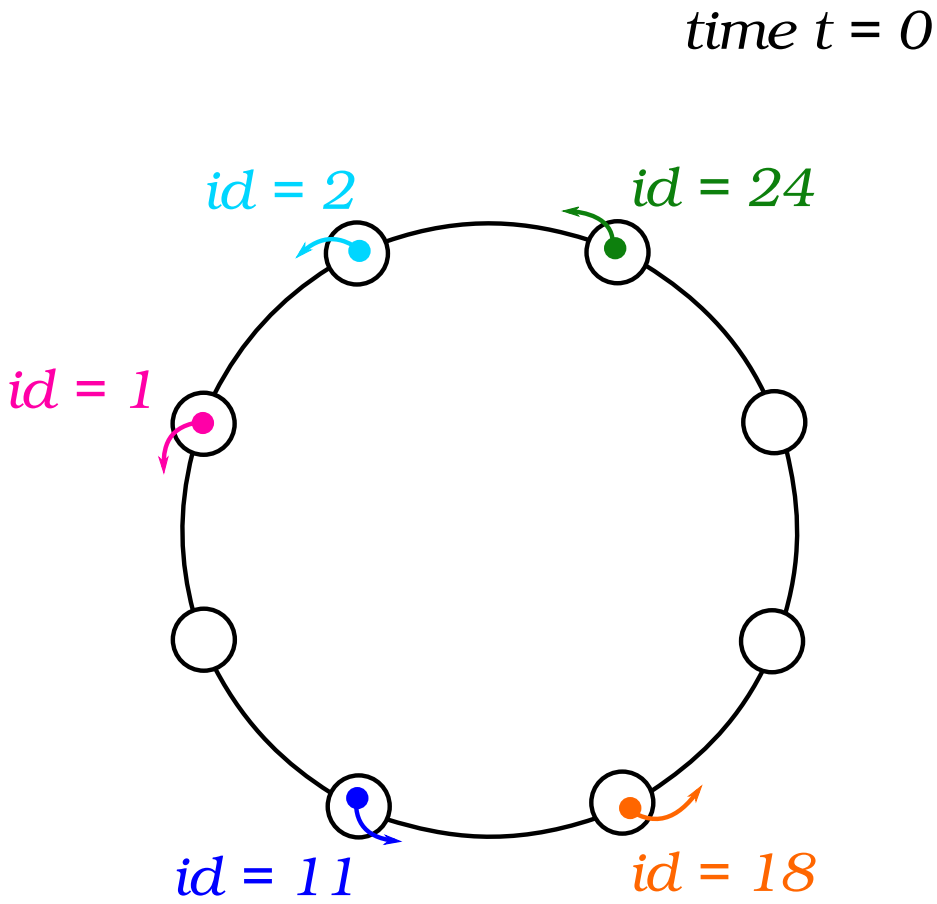
Phase IV: The robots wait for the gathering to occur

Phase I

Goal: The minimum discovers it is the minimum



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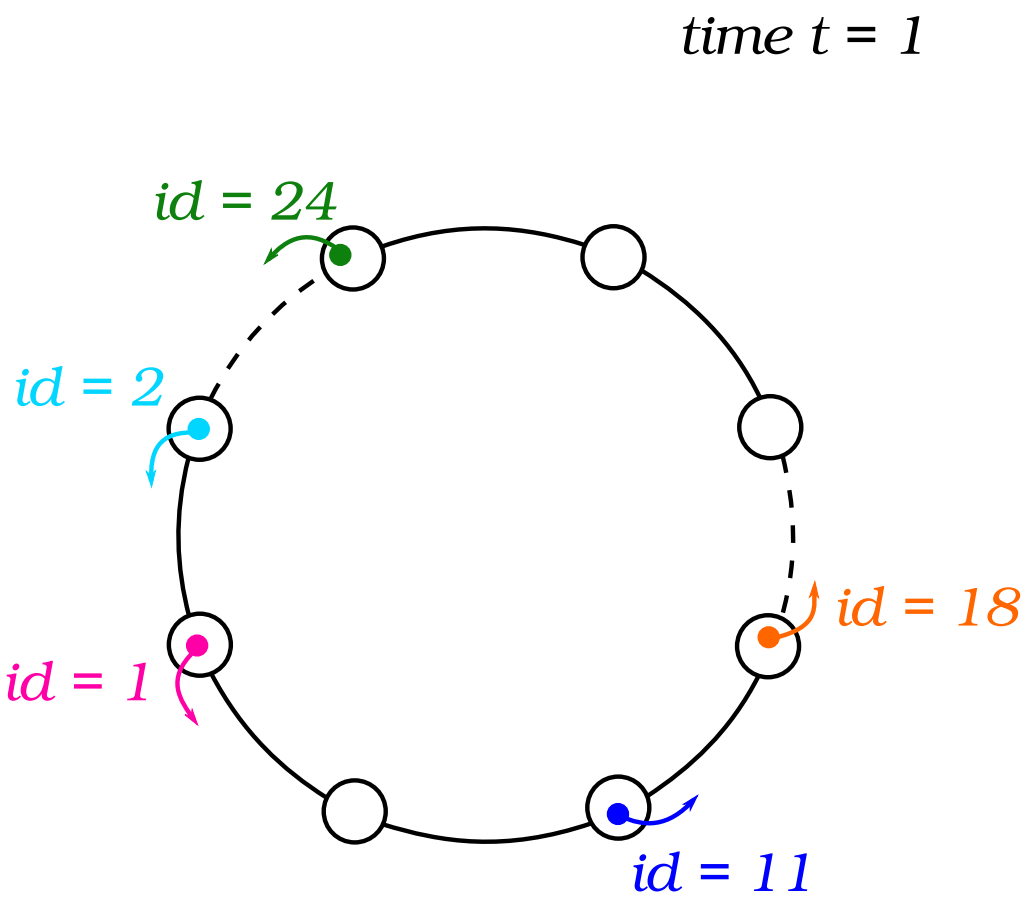

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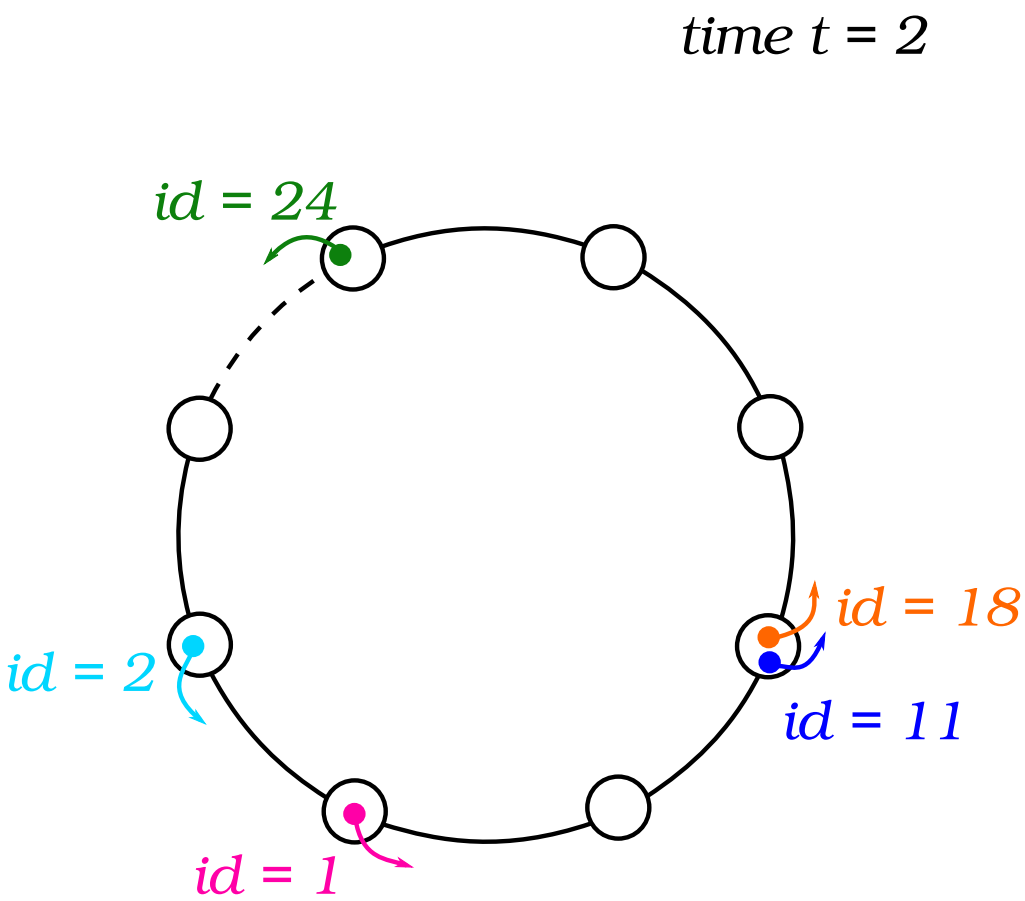

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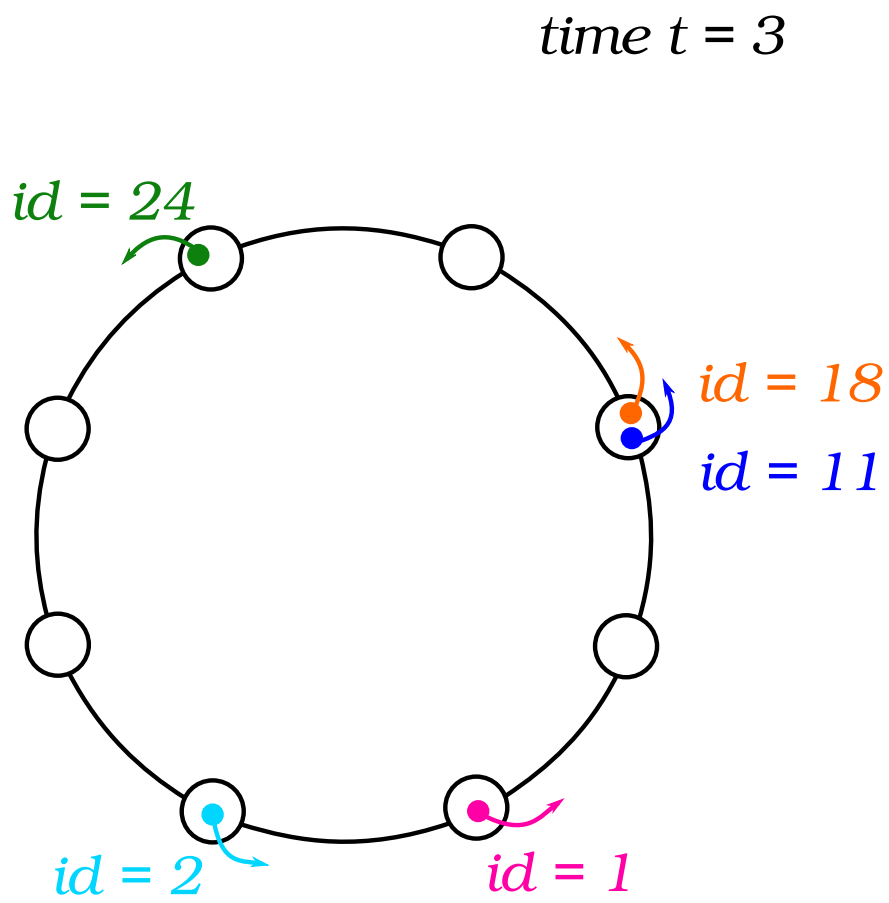

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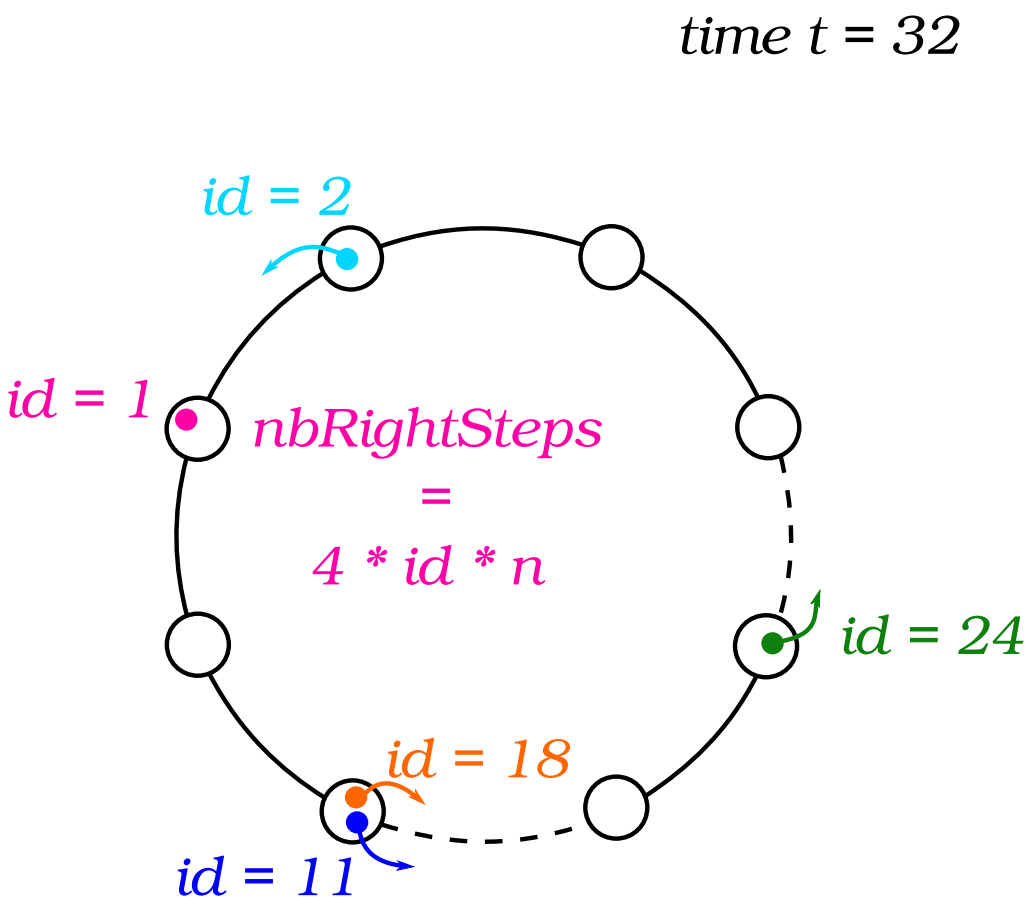

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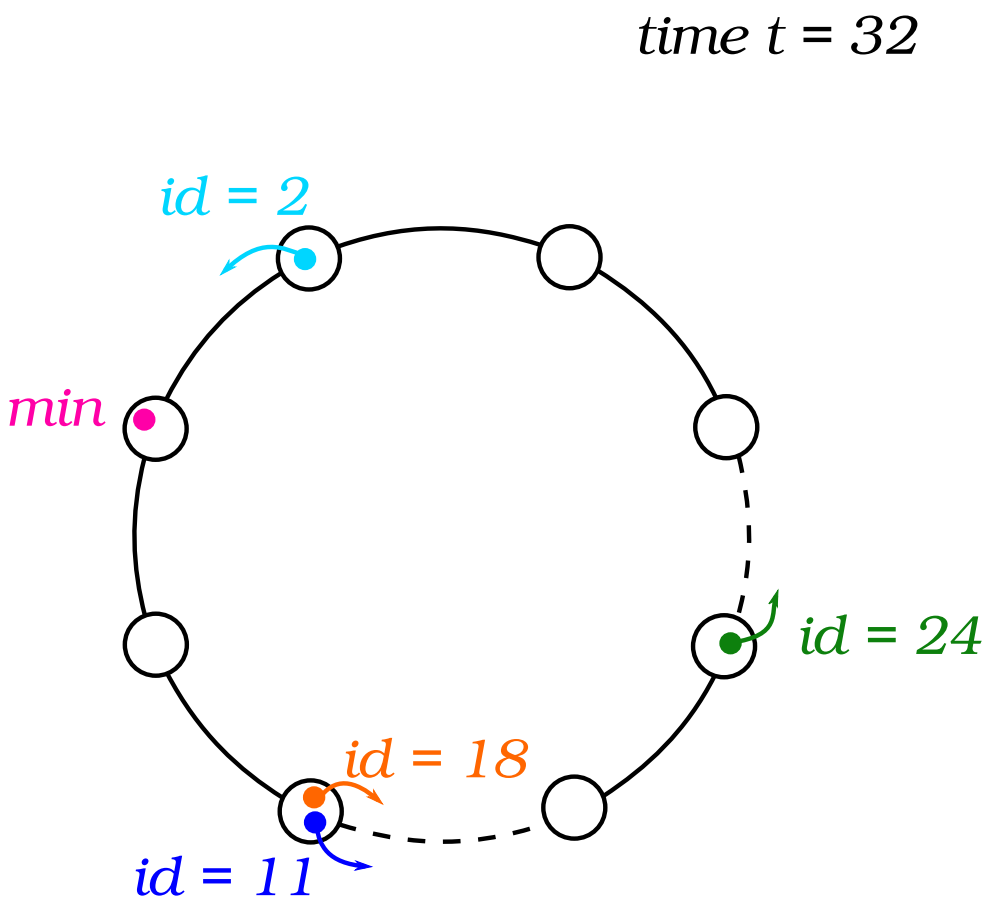
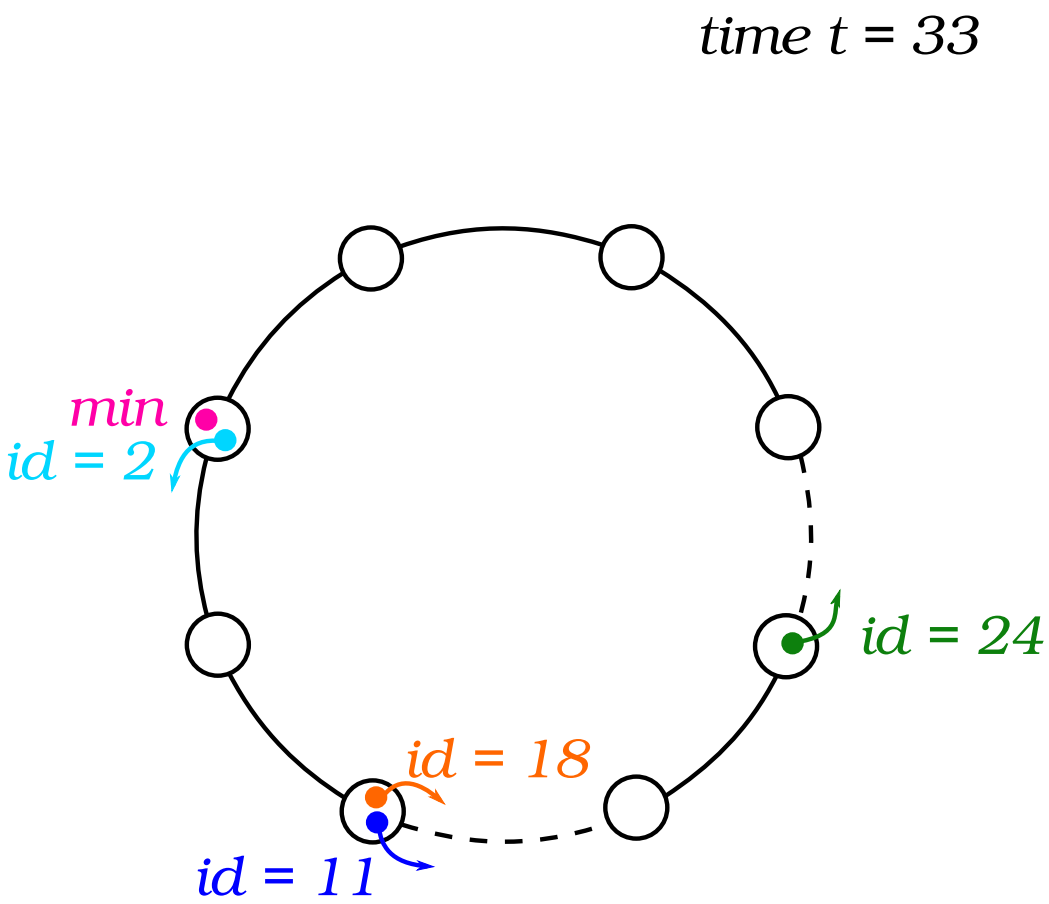


Phase II

Goal: R - 3 robots reach the min



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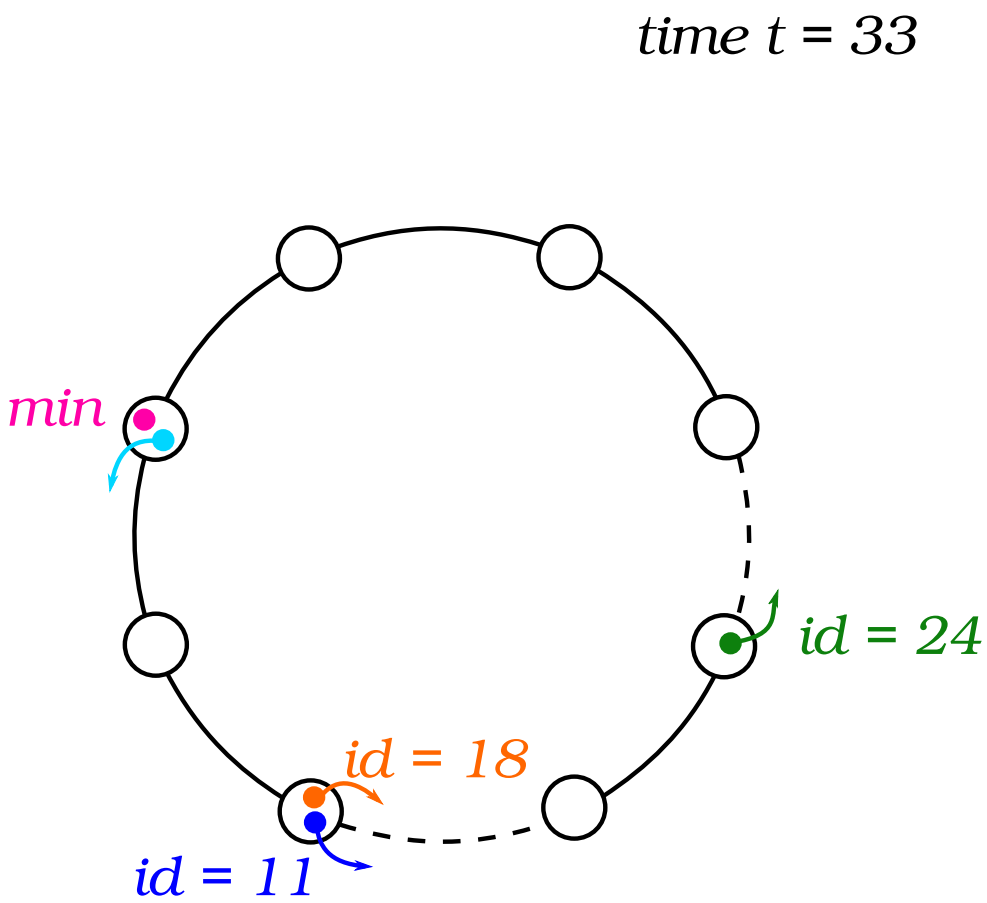

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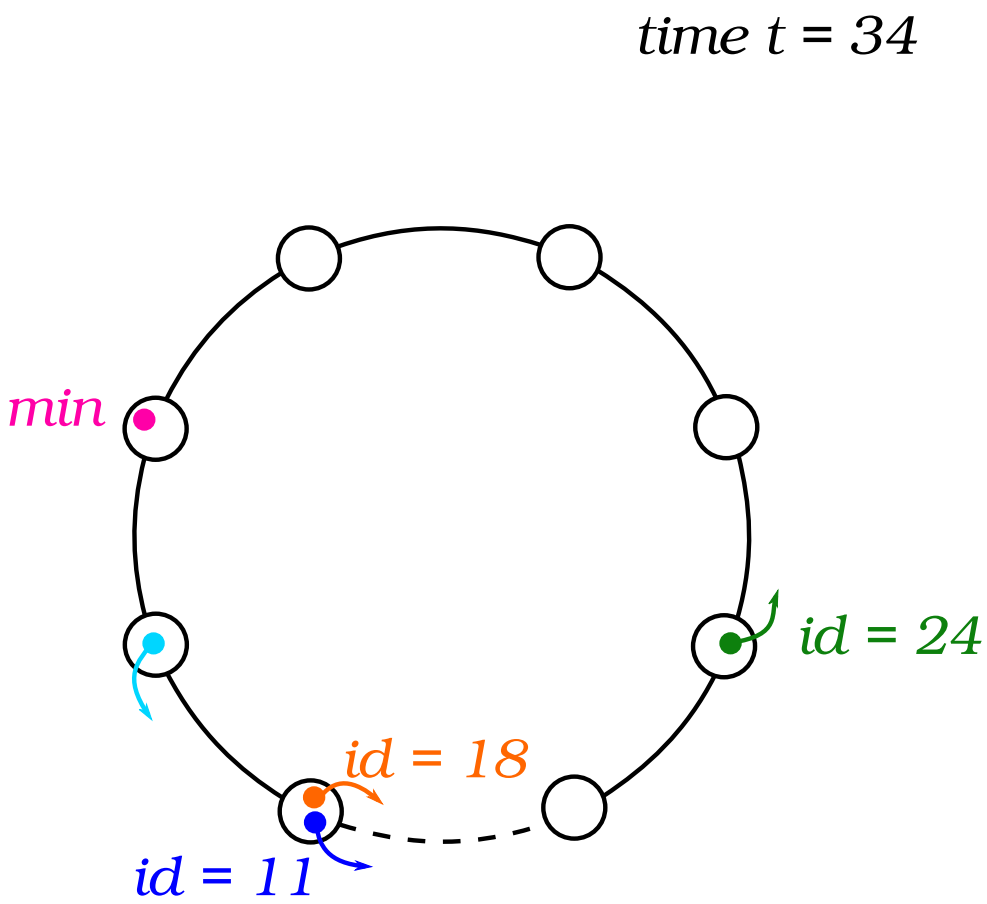

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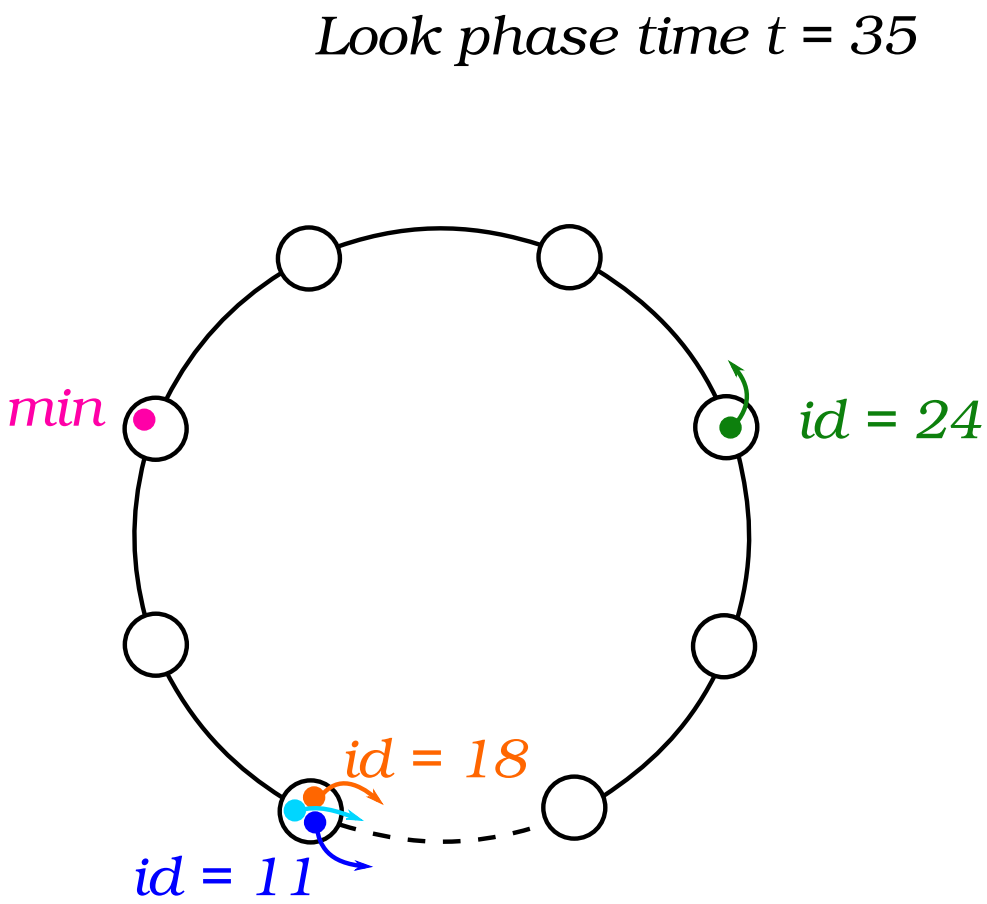

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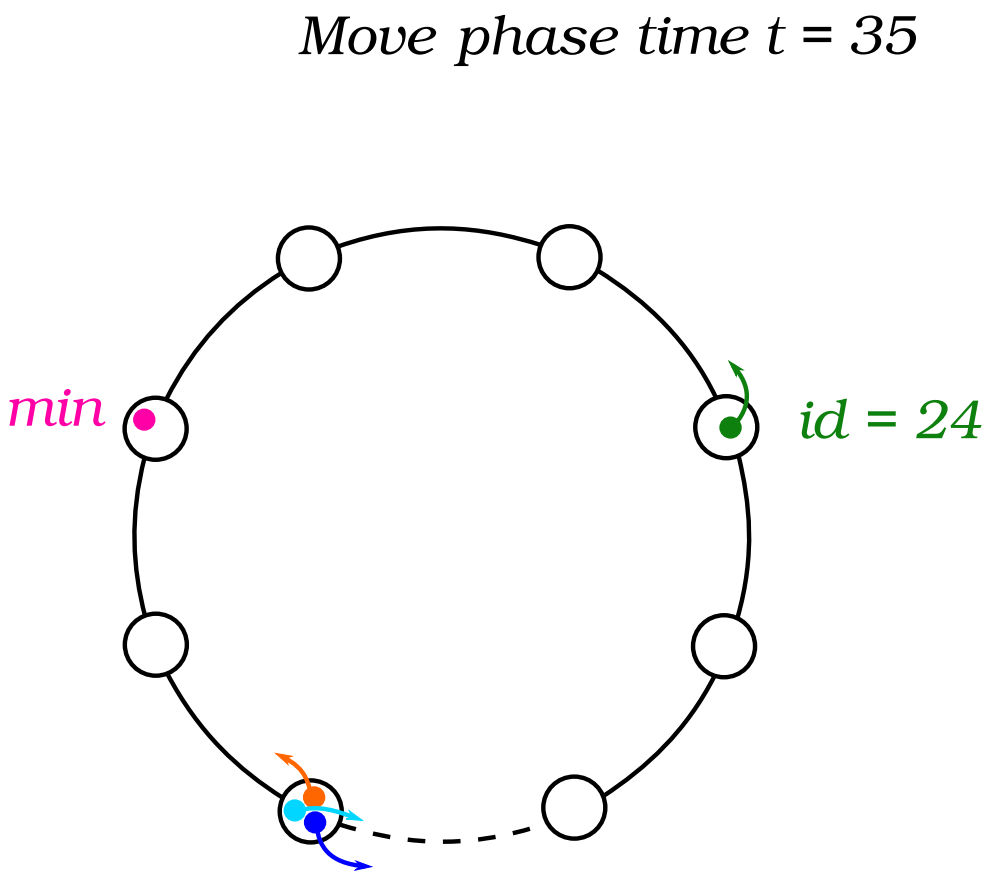

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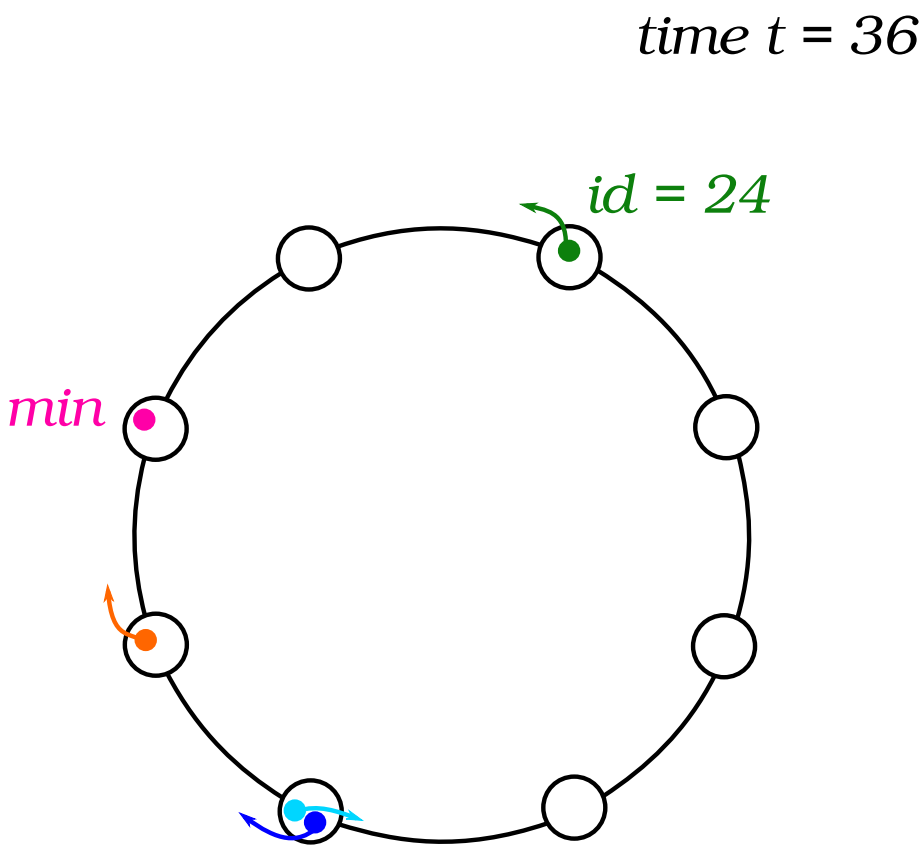

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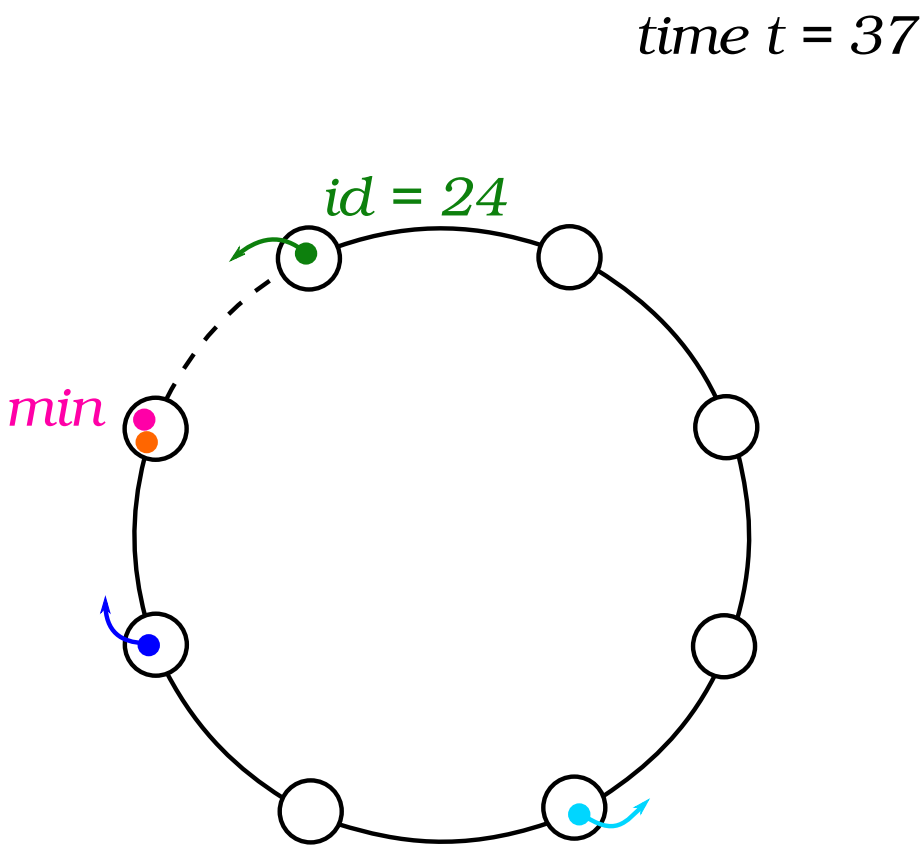

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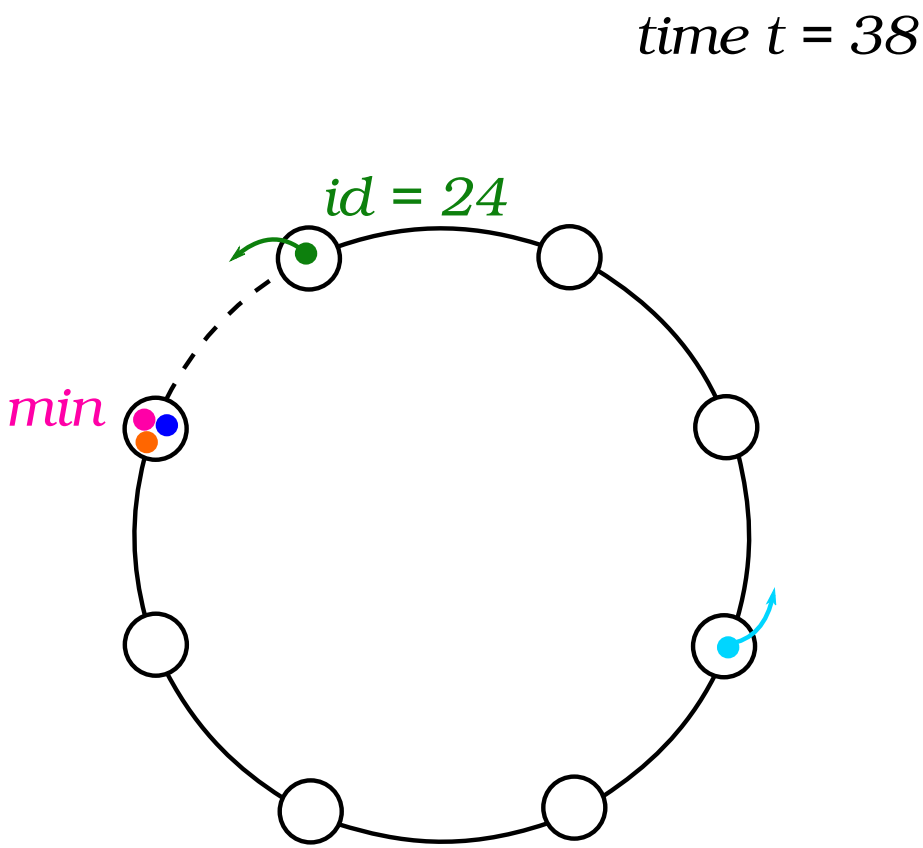
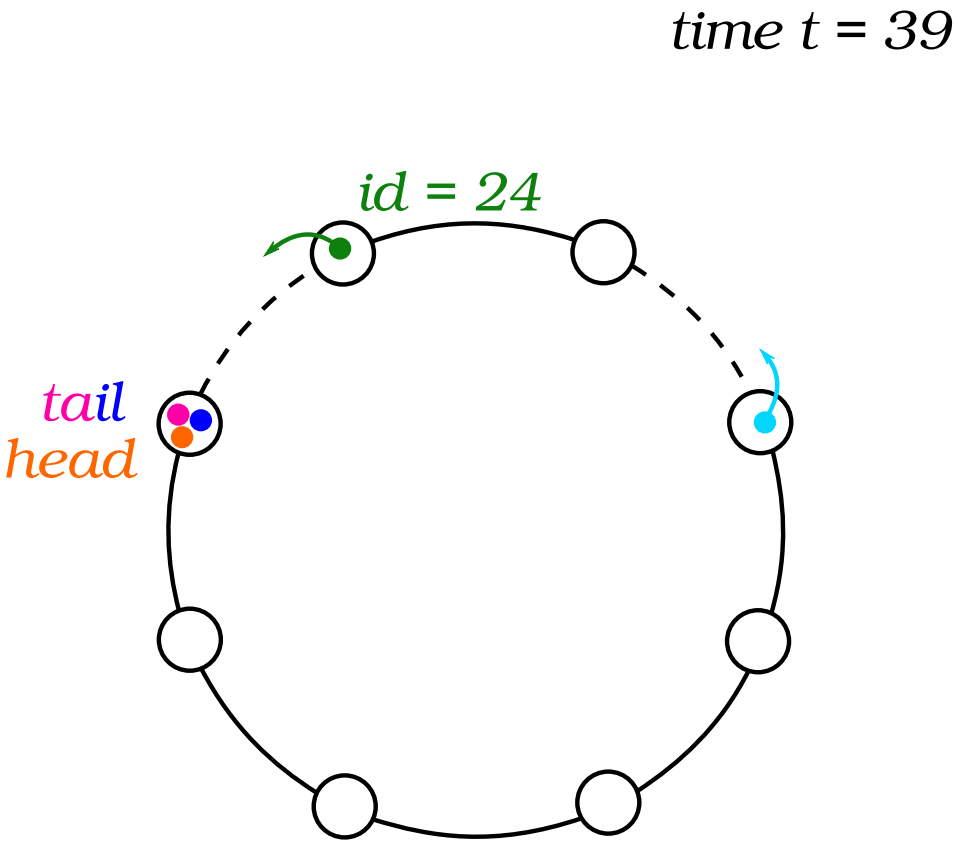


Phase III

Goal: R - 2 robots execute a special walk



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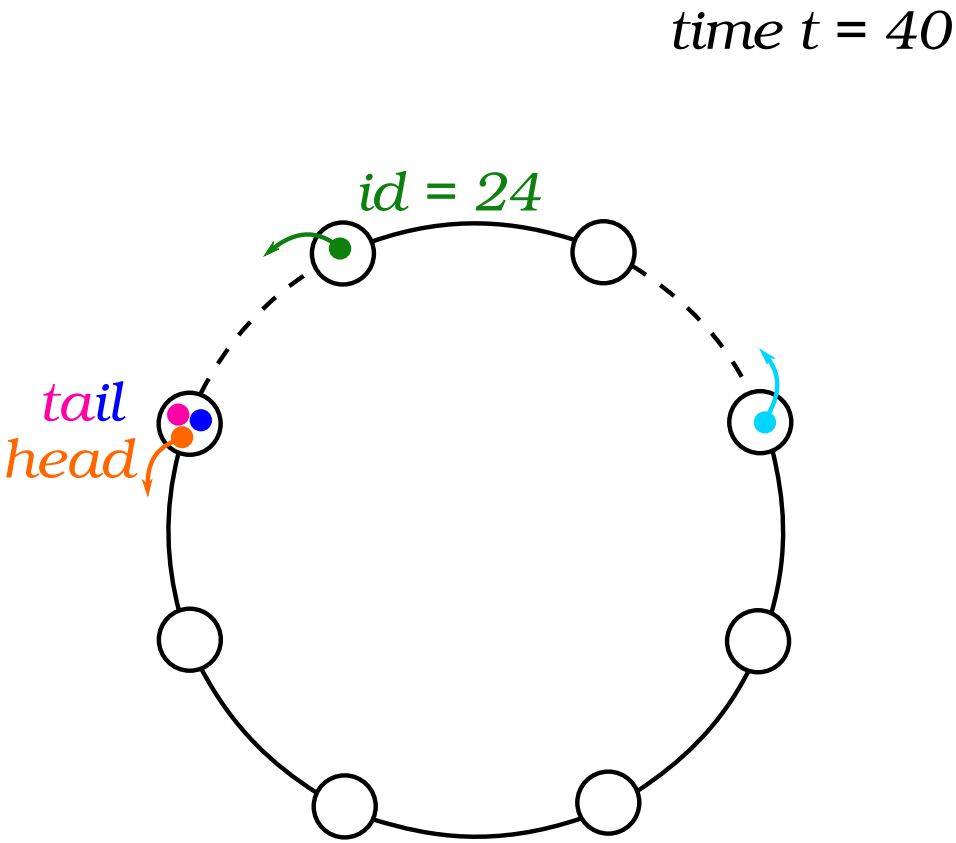
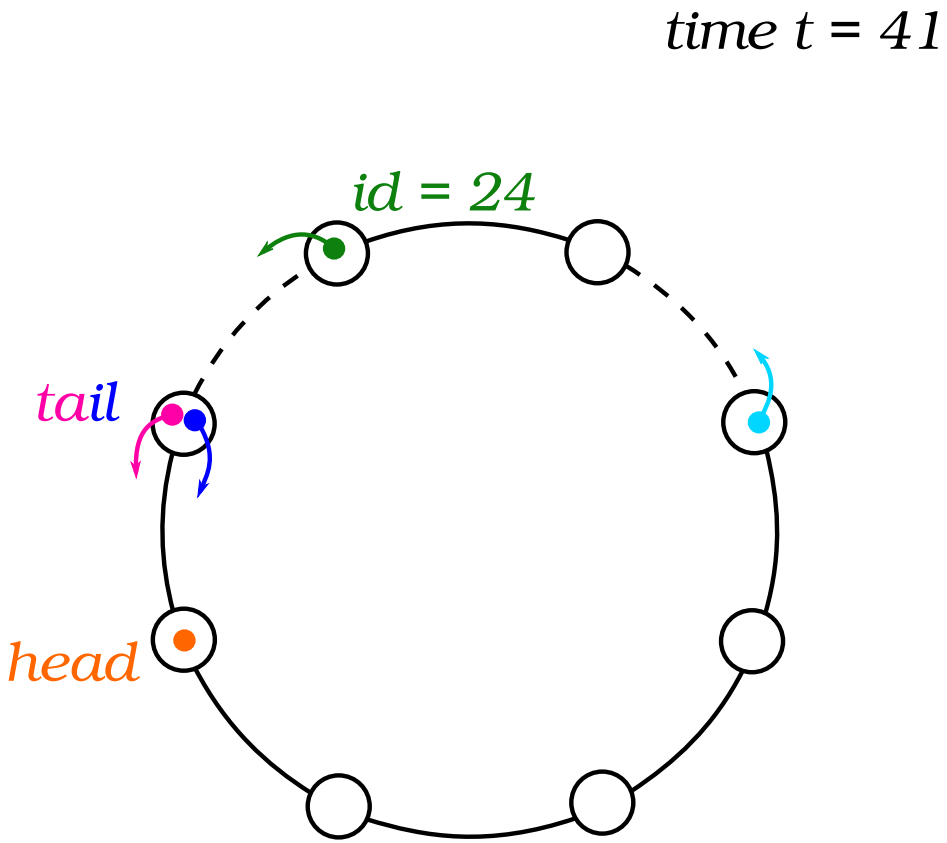


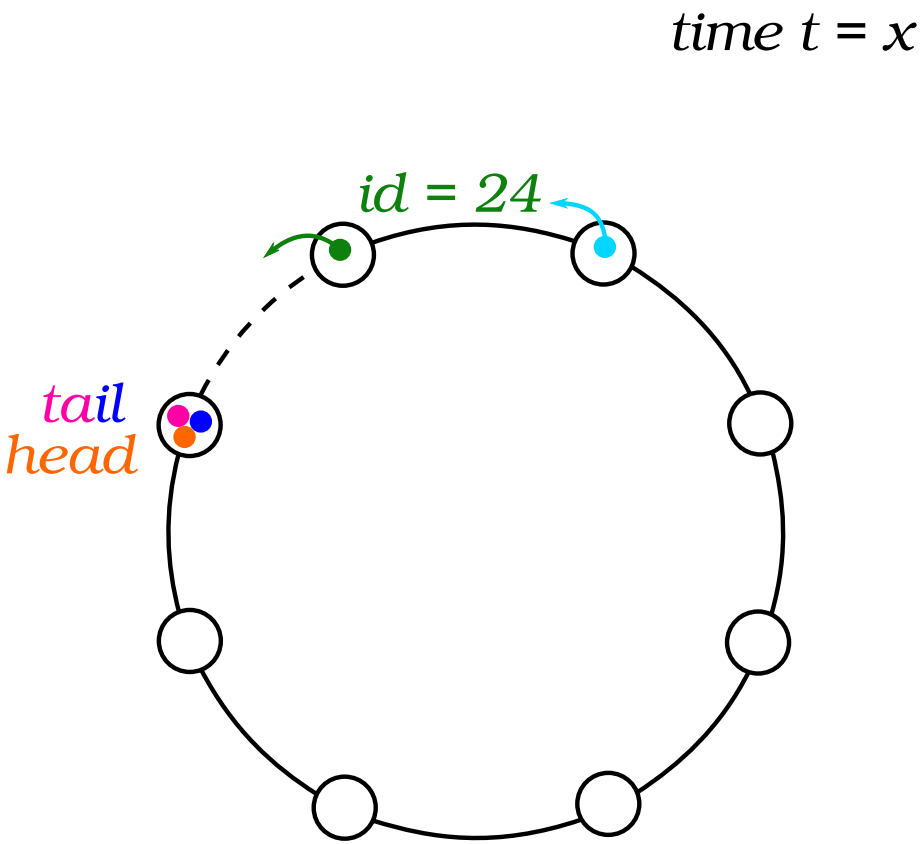
Phase III

Goal: R - 2 robots execute a special walk



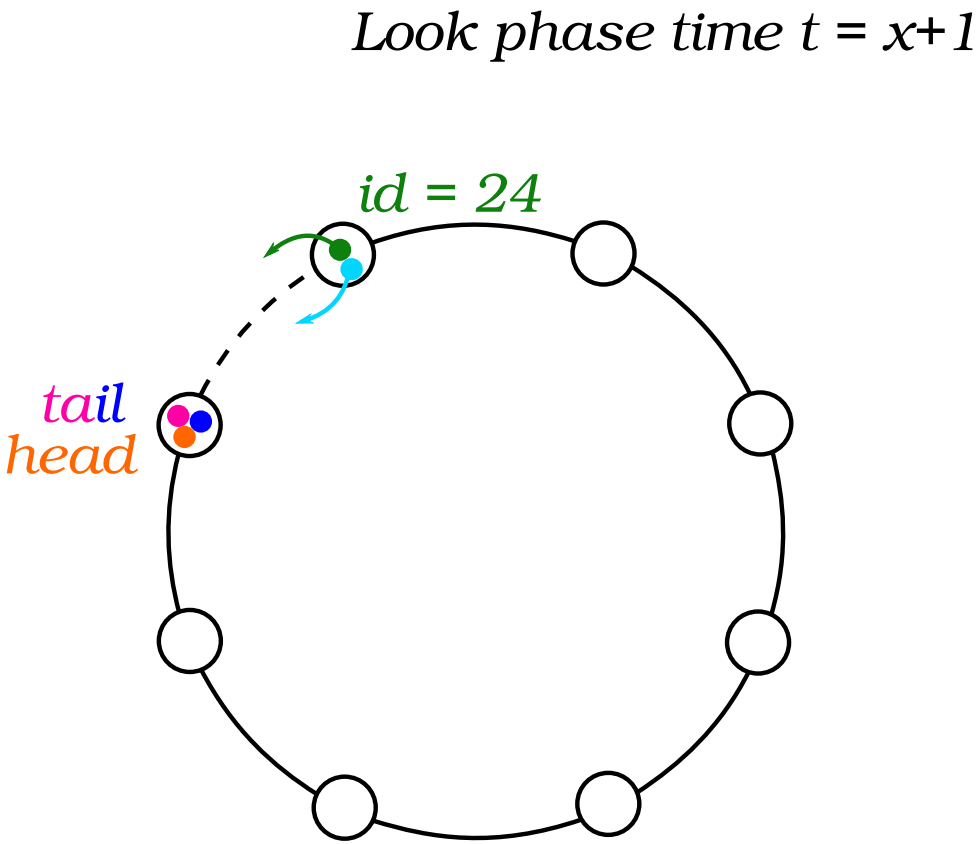
Phase IV

Goal: Waiting for gathering



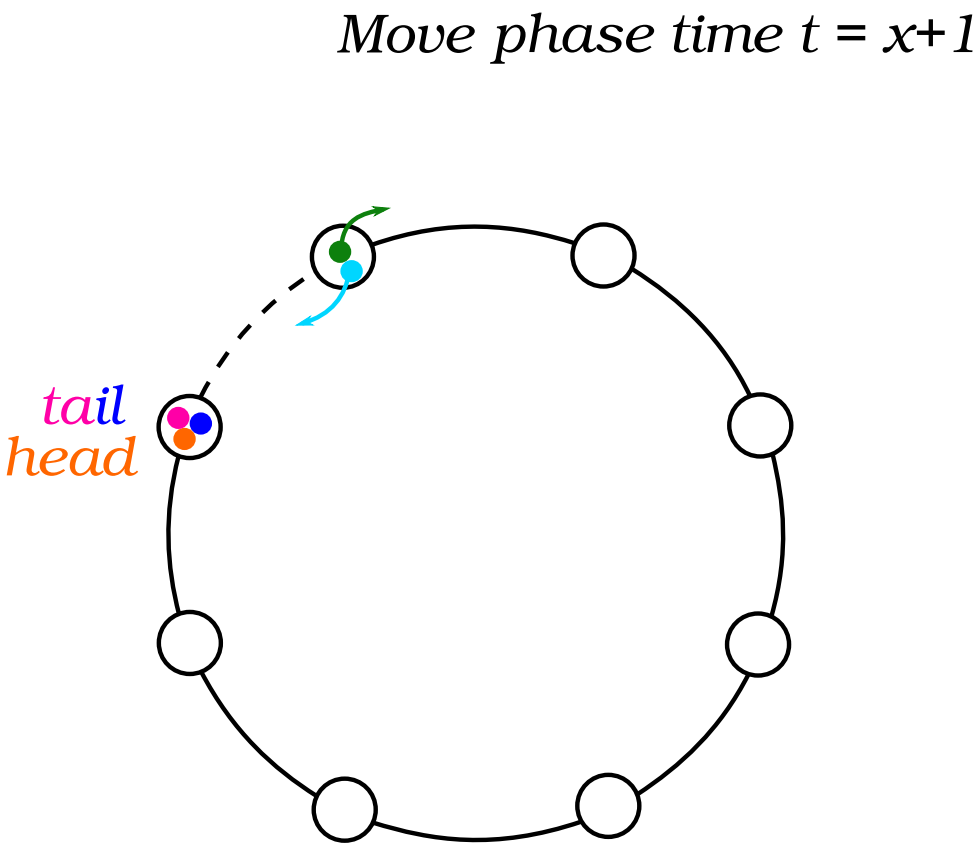
Phase IV

Goal: Waiting for gathering



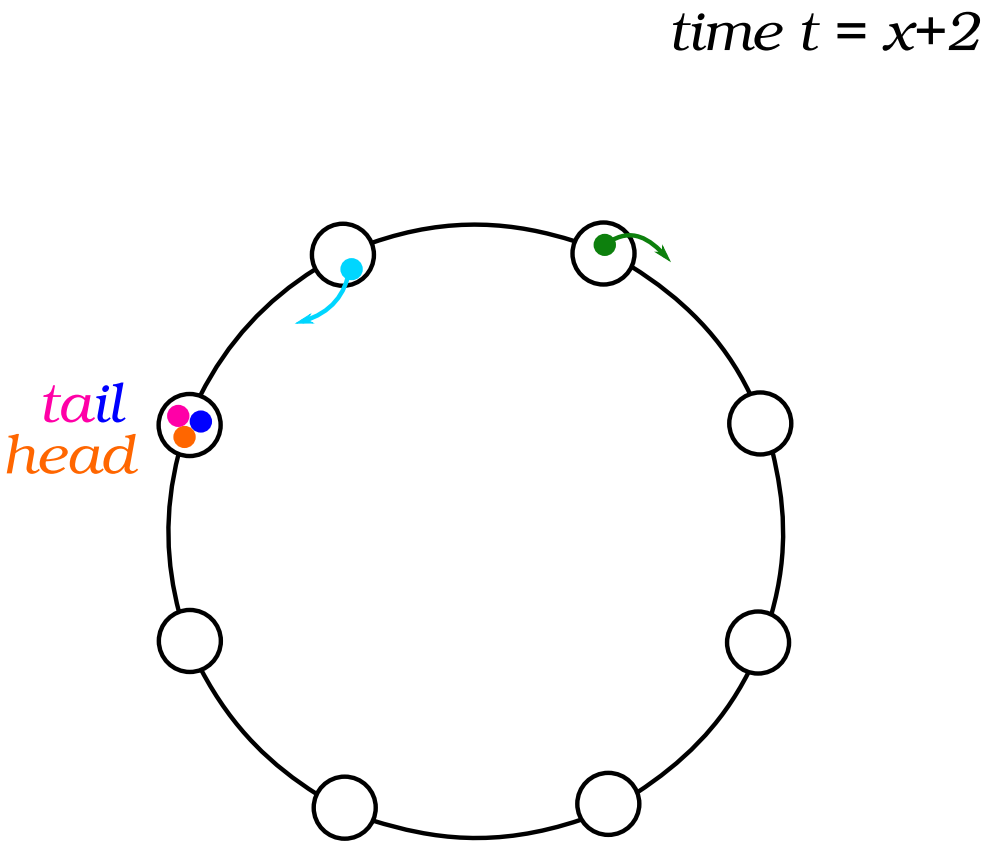
Phase IV

Goal: Waiting for gathering



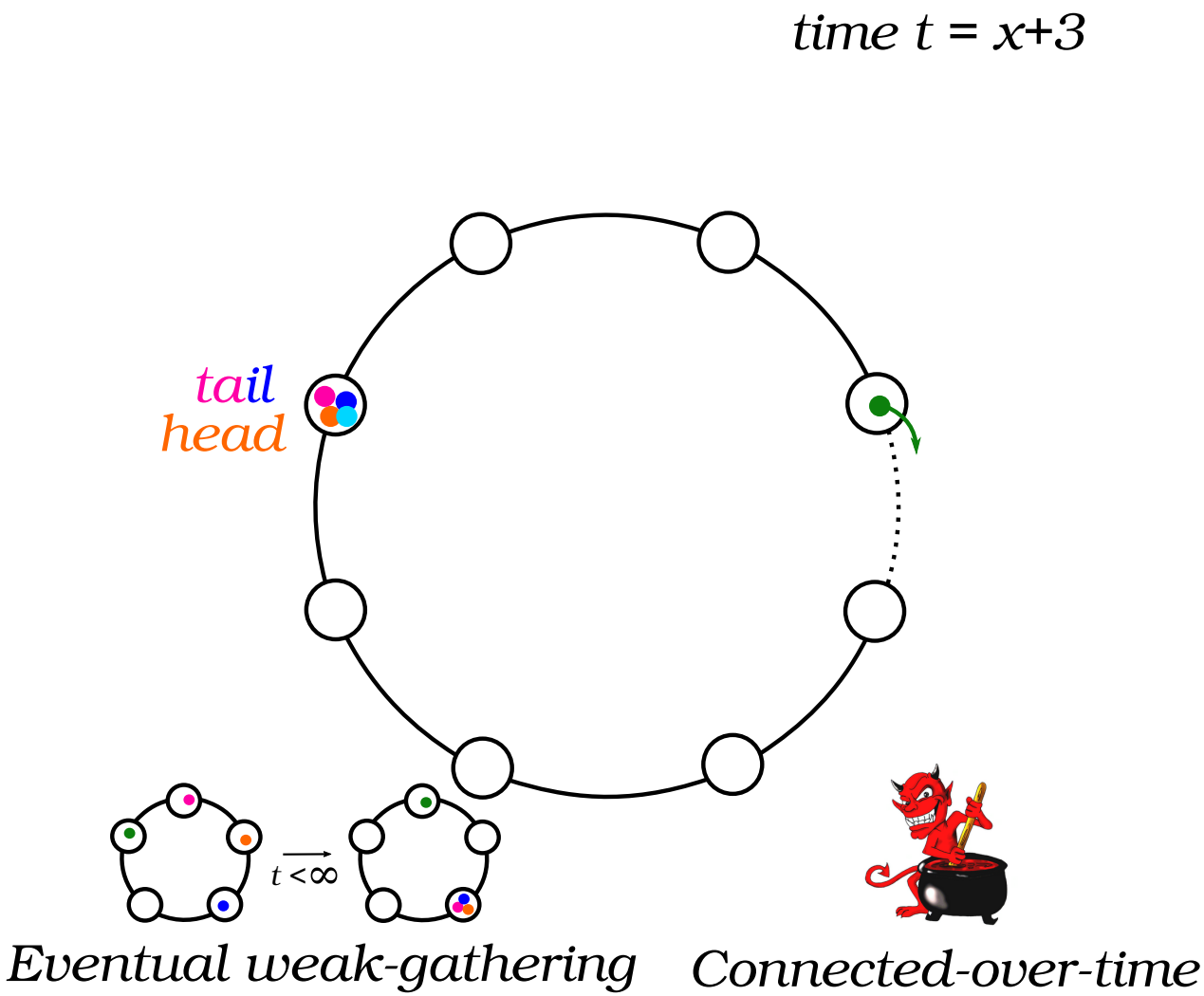
Phase IV

Goal: Waiting for gathering



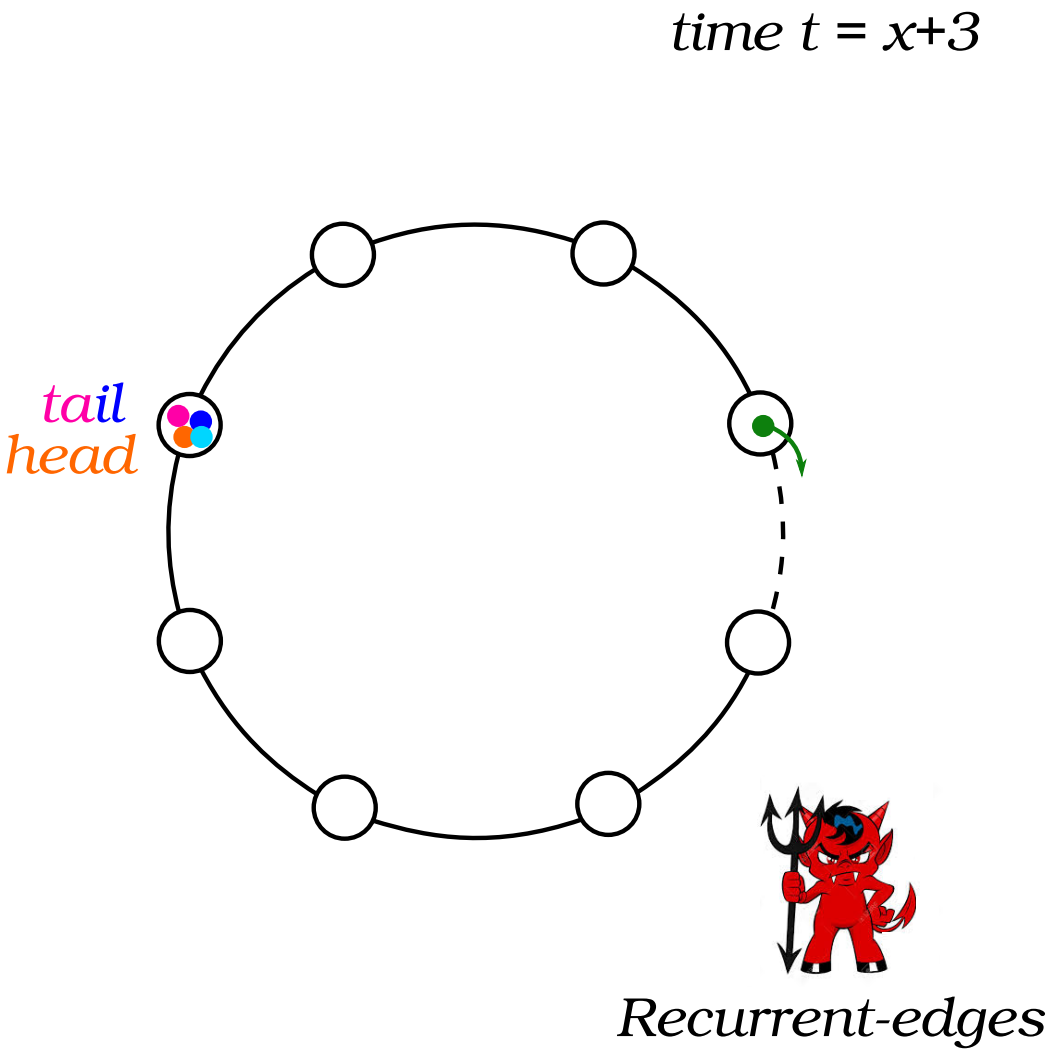
Phase IV

Goal: Waiting for gathering



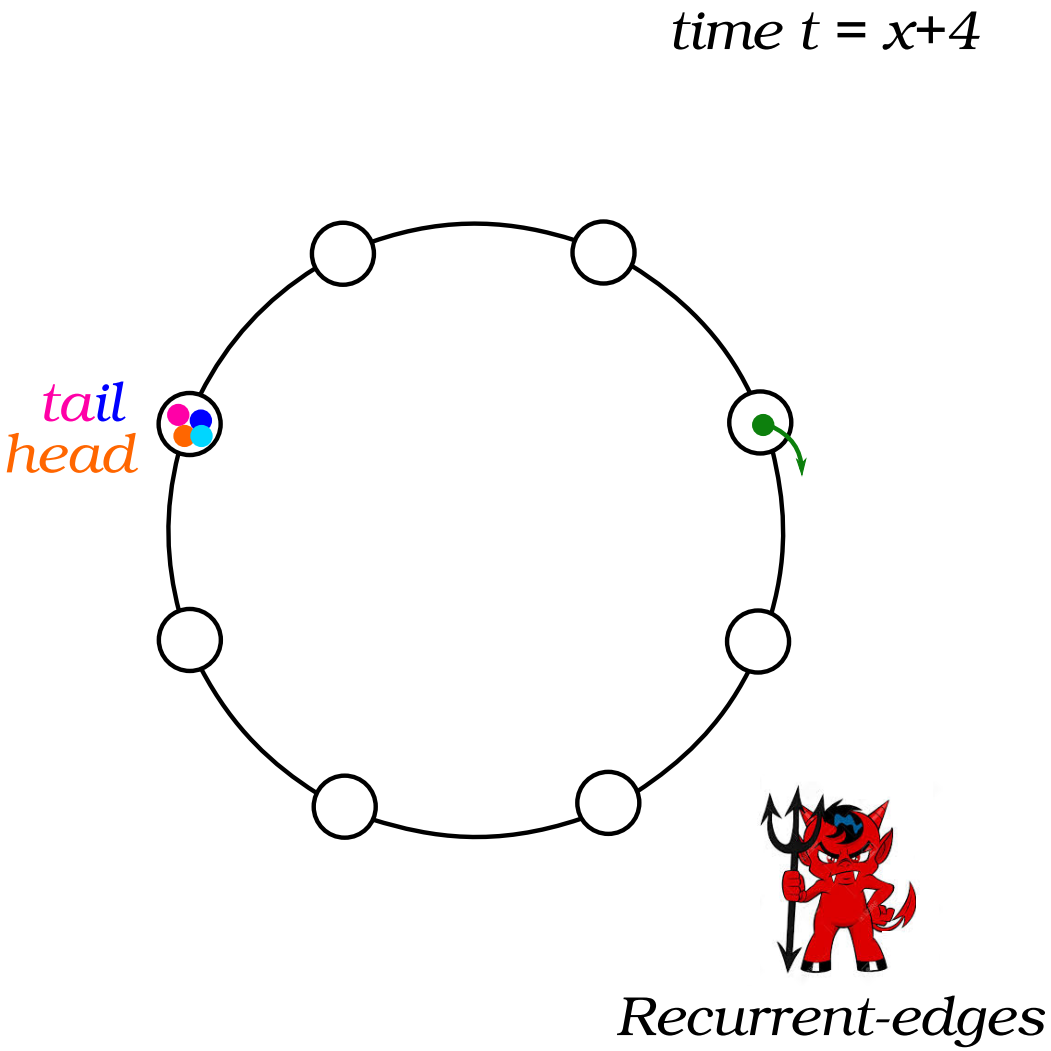
Phase IV

Goal: Waiting for gathering



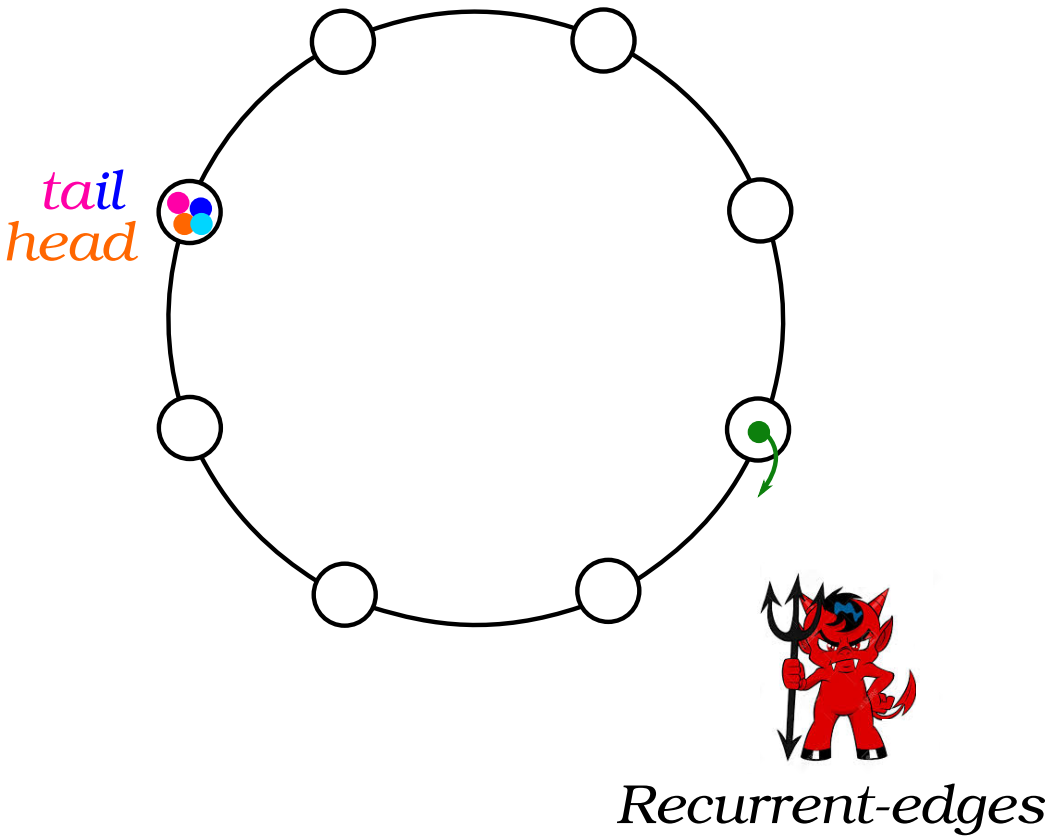
Phase IV

Goal: Waiting for gathering



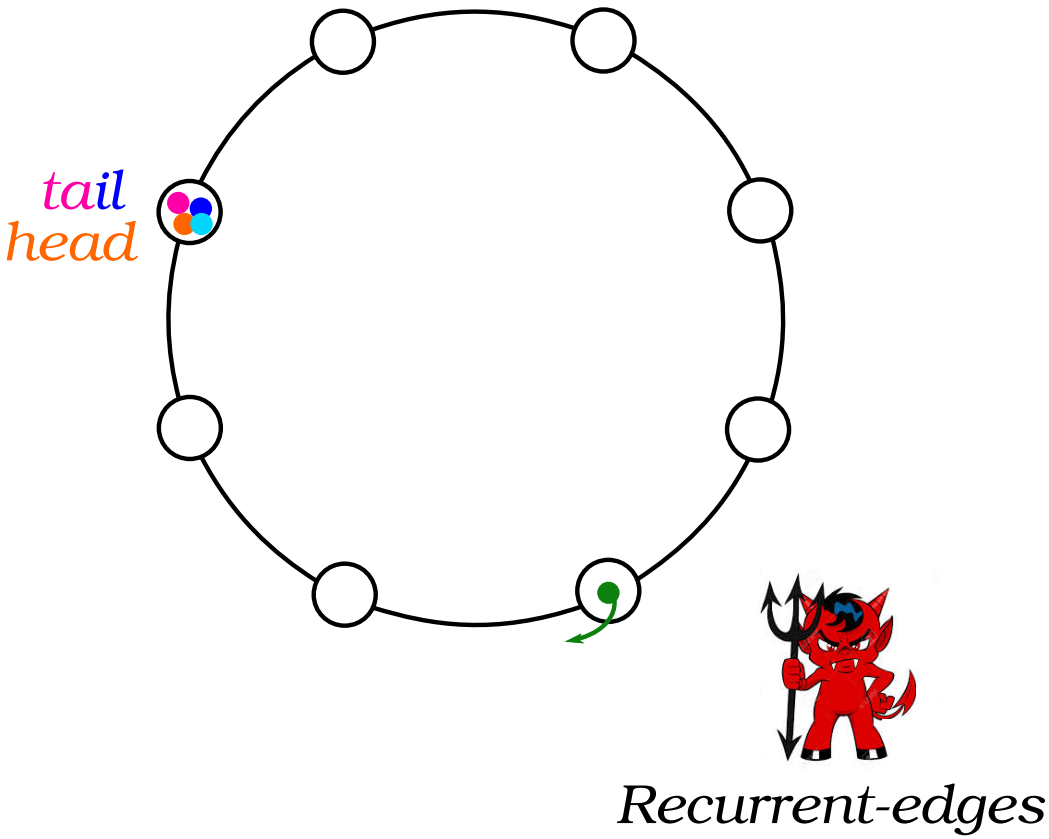
Phase IV

Goal: Waiting for gathering



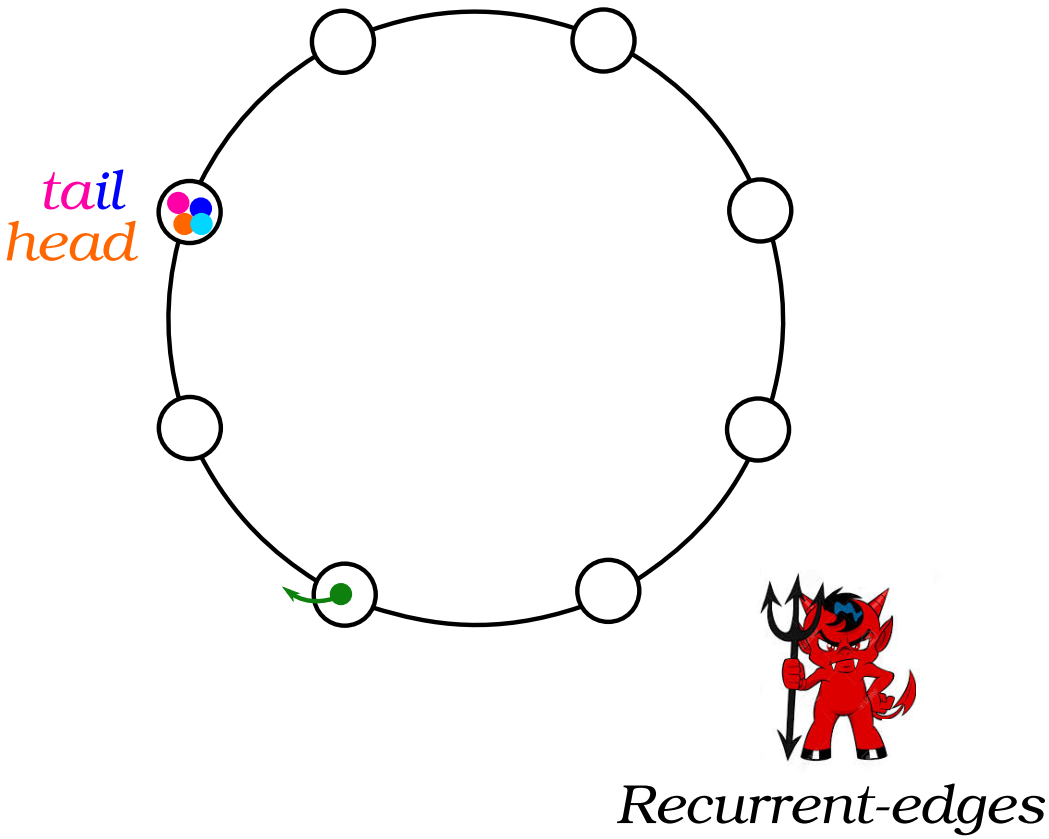
Phase IV

Goal: Waiting for gathering



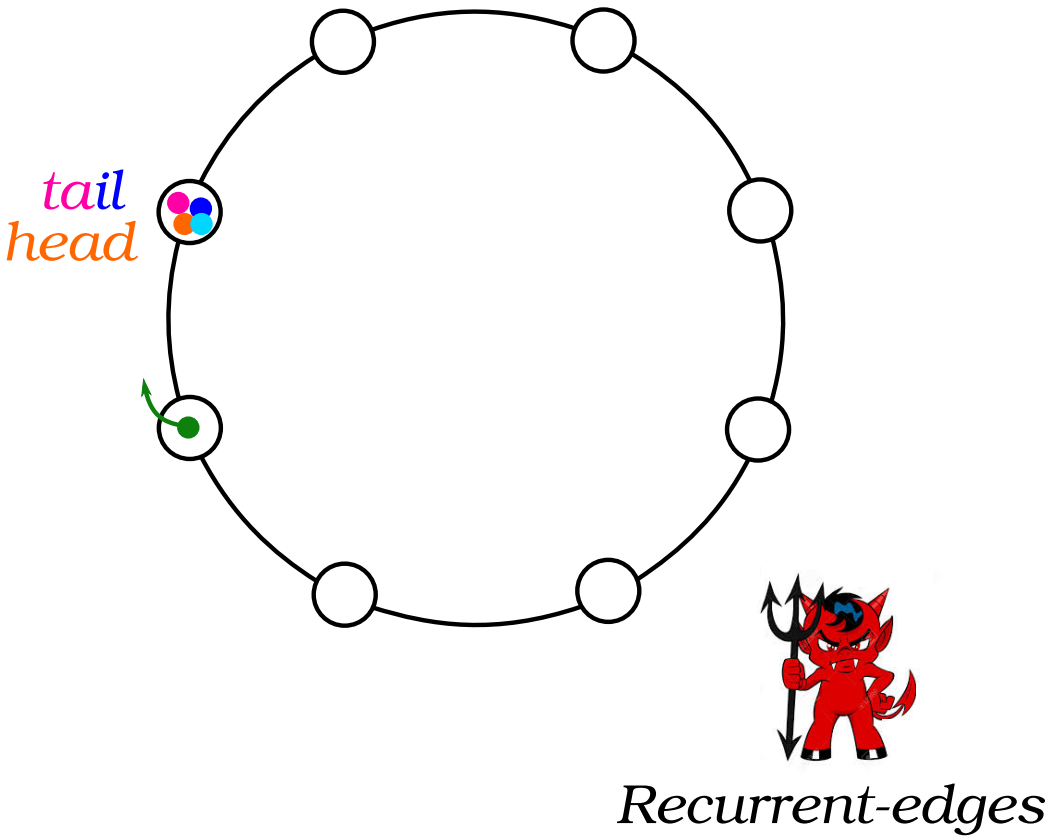
Phase IV

Goal: Waiting for gathering



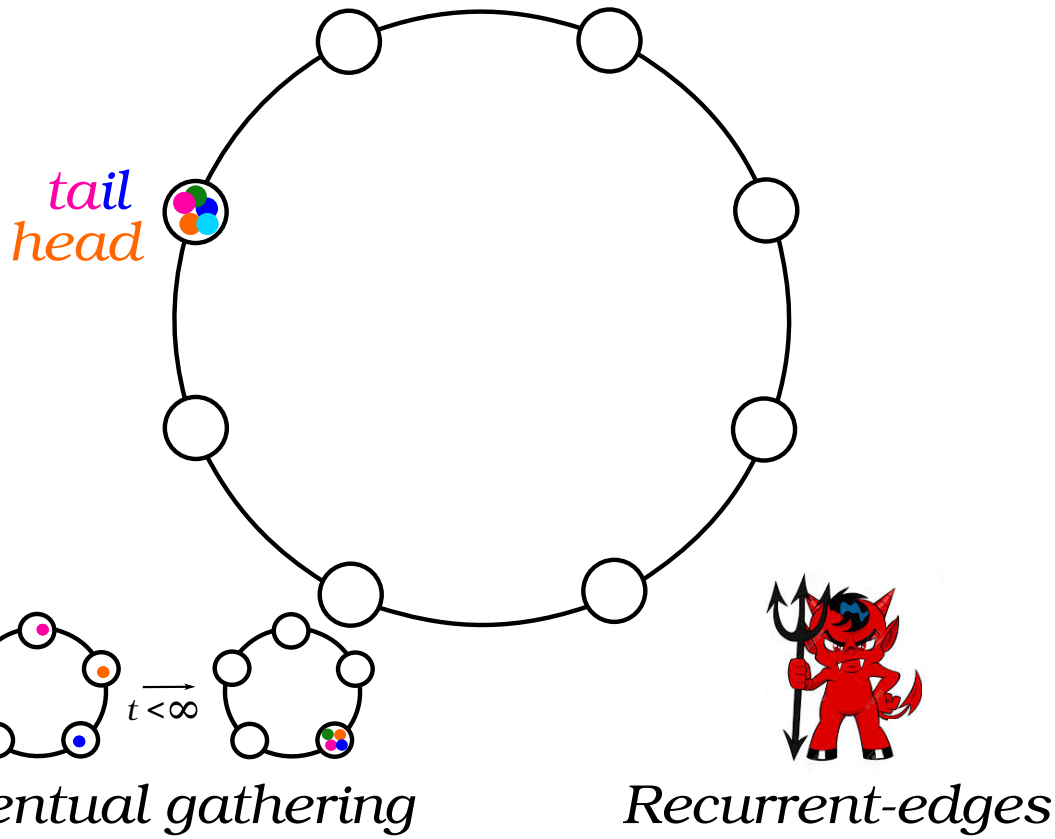
Phase IV

Goal: Waiting for gathering



Phase IV

Goal: Waiting for gathering



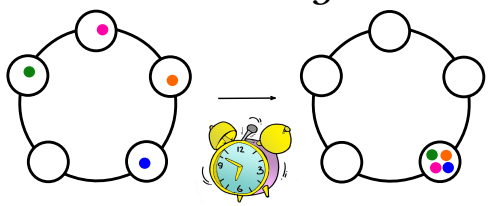
Phase IV

Goal: Waiting for gathering

Time-bounded recurrent-edges

Static

Gathering

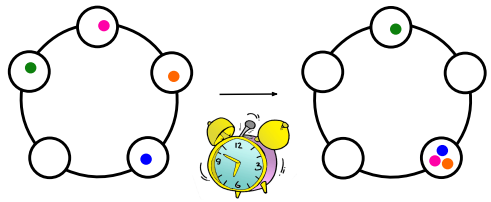


Phase IV

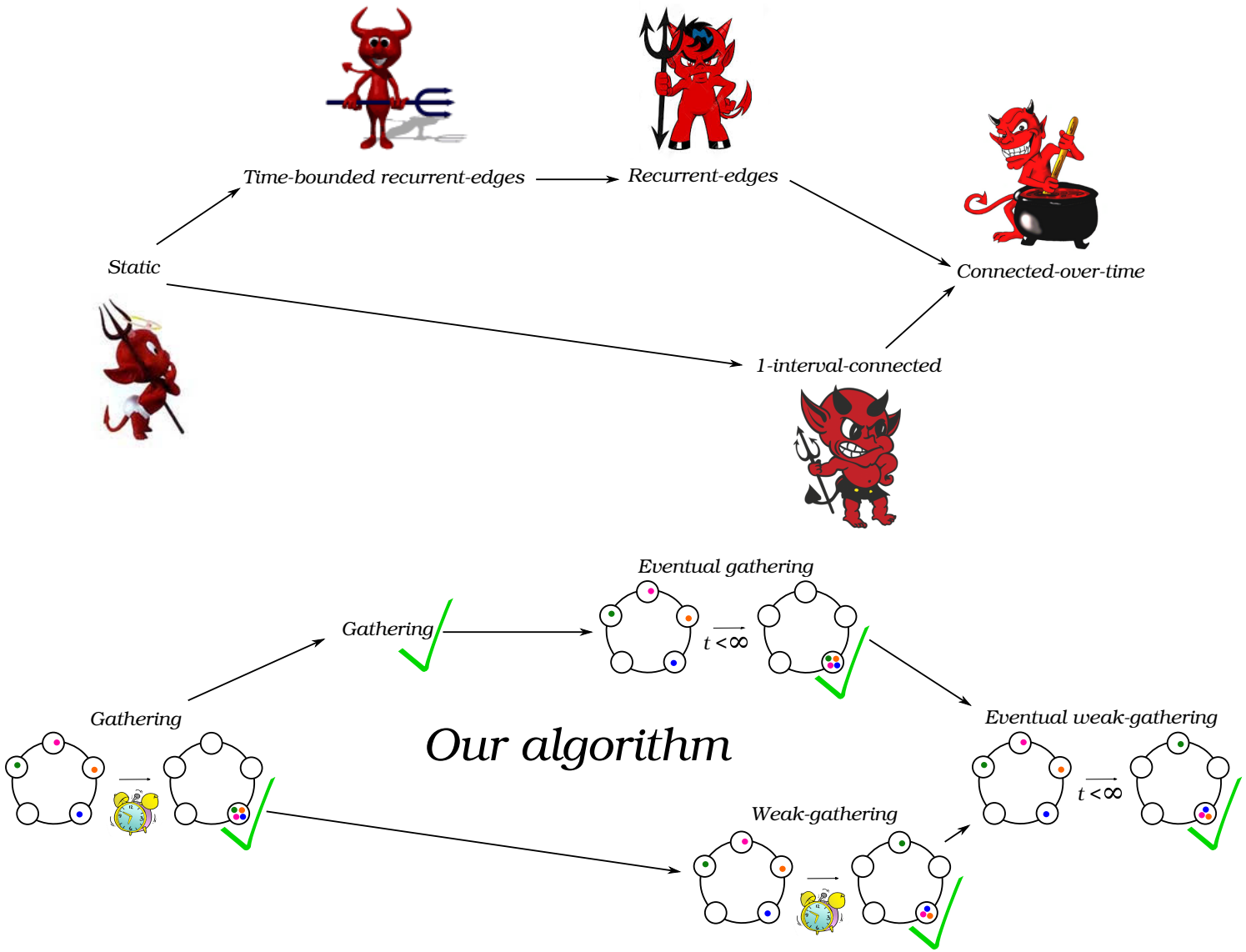
Goal: Waiting for gathering

1-interval-connected

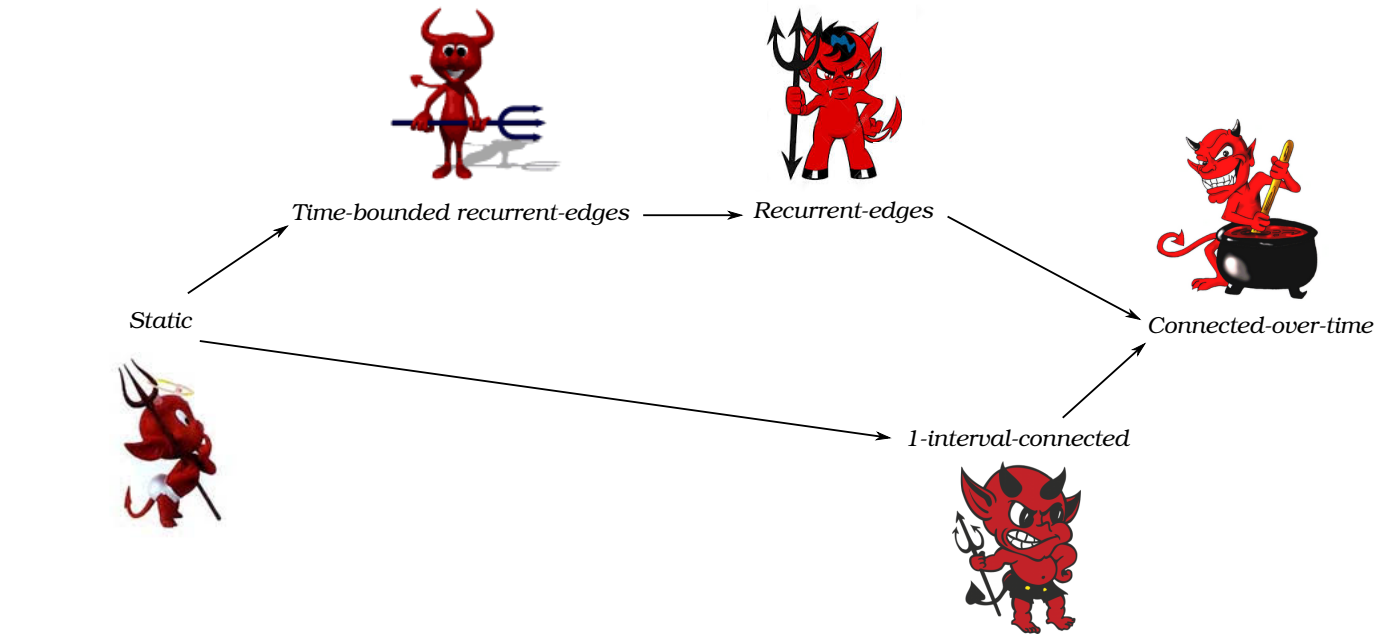
Weak-gathering

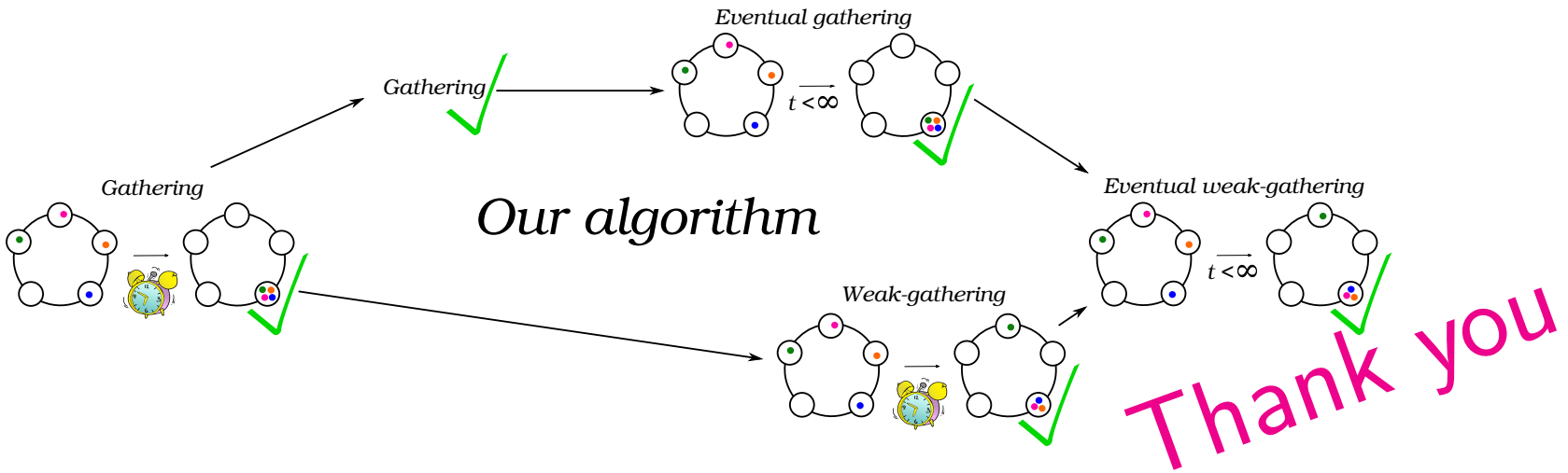


Conclusion


Time-bounded recurrent-edges
Recurrent-edges
Static
Connected-over-time
1-interval-connected
Eventual gathering
Gathering
$t < \infty$
Gathering
Our algorithm
Eventual weak-gathering
$t < \infty$
Weak-gathering

Conclusion


Time-bounded recurrent-edges
Recurrent-edges
Static
Connected-over-time
1-interval-connected


Eventual gathering
Gathering
$t < \infty$
Gathering
Our algorithm
Eventual weak-gathering
$t < \infty$
Weak-gathering
Thank you