Adaptive Parallelization of Multi-Agent Simulations with Localized Dynamics

Alexandru-Ionuț Băbeanu, Tatiana Filatova,
Jan H. Kwakkel, Neil Yorke-Smith

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Multi-Agent-Based Simulation

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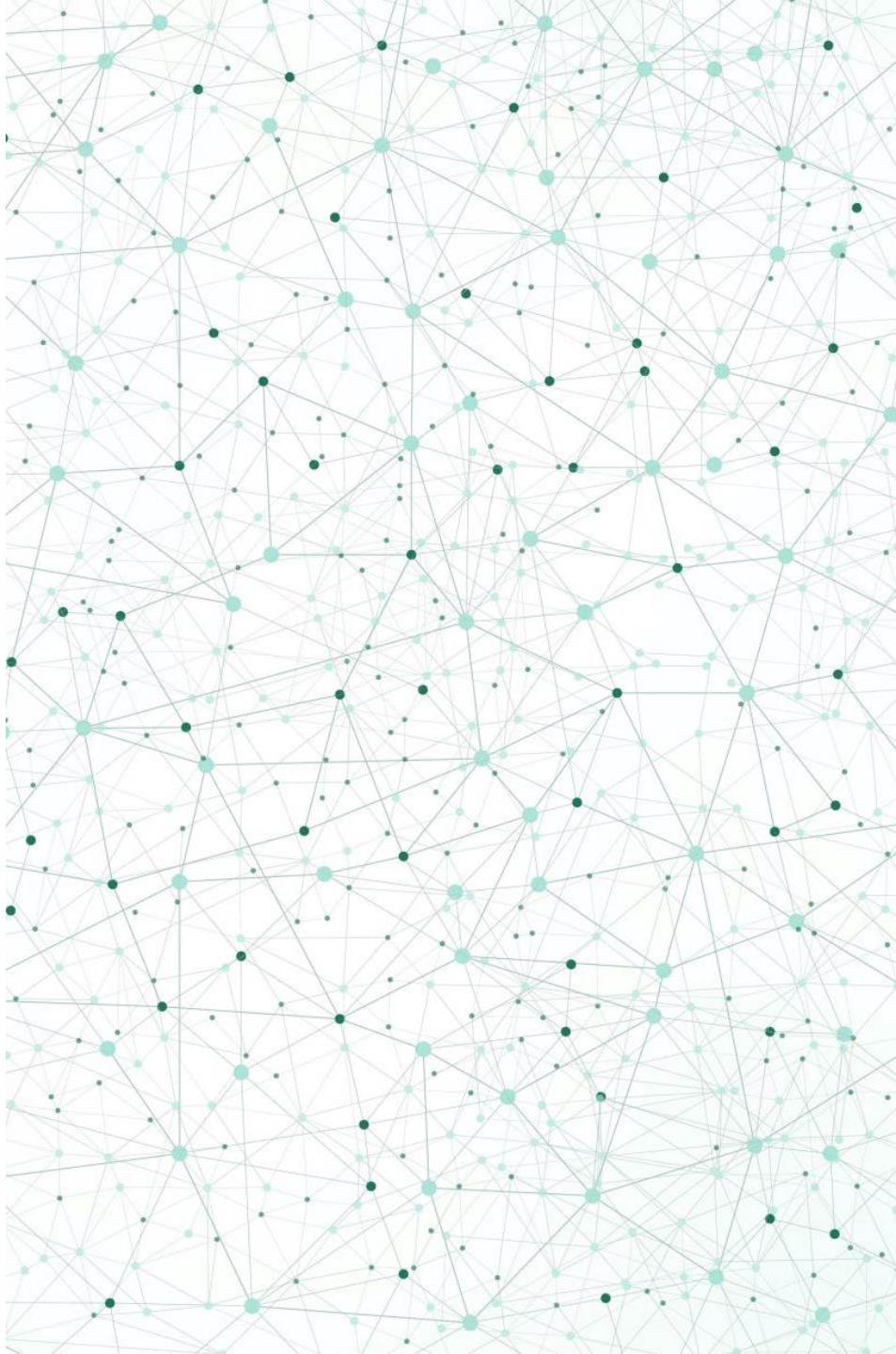
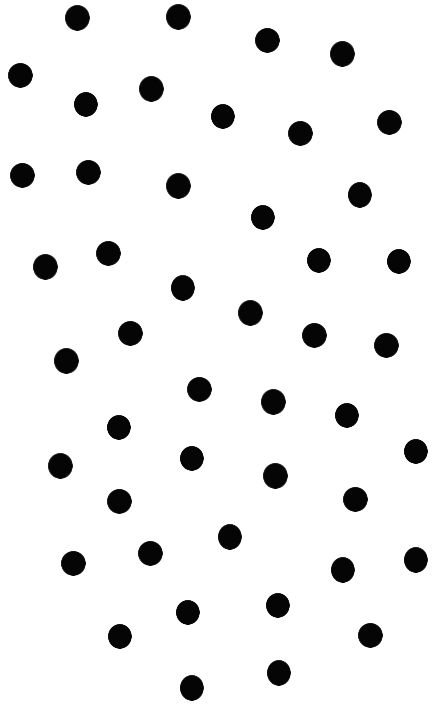


TU Delft

TAILOR

Motivation

- MABS are computationally very demanding



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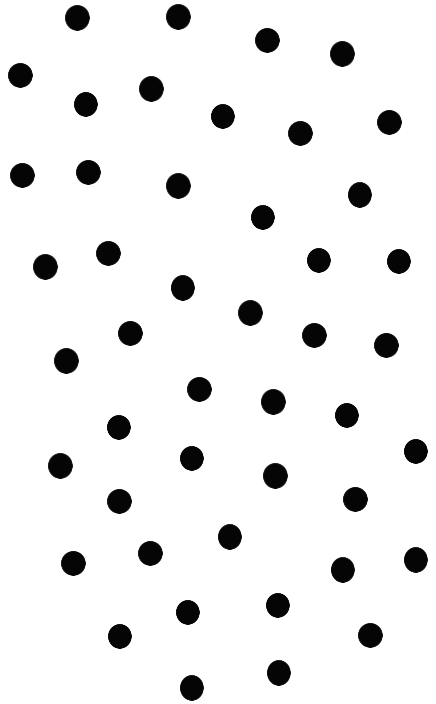

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- One acceleration strategy combines:
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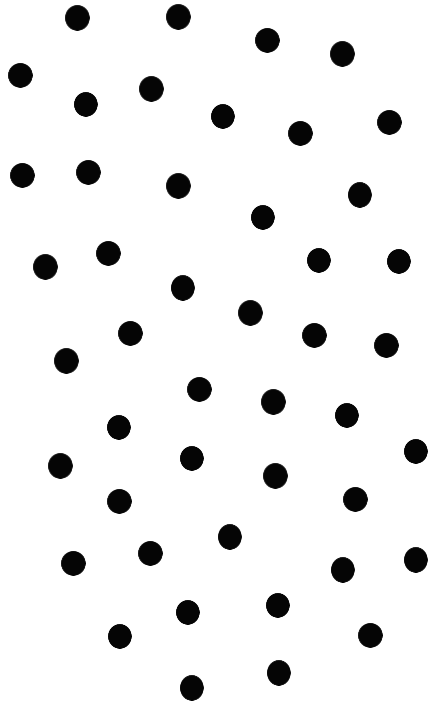
  - Multicore parallelism



Motivation

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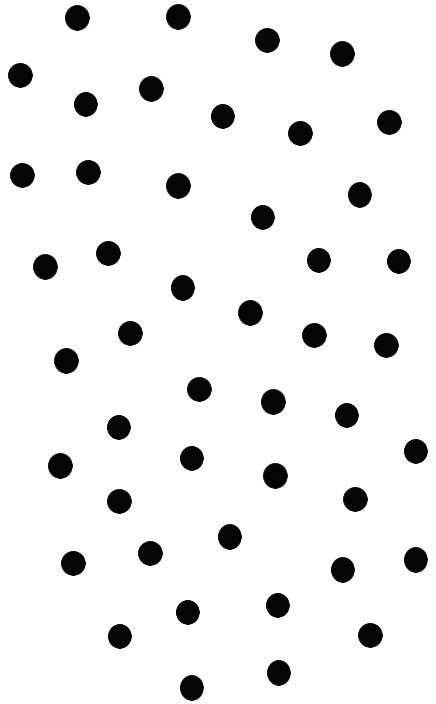
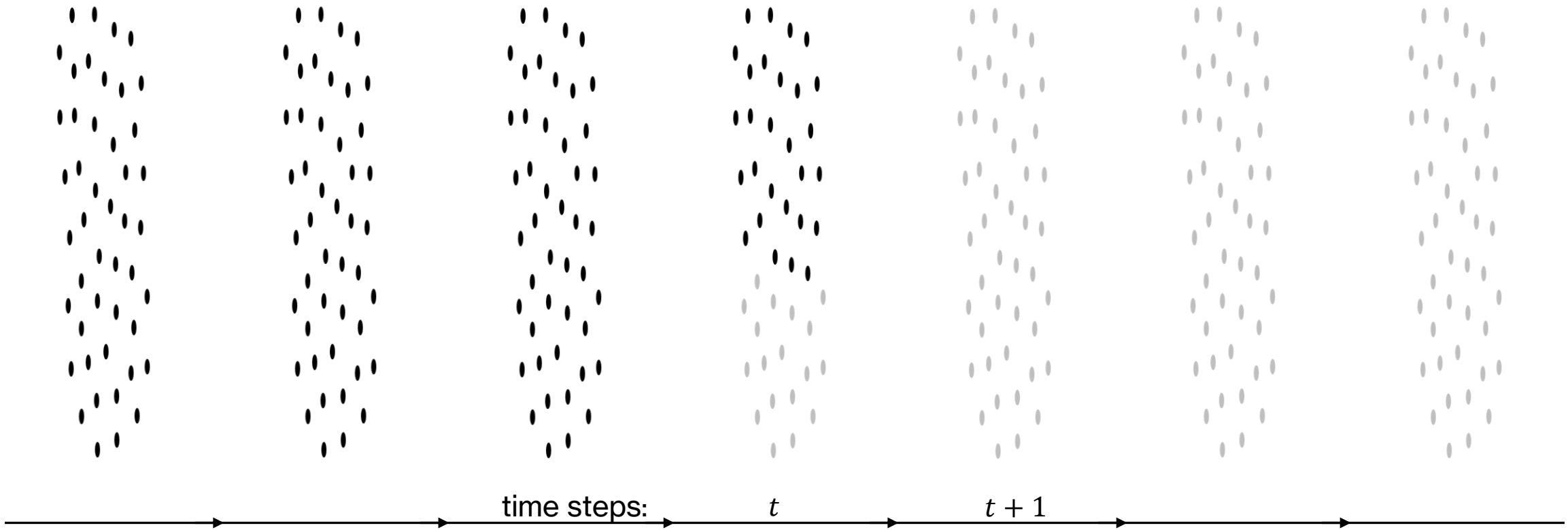
- One acceleration strategy combines:
  - System modularity
  - Multicore parallelism
- But there are complications:
  - Shared information, interactions
  - synchronization-related waiting



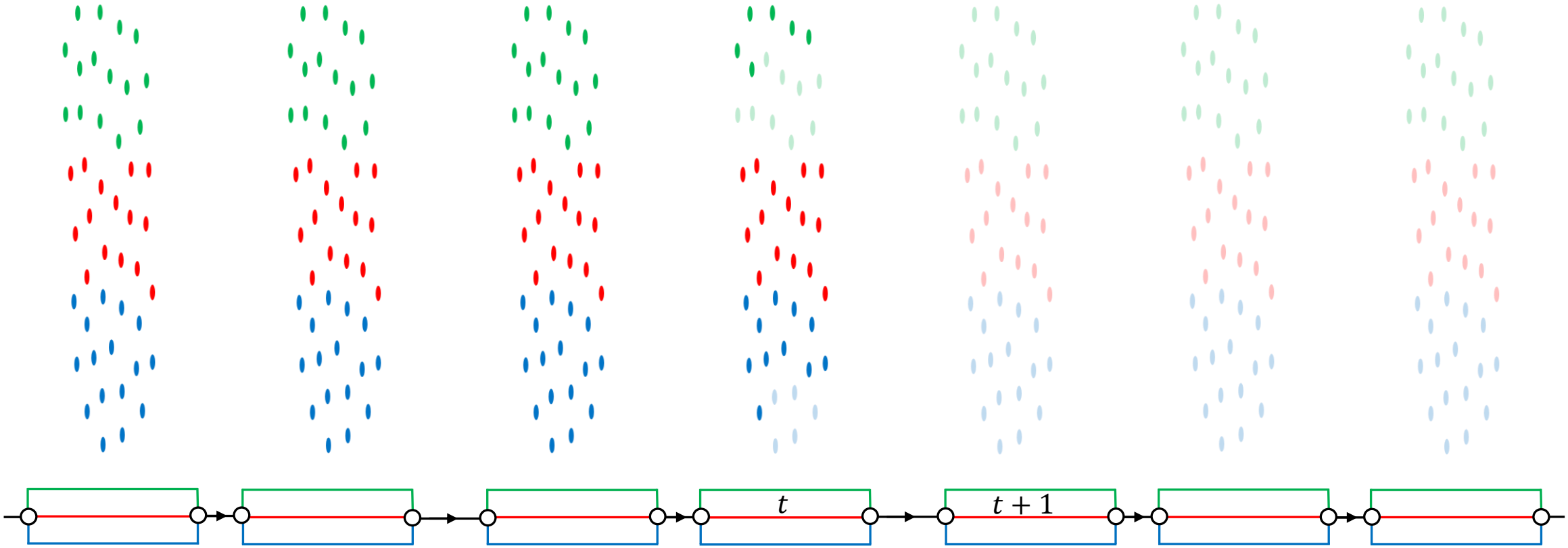
General intuition

- No parallelization:



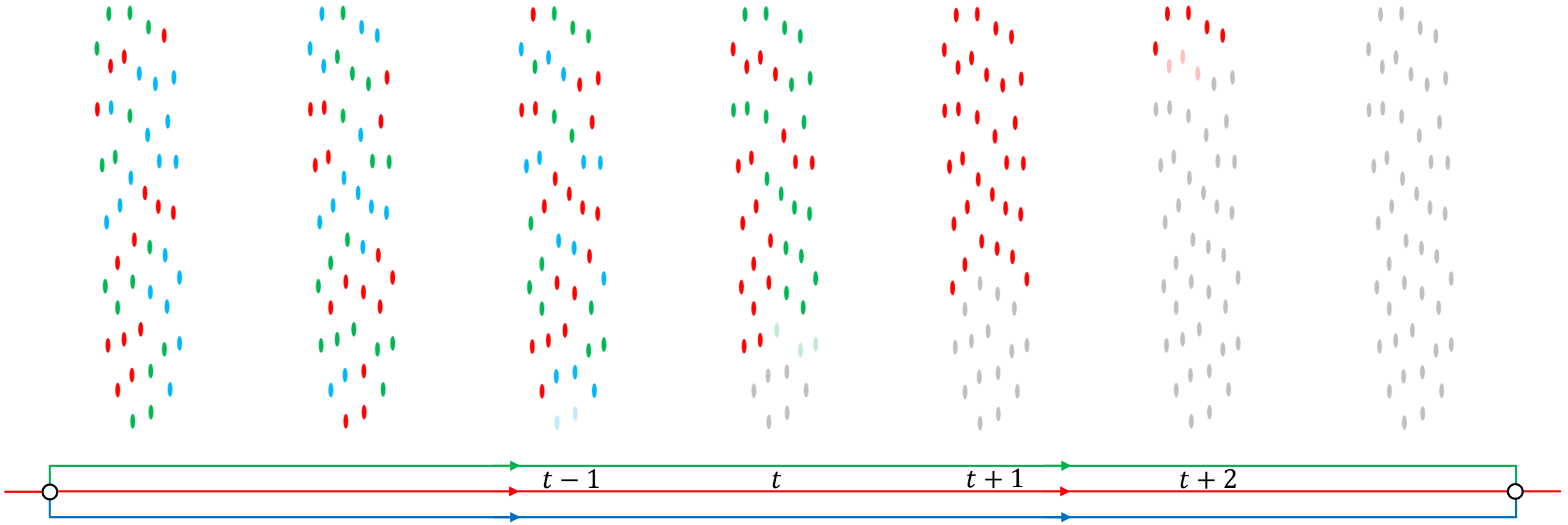
General intuition

- Conventional parallelization (rigid, top-down):



General intuition

- Desired parallelization (adaptive, bottom-up):



An adaptive parallelization protocol

- Need-based preregistration of updates

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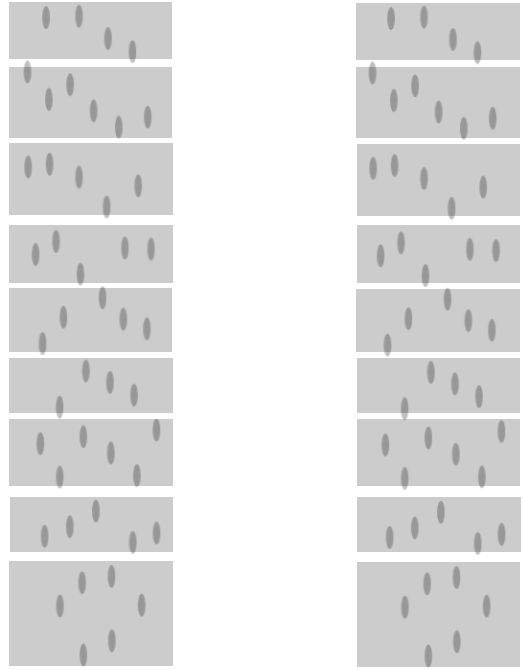
- Updates grouped into tasks



An adaptive parallelization protocol

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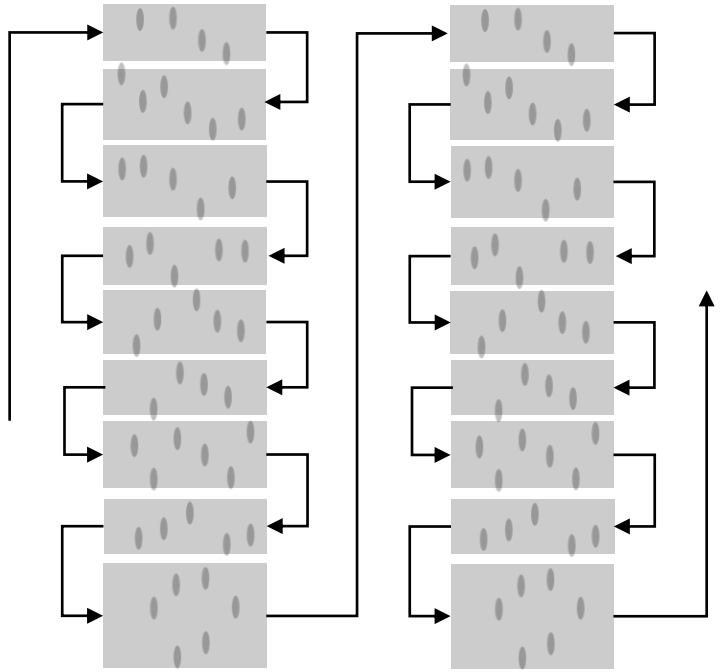
- Tasks linked within dynamic chain



An adaptive parallelization protocol

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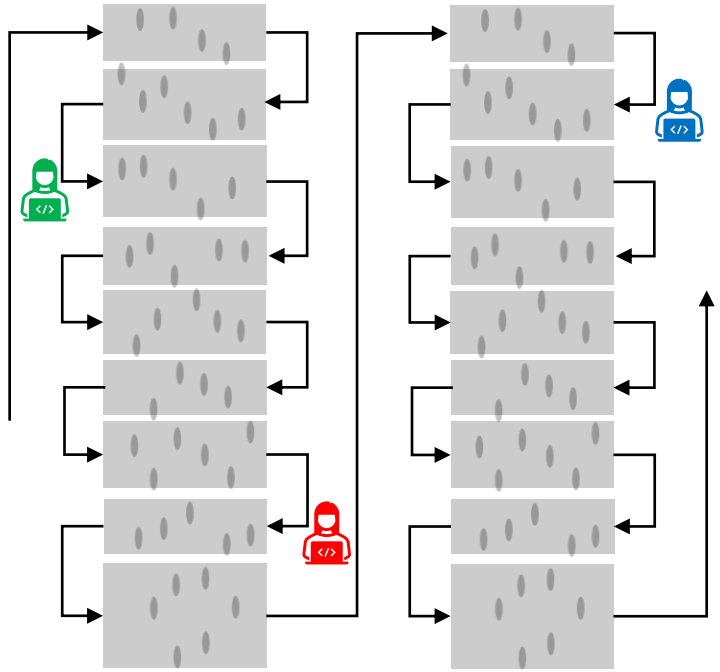
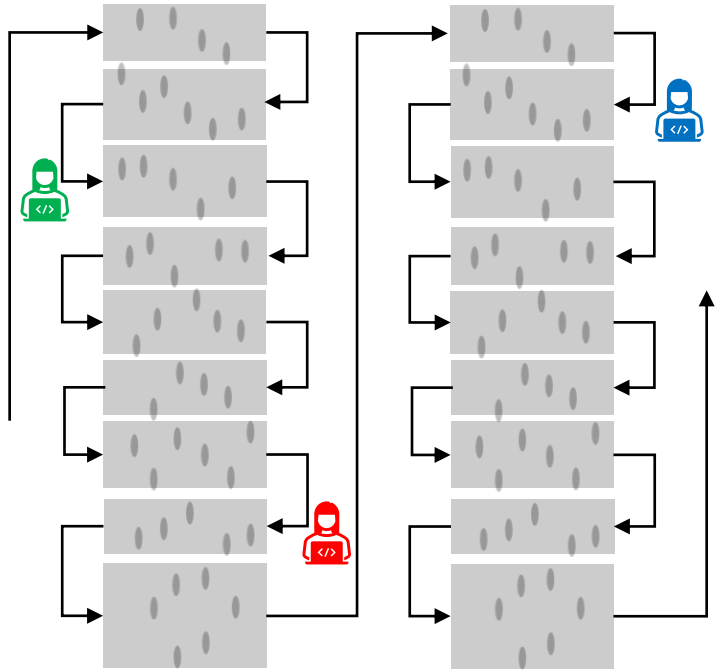
- Several workers (equal roles) operating on chain
- Gracefully handling dependence relations



An adaptive parallelization protocol

- Need-based preregistration of updates
- Updates grouped into tasks
- Tasks linked within dynamic chain
- Several workers (equal roles) operating on chain
- Gracefully handling dependence relations
- Shared-memory paradigm
- Relatively easy to plug in any model



Experimental results

Model specifications:

- SIR-type disease spreading
- 4000 agents
- Ring-like network
- 14 links per node
- 3000x2 steps
- 2 types of agent updates:
  - Computing new state
  - Advancing to new state

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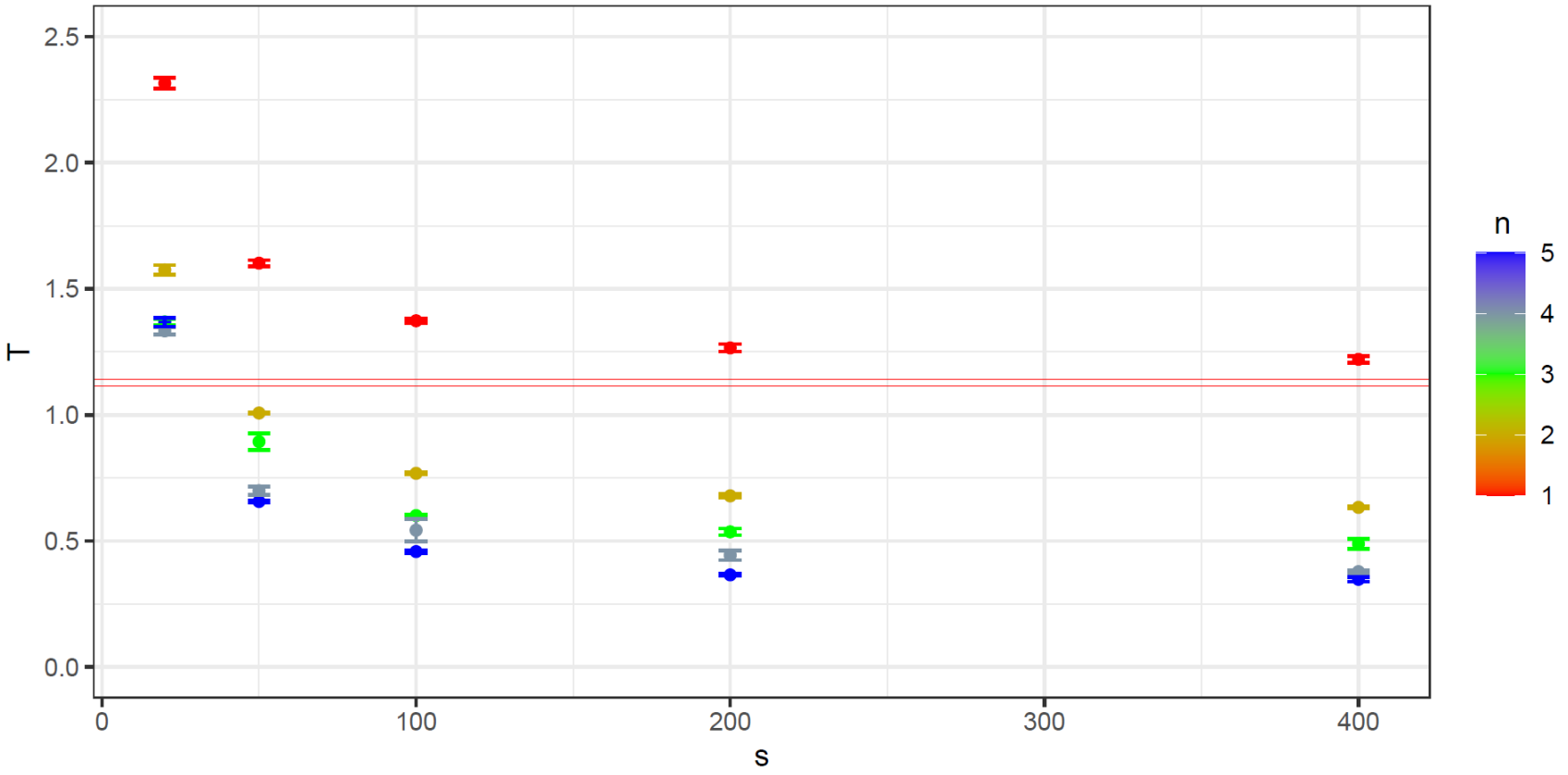
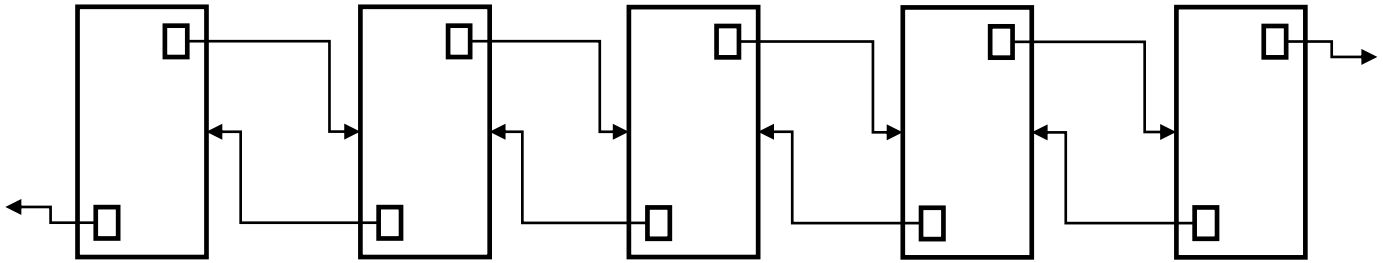
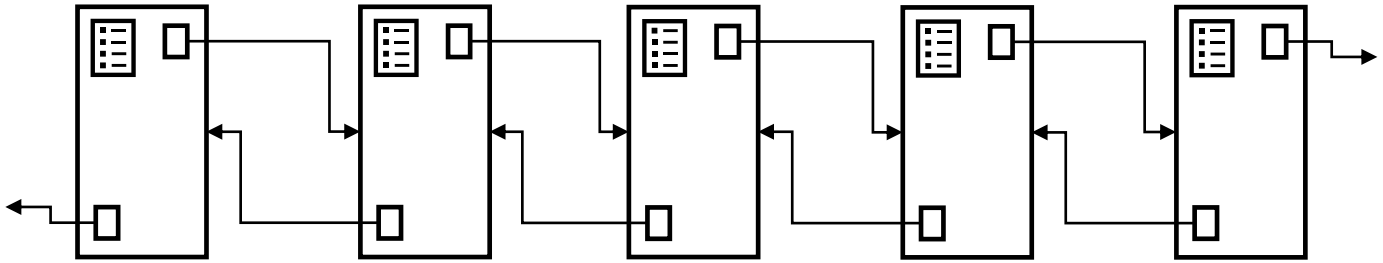


Protocol implementation



workers

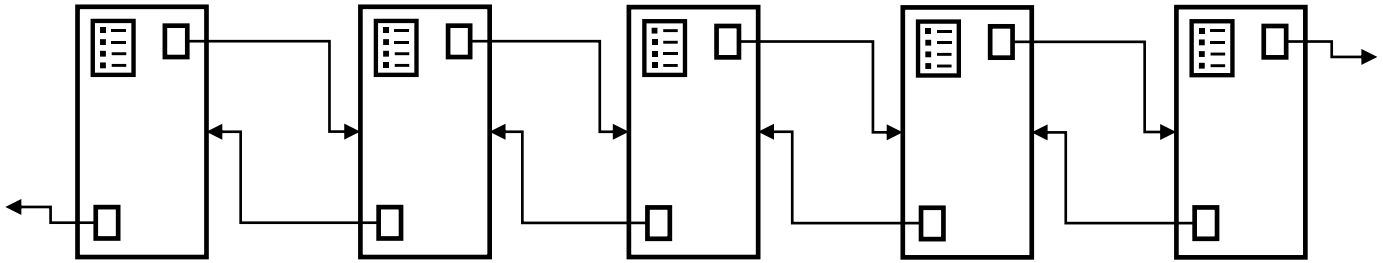
Protocol implementation



task **recipes**

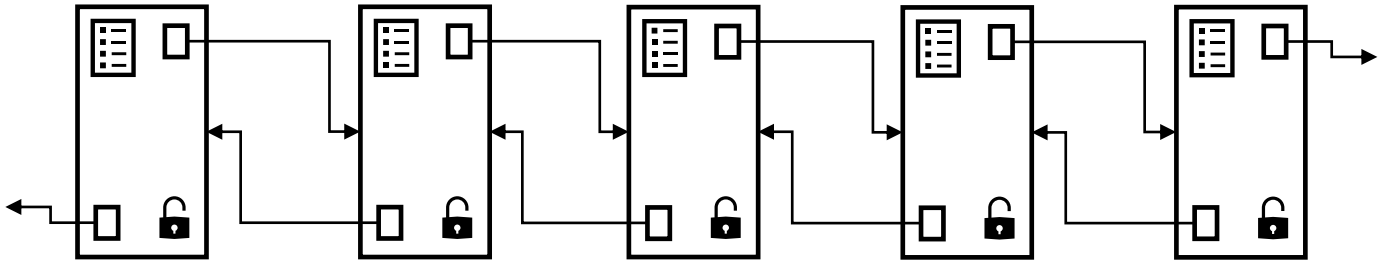
workers

Protocol implementation



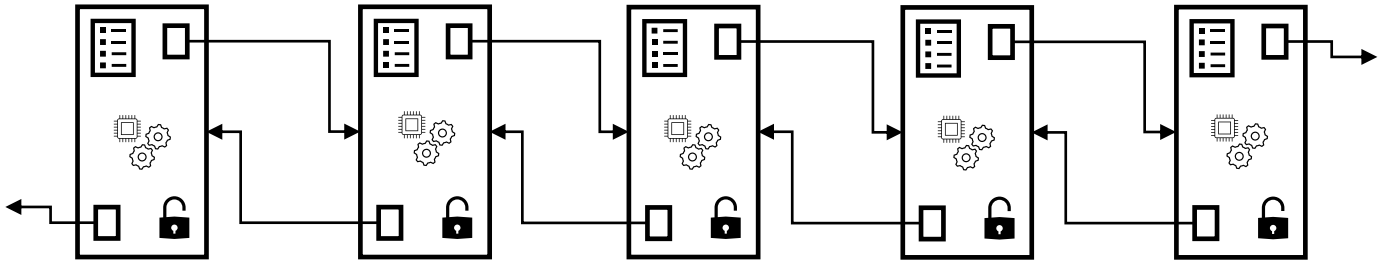
worker **records**

Protocol implementation



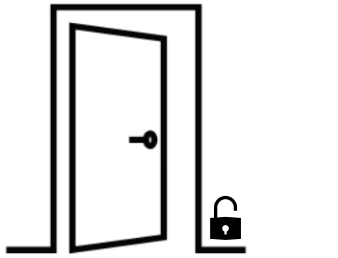
task mutex **locks**

Protocol implementation

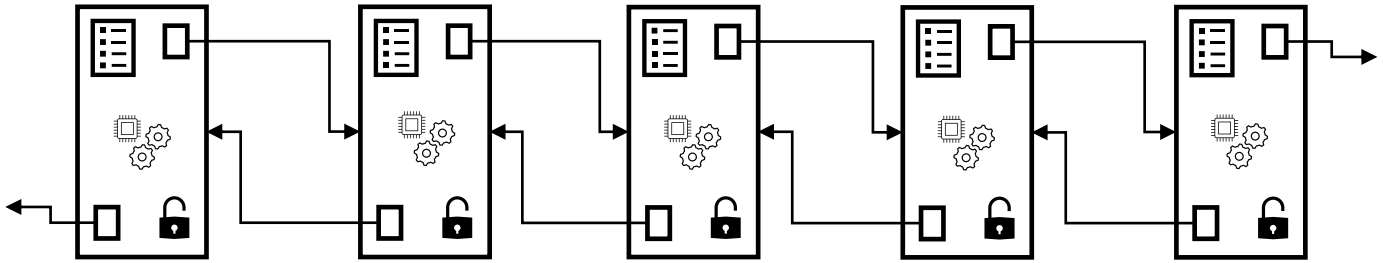


task execution **flags**

Protocol implementation



entering procedure

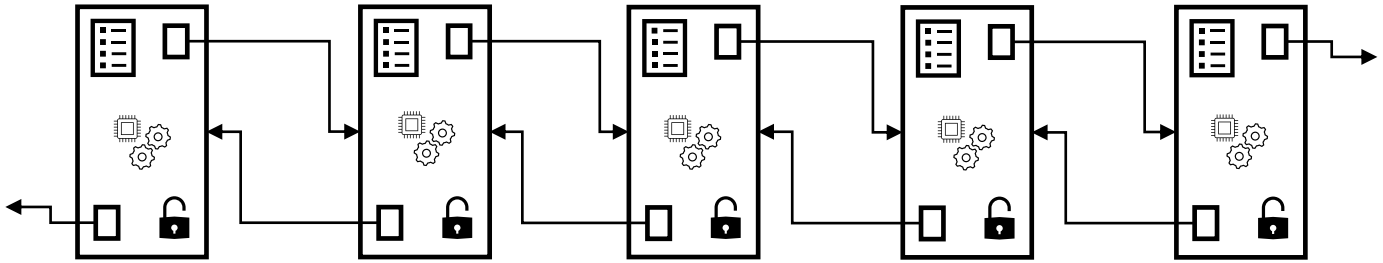


tasks

workers

Protocol implementation

entering procedure



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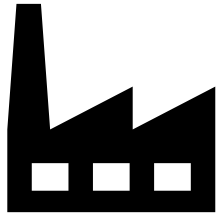

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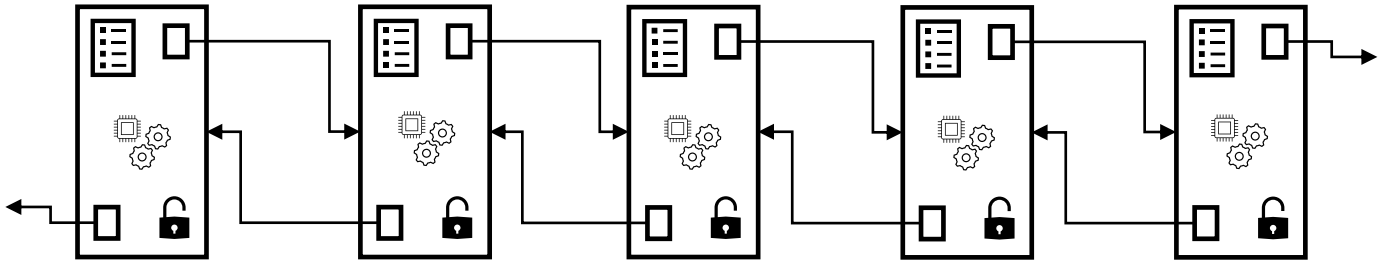

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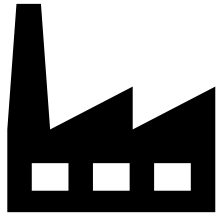

task creation procedure

task erasing procedure

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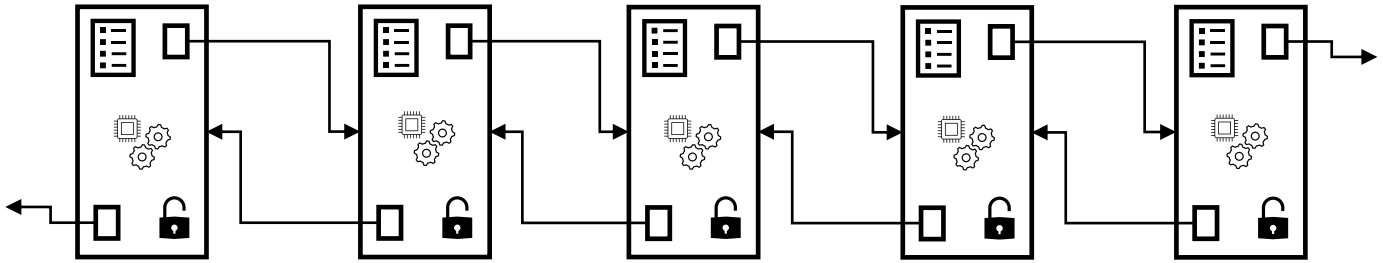

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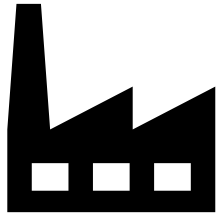

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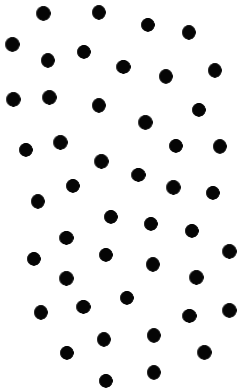
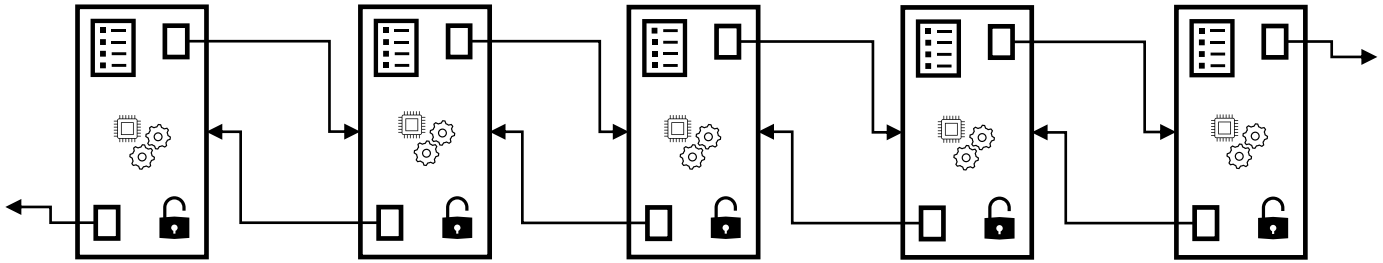


MABS model current state

Protocol implementation

entering procedure



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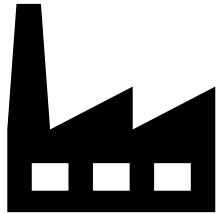

task creation procedure

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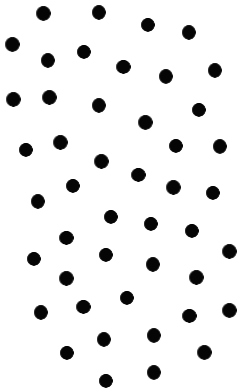
workers

researcher



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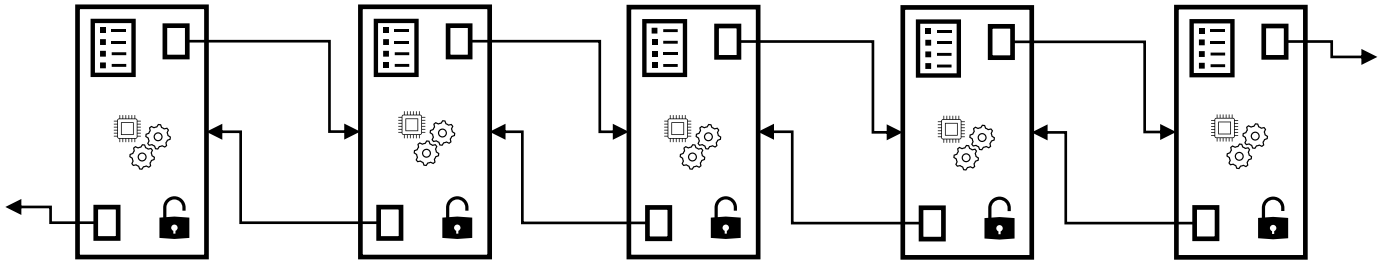

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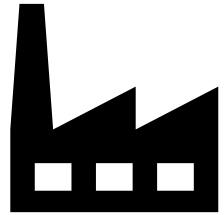

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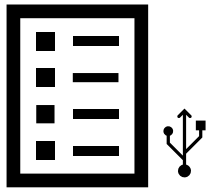
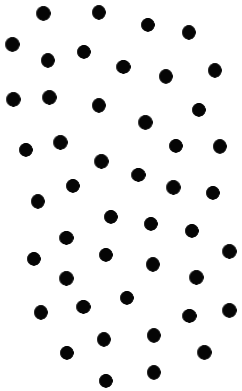


recipe class

record class

researcher



MABS model current state

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Conclusion and outlook

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- Workshop-version article (also) available online: arXiv:2304.01724

Backup

More experimental results