Collective-decision making and Self-organised aggregation

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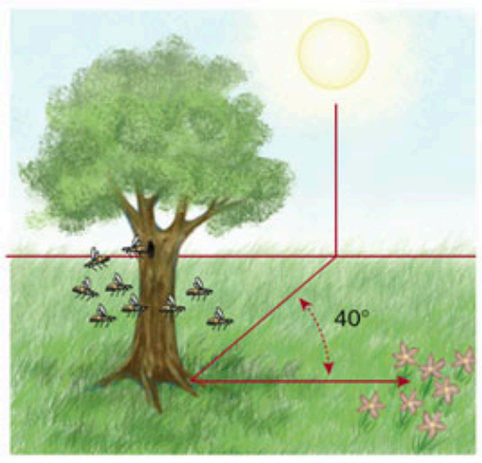
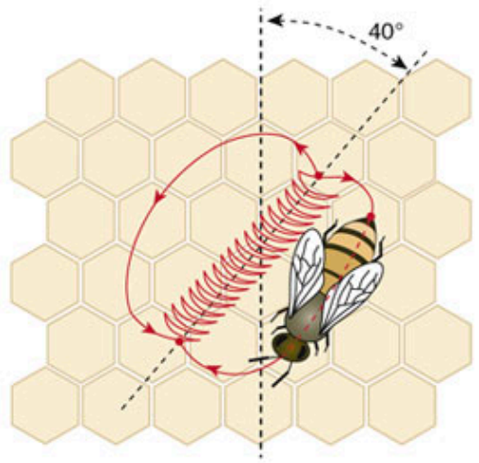
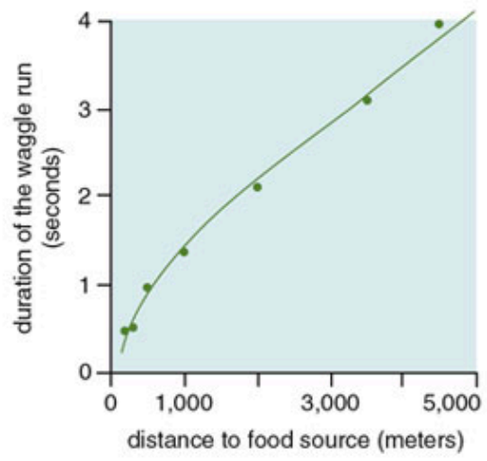
Collective-decision making

Collective decision-making refers to a process in which a group makes a decision in a way that when decision is made it is not longer attributable to any single individual of the group



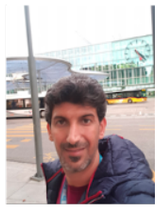




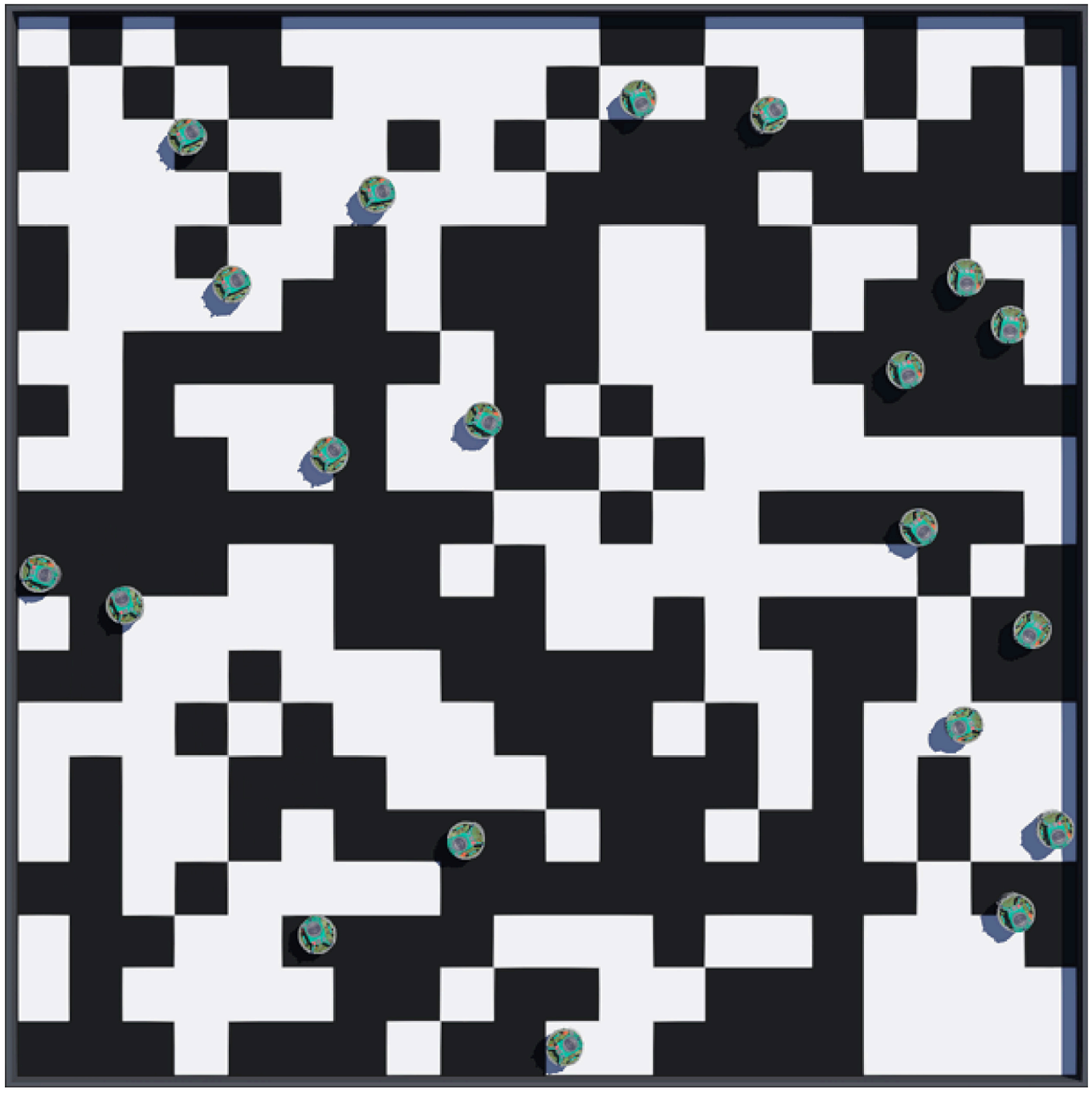
https://www.americanscientist.org/article/group-decision-making-in-honey-bee-swarms

Collective-decision making

A collective perceptual discrimination task (best-of-n with n=2)

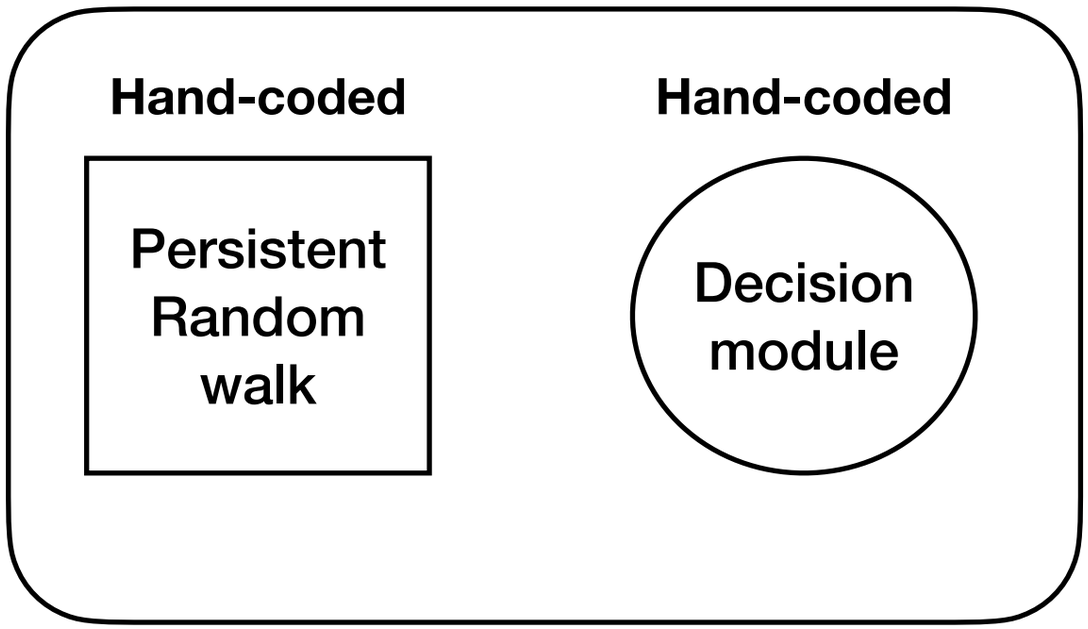


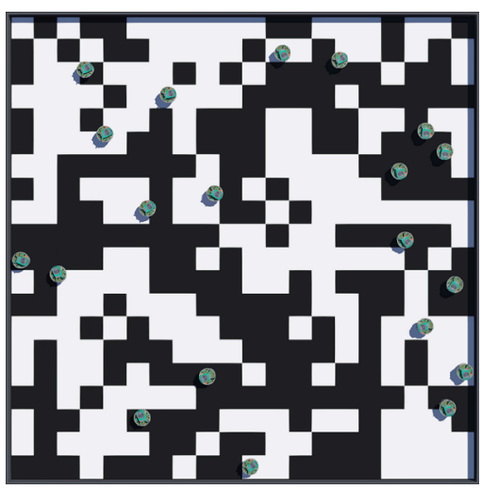
A. Almansoori



Collective-decision making

Valentini, G., Brambilla, M., Hamann, H., Dorigo, M. (2016). Collective perception of environmental features in robot swarm. International conference on swarm intelligence (pp. 65–76). Springer





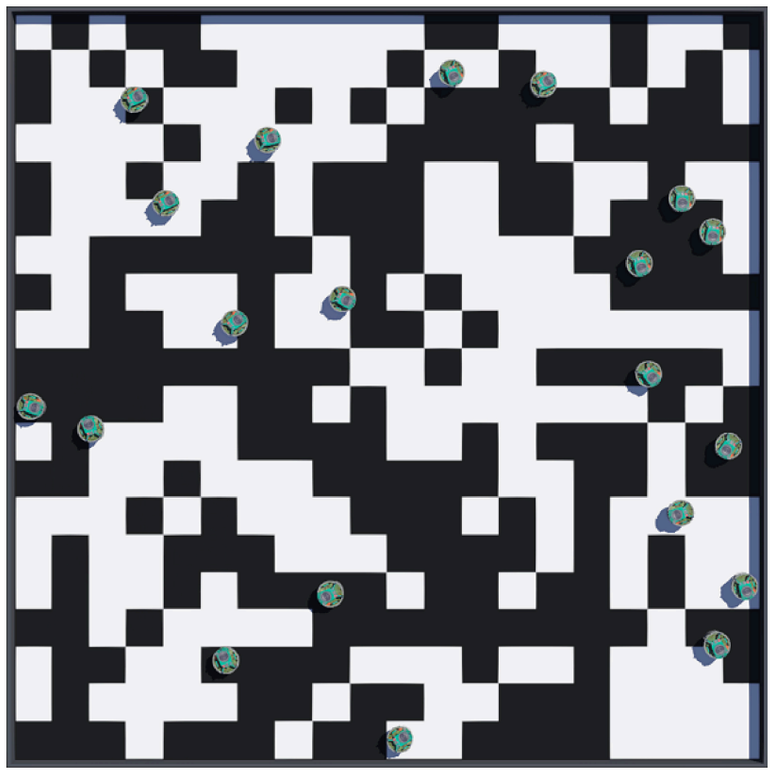
1) Hand-coded decision module
   - Voter model
     Copy the option of a random neighbours
   - Majority model
     Copy the option of the majority of n+1 neighbours

2) Exploration phase and Dissemination phase

3) The integrated sensory information contributes to determine the dissemination time

Collective-decision making

Objectives



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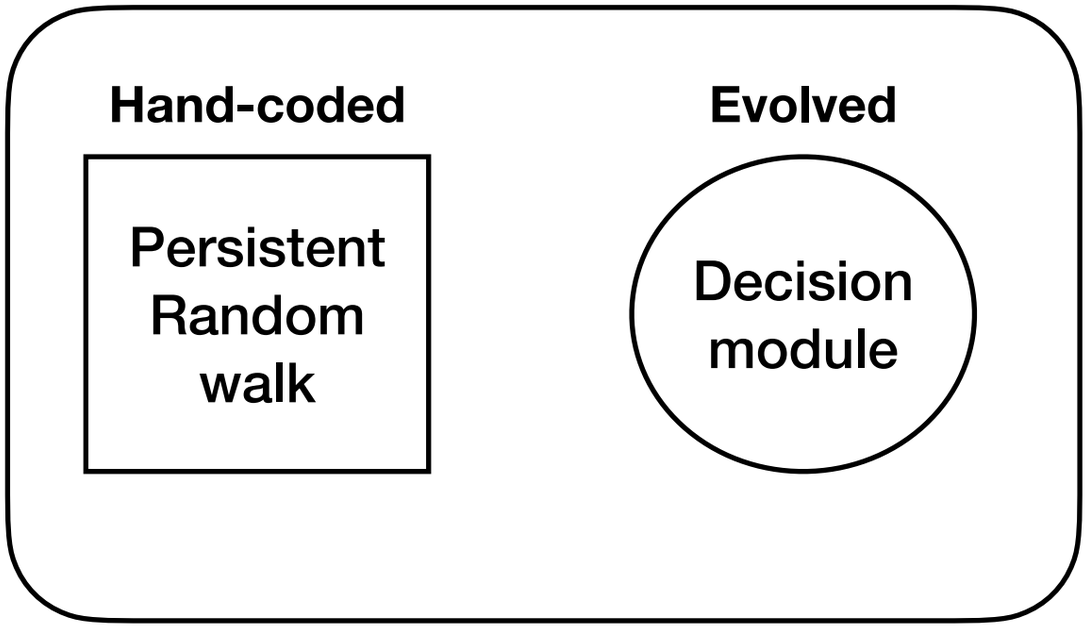
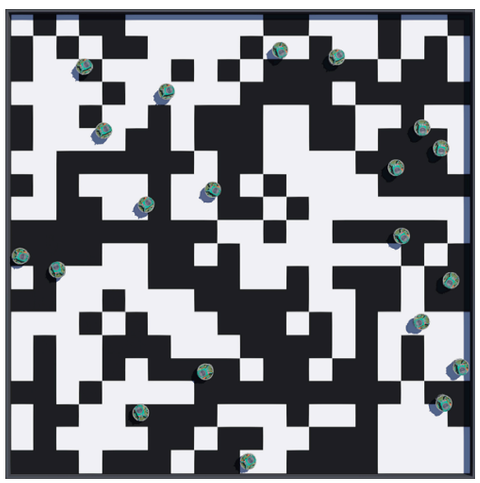
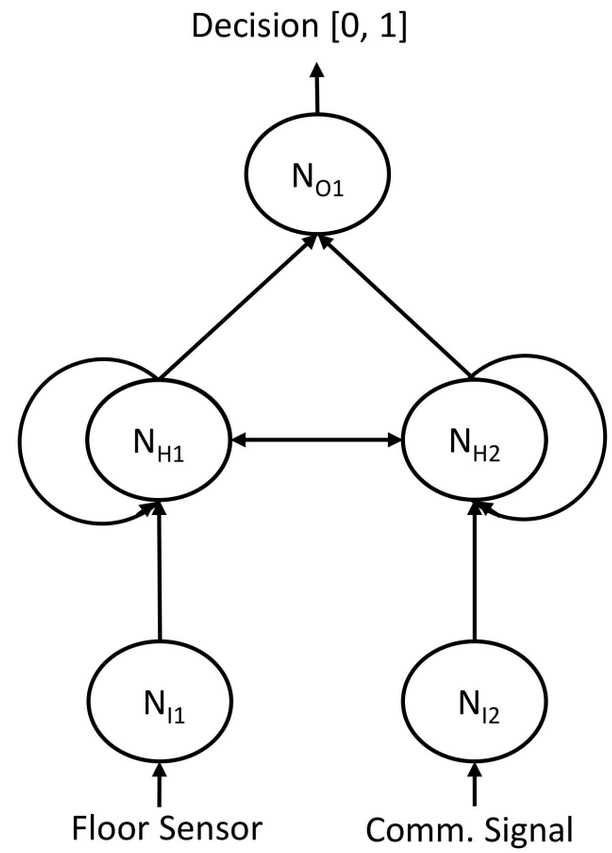
Collective-decision making

The robots controller



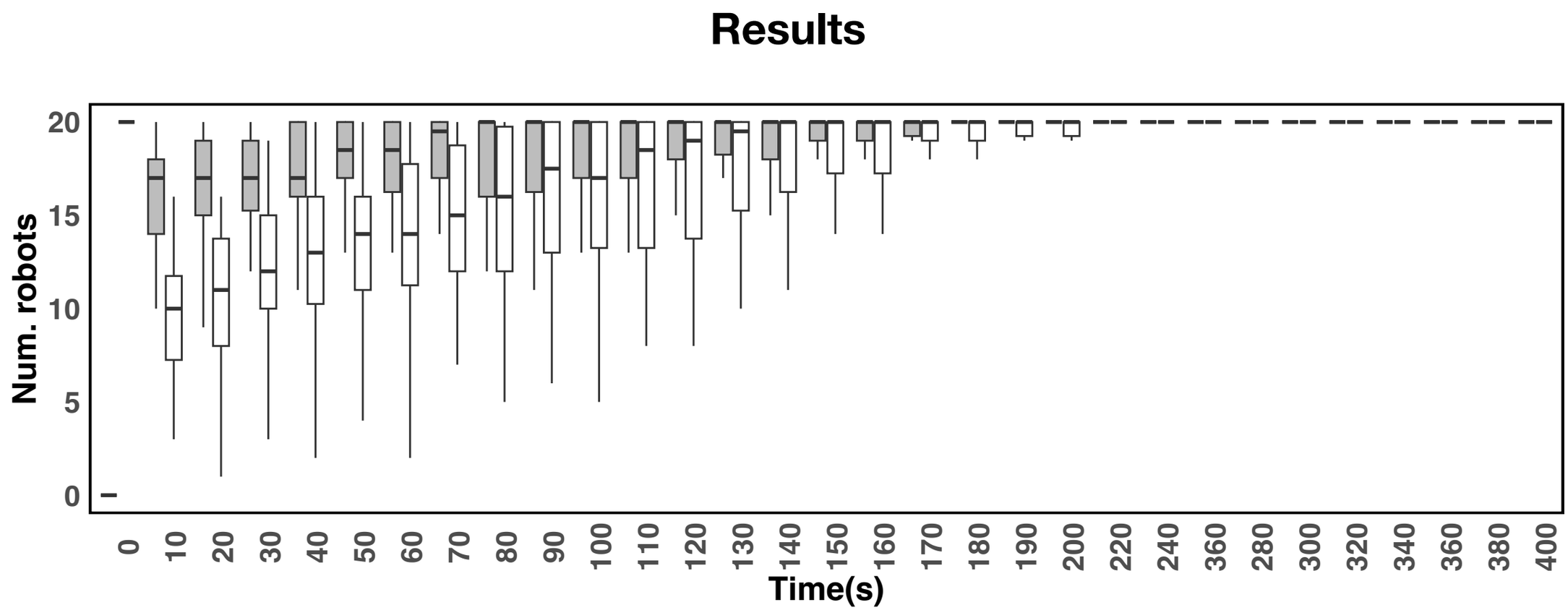




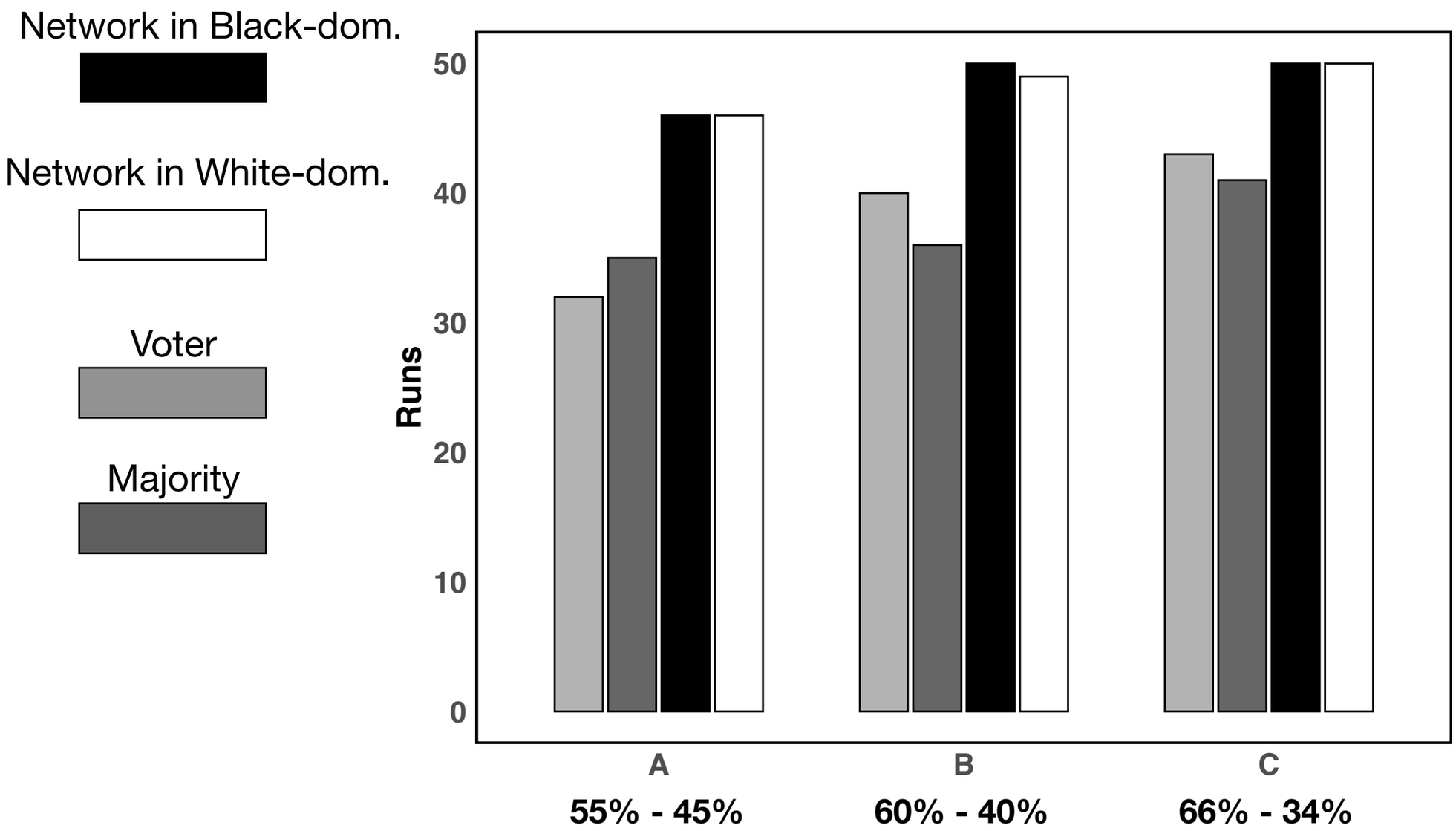
Decision module

Comm. Signal = output of decision unit of closest robot within 50 cm range

Collective-decision making



Collective-decision making



Collective-decision making

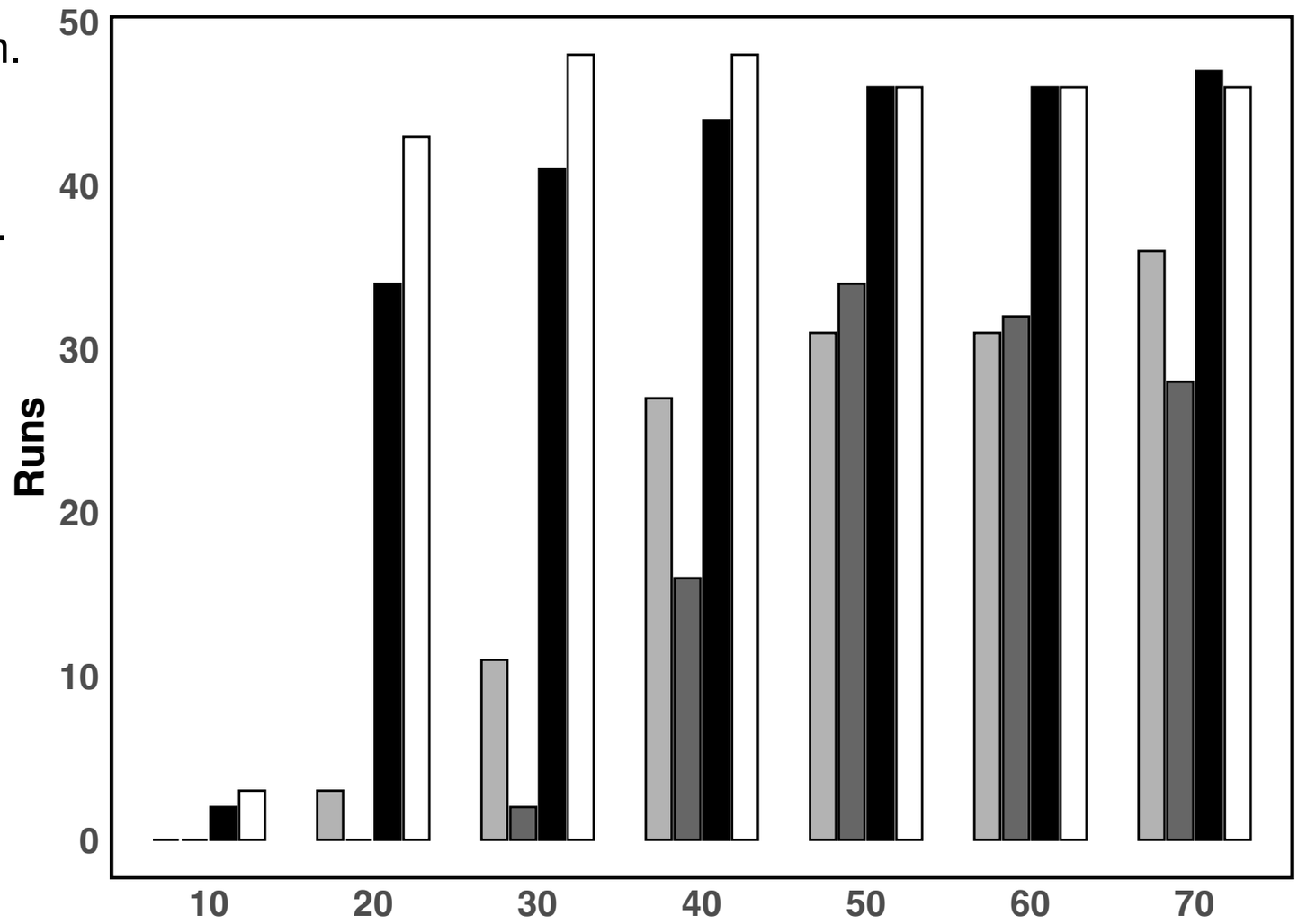
Max comm. distance (accuracy)

Network in Black-dom.

Network in White-dom.

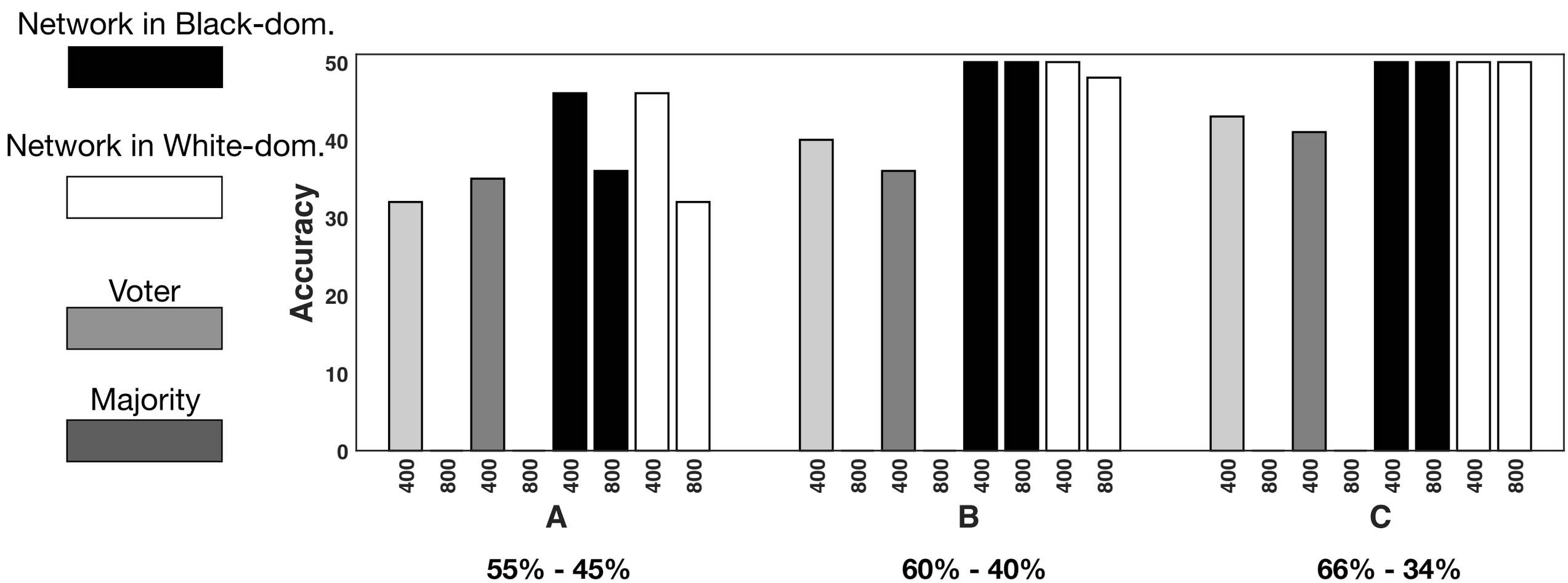
Voter

Majority

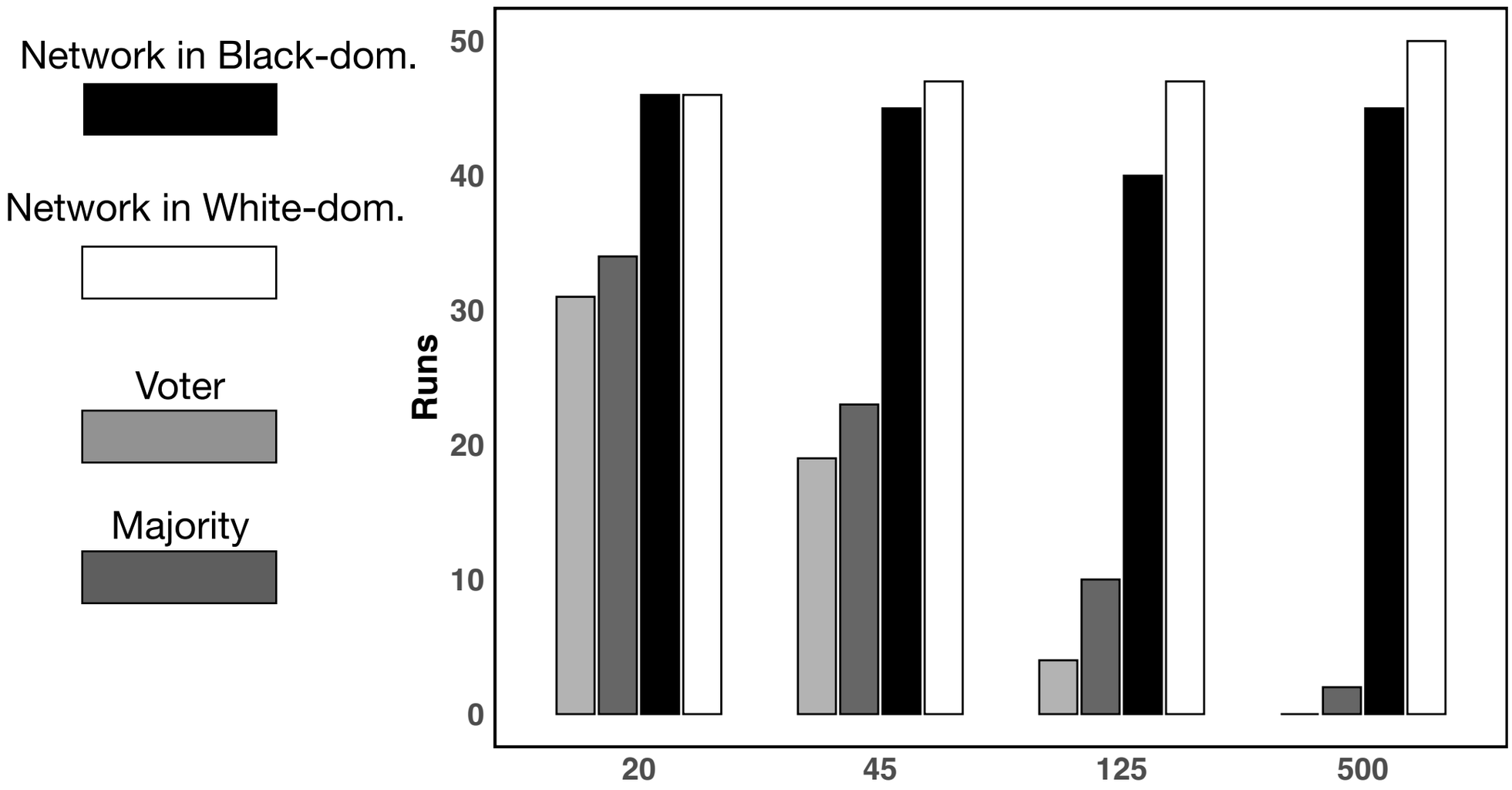


Collective-decision making

Dynamic environment (accuracy)



Collective-decision making



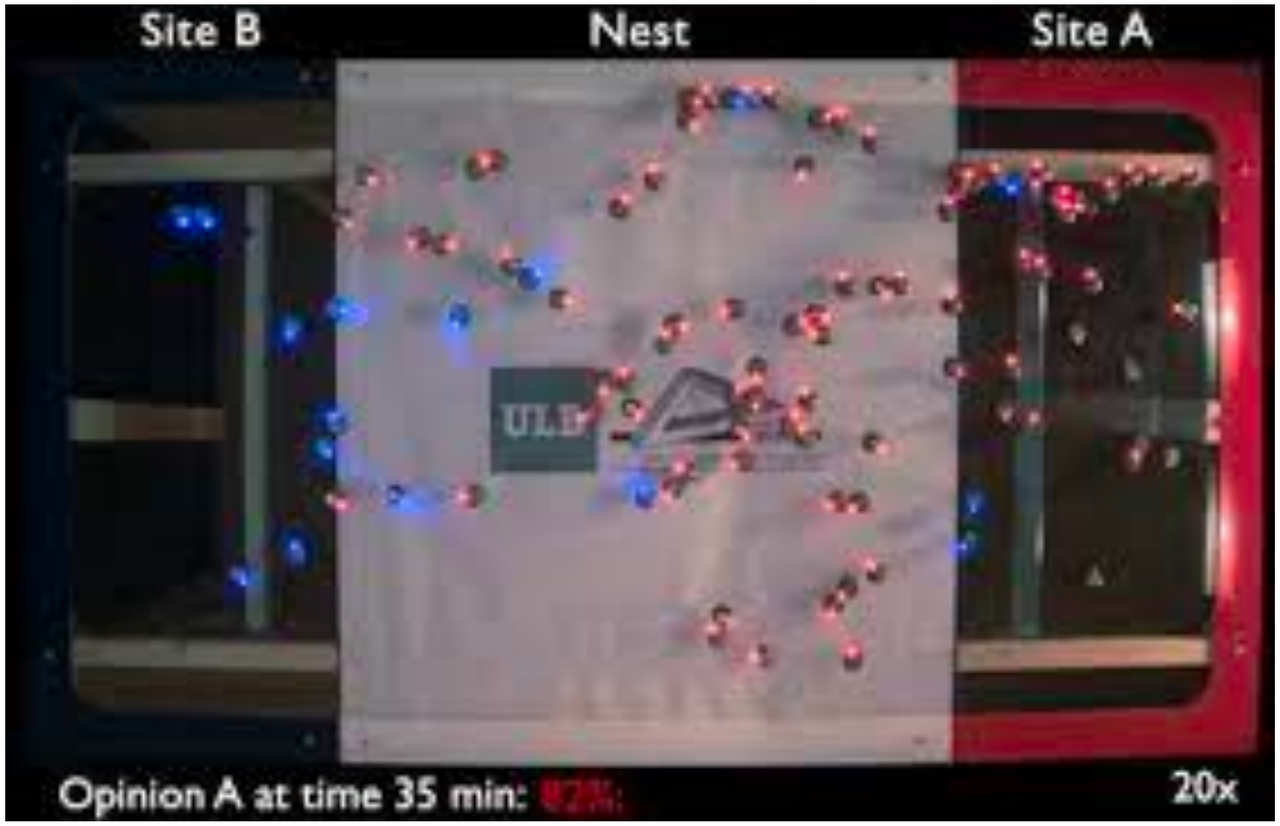
Collective-decision making

Physical robots

-White-dominant environment.
-55% white vs 45% black.
-10 e-puck2 robots.
-robots with red lights believe in the white-dominant option.
-robots with green lights believe in the black-dominant option.
-Trail time: 200 s.
-Speed: about 3x.

Collective-decision making

A site selection task (best-of-n with n=2)



1) Hand-coded decision module
   - Voter model
     Copy the option of a random neighbours
   - Majority model
     Copy the option of the majority of n+1 neighbours

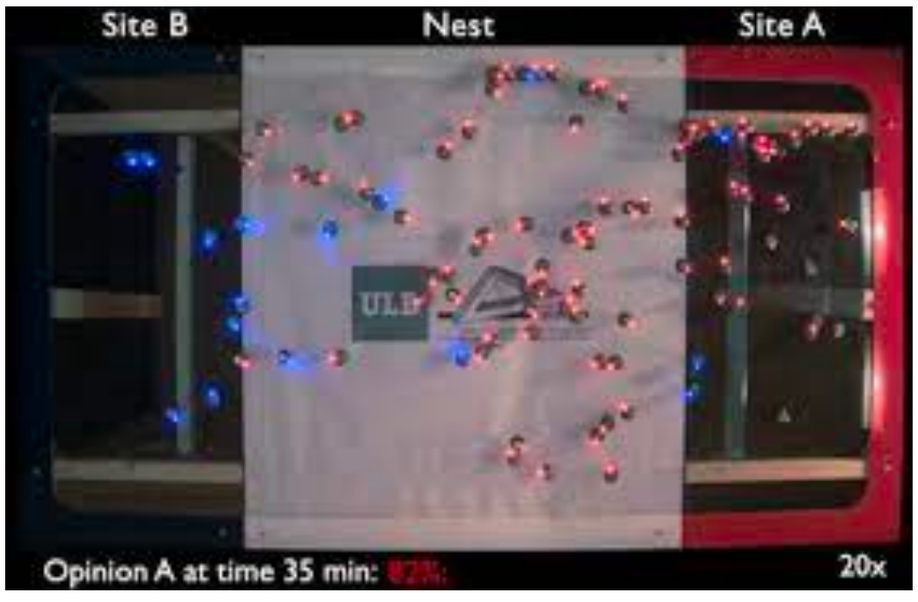
3) Exploration phase and Dissemination phase

5) The perceived quality of the visited site contributes to determine the dissemination time for that site.

Valentini G., Hamann H., and Dorigo M.. "Self-organized collective decision-making in a 100-robot swarm." Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 29. No. 1. 2015.

Collective-decision making

Objectives



1) Hand-coded decision module

   Voter model
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   Majority model
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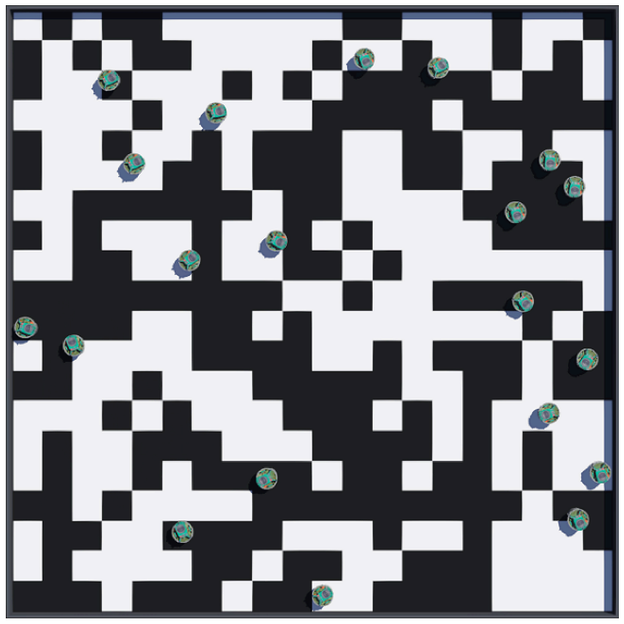
2) The perceived quality of the visited site contributes to determine the dissemination time for that site.

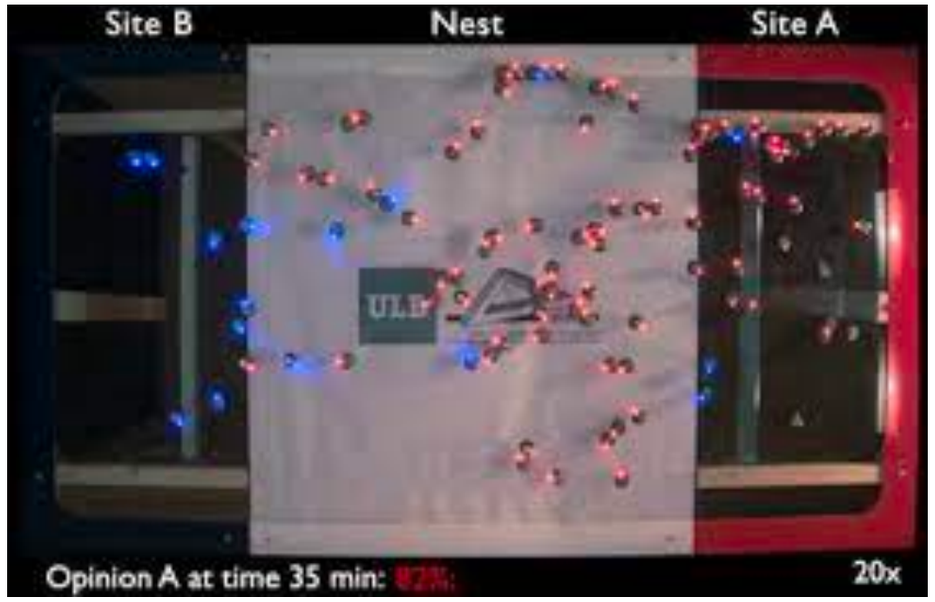
Collective-decision making

A collective perceptual discrimination task



nb. sites = 1
nb. options = 2
nest = no
site's quality perception and communication = simultaneous

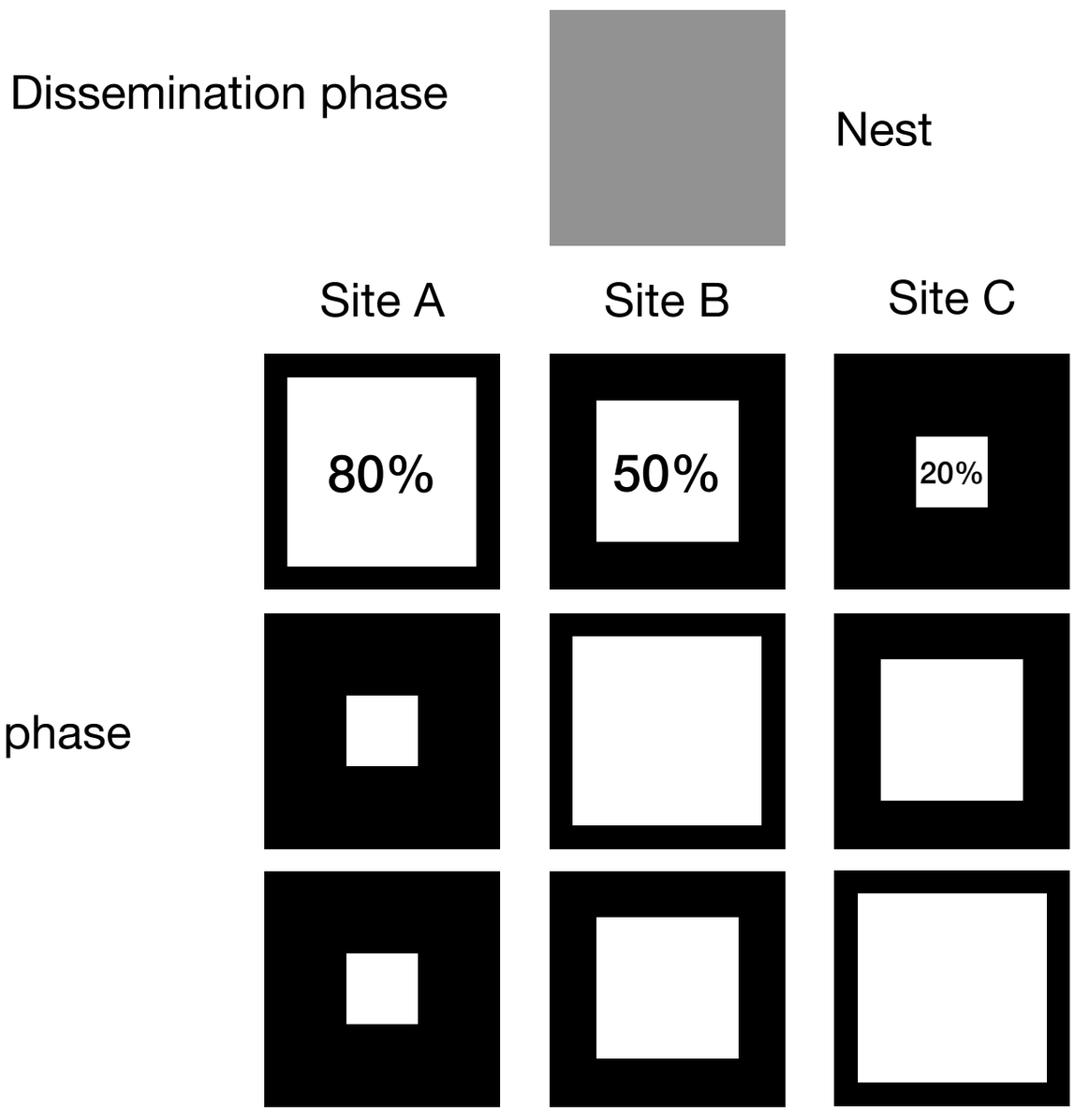
A site selection task



nb. sites = 2
nb. options = 2
nest = yes
site's quality perception and communication = asynchronous

Collective-decision making

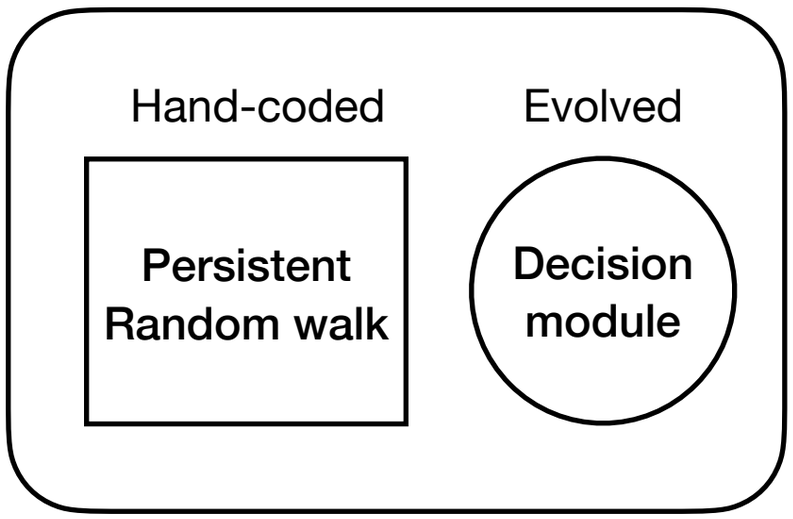
A new site selection task



nb. sites = 3
nb. options = 3
nest = yes
site's quality perception and communication = asynchronous

Collective-decision making

A new site selection task

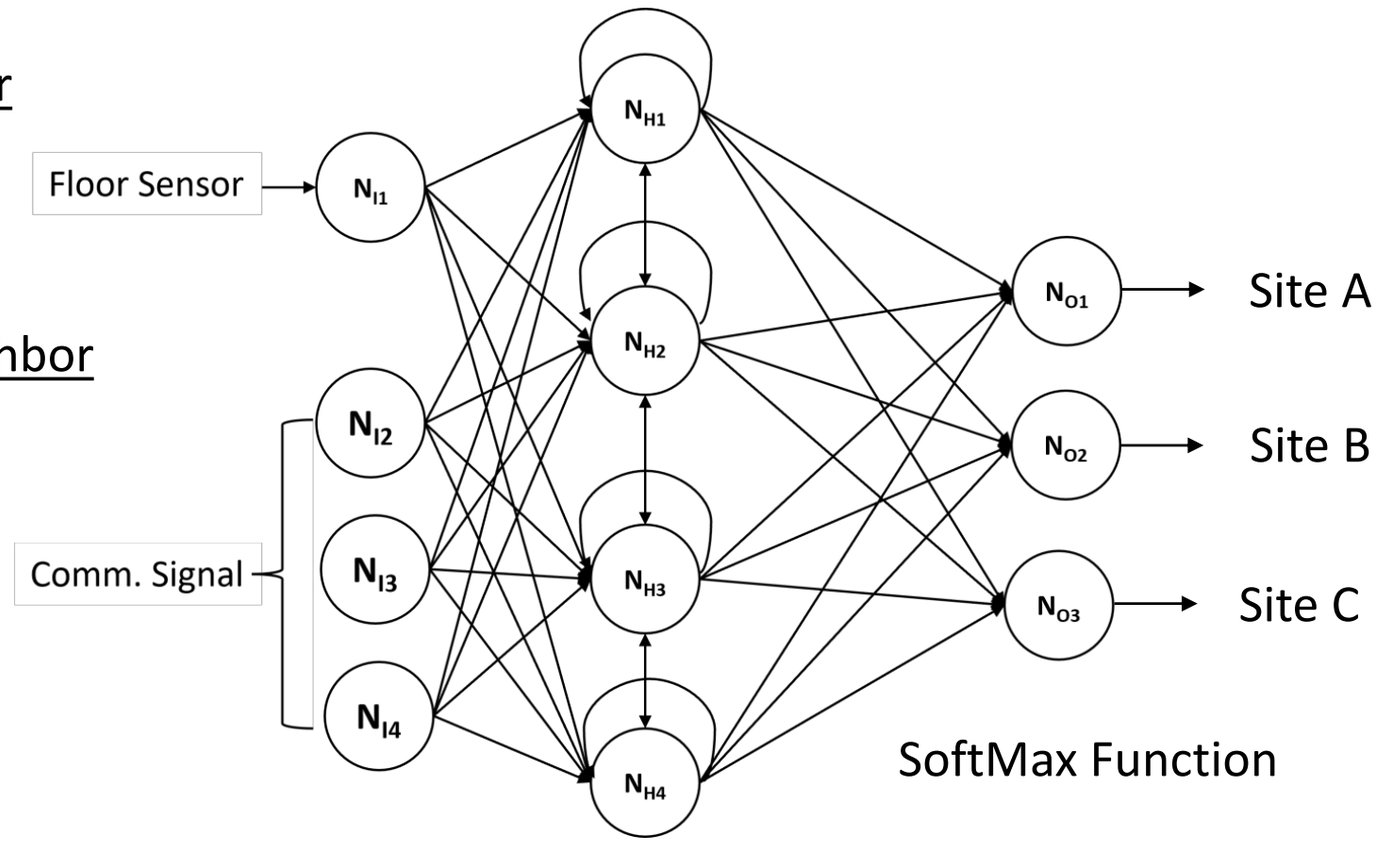


Decision module

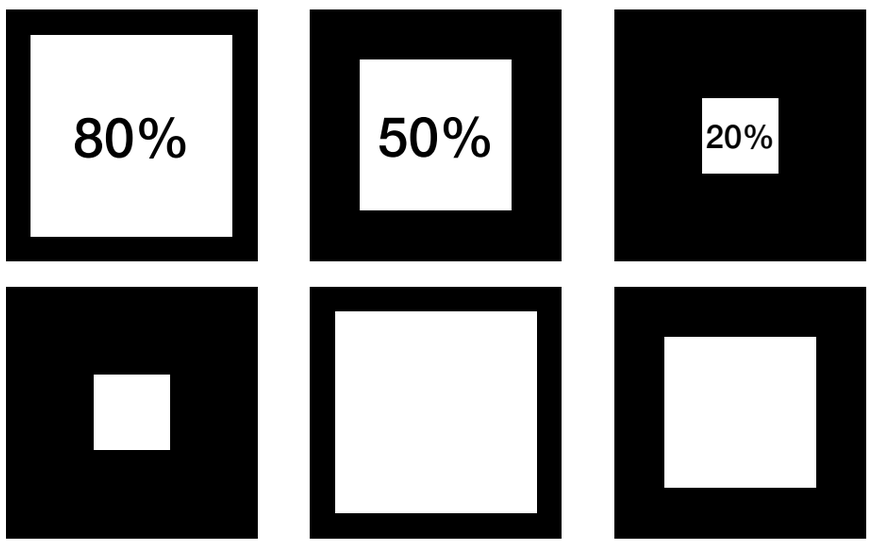
Comm. Signal = output of decision unit of closest robot within 50 cm range

Floor
1
0

Site A	Site B	Site C	No Neighbor
1	0	0	0
0	1	0	0
0	0	1	0



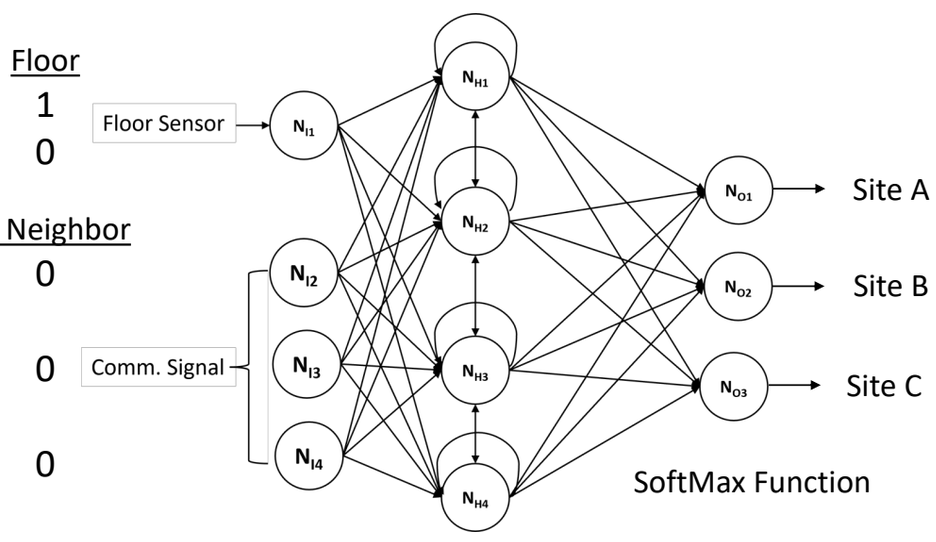
Collective-decision making



Condition 1

Condition 2

Site A	Site B	Site C	No Neighbor
1	0	0	0
0	1	0	0
0	0	1	0



Collective-decision making

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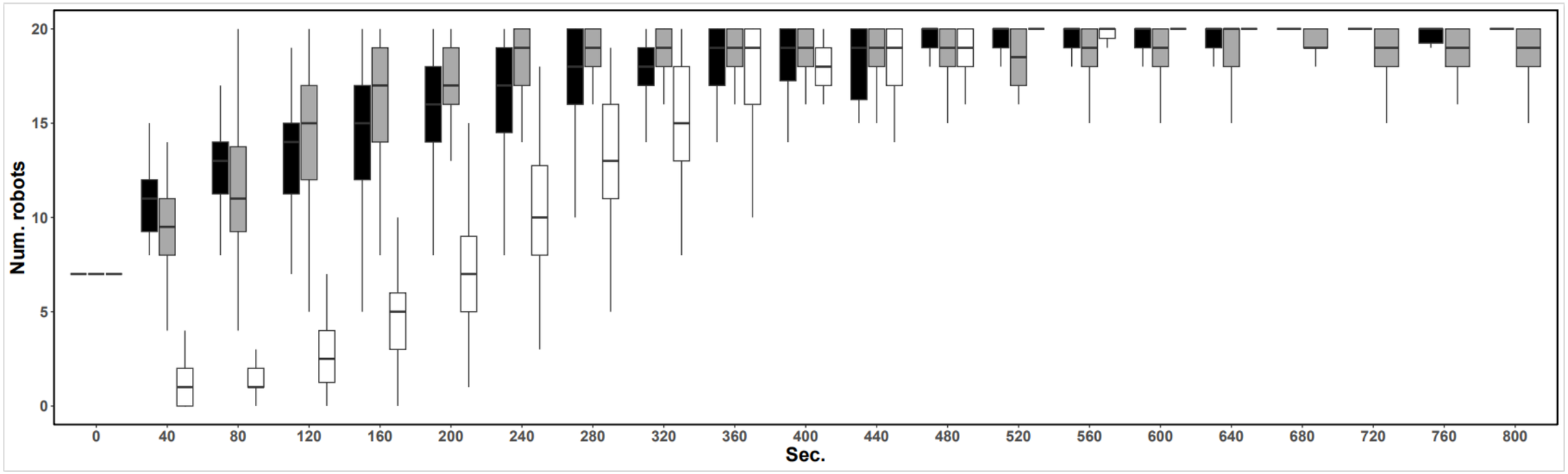

Collective-decision making

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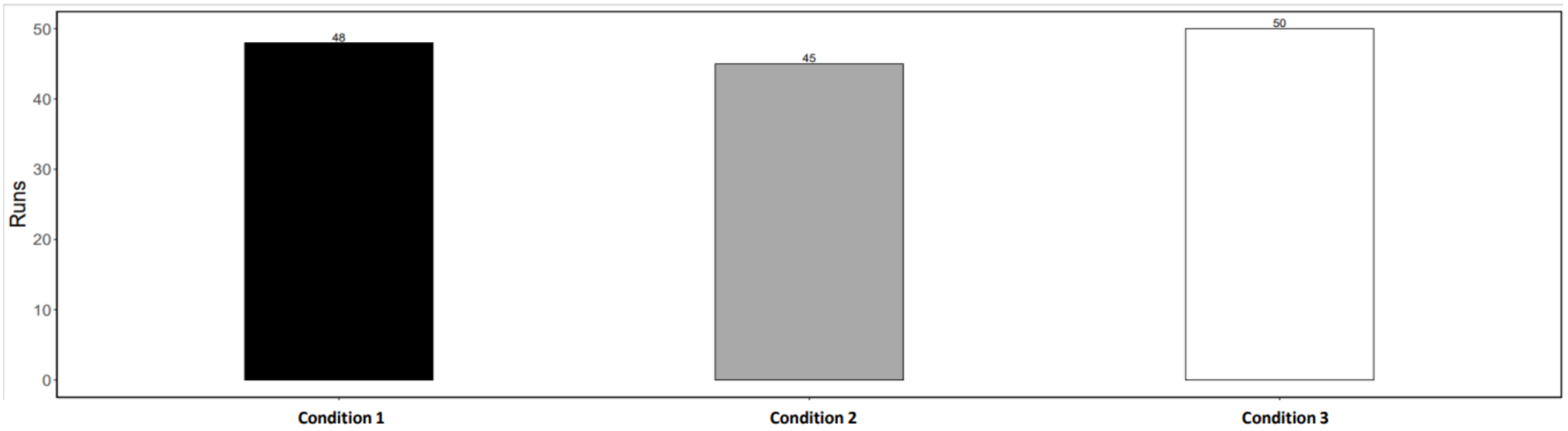

Collective-decision making

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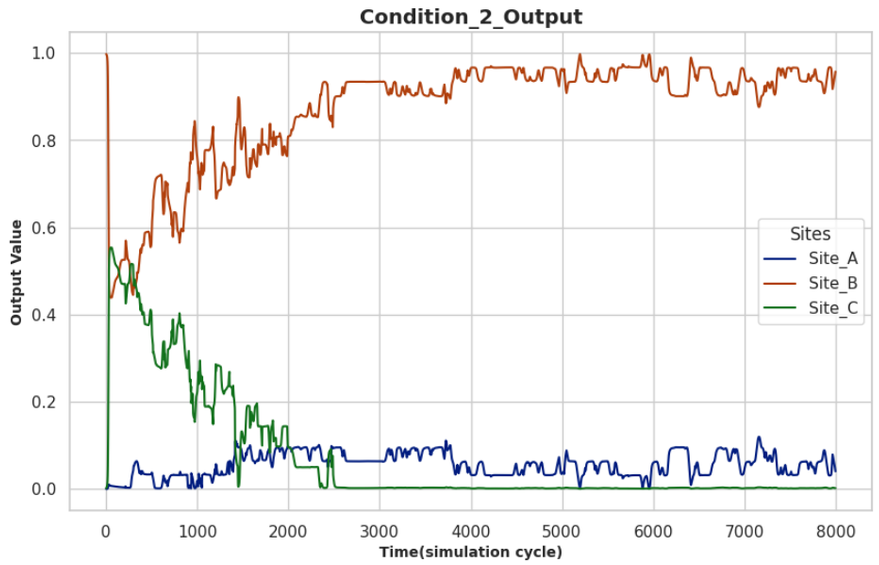

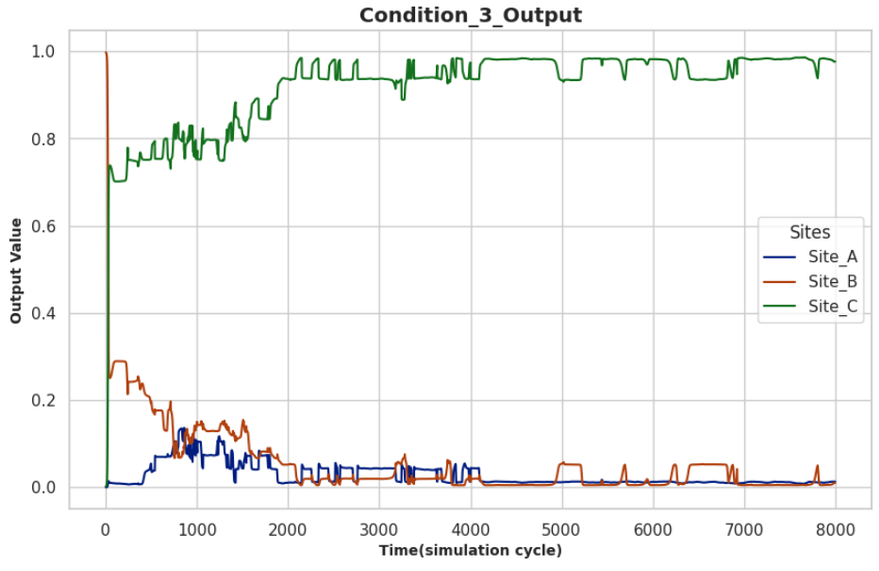

Conclusions

Collective-decision making

- With ER is possible to design decision-making mechanisms
- No need to have explicit feedback modulation mechanisms
- With ER we can overcome limitations of hand-coded solutions
- Whether or not ER designed systems are valuable engineering solutions can be discussed