Swarm Intelligence

Roger Wattenhofer

ETH Zurich – Distributed Computing Group

SIROCCO-POCO

STACSY

Zurich – Madrid

SIRO CCO

SIROCCO 2023

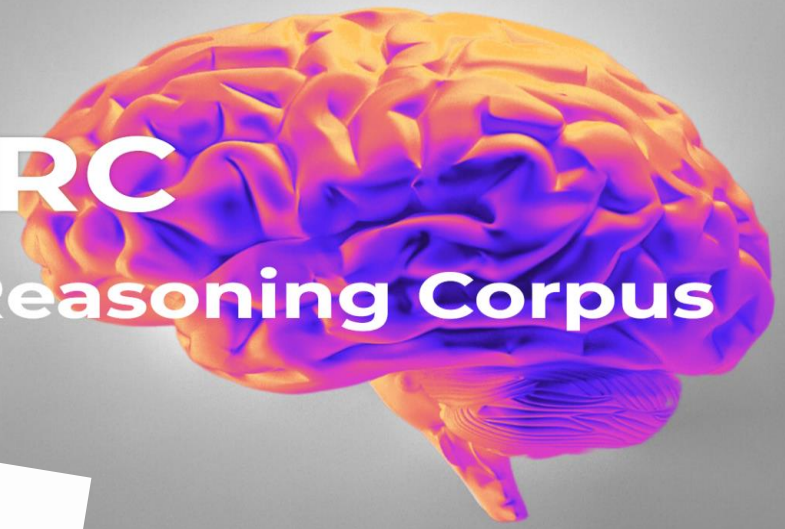
Simple ~~Special~~ Models of Computation

To complement the 30th Anniversary of SIROCCO, there will be a tutorial session on Special Models of Computation on June 6th. In this session, SIROCCO researchers will share the histories and open problems for distributed computing models that bridge computer science theory to other interdisciplinary aims.

LAB 42

ARC

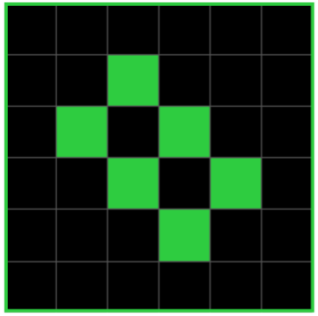
Abstraction & Reasoning Corpus



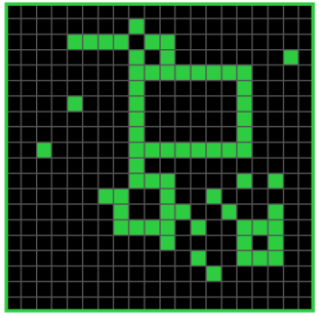
On the Measure of Intelligence

François Chollet *
Google

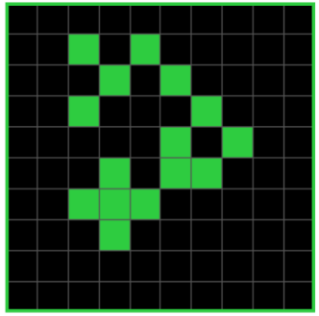
Example 1: Input



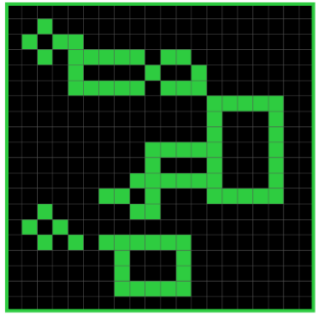
Example 2: Input



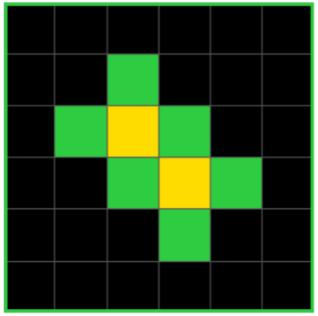
Example 3: Input



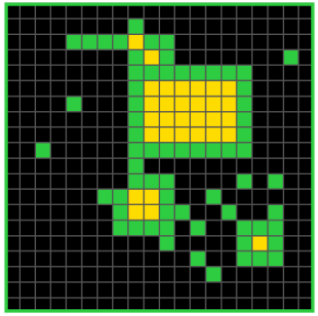
Test: Input



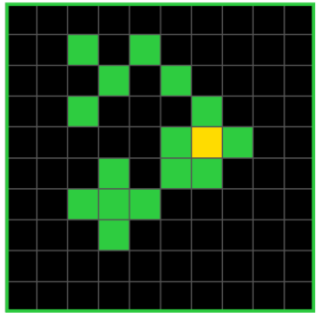
Example 1: Output



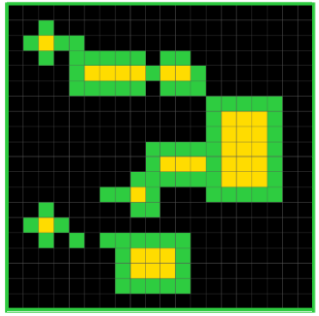
Example 2: Output



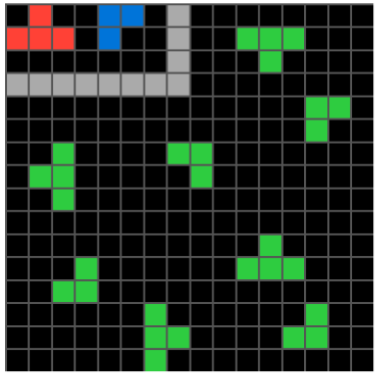
Example 3: Output



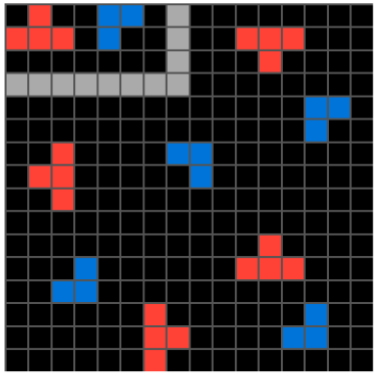
Test: Output



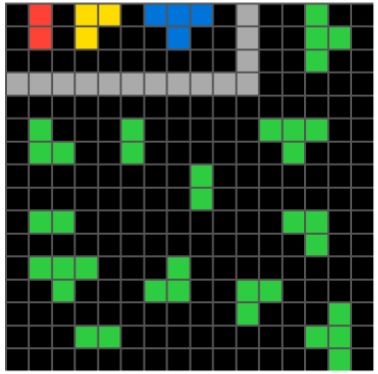
Input 1



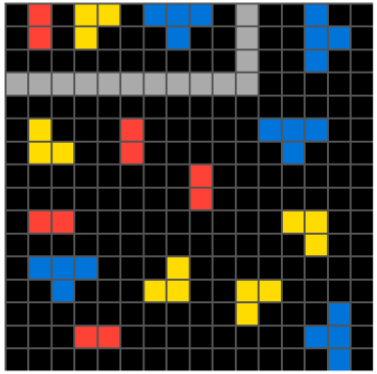
Output 1



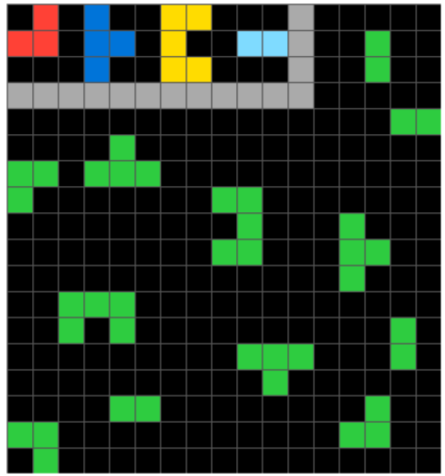
Input 2



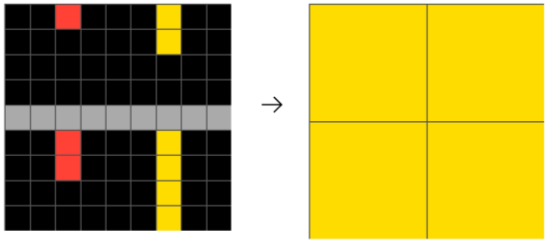
Output 2



Input

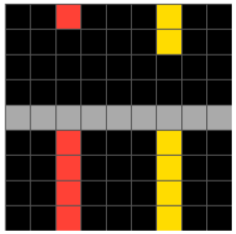


Input 1

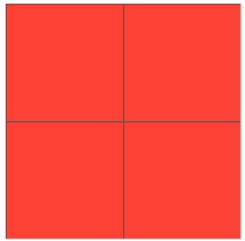


Output 1

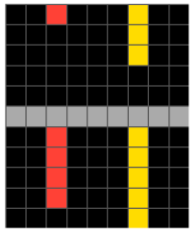
Input 2



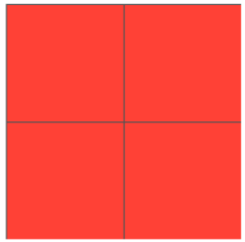
Output 2



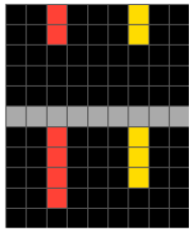
Input 3



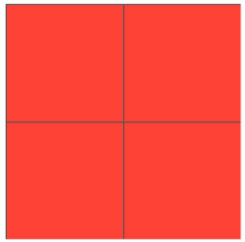
Output 3



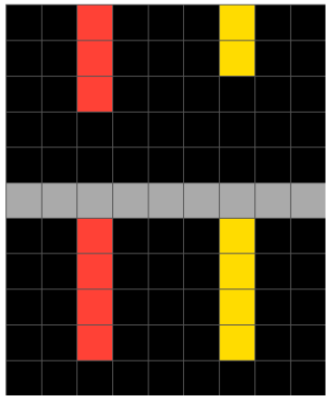
Input 4



Output 4

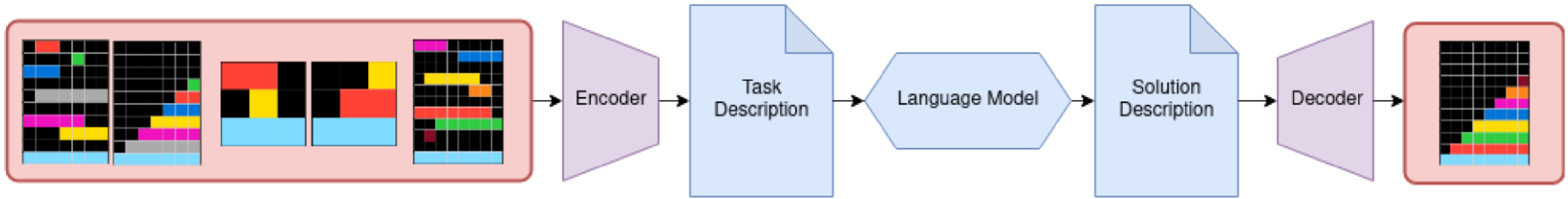


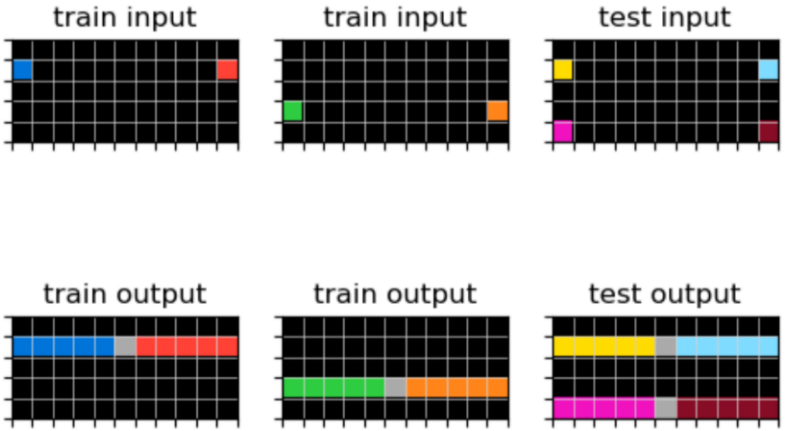
Input

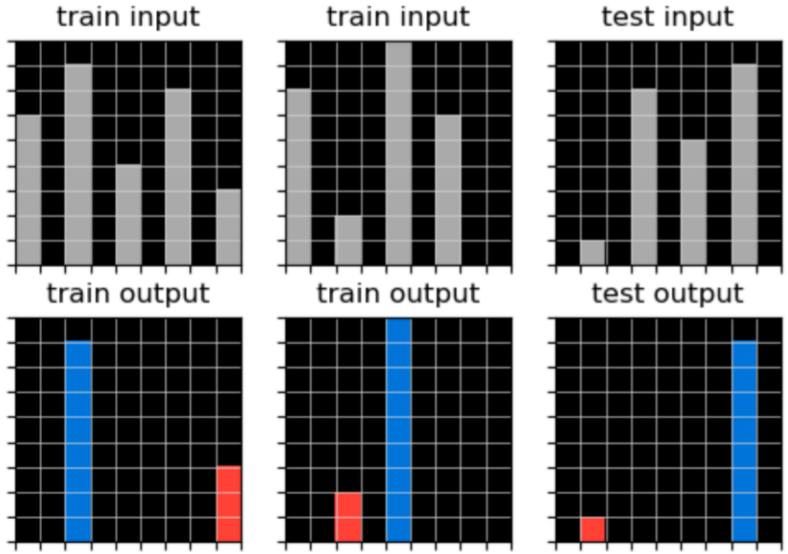


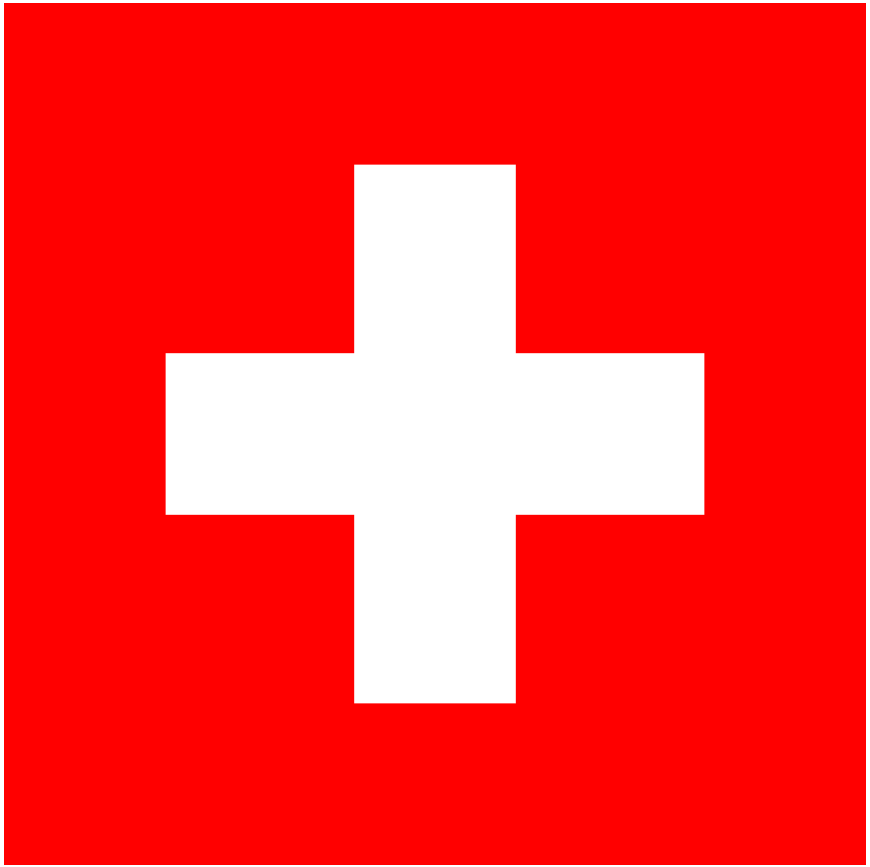
Abstract Visual Reasoning Enabled by Language

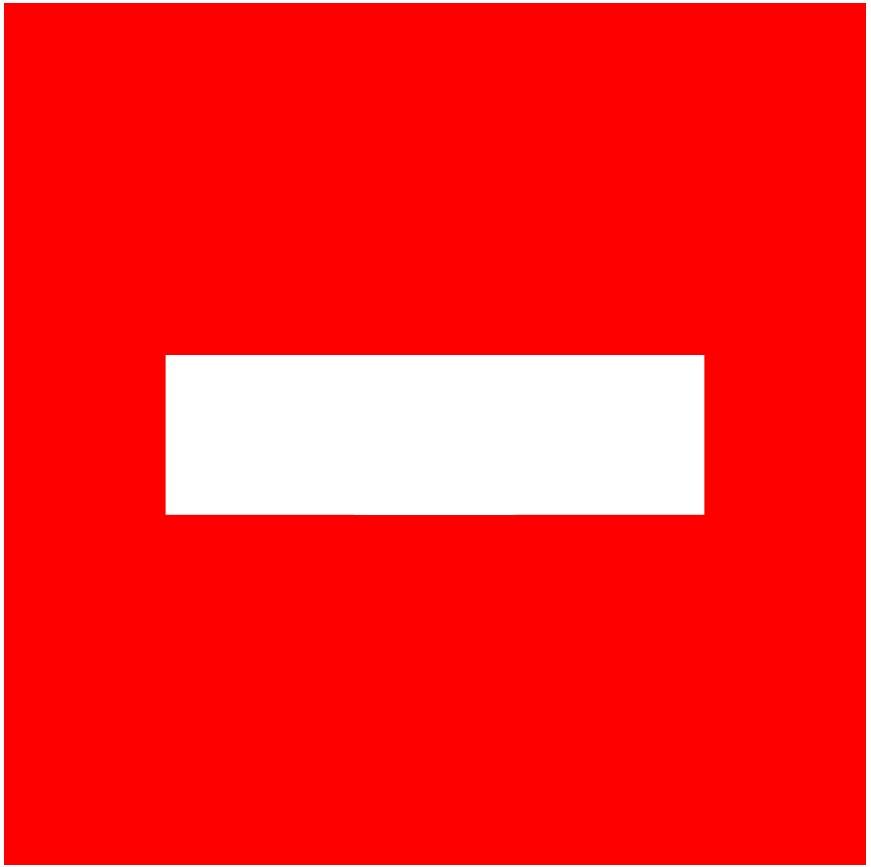
Giacomo Camposampiero* Loïc Houmard* Benjamin Estermann Joël Mathys
Roger Wattenhofer
ETH Zürich, Switzerland
{gcamposampie, lhoumard, estermann, jmathys, wattenhofer}@ethz.ch

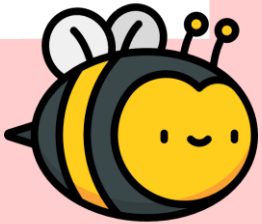



train input
train input
test input
train output
train output
test output


train input
train input
test input
train output
train output
test output

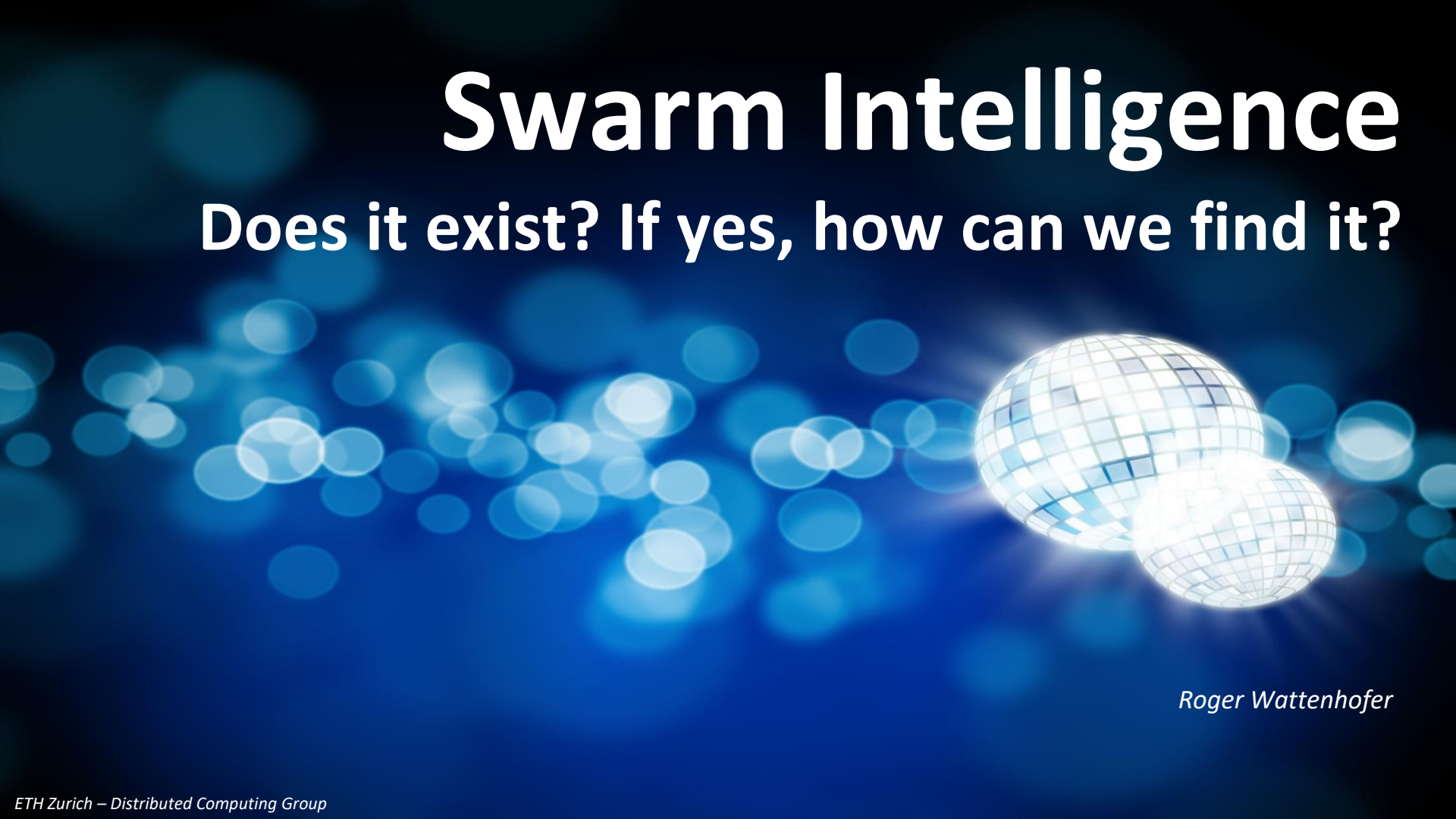






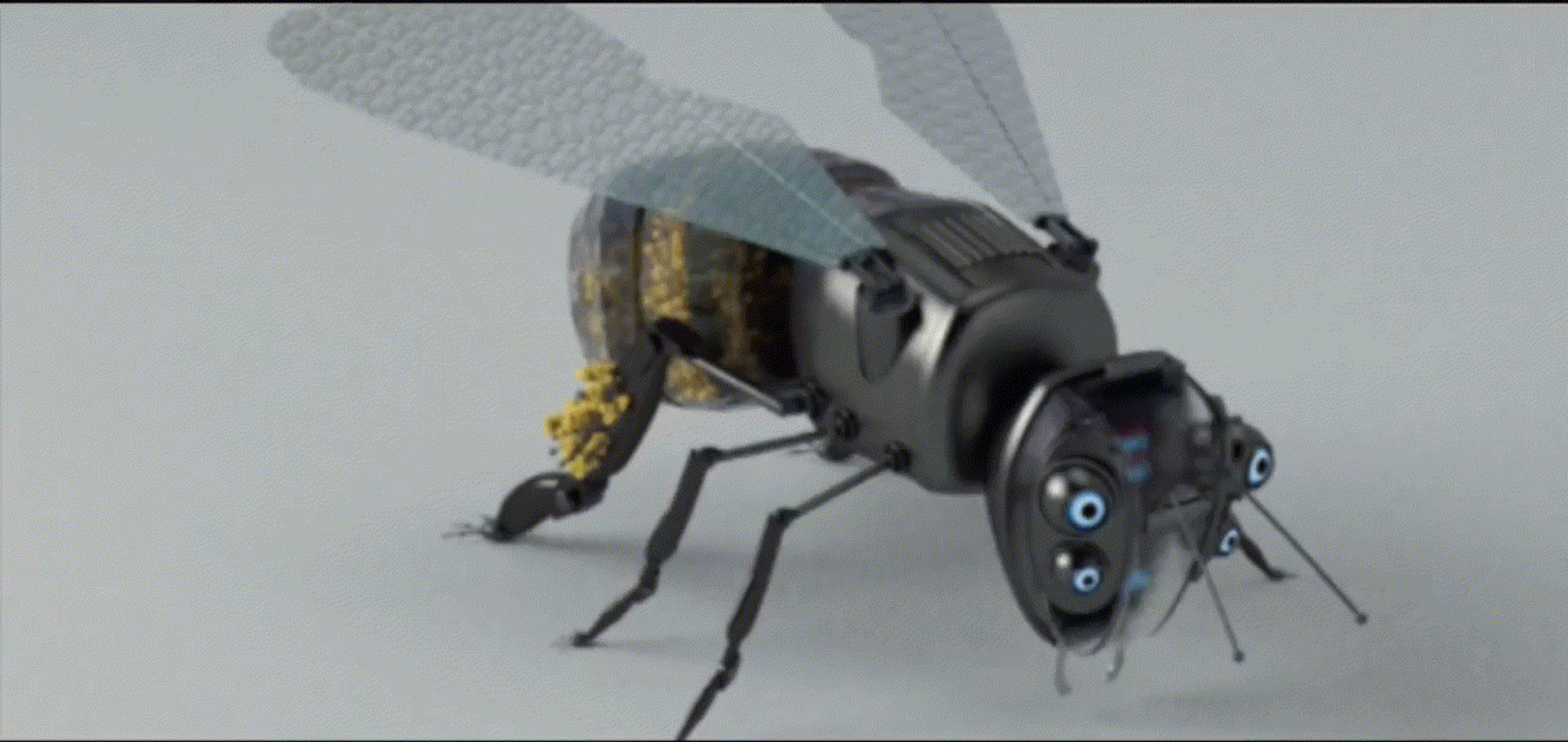
Swarm Intelligence

Does it exist? If yes, how can we find it?



Roger Wattenhofer

ETH Zurich – Distributed Computing Group



Black Mirror

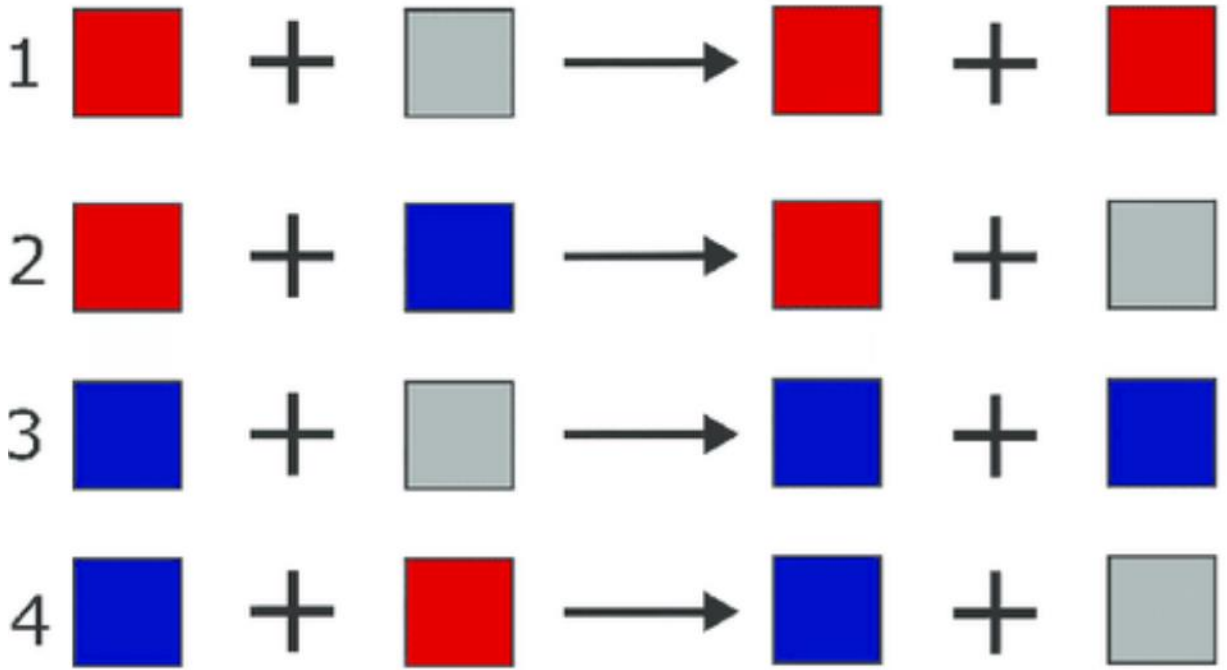
Swarm Intelligence Cup

AI through emergence

Related Work

Dana Angluin · James Aspnes · Zoë Diamadi ·
Michael J. Fischer · René Peralta

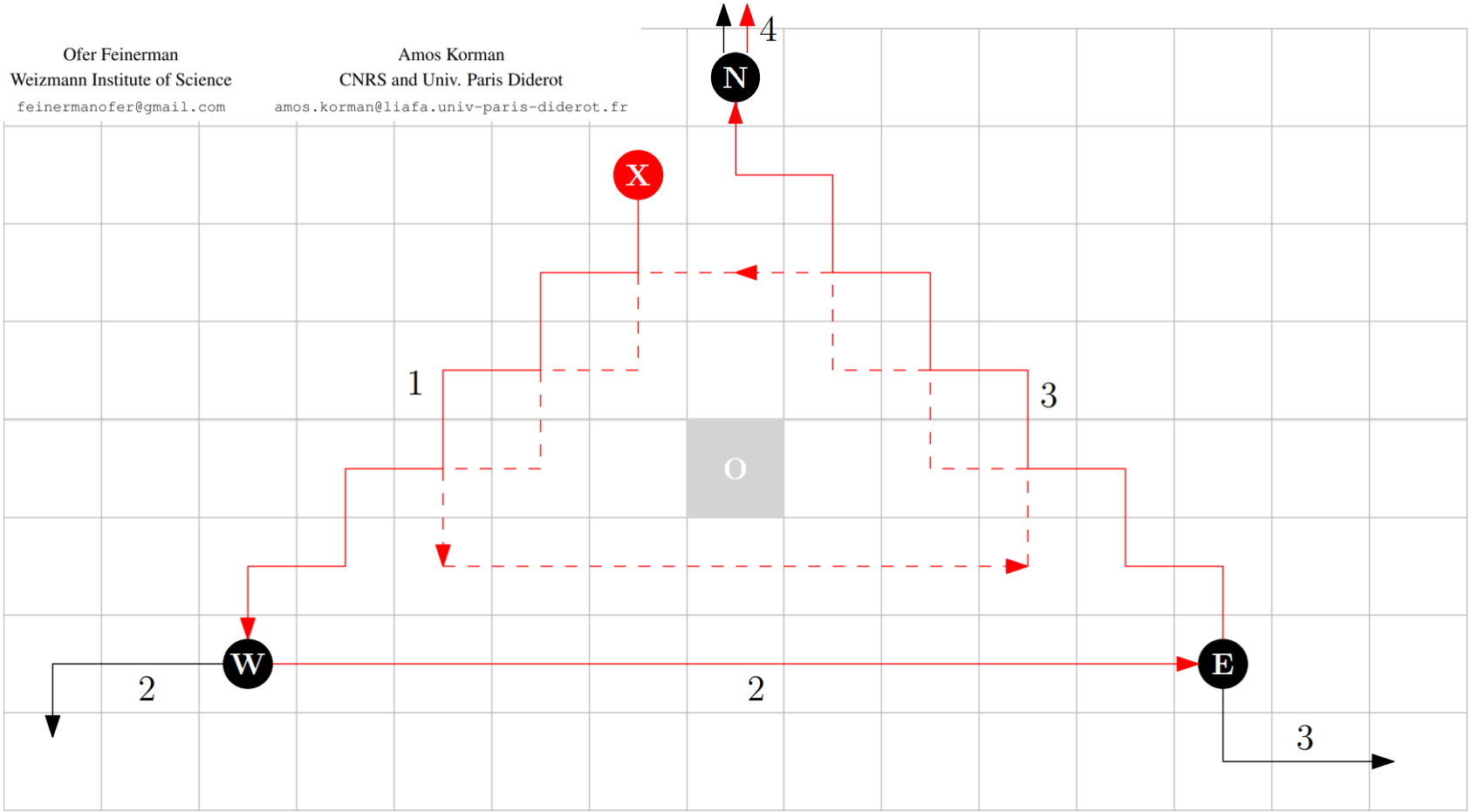
Computation in networks of passively mobile finite-state sensors



The ANTS Problem*

Ofer Feinerman
Weizmann Institute of Science
feinermanofer@gmail.com

Amos Korman
CNRS and Univ. Paris Diderot
amos.korman@liafa.univ-paris-diderot.fr

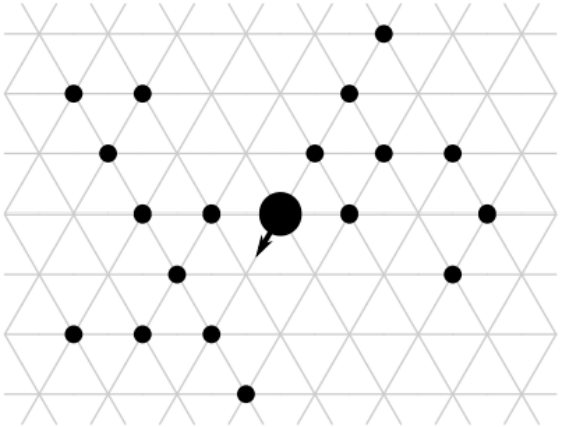


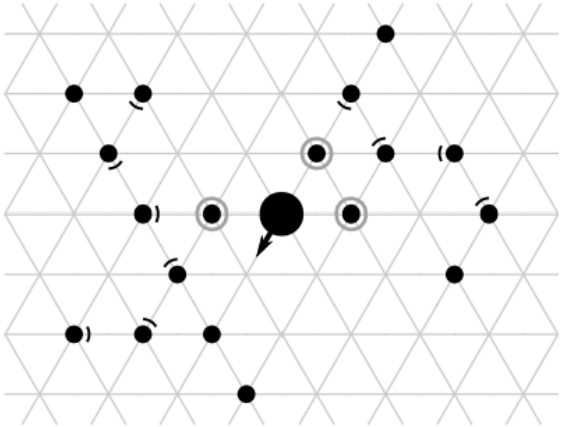
The Canonical Amoebot Model: Algorithms and Concurrency Control

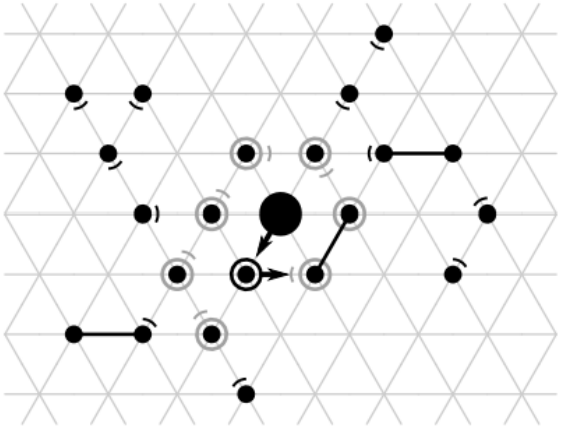
Joshua J. Daymude
School of Computing and Augmented Intelligence
Biodesign Center for Biocomputing, Security and Society
Arizona State University, Tempe, AZ, USA

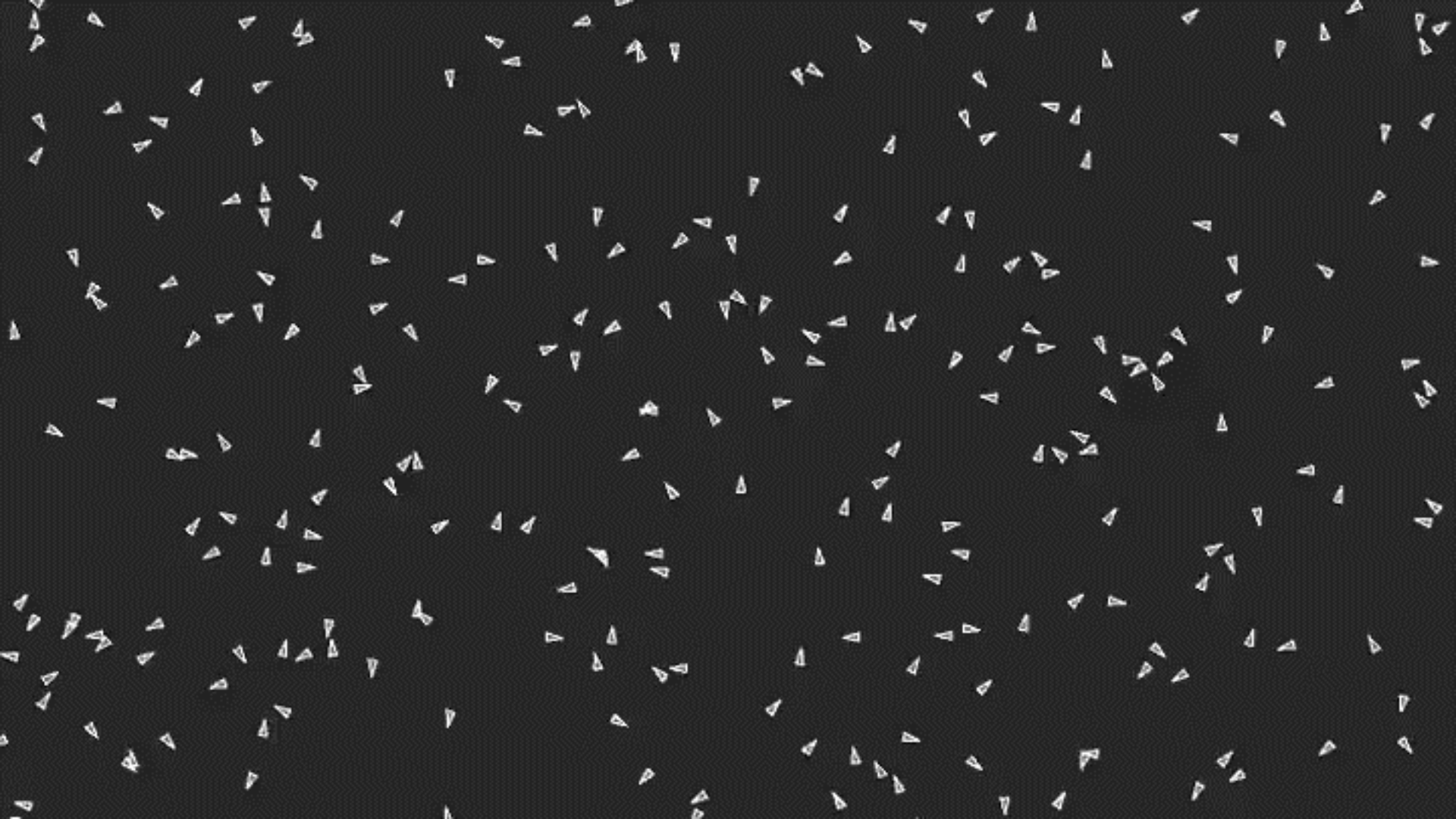
Andréa W. Richa
School of Computing and Augmented Intelligence, Arizona State University, Tempe, AZ, USA

Christian Scheideler
Department of Computer Science, Paderborn University, Paderborn, Germany

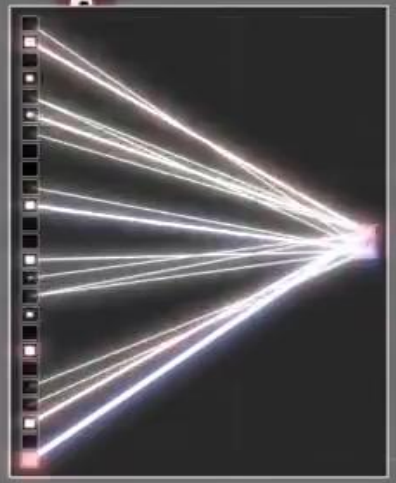








Iain Couzin



Energy

Speed

Split

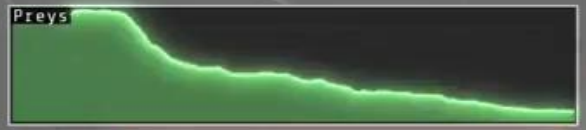
Time survived: 8.65s

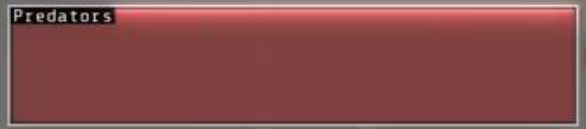
Generation : 60

Children: 1

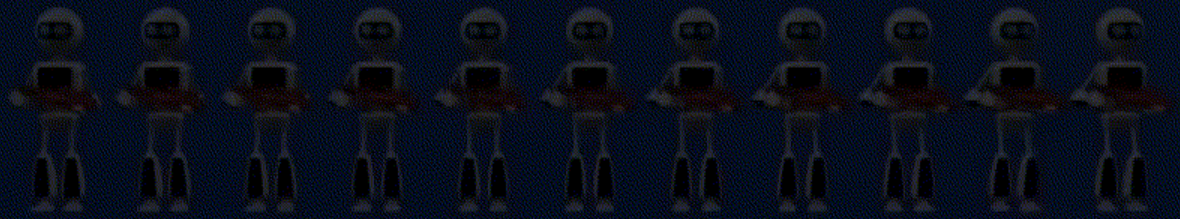
12:14

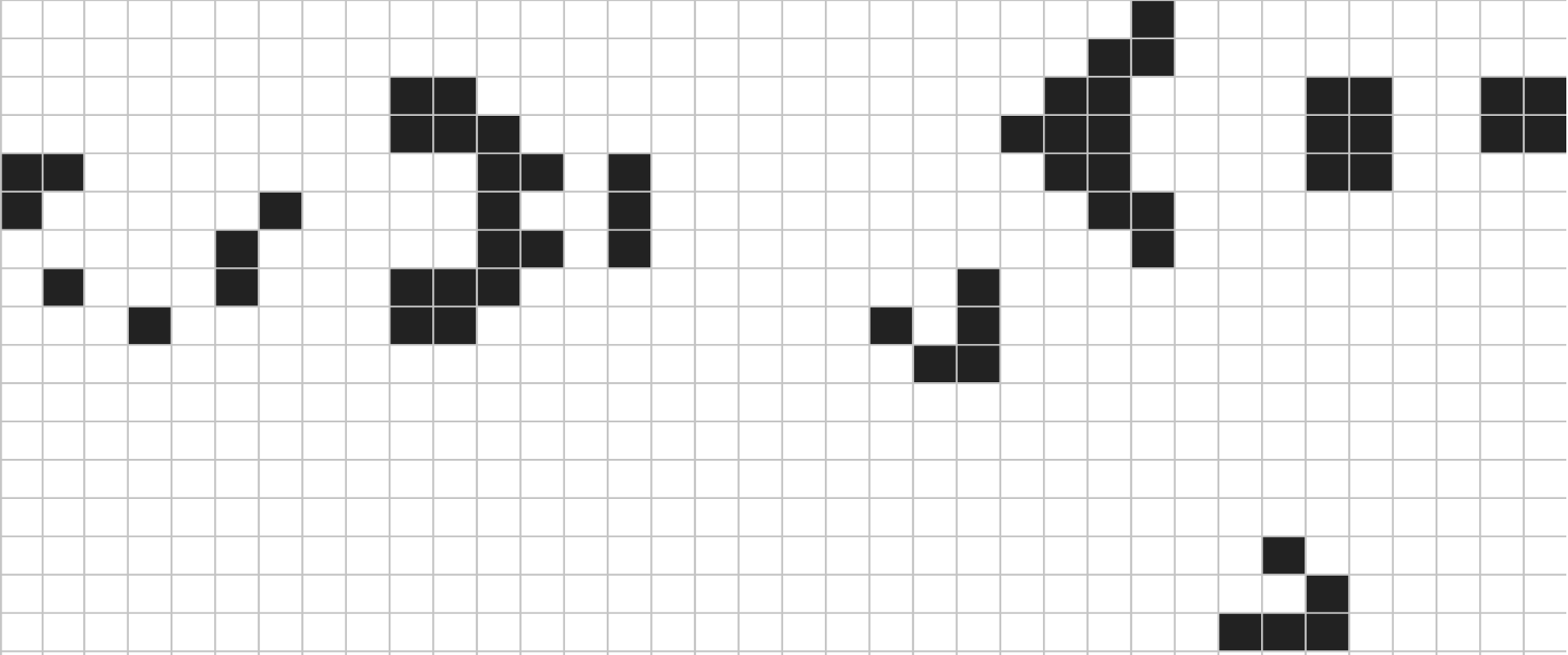
Ticks: 44065



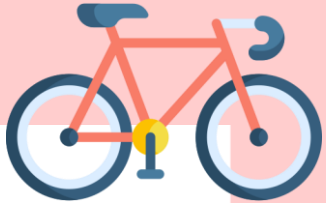


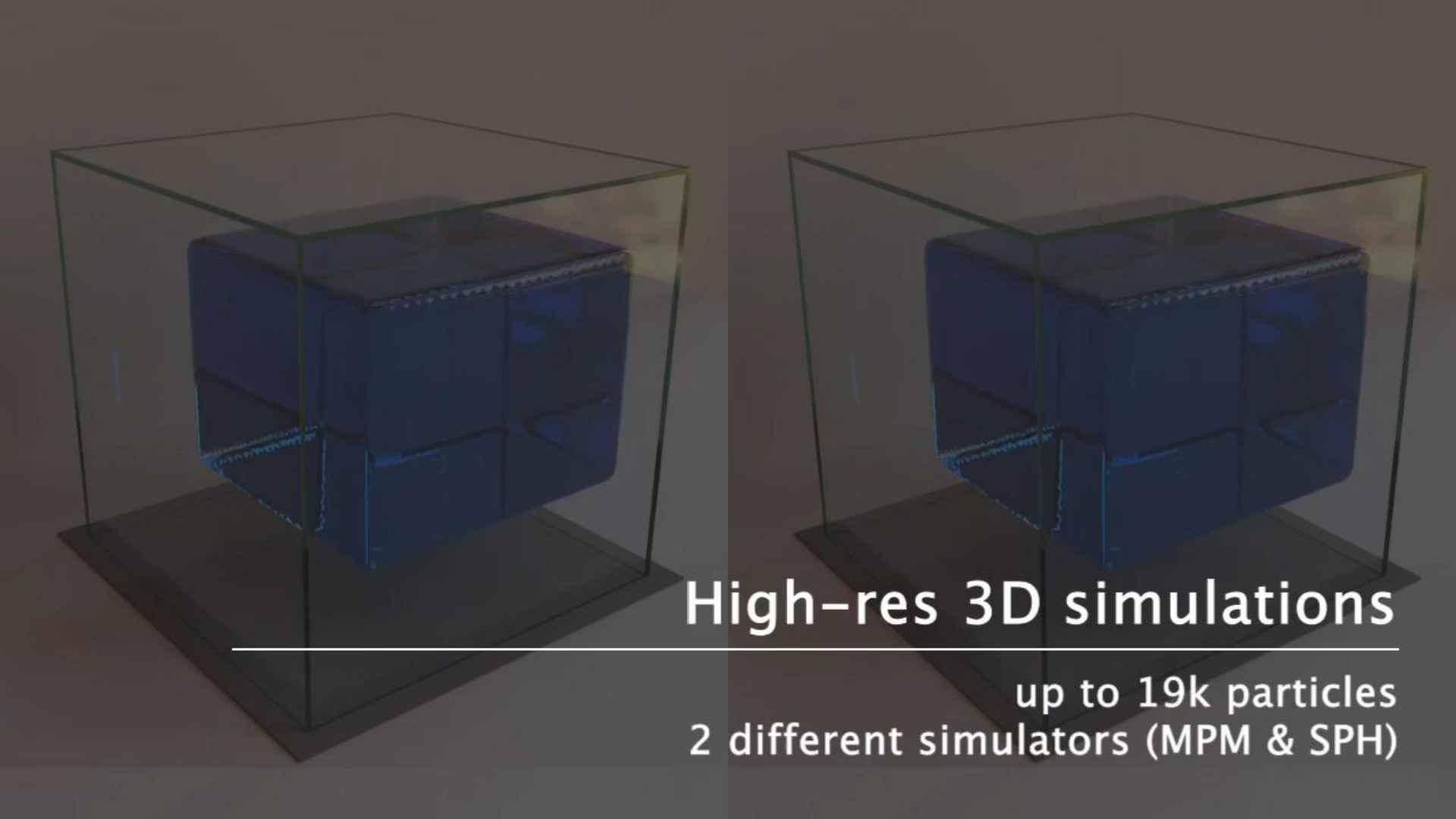
Confetti Squad

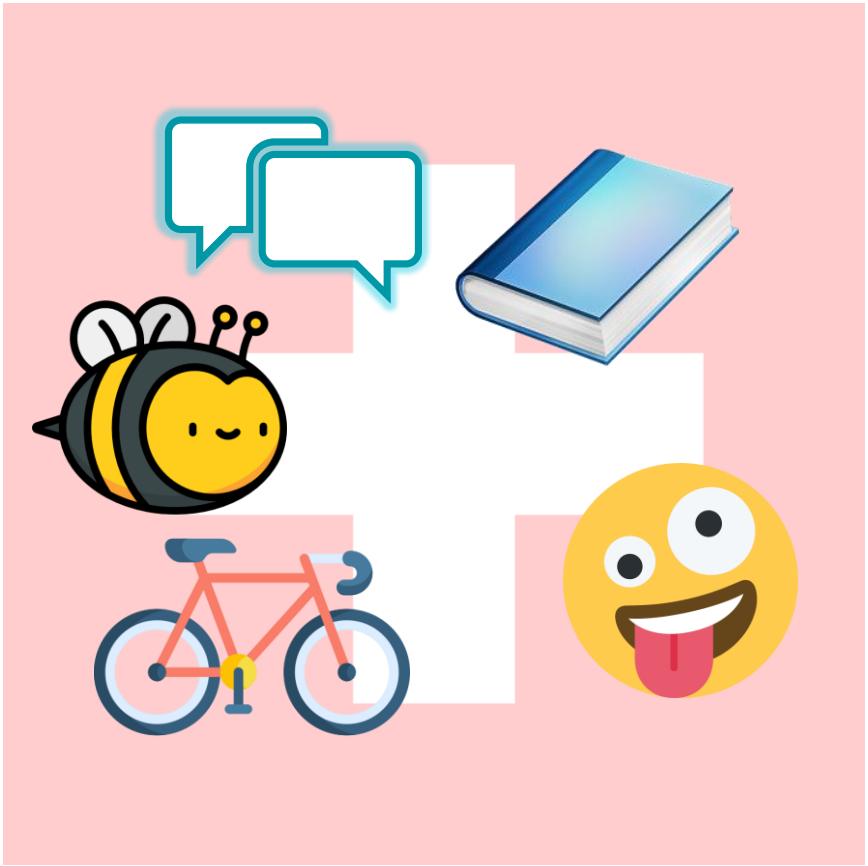




Convay’s Game of Life

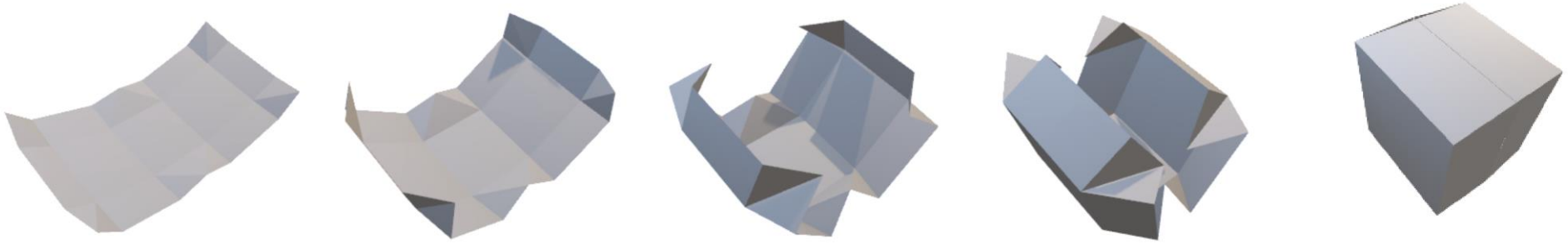


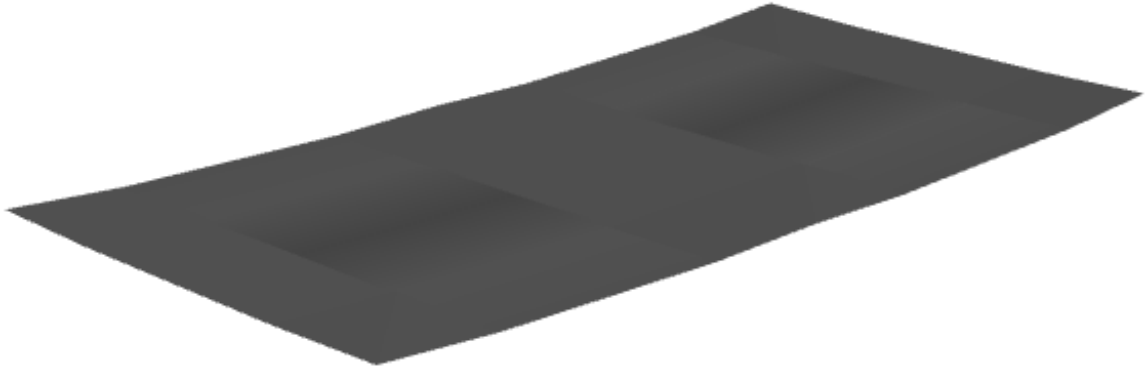

High-res 3D simulations
up to 19k particles
2 different simulators (MPM & SPH)

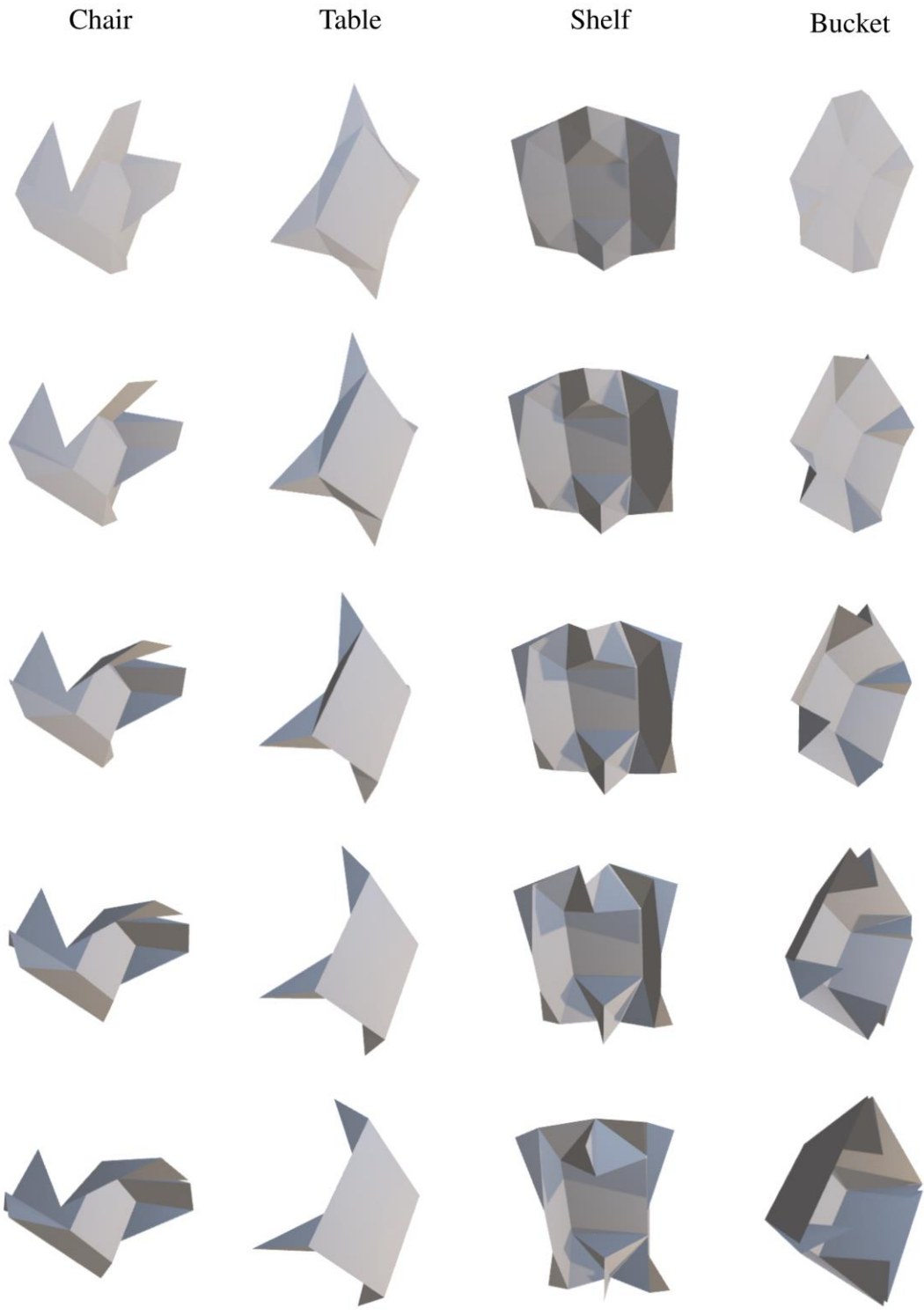


Automating Rigid Origami Design

Jeremia Geiger, Karolis Martinkus, Oliver Richter, Roger Wattenhofer

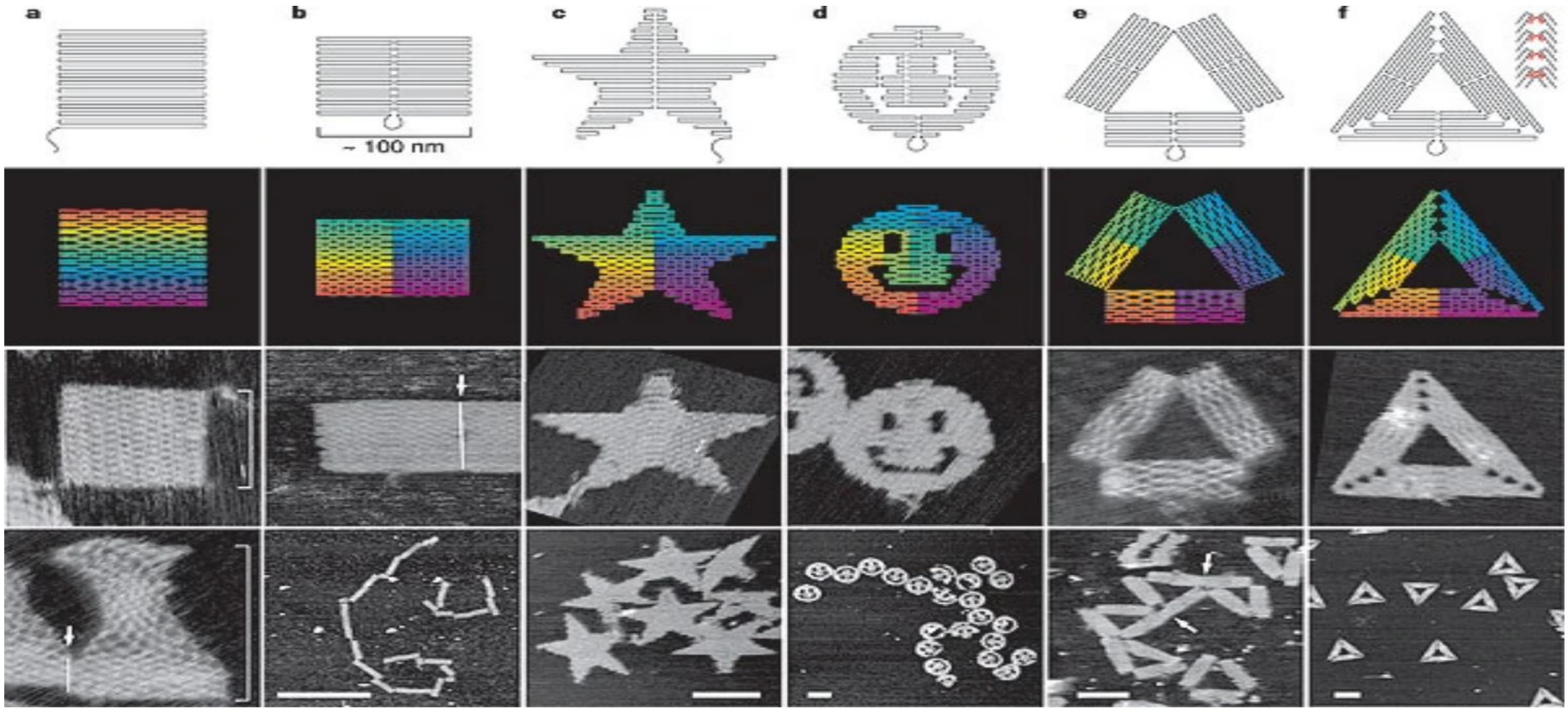


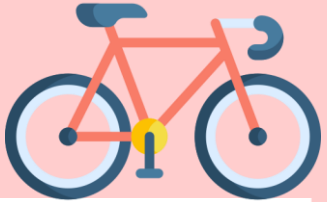



Chair
Table
Shelf
Bucket

Folding DNA to create nanoscale shapes and patterns

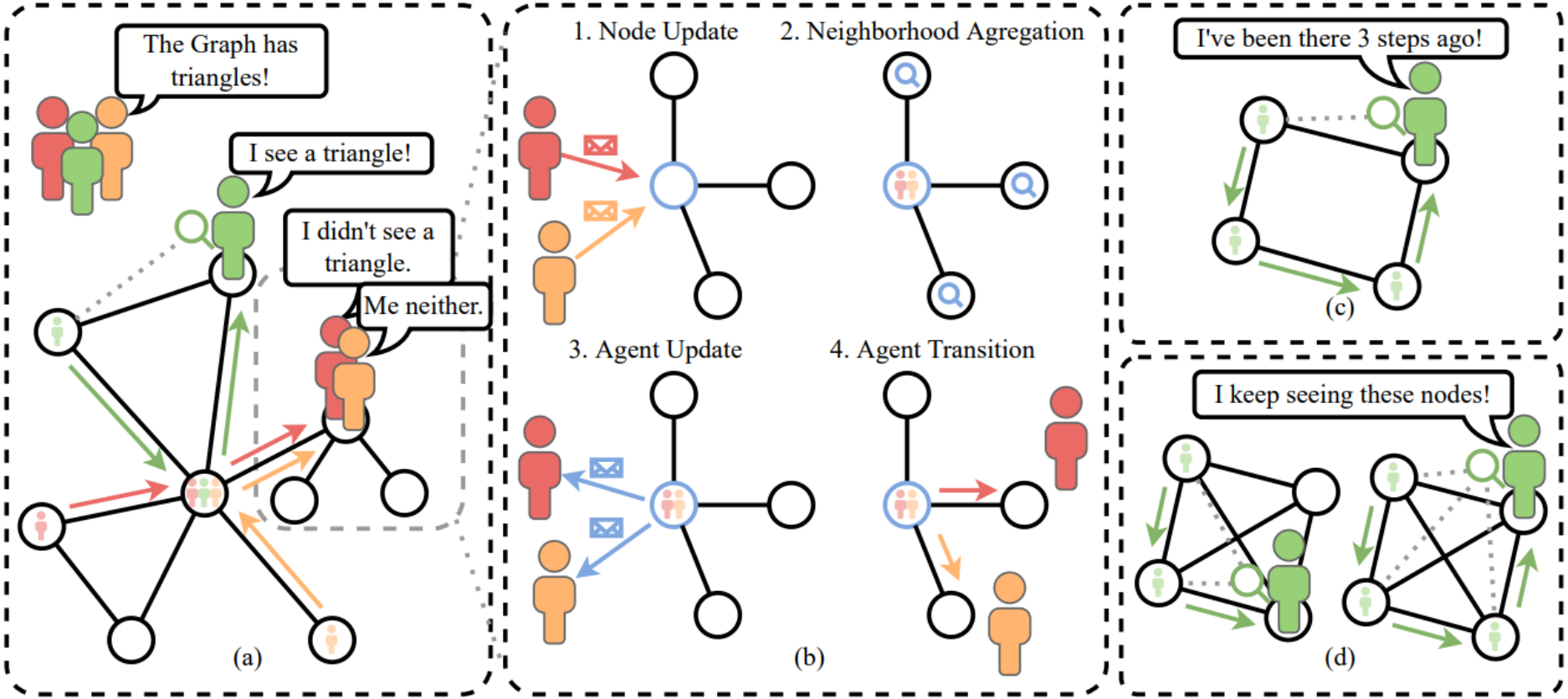
Paul W. K. Rothemund





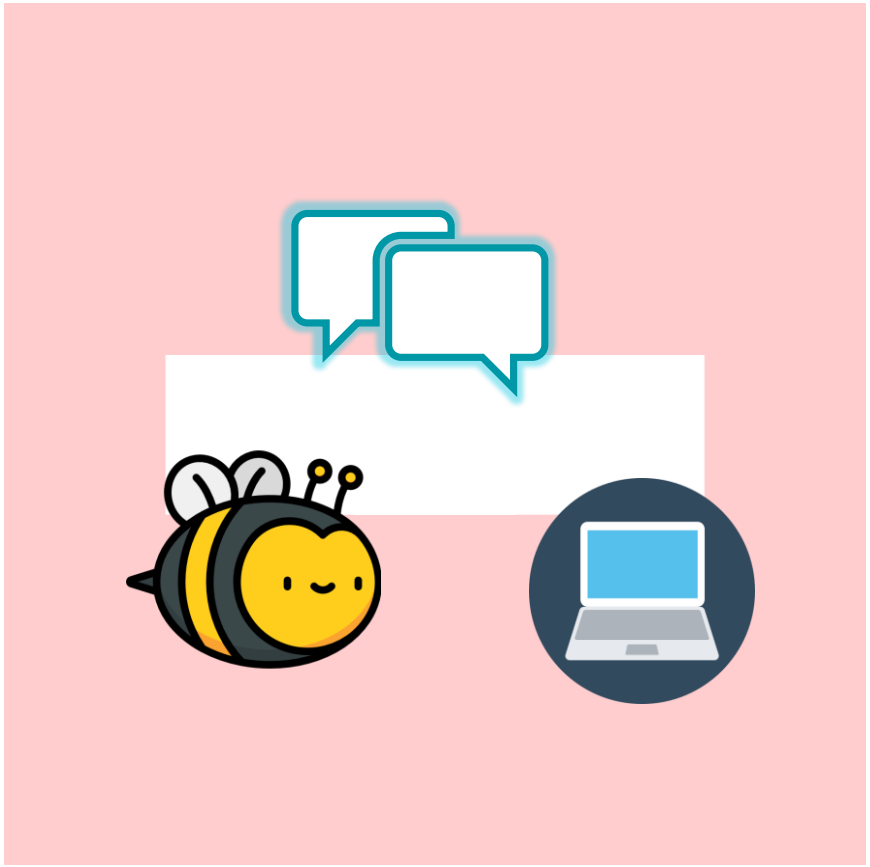
AGENT-BASED GRAPH NEURAL NETWORKS

Karolis Martinkus[1], **Pál András Papp**[2], **Benedikt Schesch**[1], **Roger Wattenhofer**[1]



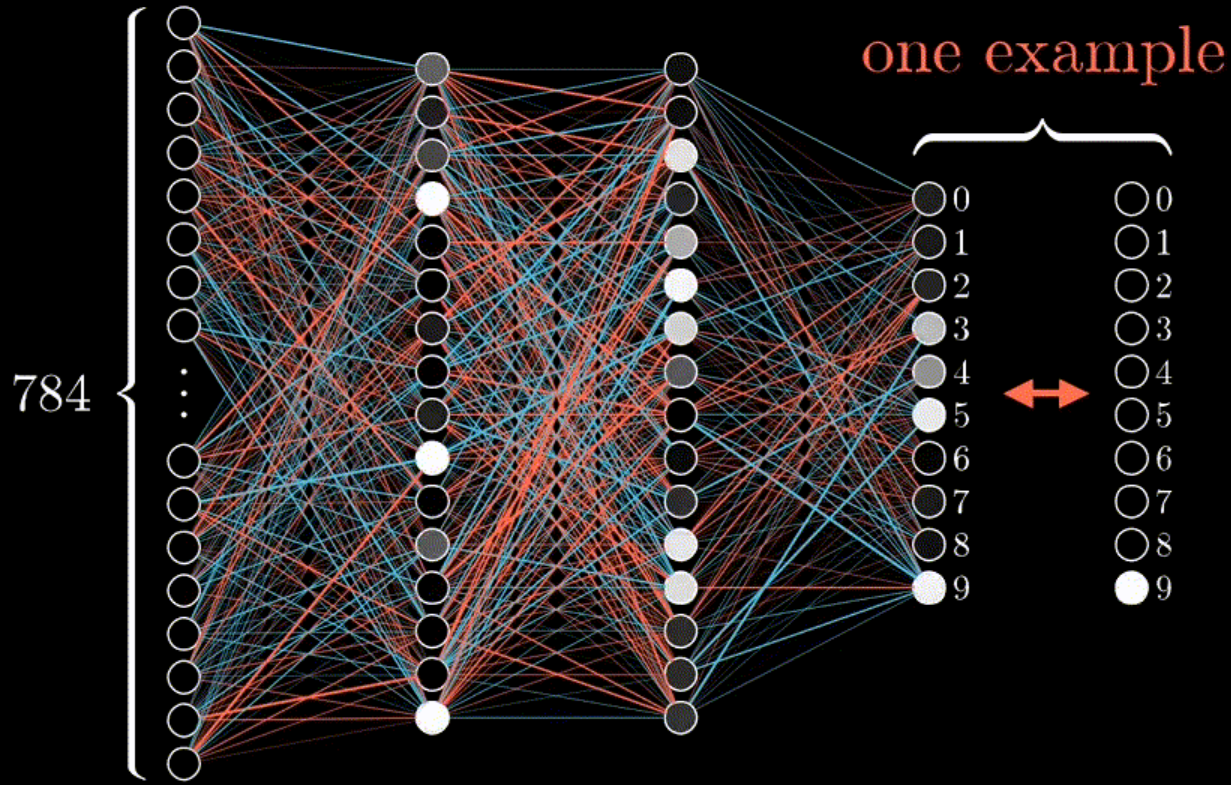
Model	4-CYCLES [59]	CIRCULAR SKIP LINKS [15]	2-WL
GIN [75]	50.0 ±0.0	10.0 ±0.0	50.0 ±0.0
GIN with random features [64; 1]	99.7 ±0.4	95.8 ±2.1	92.4 ±1.6
SMP [71]	**100.0 ±0.0**	**100.0 ±0.0**	50.0 ±0.0
DROPGIN [59]	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0**
ESAN [8]	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0***
1-2-3 GNN [53]	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0†**
PPGN [51]	**100.0 ±0.0**	**100.0 ±0.0**	50.0 ±0.0
CRAWL [67]	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0**
RANDOM WALK AGENTNET	**100.0 ±0.0**	**100.0 ±0.0**	50.5 ±4.5
SIMPLIFIED AGENTNET	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0**
AGENTNET	**100.0 ±0.0**	**100.0 ±0.0**	**100.0 ±0.0**

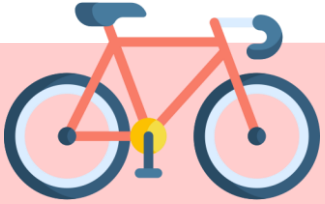
Hide & Seek



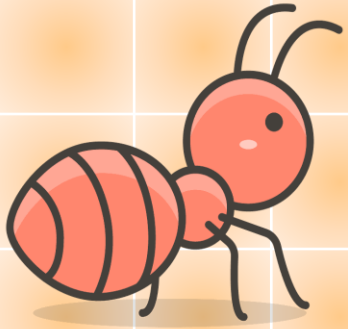
Each step uses every example

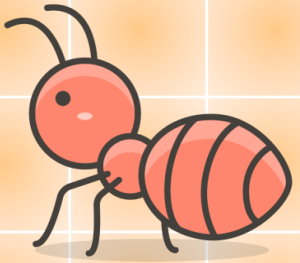
Average over all training examples



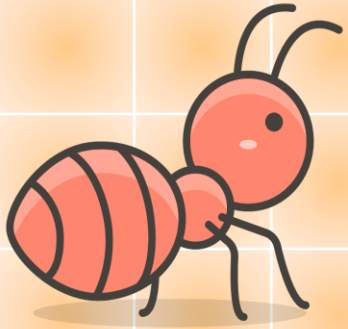


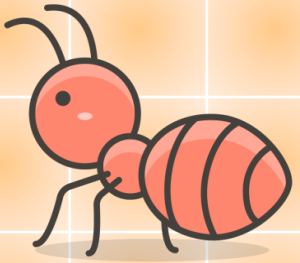
	1	1	0	0	1	1	0
+	1	0	1	0	0	1	1
1	0	1	1	1	0	0	1

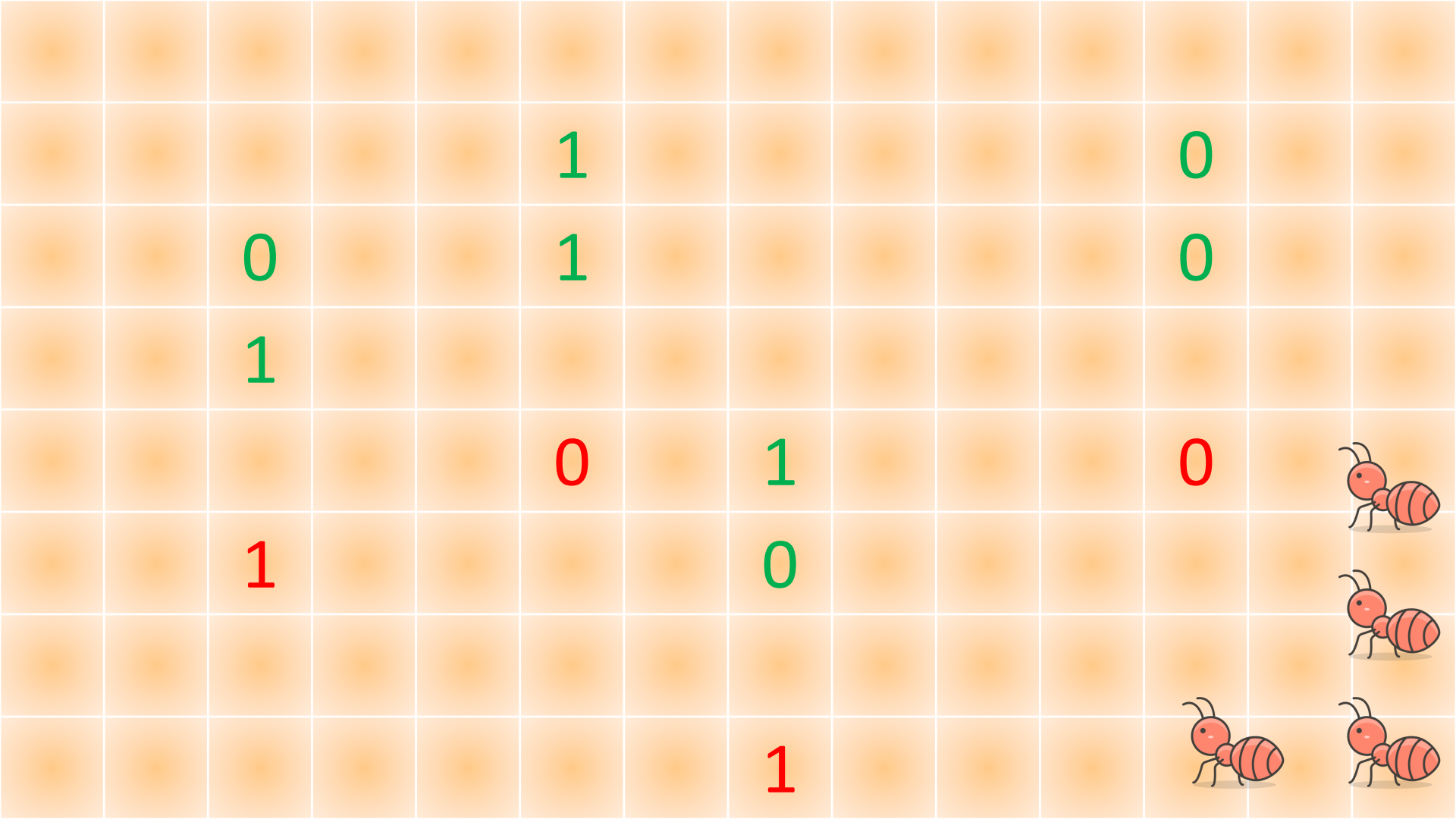


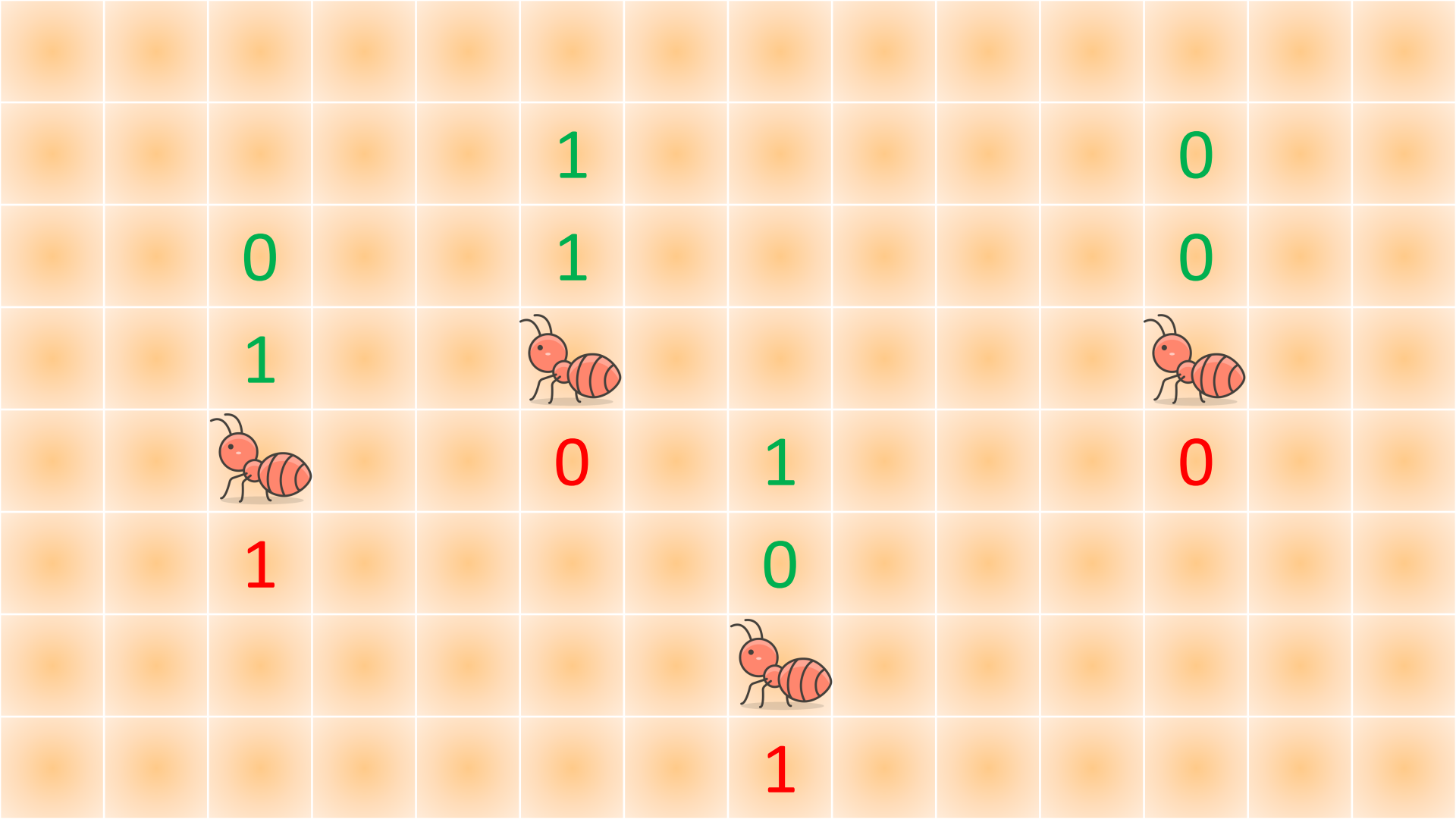


			1	1	0	0	1	1	0
		+	1	0	1	0	0	1	1
		1	0	1	1	1	0	0	1





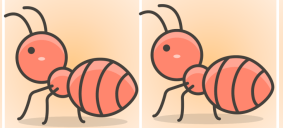

1
0
0
1
1
0
0
1
1
0
1

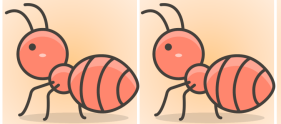

1
0
0
1
1
0
1
0
1
0
1
0
1

1 0

0 0

0 1



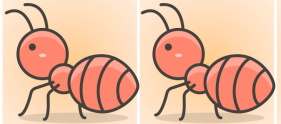


1 0

0 1

0 0

0 1



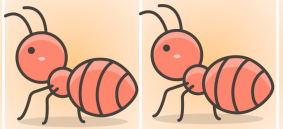
0 1

? ?

1 0 0

1 0

0 0

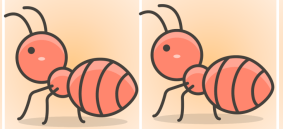


1 0

1 0

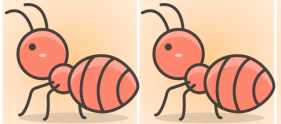
0 0

0 0



0 1

1 1



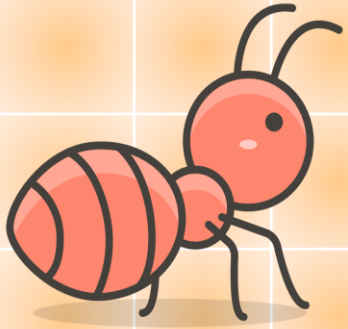
0 1

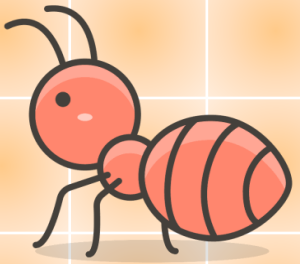
1 0

1 1

1 0 0

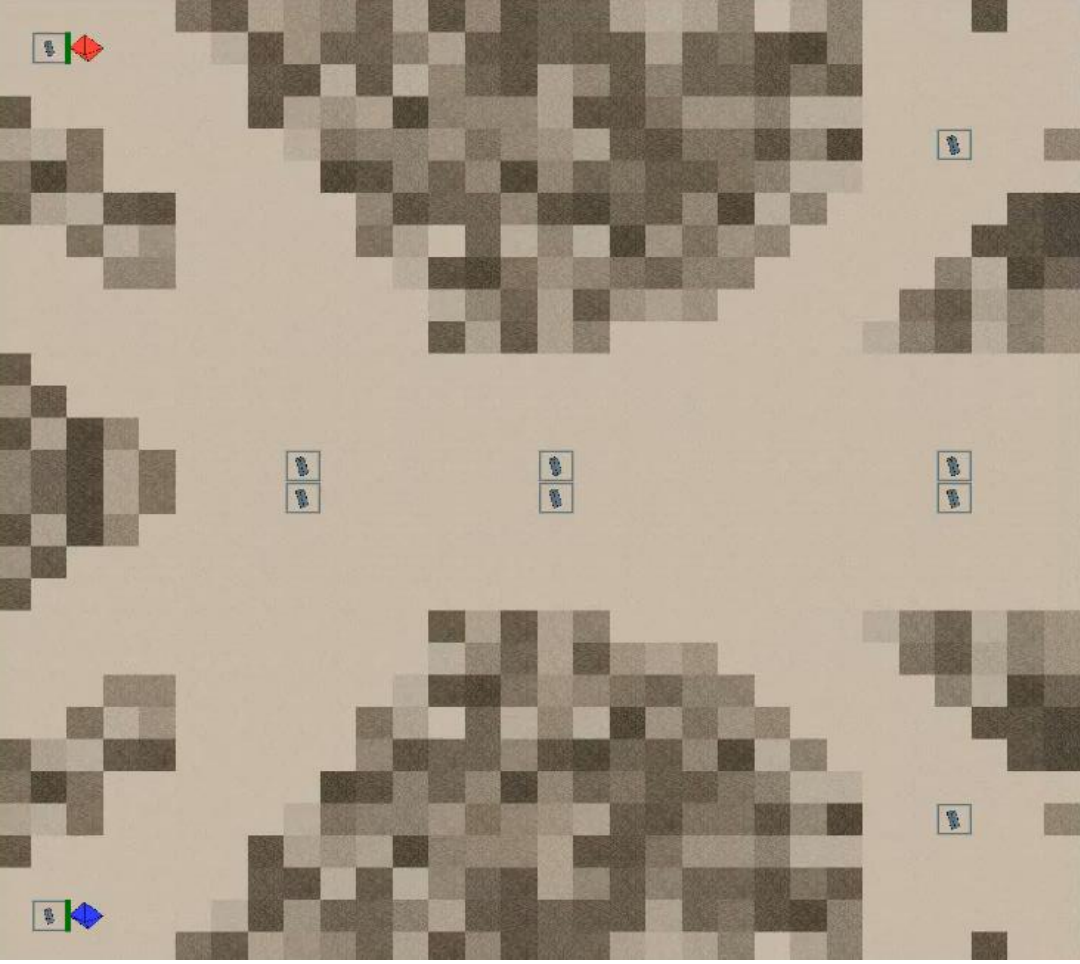
	1	1	0	0	1	1	0	
+	1	0	1	0	0	1	1	
1	0	1	1	1	0	0	1	



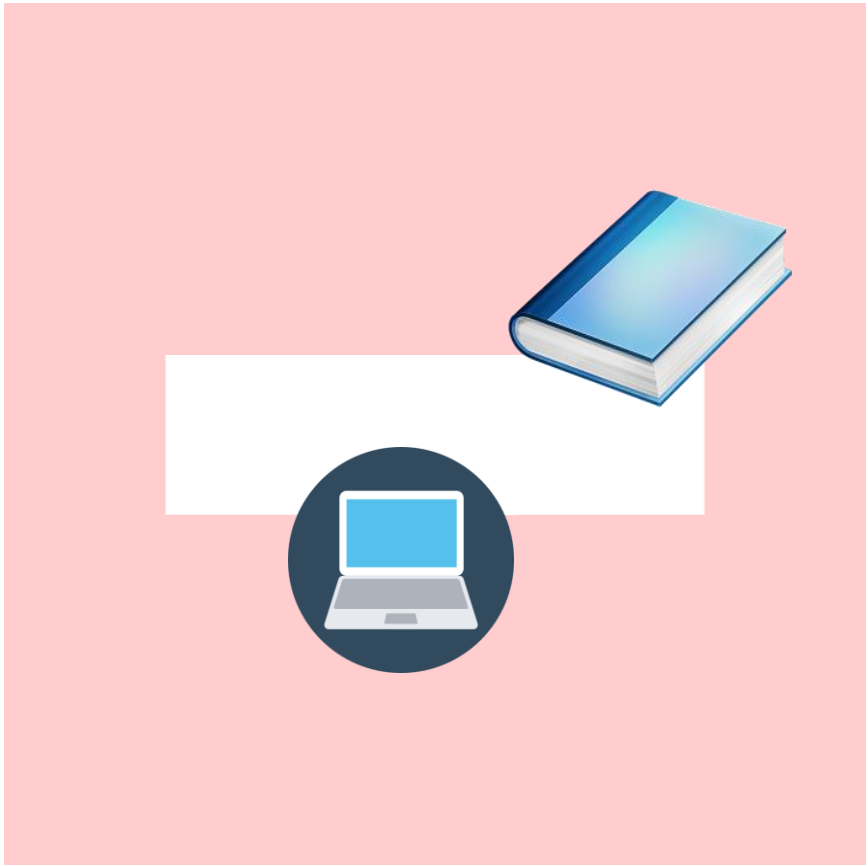


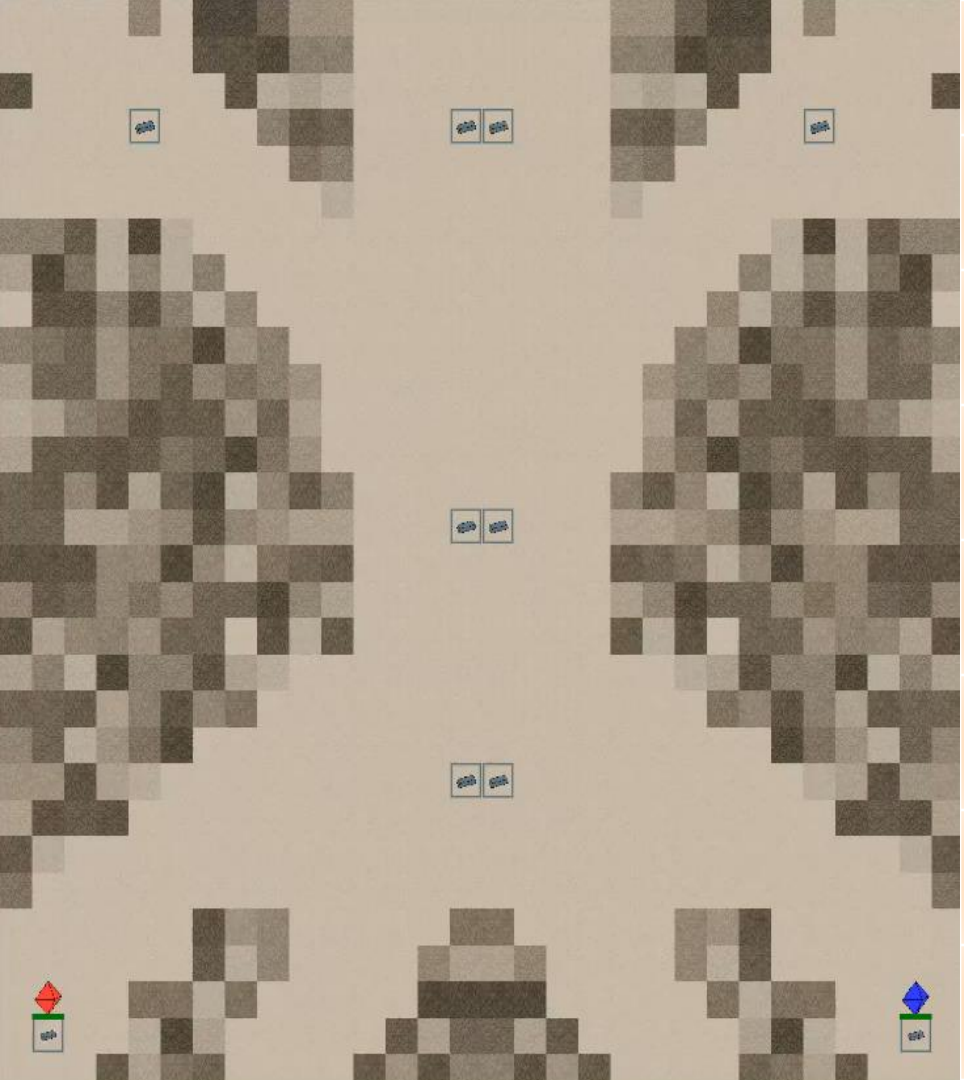
Swarm Intelligence Cup

AI through emergence



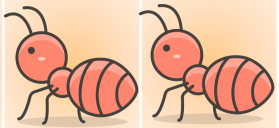
BATTLECODE





1 0

0 0



1 0

Thanks!
Any Suggestions?