

**MICHIGAN STATE**  
**UNIVERSITY**

# **Understanding Fraternal Transitions in Individuality**

OEE3 @ ALife 2018

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Matthew Andres Moreno

[mmore500@msu.edu](mailto:mmore500@msu.edu)

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## Background

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# Why



**Figure 1:** TODO [Trader, 2014]

## **Selection on Kin Cooperating Group Structure**

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- expect transition to occur
- scalable
- no simulation of “realistic” physics, abstract instead

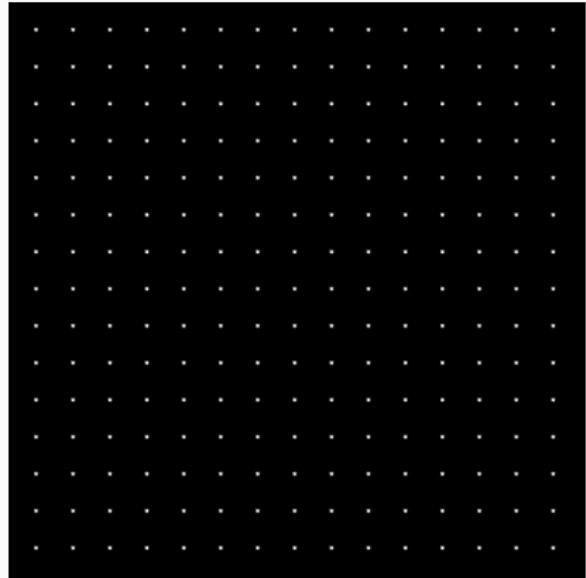
# Resource Collection

- need to anticipate
- communication with neighbors

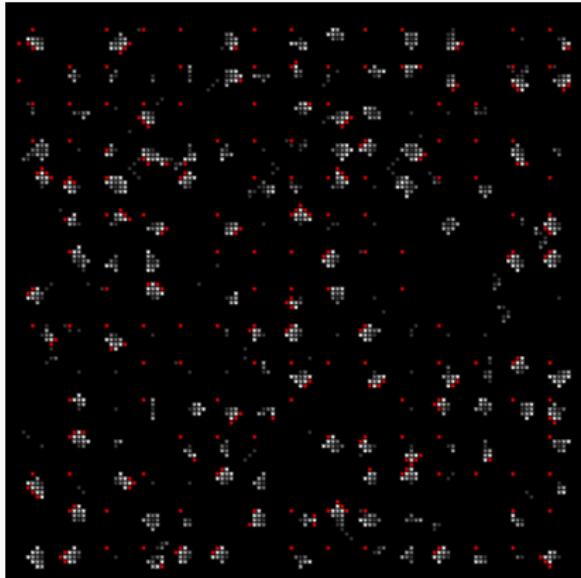
# Channels, Signals, & Resource

- register into explicit cooperating groups called channels

# Signals & Resource



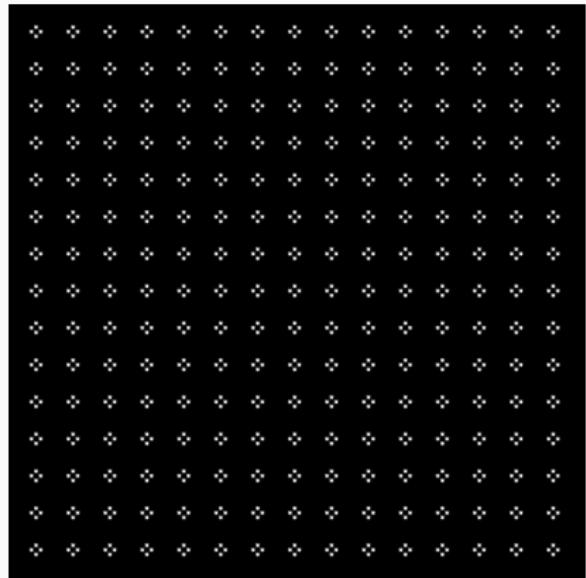
(a) resource



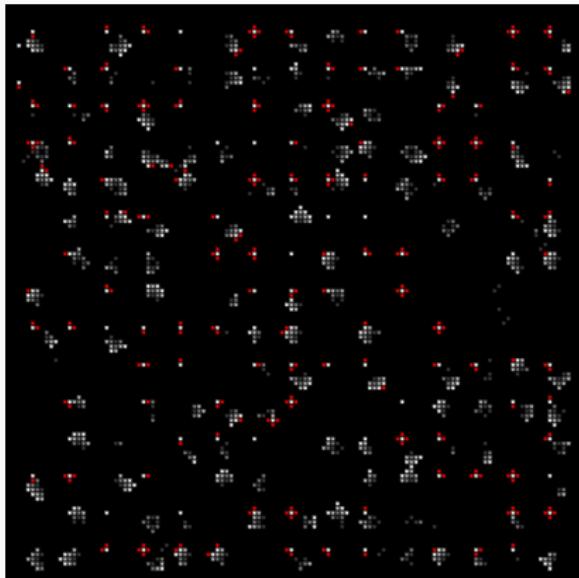
(b) activation-quiescence signals

**Figure 2:** Co-visualization of same-channel signaling and resource distribution.

# Signals & Resource



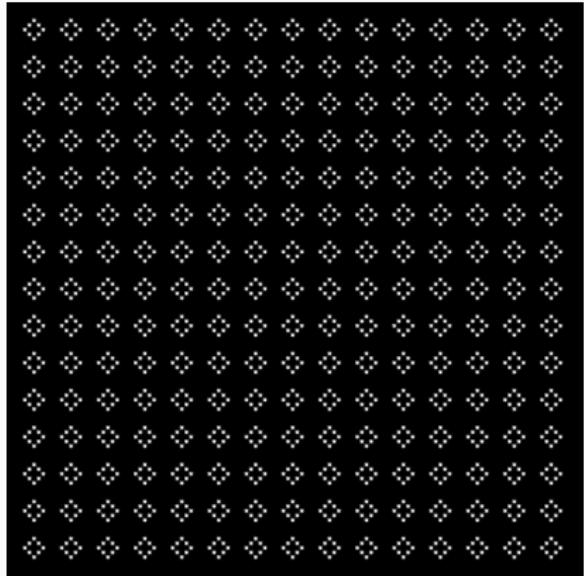
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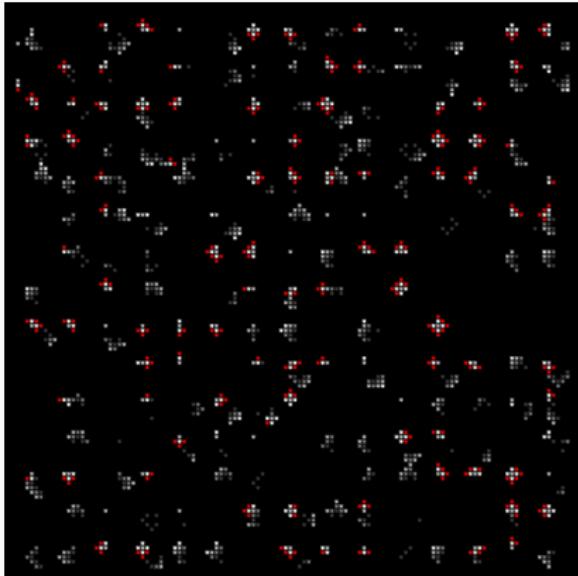
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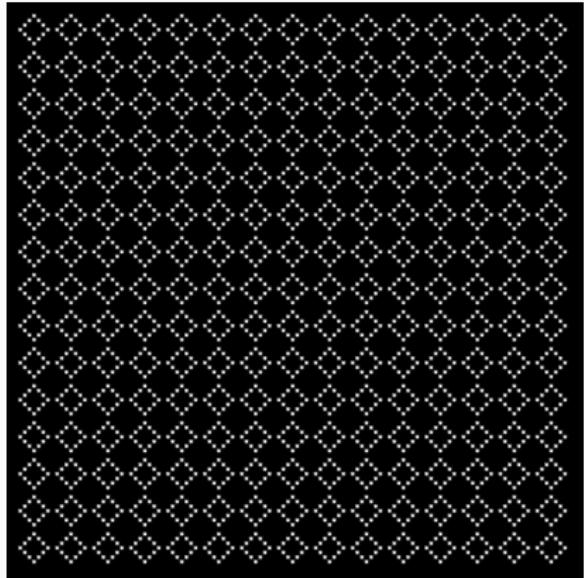
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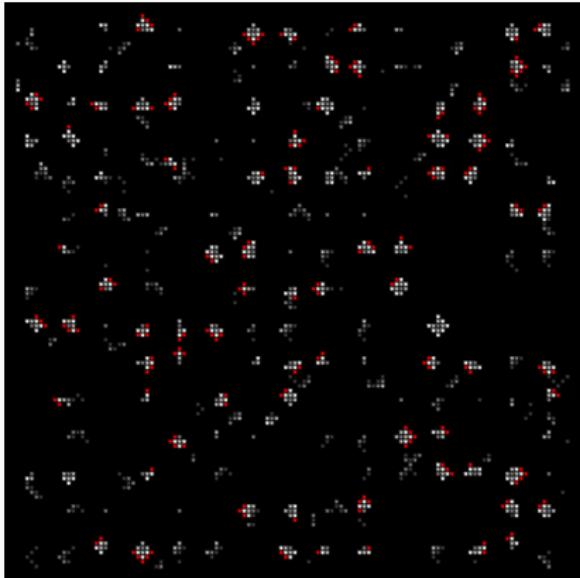
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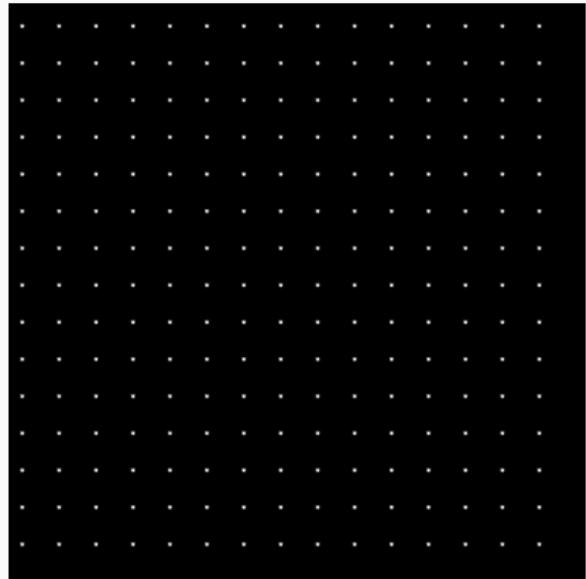
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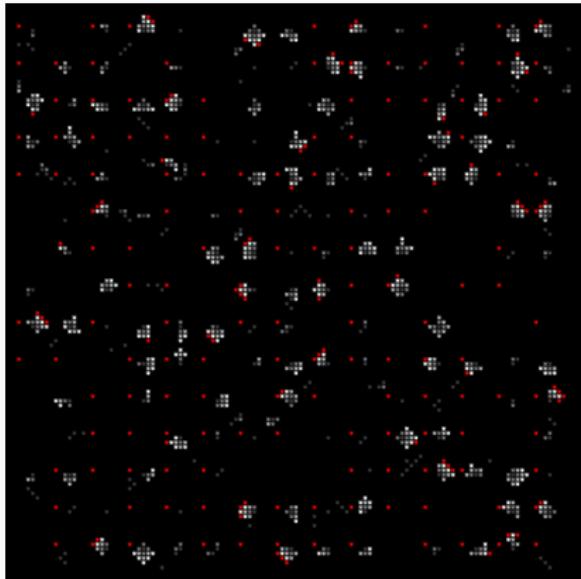
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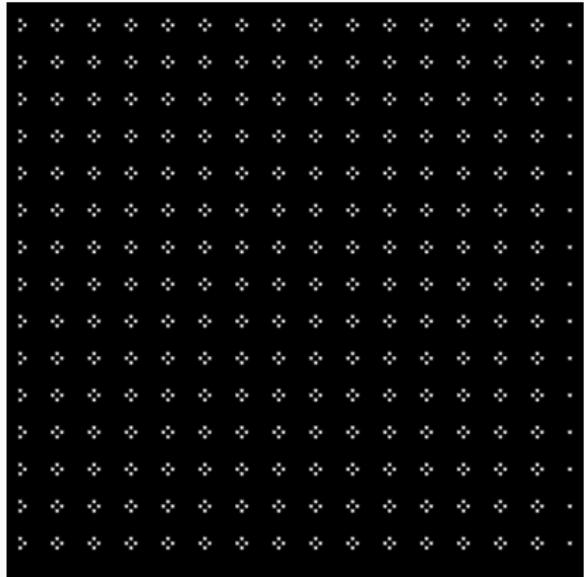
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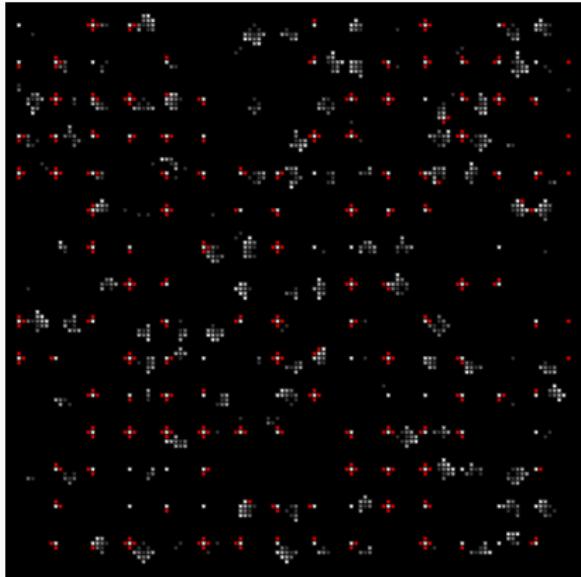
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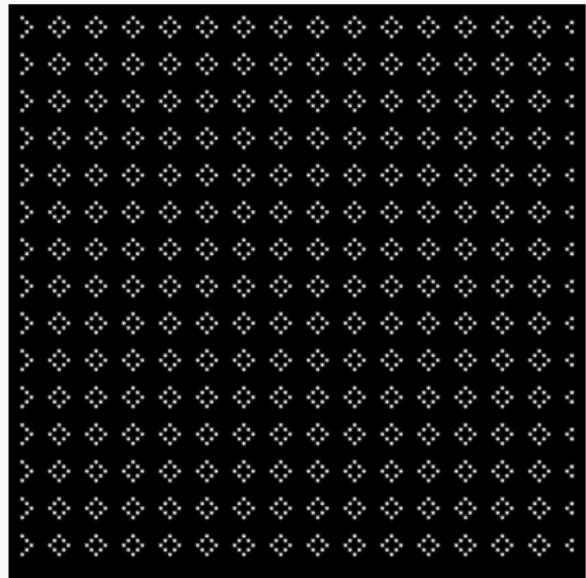
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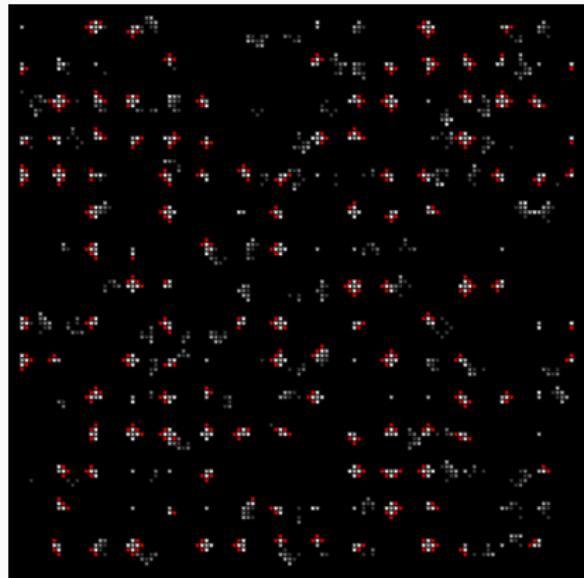
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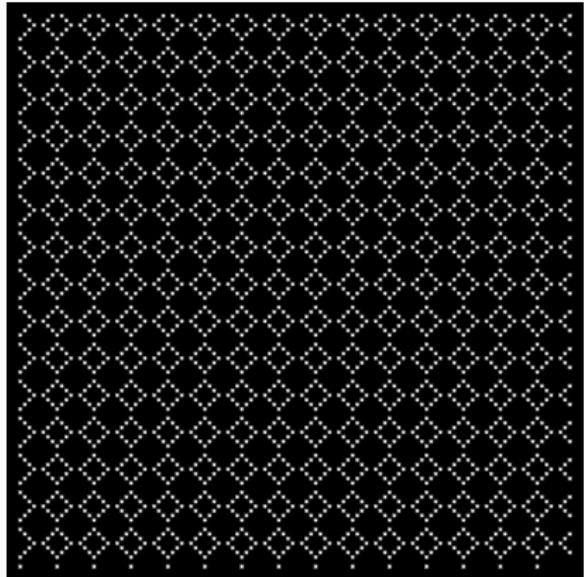
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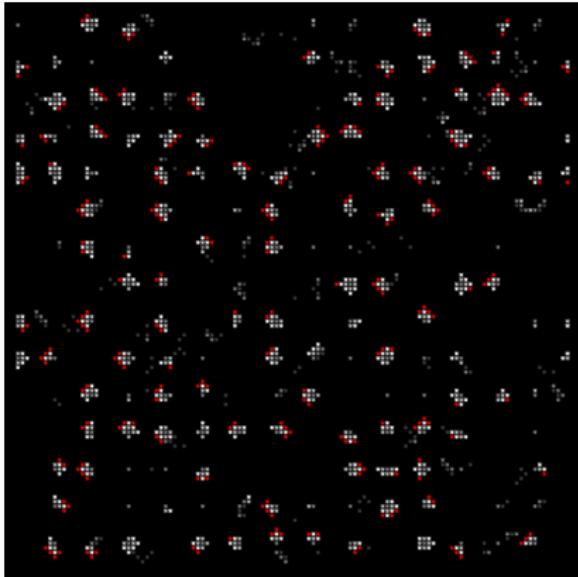
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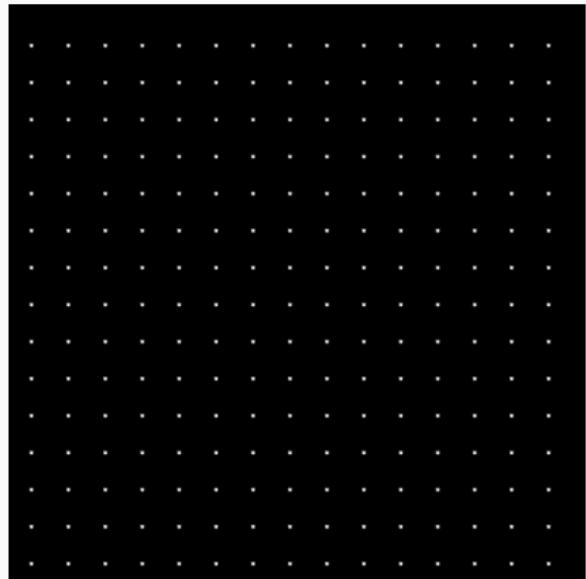
(a) resource



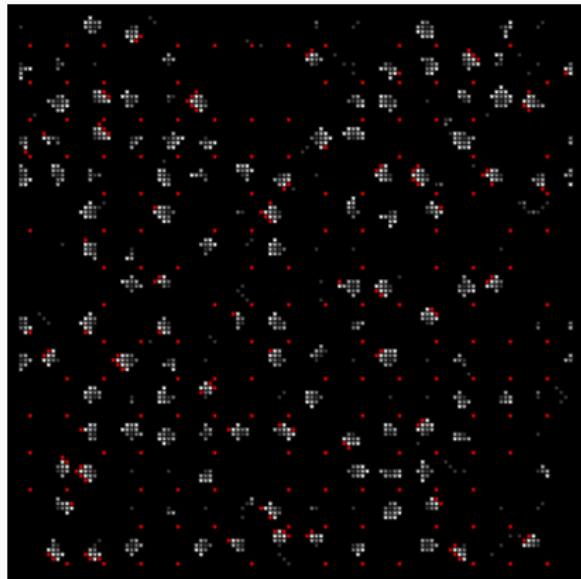
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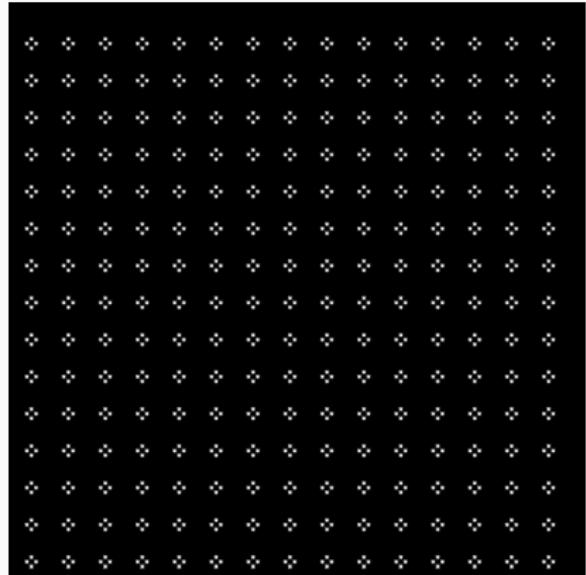
(a) resource



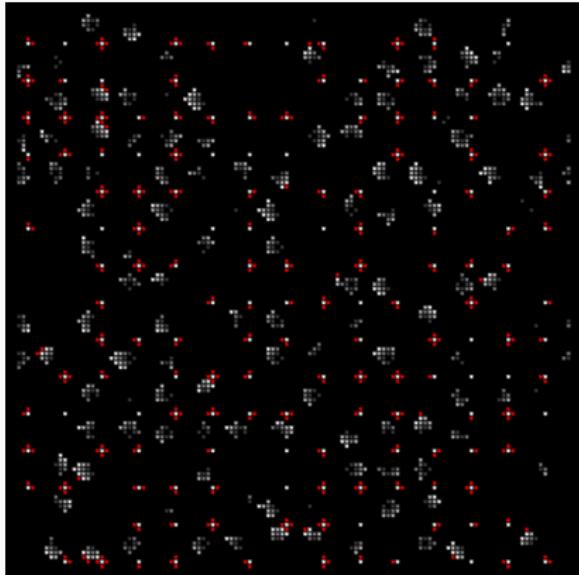
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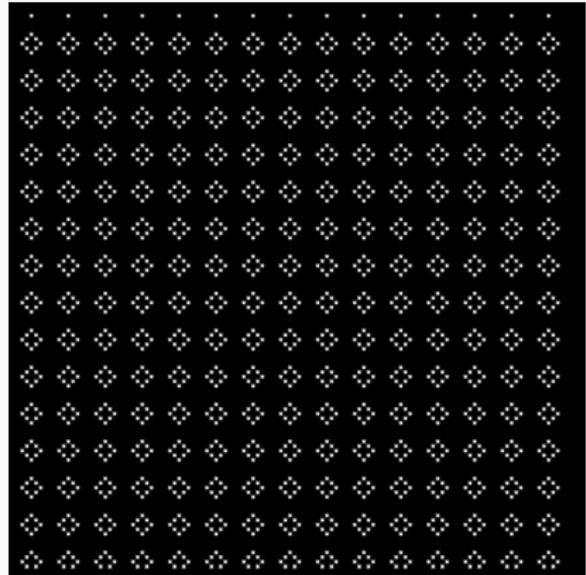
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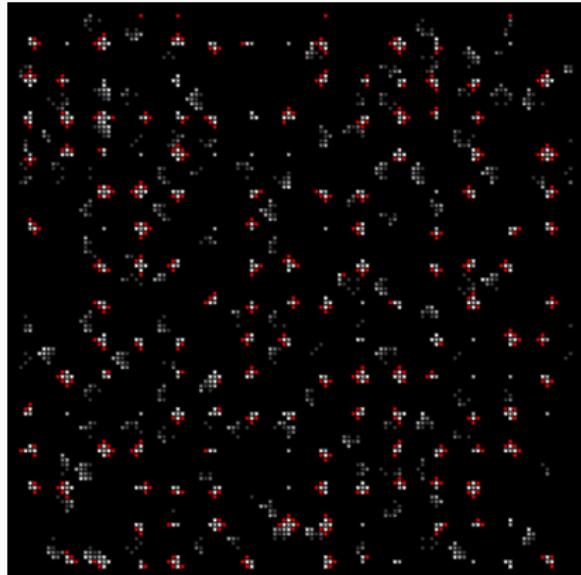
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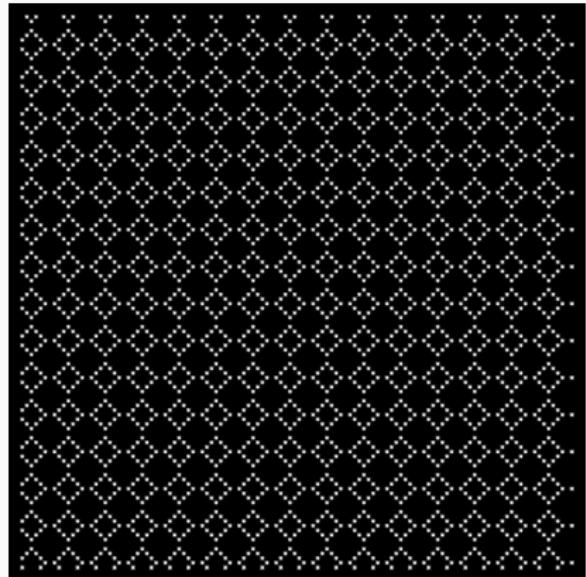
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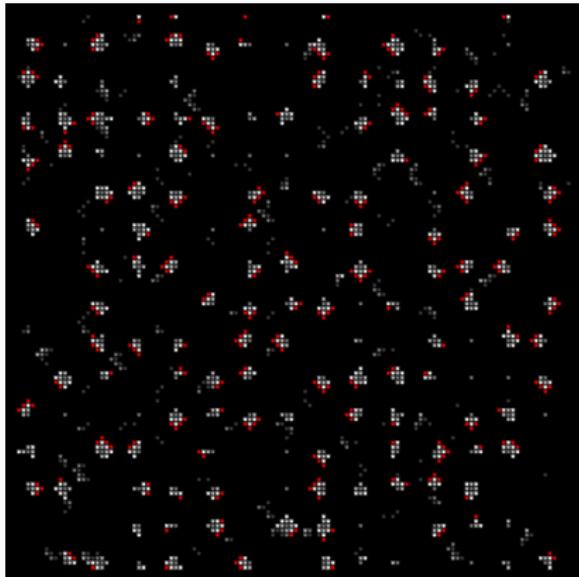
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# Signals & Resource



(a) resource



(b) activation-quiescence signals

**Figure 2:** Co-visualization of same-channel signaling and resource distribution.

# Channel Inheritance



**(a)** Offspring inherits channel ID from parent.

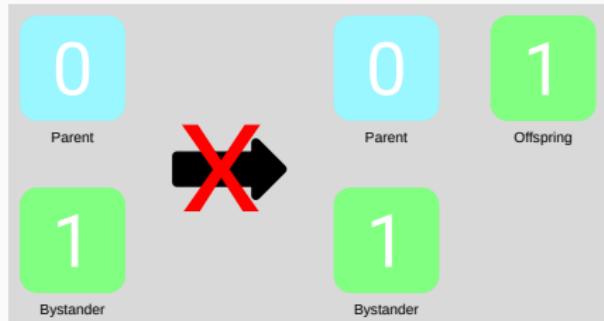
**(b)** Offspring assigned new, unique channel ID.

**Figure 3:** The two possible channel inheritance outcomes.

# Excluded Channel Dynamics



(a) during-lifetime channel change



(b) non-inherited channel match\*

**Figure 4:** Illustration of excluded channel dynamics.

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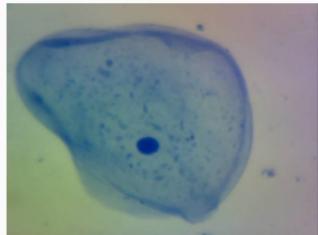
\*infrequent, non-inducible

## Hierarchical Extension

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# Clumps & Clumps of Clumps

(a)



cell [Clare and Ben, 2017]

ant [Quinzani, 2008]

(clump)

ant colony [Gallice, 2011]

(clump of clumps)

(b)



cell

clump



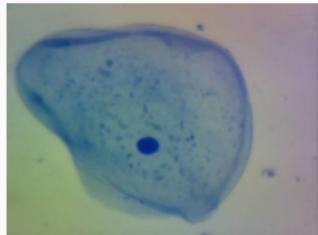
?

(clump of clumps)

**Figure 5:** Analogy between (a) natural and (b) simulated hierarchical fraternal transitions of individuality.

# Clumps & Clumps of Clumps

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cell [Clare and Ben, 2017]

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(clump)

ant colony [Gallice, 2011]

(clump of clumps)

(b)



cell

clump

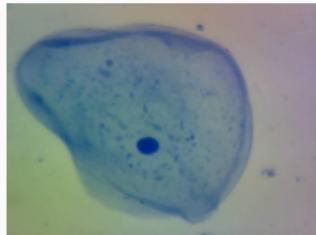


(clump of clumps)

**Figure 5:** Analogy between (a) natural and (b) simulated hierarchical fraternal transitions of individuality.

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(a)



cell [Clare and Ben, 2017]

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(clump)

ant colony [Gallice, 2011]

(clump of clumps)

(b)



cell

clump



clump of clumps

**Figure 5:** Analogy between (a) natural and (b) simulated hierarchical fraternal transitions of individuality.

# Clumps & Clumps of Clumps

Level 1 Channel ID



Level 2 Channel ID

(a) channel ID HSV key

(b) channel map visualization

**Figure 6:** Visualization of hierarchically-nested signaling networks.

# Clumps & Clumps of Clumps

Level 1 Channel ID



Level 2 Channel ID

(a) channel ID HSV key



(b) channel map visualization

**Figure 6:** Visualization of hierarchically-nested signaling networks.

# Clumps & Clumps of Clumps

Level 1 Channel ID



(a) channel ID HSV key

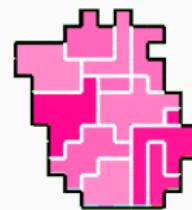
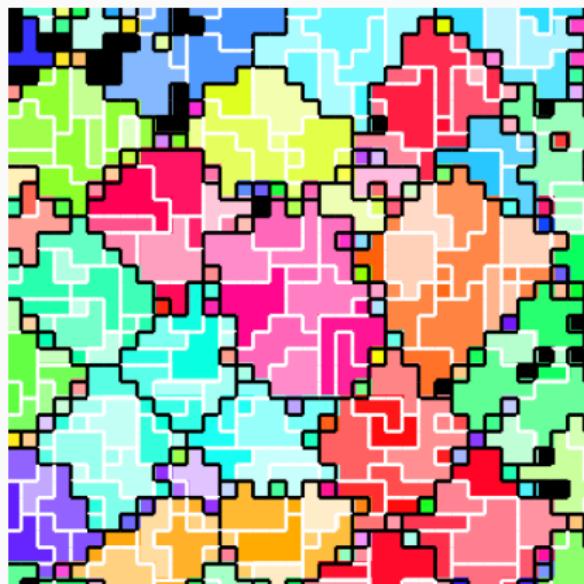
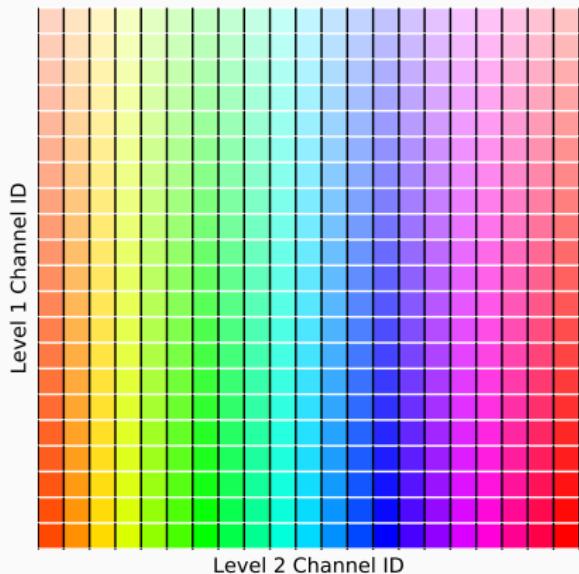


Figure 6: Visualization of hierarchically-nested signaling networks.

# Clumps & Clumps of Clumps



**Figure 6:** Visualization of hierarchically-nested signaling networks.

# Signals & Resource

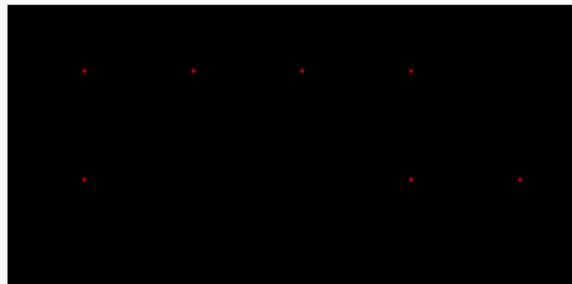
Level 2



Level 1



(a) resource



(b) activation-quiescence signals

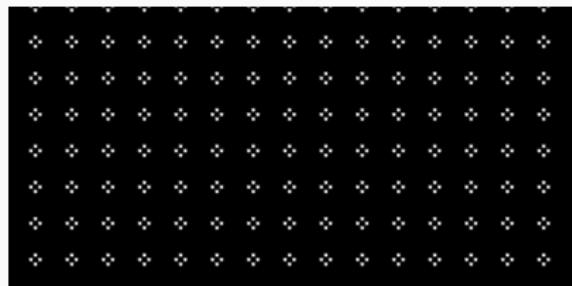
**Figure 7:** Co-visualization of same-channel signaling and resource distribution.

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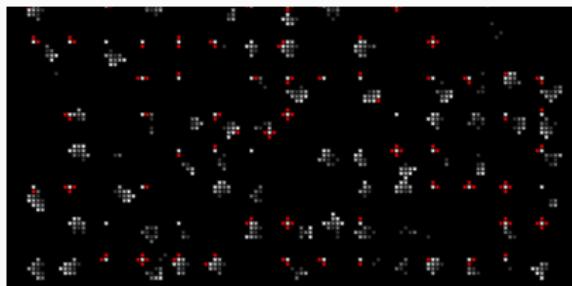
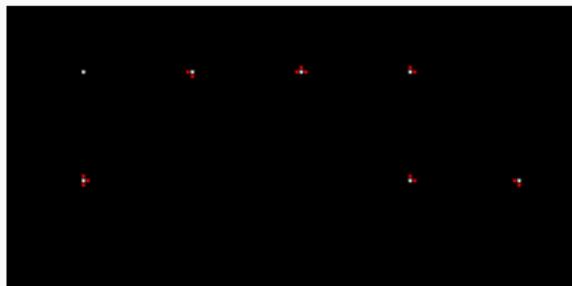
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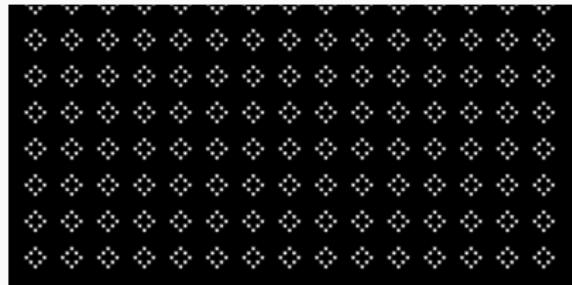
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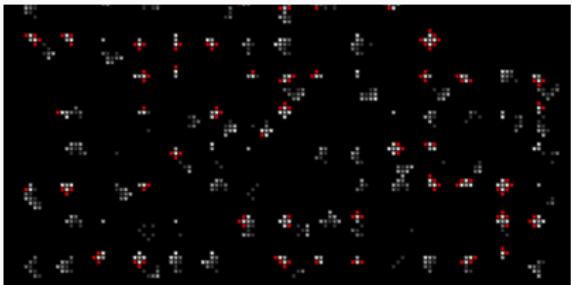
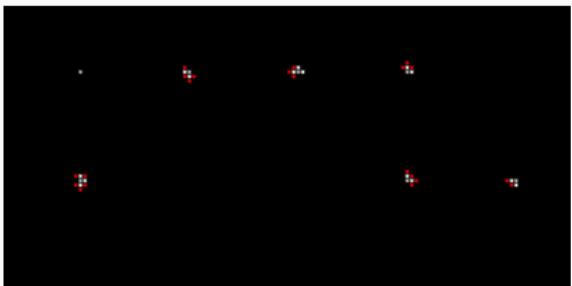
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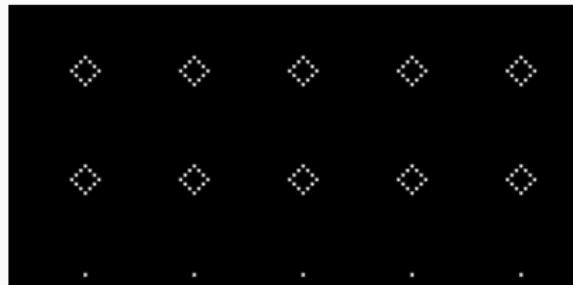


(b) activation-quiescence signals

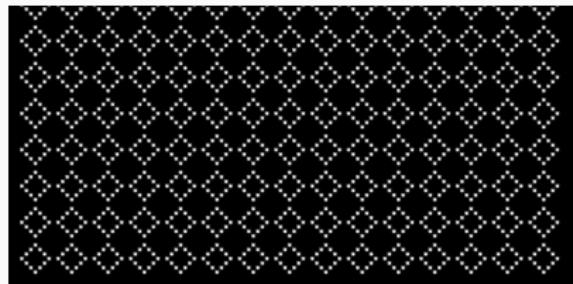
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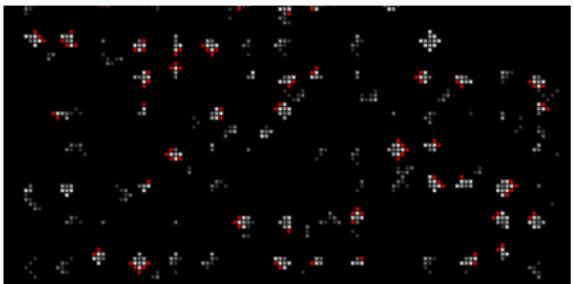
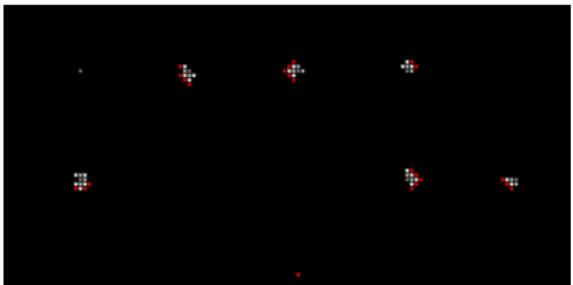
Level 2



Level 1



(a) resource

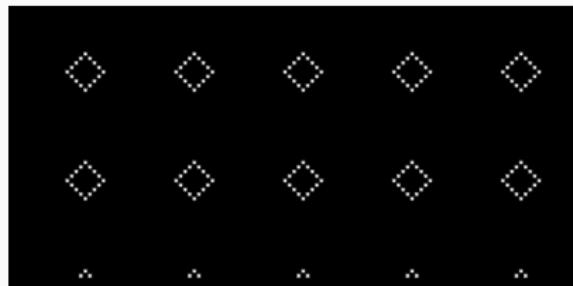


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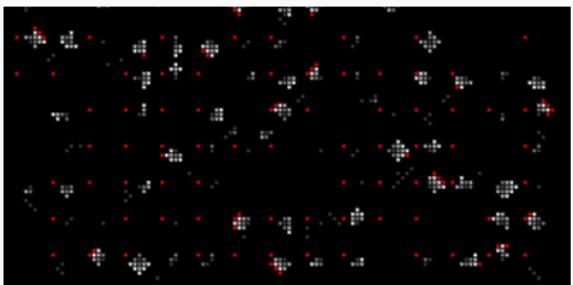
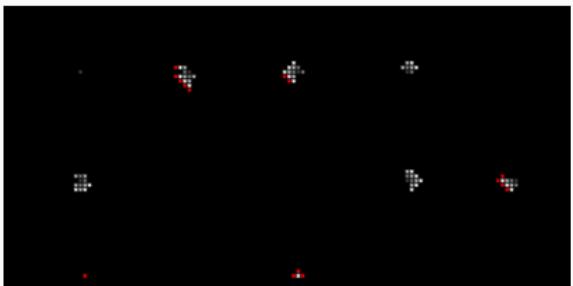
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Level 1



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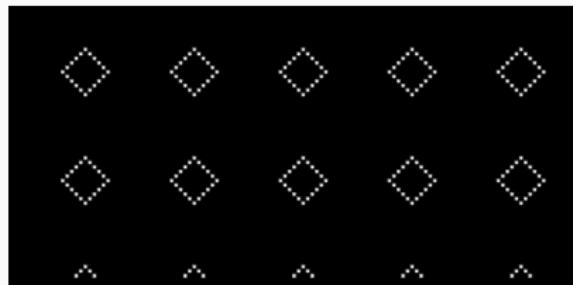


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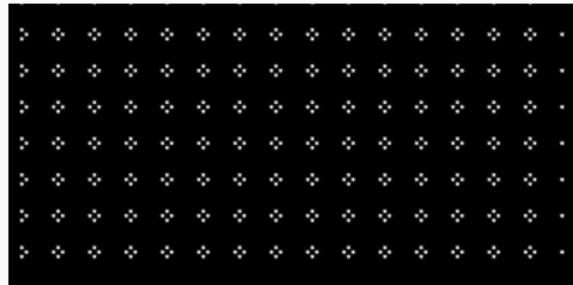
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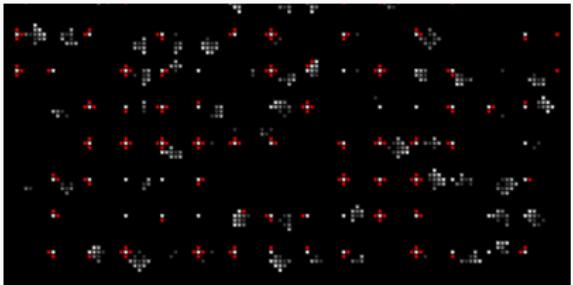
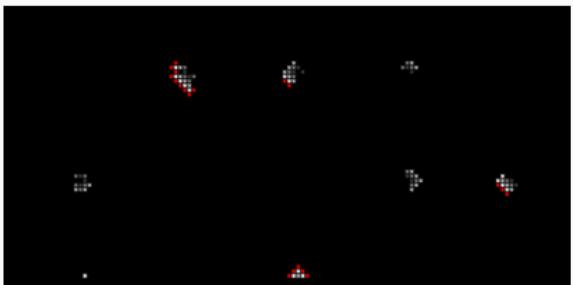
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Level 1



(a) resource

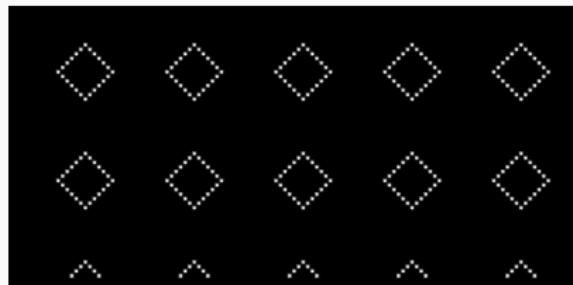


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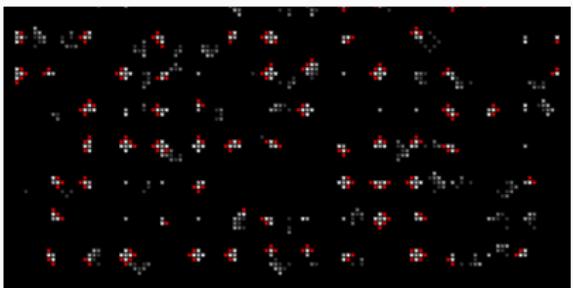
Level 2



Level 1



(a) resource

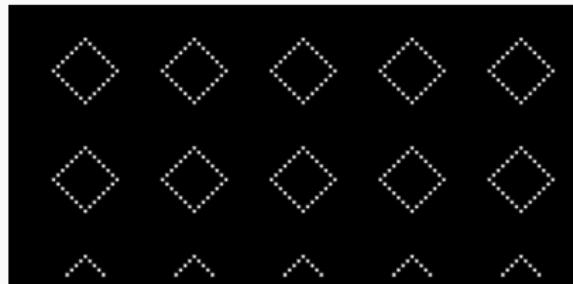


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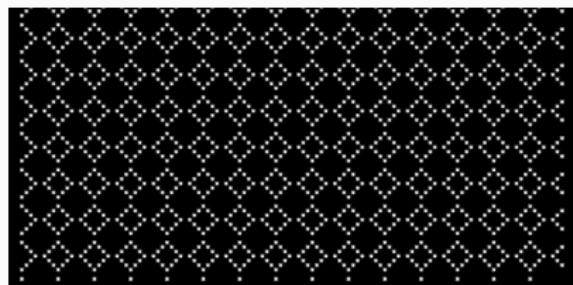
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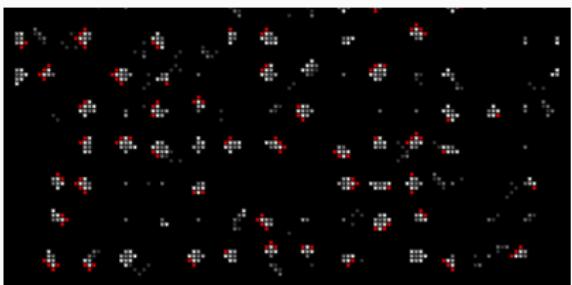
Level 2



Level 1



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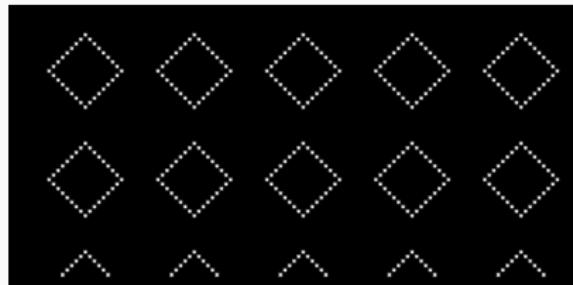


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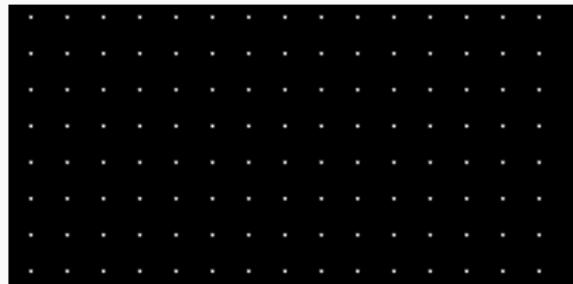
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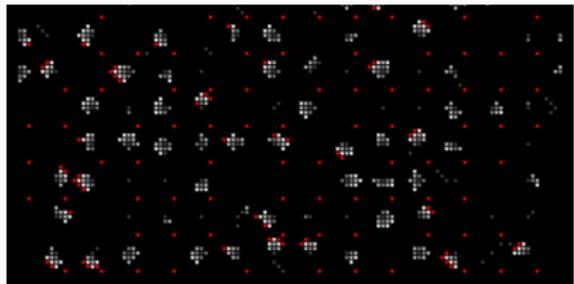
Level 2



Level 1



(a) resource

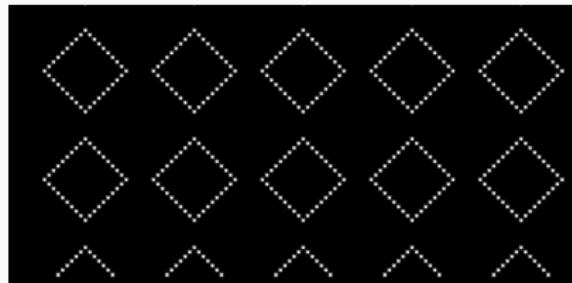


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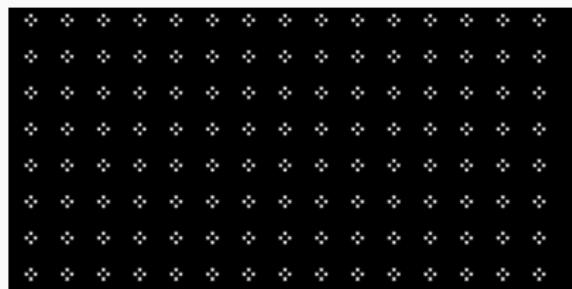
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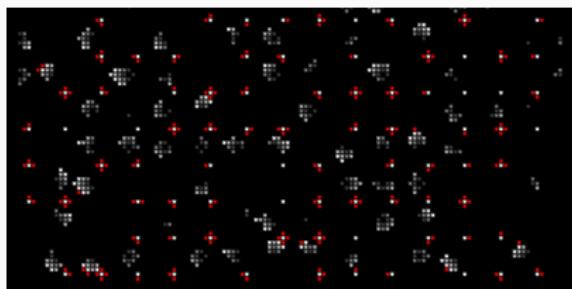
Level 2



Level 1



(a) resource

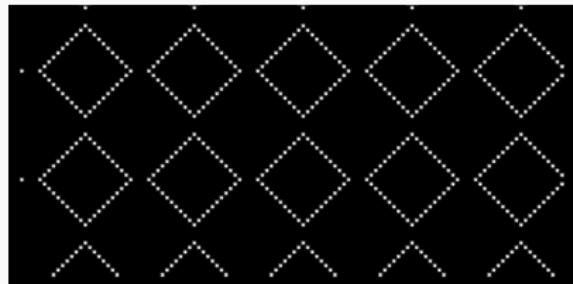


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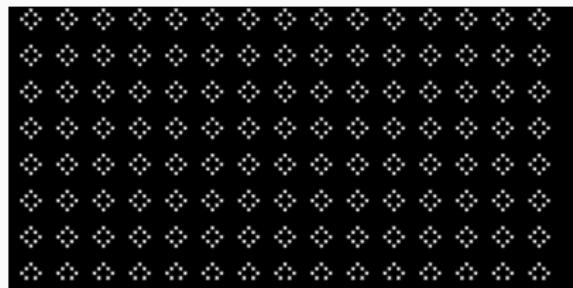
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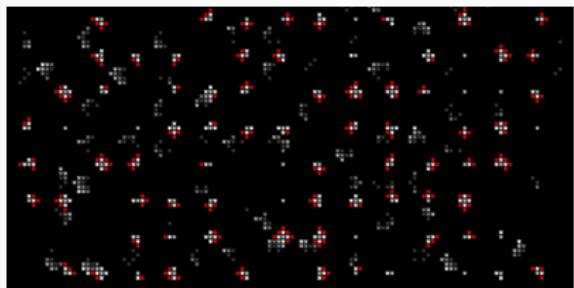
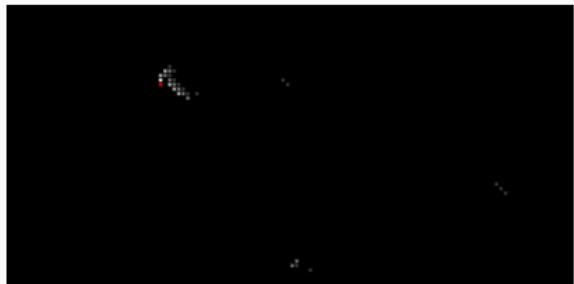
Level 2



Level 1



(a) resource

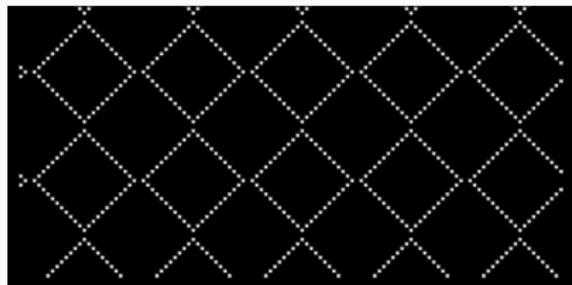


(b) activation-quiescence signals

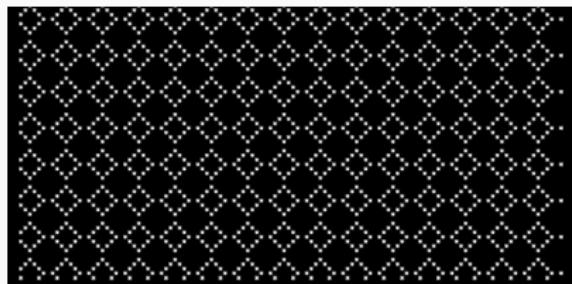
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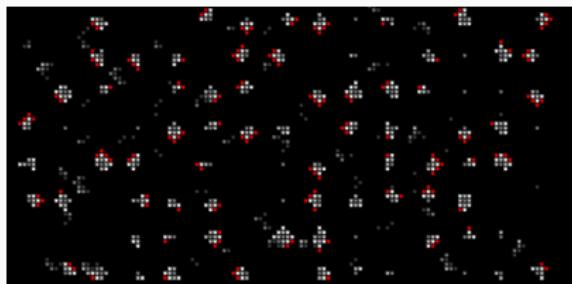
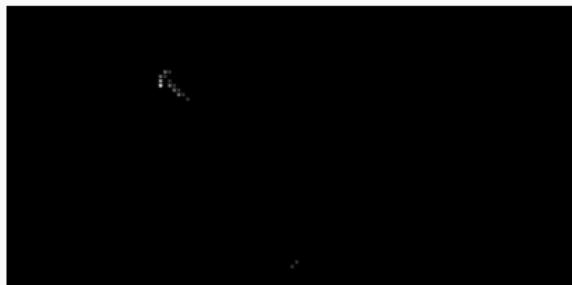
Level 2



Level 1



(a) resource



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# Clumps of Clumps

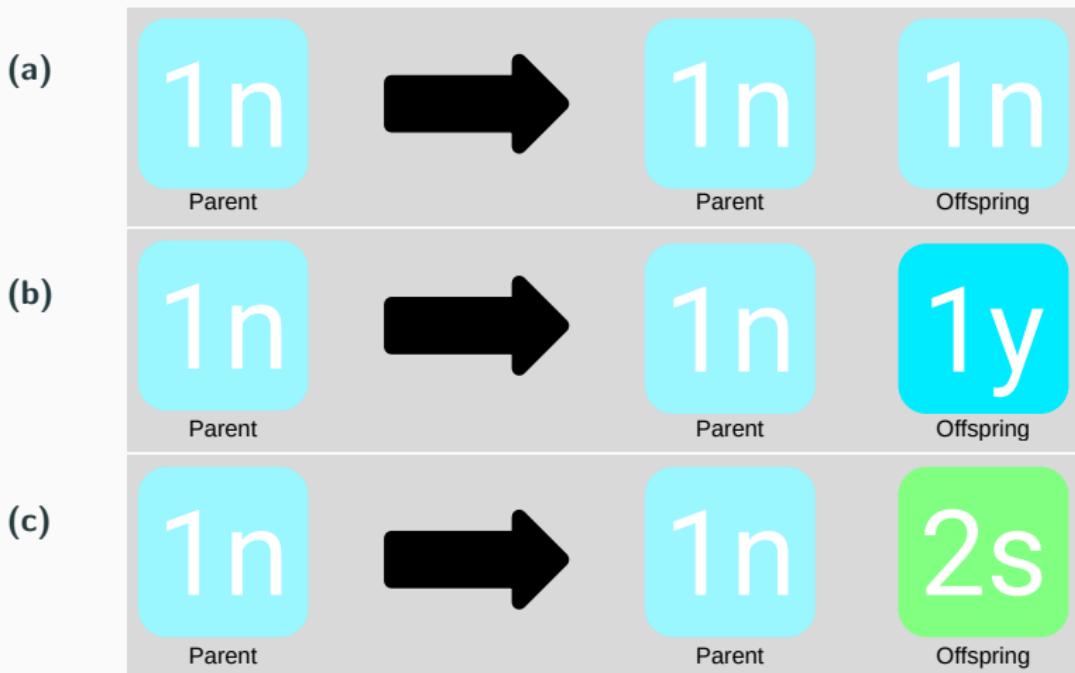
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## Signals & Resource: Level 2 (Clumps of Clumps)

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foo

# Multichannel Inheritance Outcomes



**Figure 8:** Allowed multichannel inheritance outcomes; (a) identical level 1 and 2 channels, (b) new level 1 channel with identical level 2 channel, and (c) new level 1 and 2 channels.

## Signals & Resource: Level 1 (Clumps) & Level 2 (Clumps of Clumps)

foo

## For More Information

<https://osf.io/ewvg8/>

- live in-browser demo
- source code
- data
- figures and graphics
- how-to-replicate tutorial
- publication
- slides
- blog article

# People



**Matthew Andres Moreno**

🐦 @MorenoMatthewA  
🌐 <https://mmore500.github.io>  
✉️ mmore500@msu.edu



**Charles Ofria**

🐦 @CharlesOfria  
🌐 <https://ofria.com>  
✉️ ofria@msu.edu

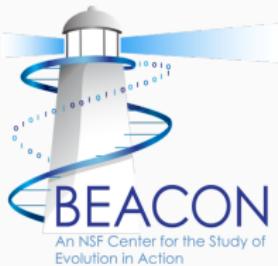


**devolab**

DIGITAL EVOLUTION LAB | MICHIGAN STATE UNIVERSITY

# Acknowledgements

- Empirical Library for scientific software development in C++
- Open Science Framework via the Center for Open Science
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**Questions?**

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