Evolution of ethnocentrism with minimal cognition in a spatially structured population

Artem Kaznatcheev
University of Waterloo
June 1st, 2011

McGill

The Robert J. Glushko and Pamela Samuelson Foundation

NSERC CRSNG

Based on

- T.R. Shultz, M. Hartshorn, and **AK**. [2009] "Why is ethnocentrism more common than humanitarianism?" Proceedings of the 31st annual conference of the cognitive science society.
- **AK**. [2010] "The cognitive cost of ethnocentrism." Proceedings of the 32nd annual conference of the cognitive science society.
- **AK**. [2010] "Robustness of ethnocentrism to changes in inter-personal interactions." Complex Adaptive Systems - AAAI Fall Symposium.
- **AK**, and T.R. Shultz. [2011] "Ethnocentrism Maintains Cooperation, but Keeping One's Children Close Fuels It." Proceedings of the 33rd annual conference of the cognitive science society.
- M. Hartshorn, T.R. Shultz, **AK**, and R.A. Hammond. [in prep] "The evolutionary dominance of ethnocentric cooperation".

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- Seeing in-group as superior and out-groups as inferior

Cashdan (2001) *Current Anthropology*

Brown (2004) *Daedalus*

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  - Human placenta, ants, microbes (Biology: known as Green-beard effect)
- Ethnocentrism may have a basis in evolution

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Method

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- Build computational models and simulate them

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- Build computational models and simulate them
- Use tools from evolutionary game theory to model interactions between agents

Competitive Environment

Prisoner's dilemma

Alice

Competitive Environment

Prisoner's dilemma

Bob

Alice

Competitive Environment

Prisoner's dilemma

Bob

b - c

Alice

b

Competitive Environment

Prisoner's dilemma

Bob

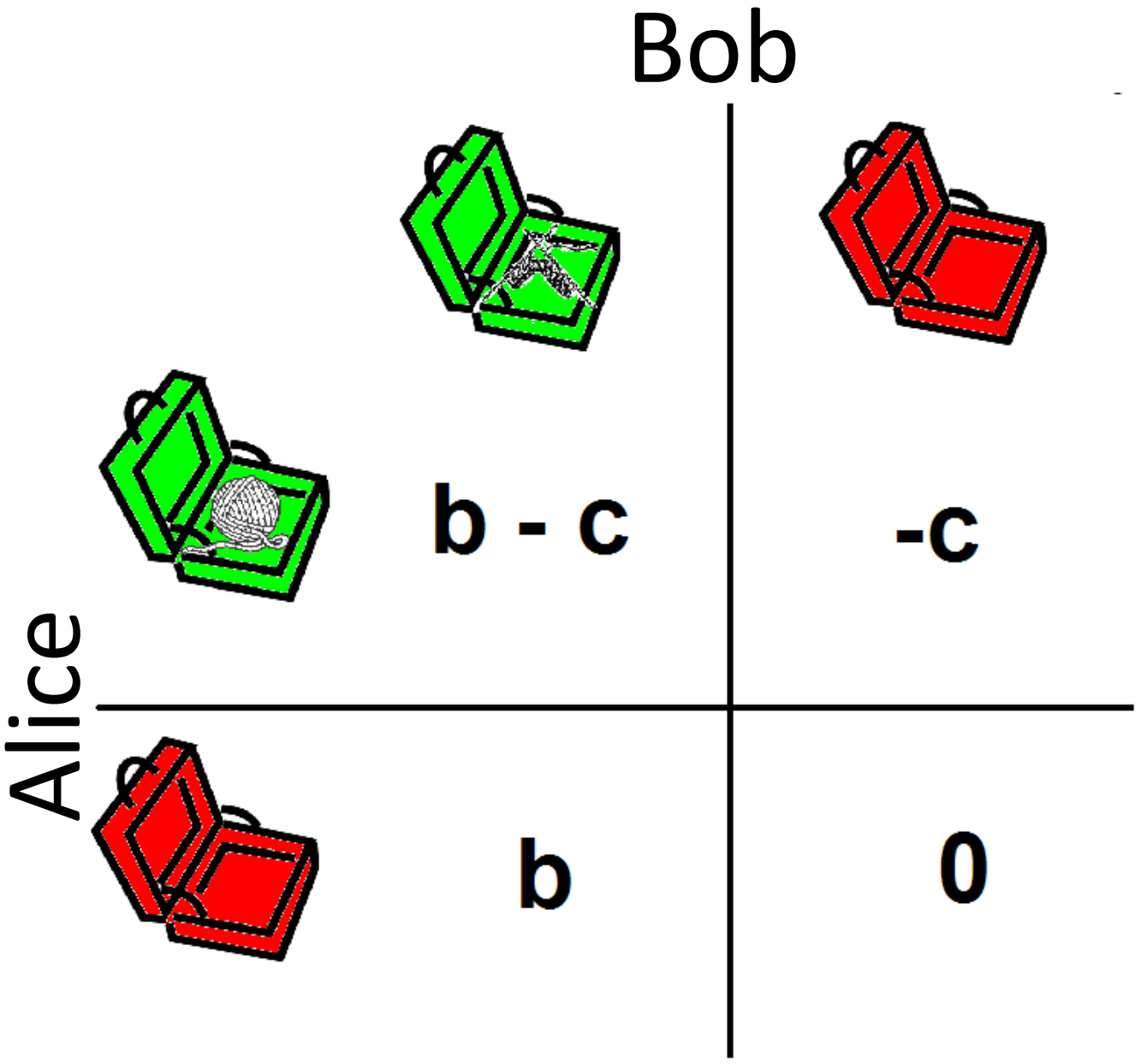
-c

Alice

0

Competitive Environment

Prisoner's dilemma

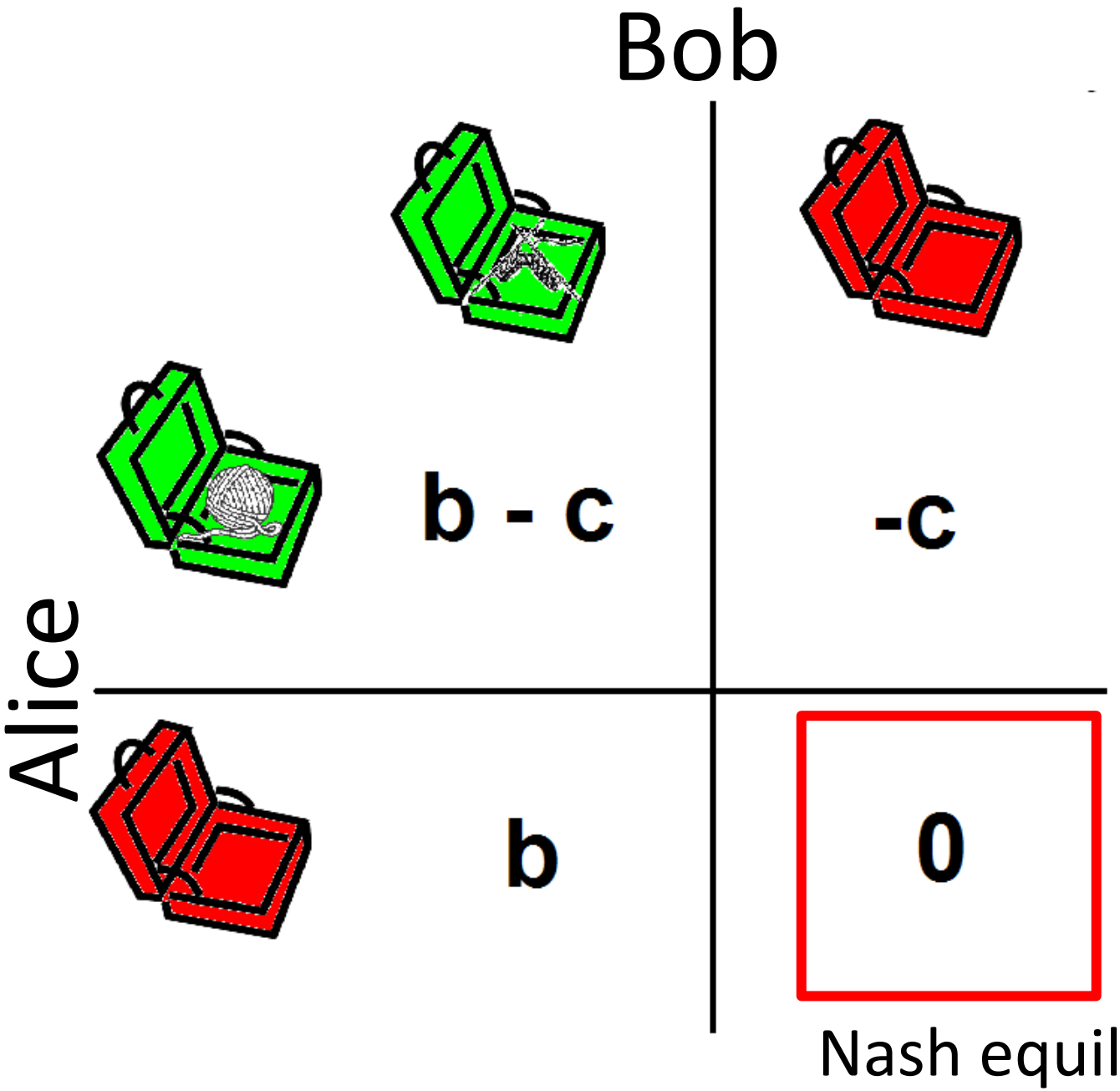


b - benefit of cooperation

c - cost of cooperating

Competitive Environment

Prisoner's dilemma



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Nash equilibrium

Competitive Environment

Prisoner's dilemma

Bob

b - benefit of cooperation

Pareto optimum

b - c

-c

Alice

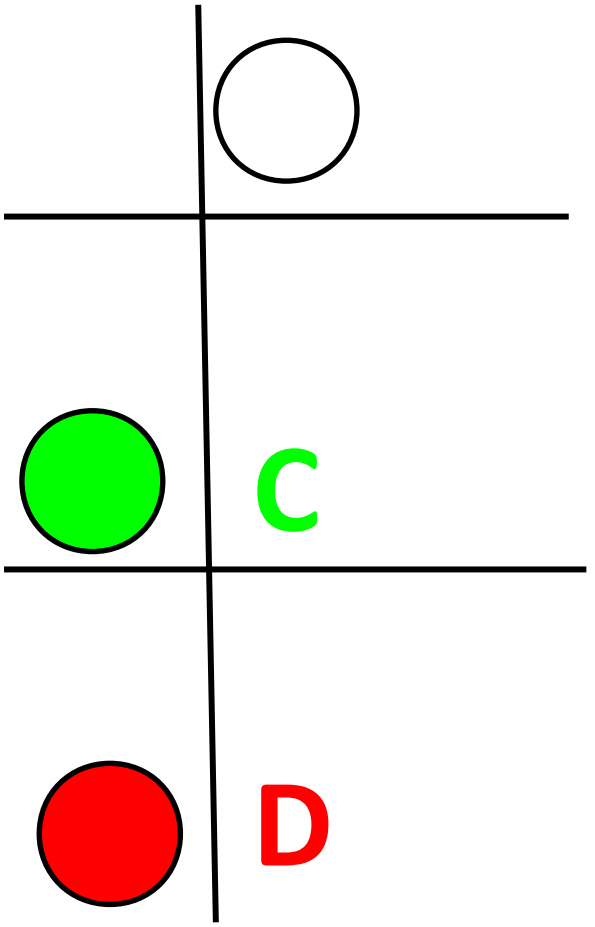
b

0

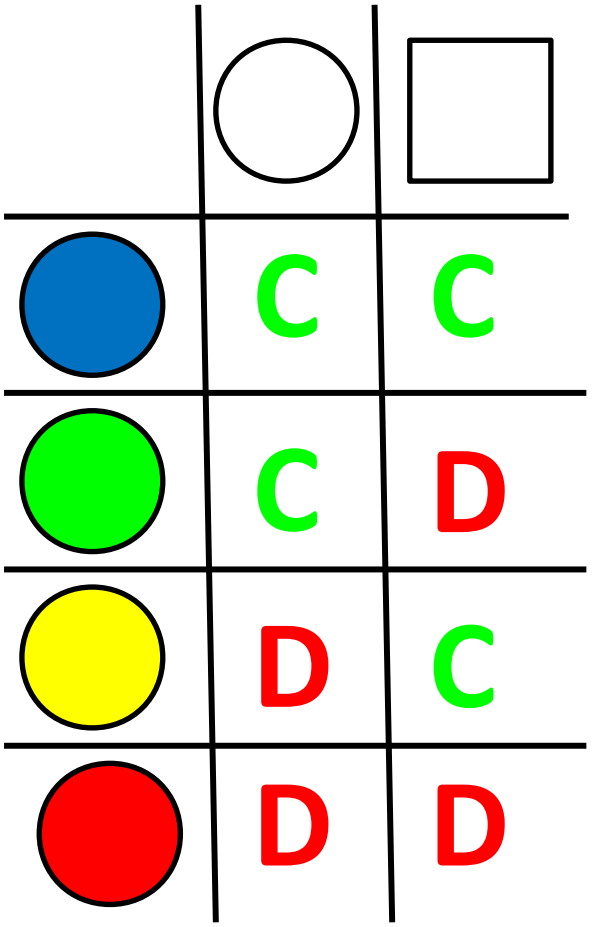
c - cost of cooperating

Nash equilibrium

Strategy Space



Strategy Space



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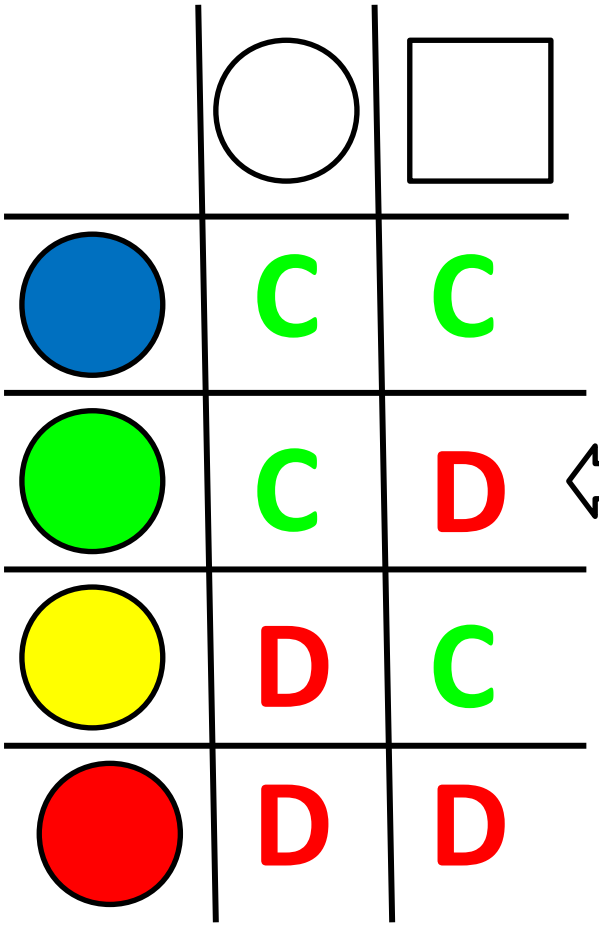
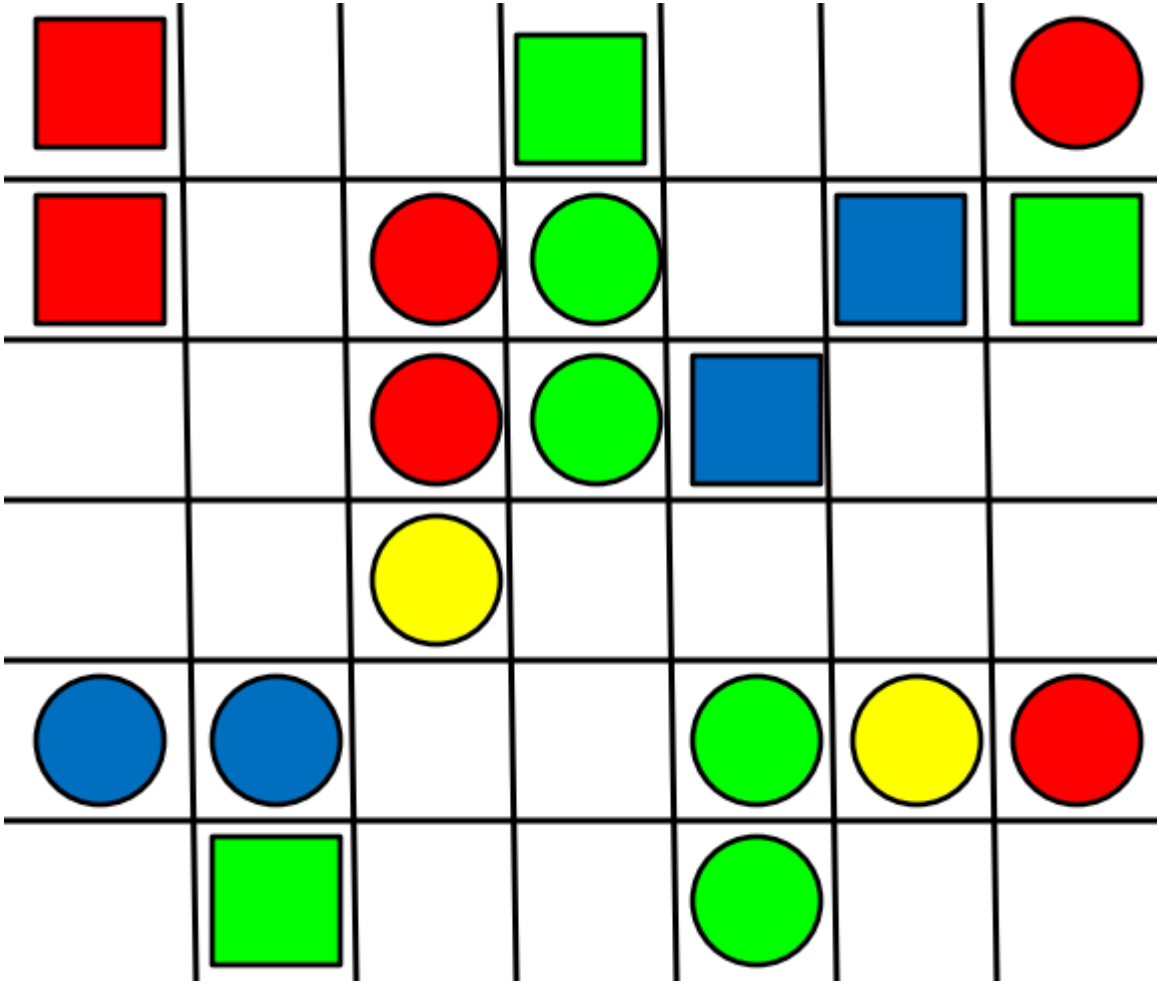


⇦ Ethnocentrism

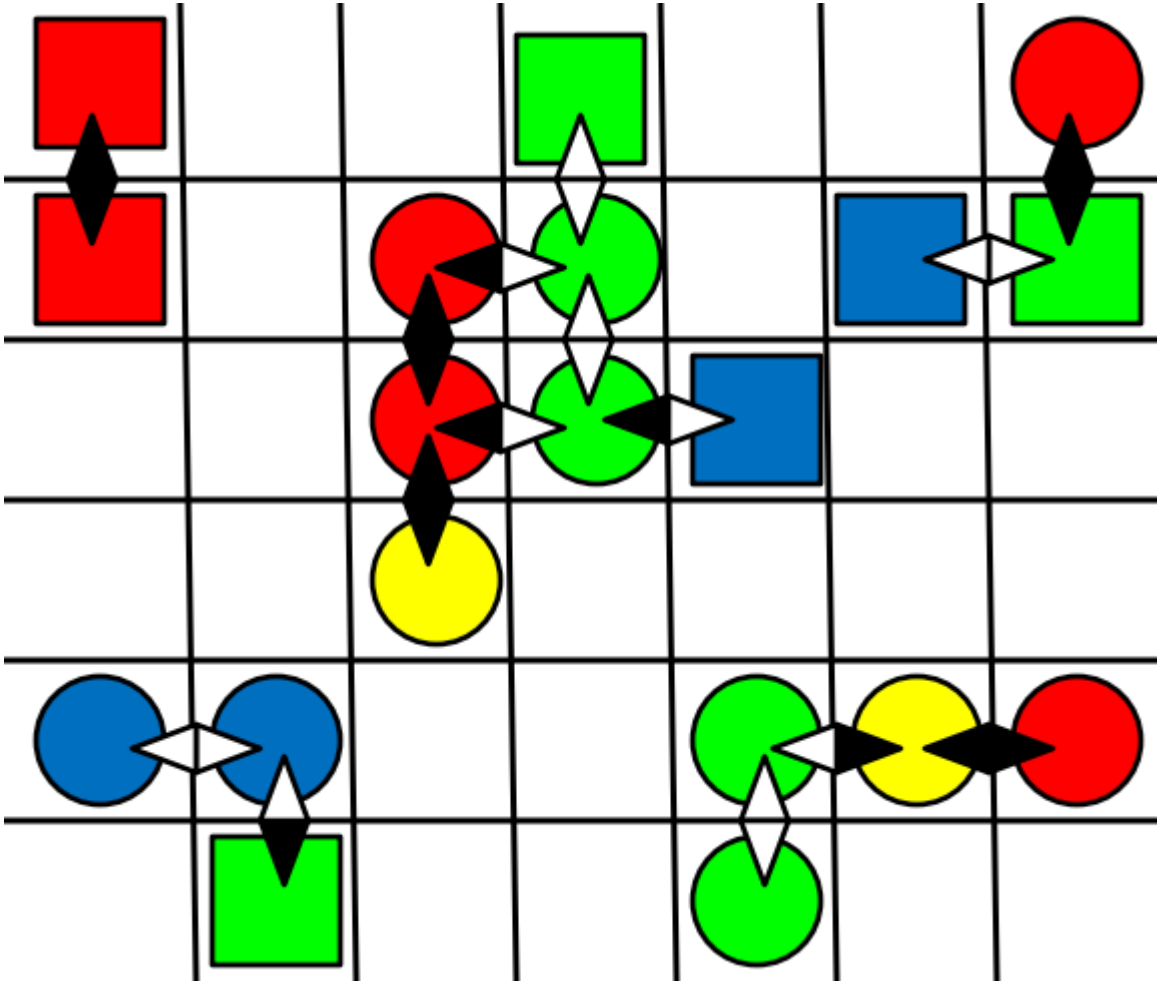
Spatial Model

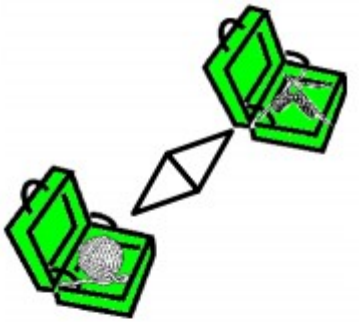
Initial configuration

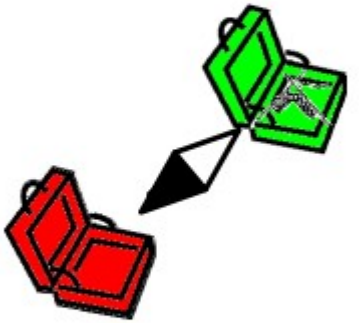


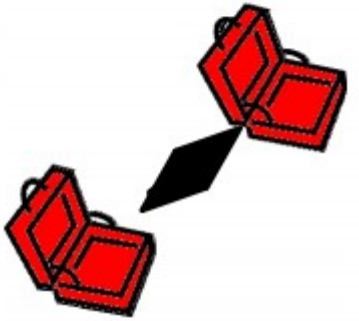
Spatial Model

Game interaction



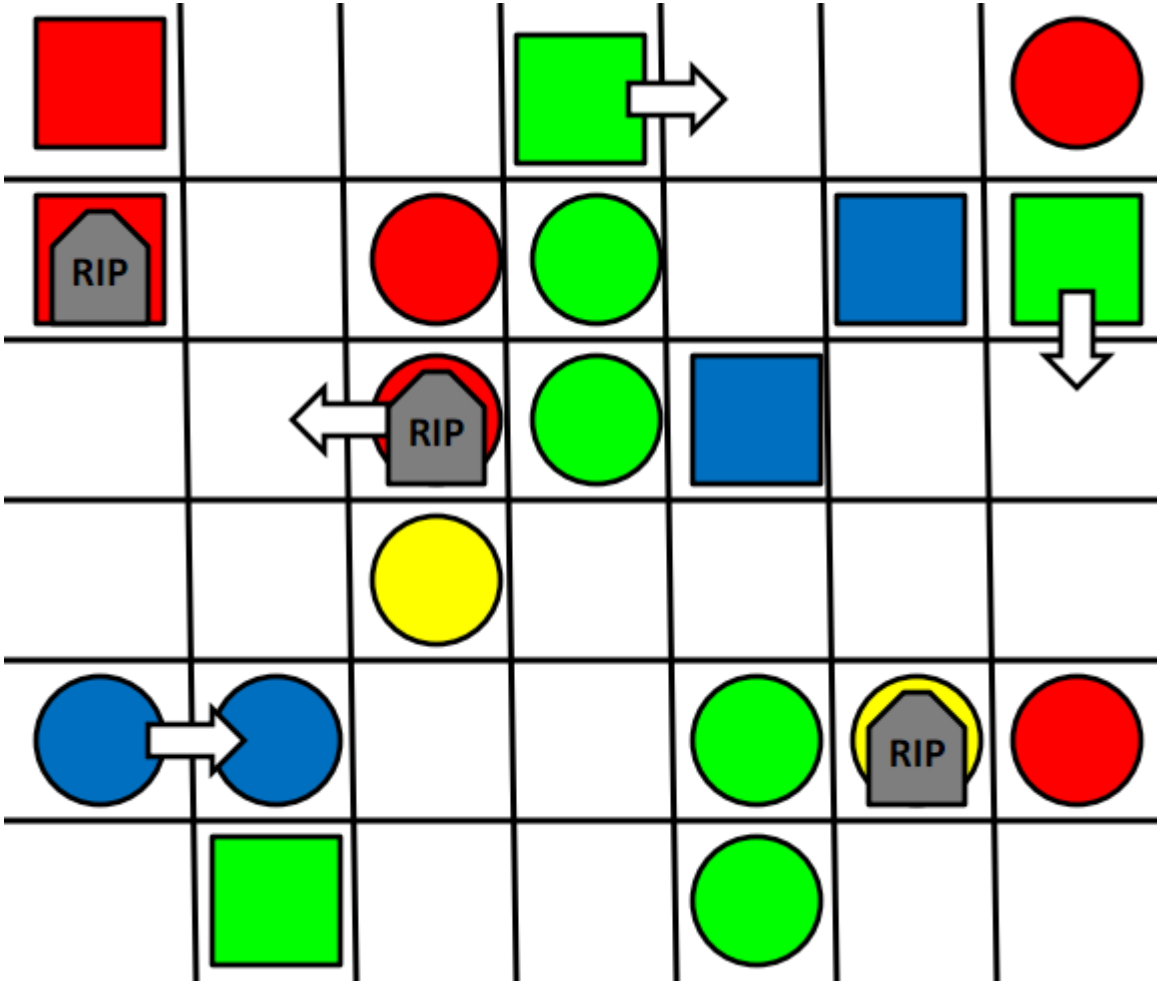






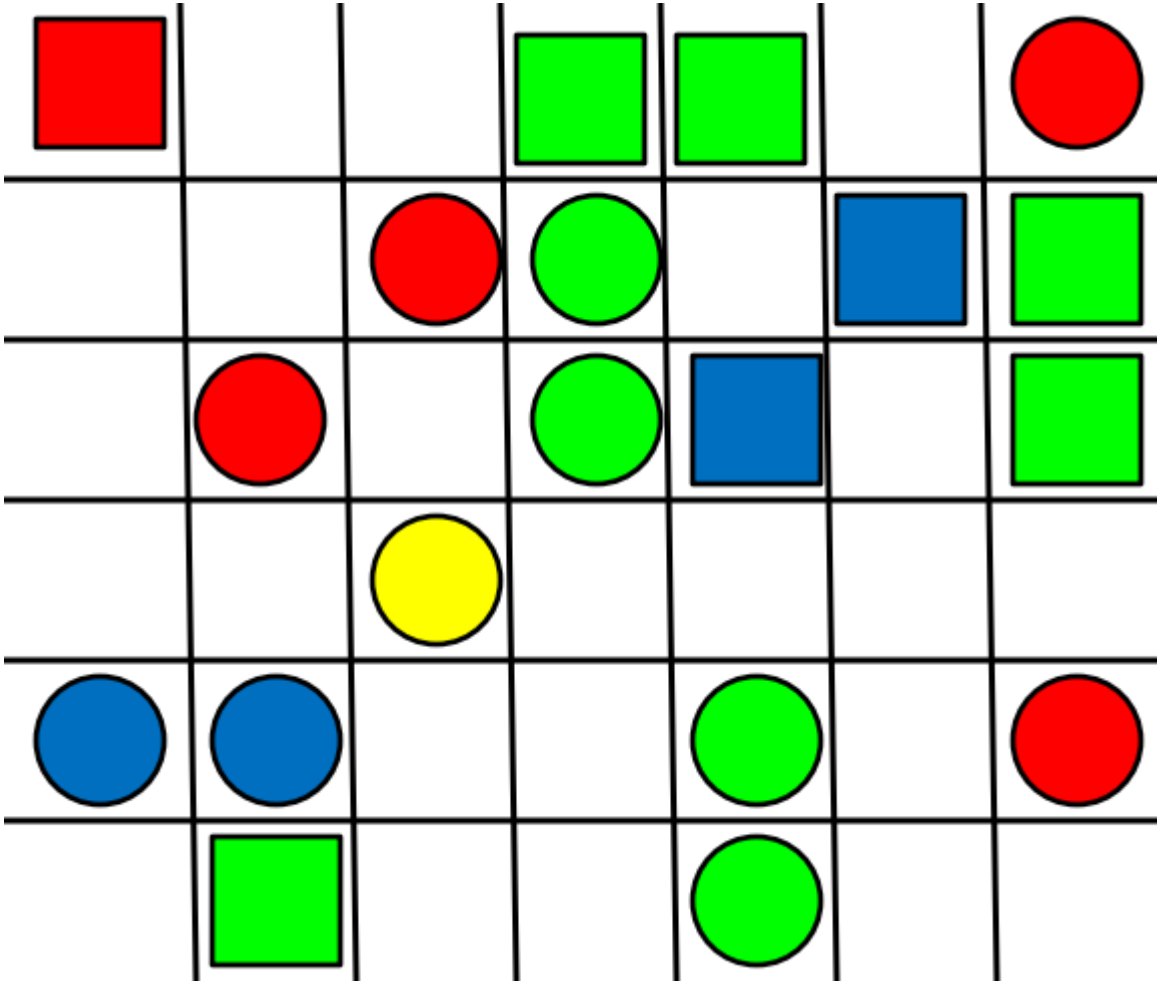
Spatial Model

Death & reproduction



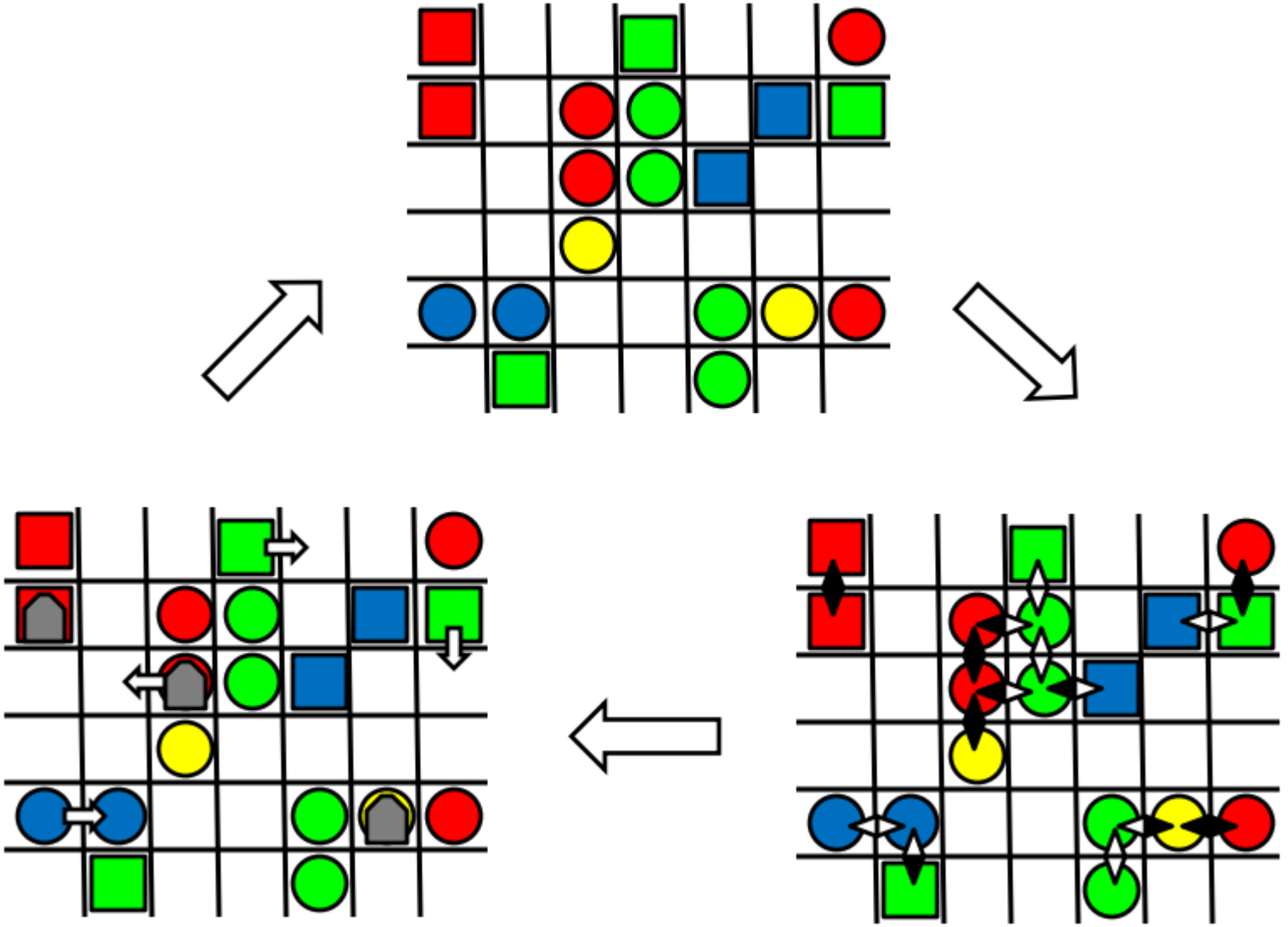
Spatial Model

Final configuration

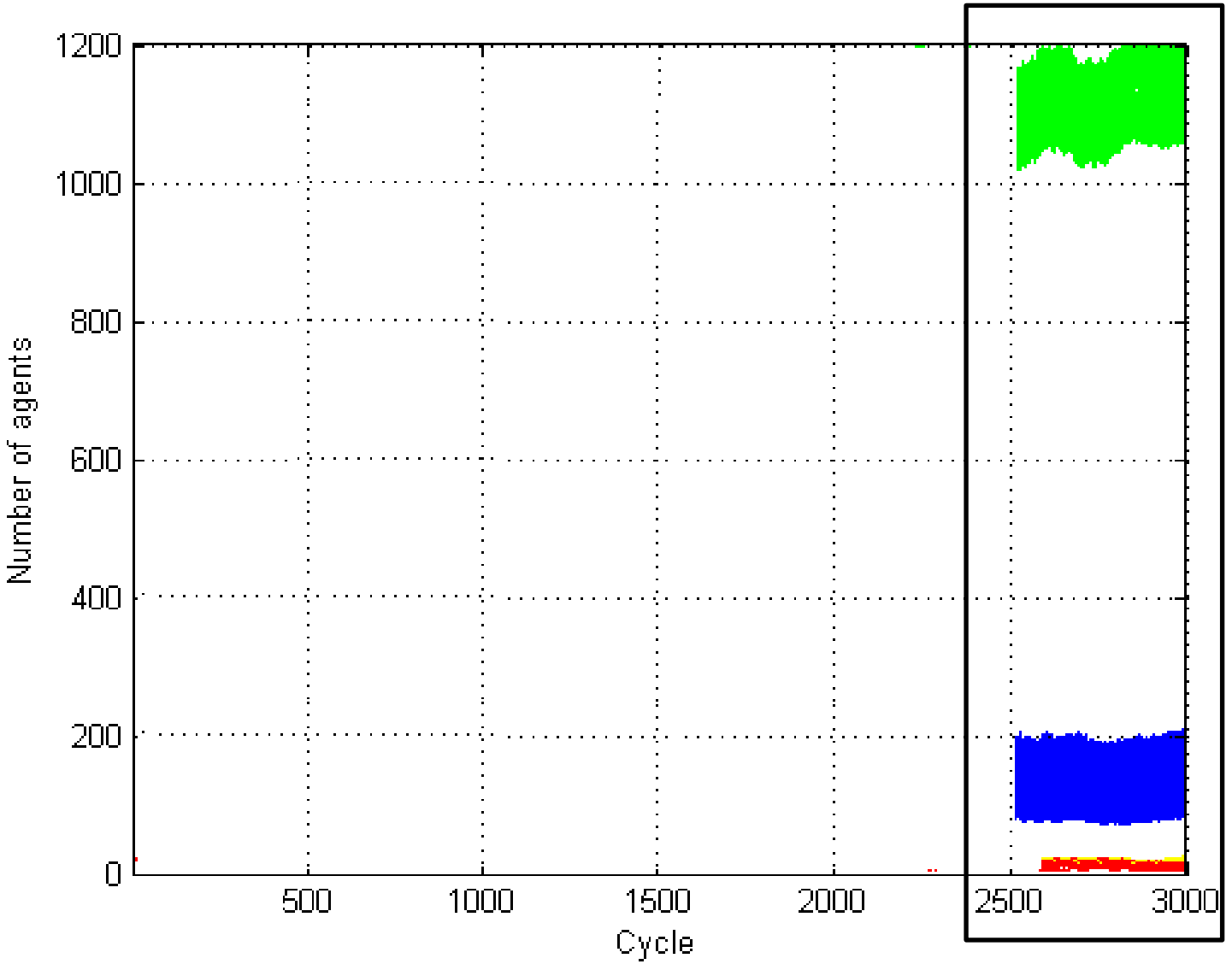


Spatial Model

Rinse and repeat



Previous Results



ptr = 0.1
death = 0.1
b = 0.025
c = 0.01

Hammond & Axelrod (2006)
Journal of Conflict Resolution

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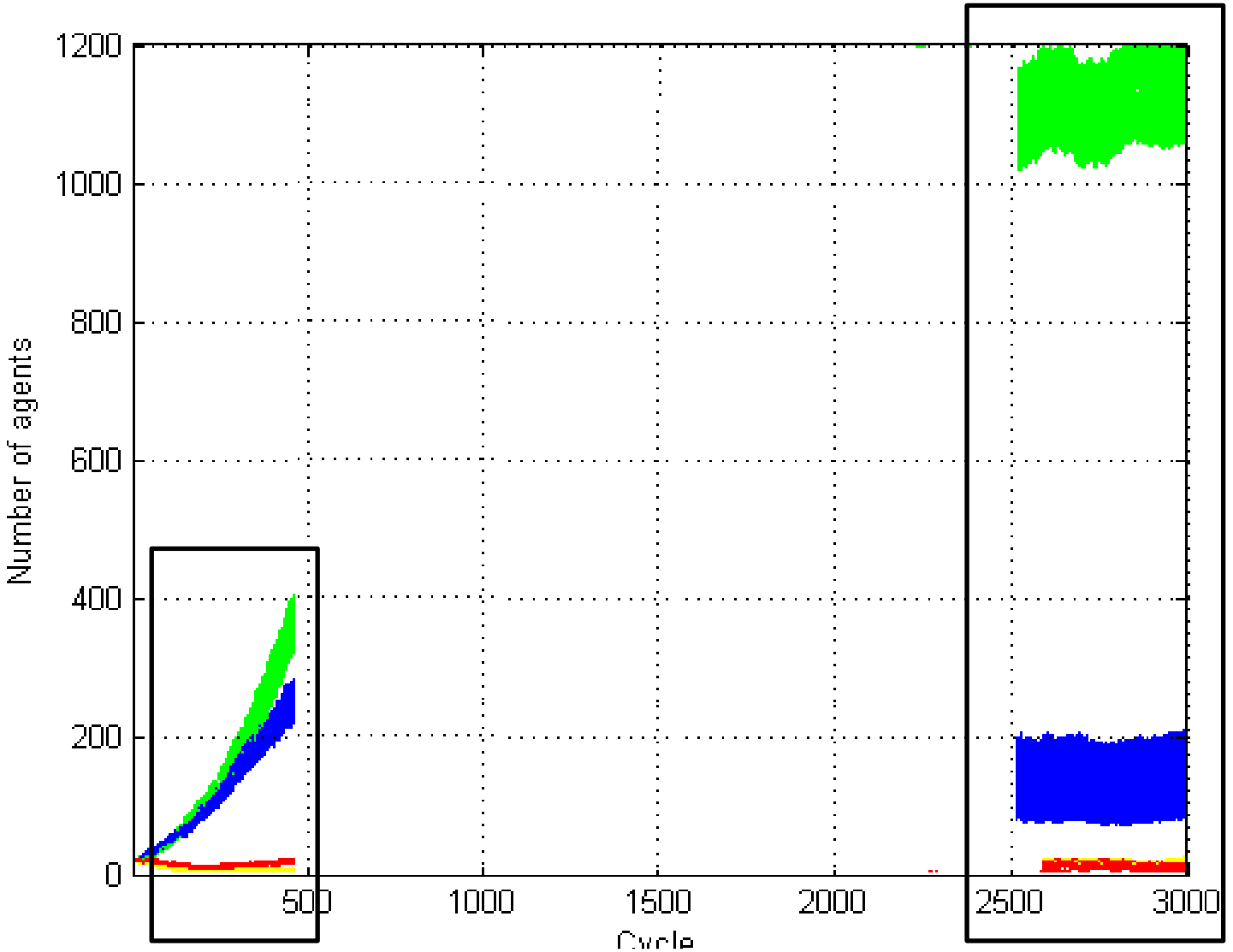

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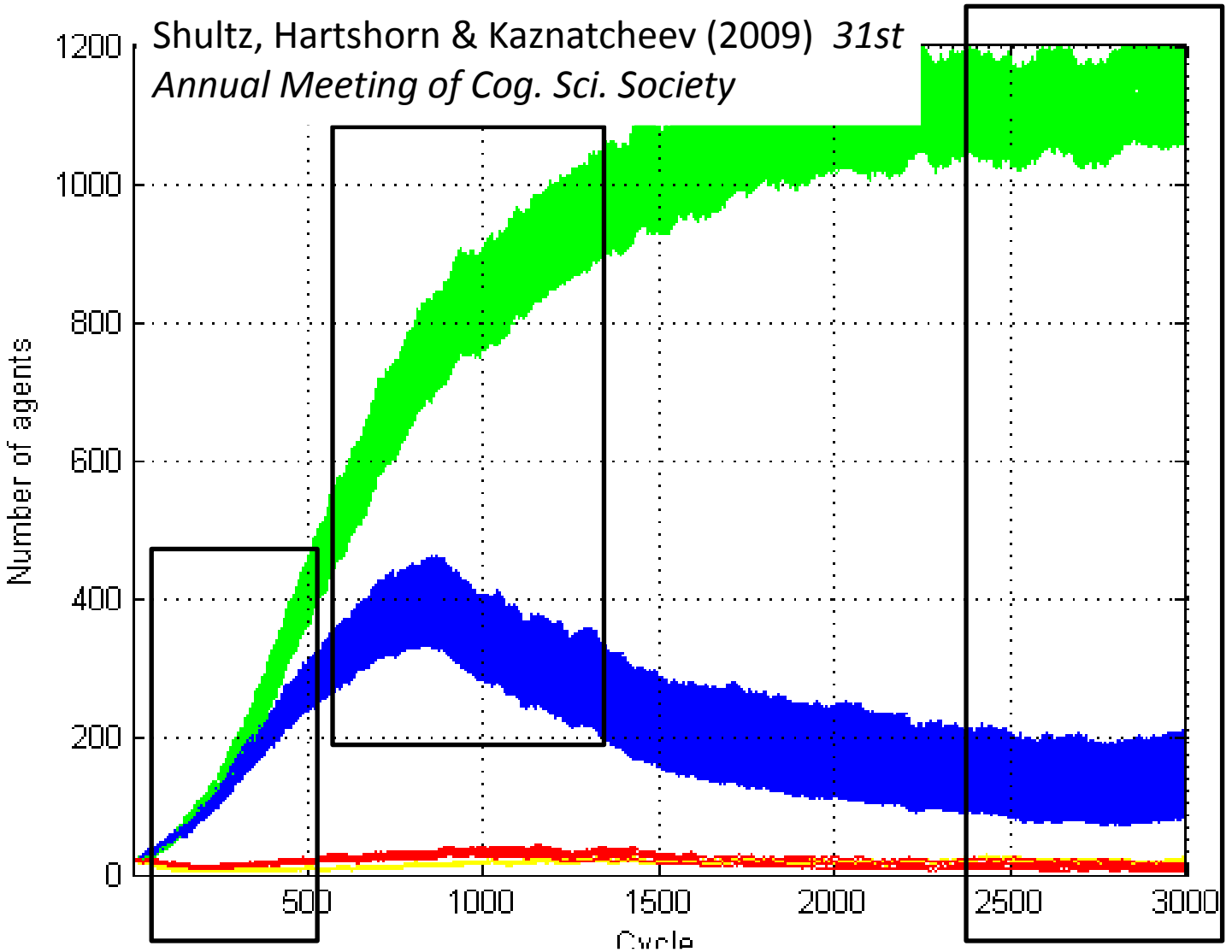

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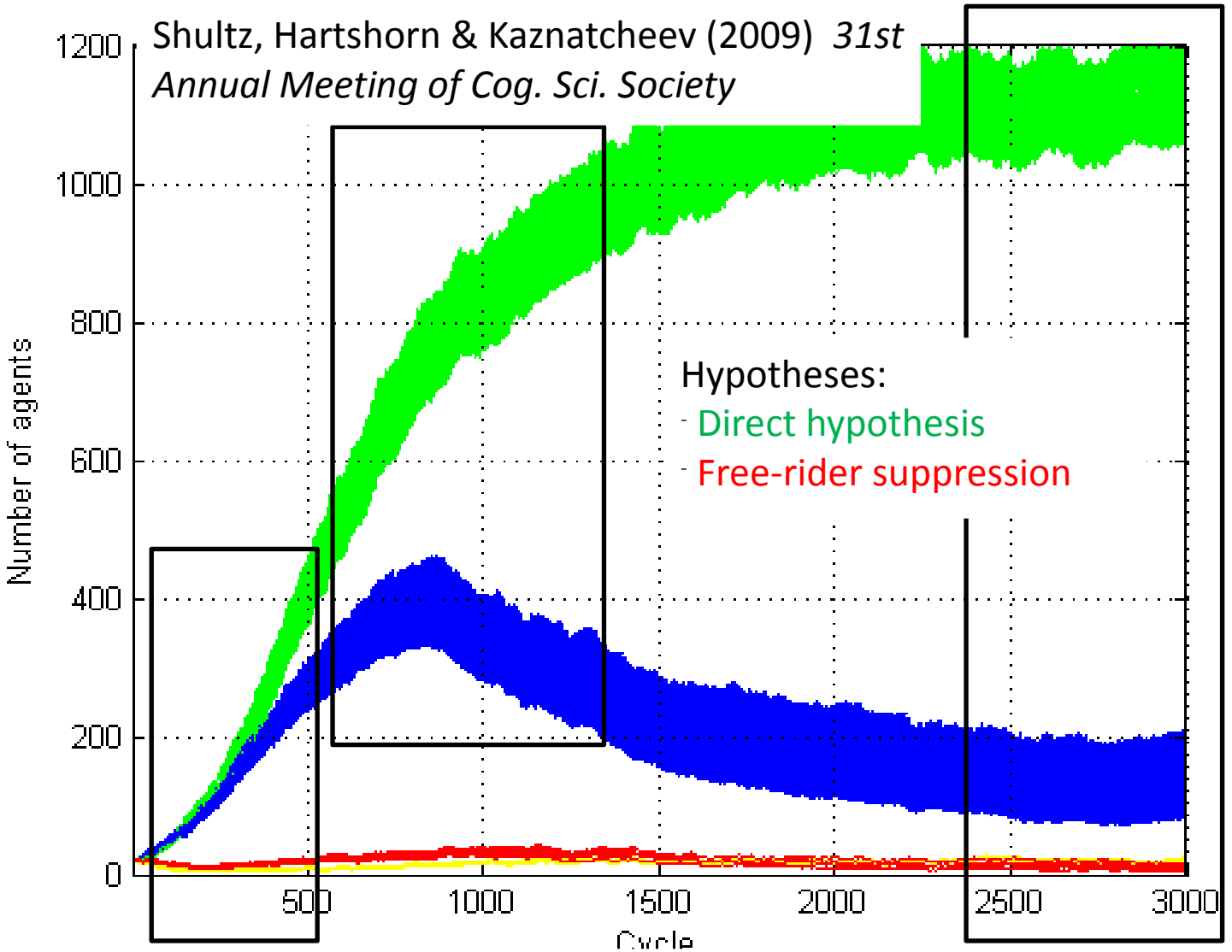

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Two Hypotheses

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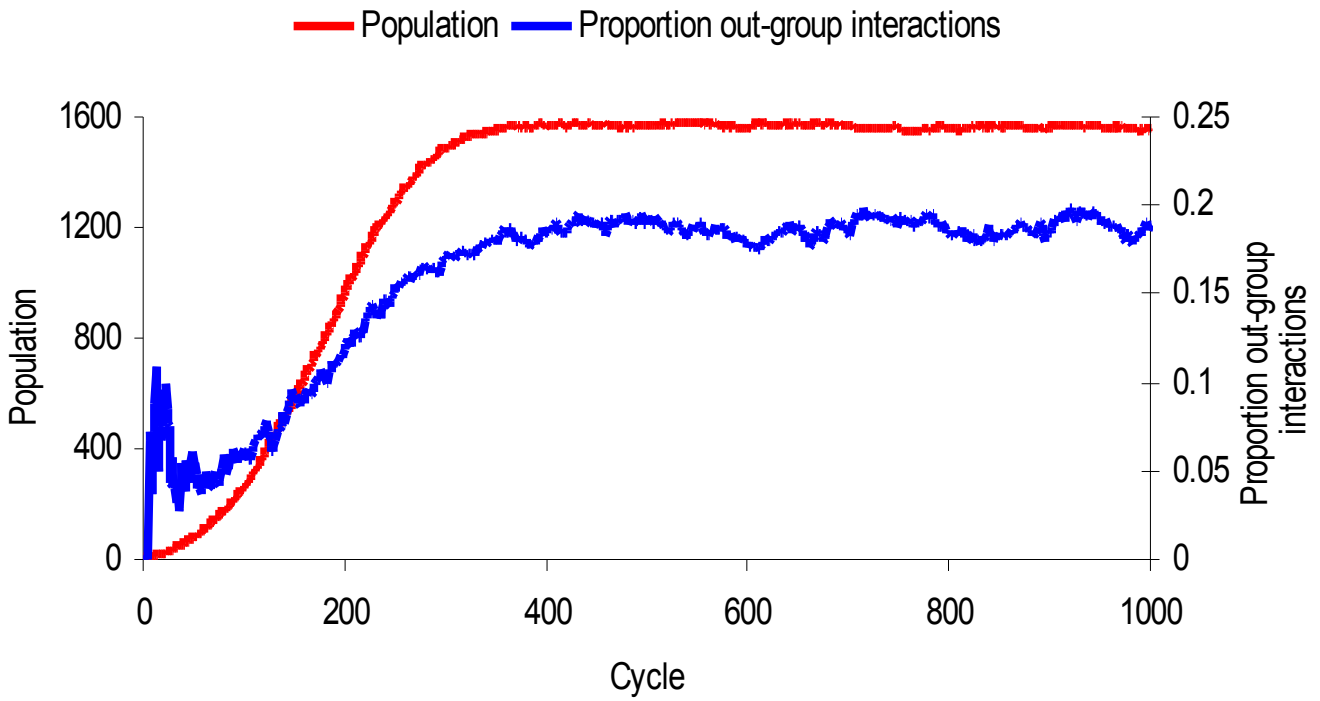
- Direct hypothesis: ethnocentric clusters of agents directly suppress contacted clusters of humanitarian agents.
- Free-rider-suppression hypothesis: ethnocentrics are more effective than humanitarians at suppressing free riders: selfish and traitorous agents
- Both predict ethnocentrics and humanitarians to diverge after world saturation

World Saturation



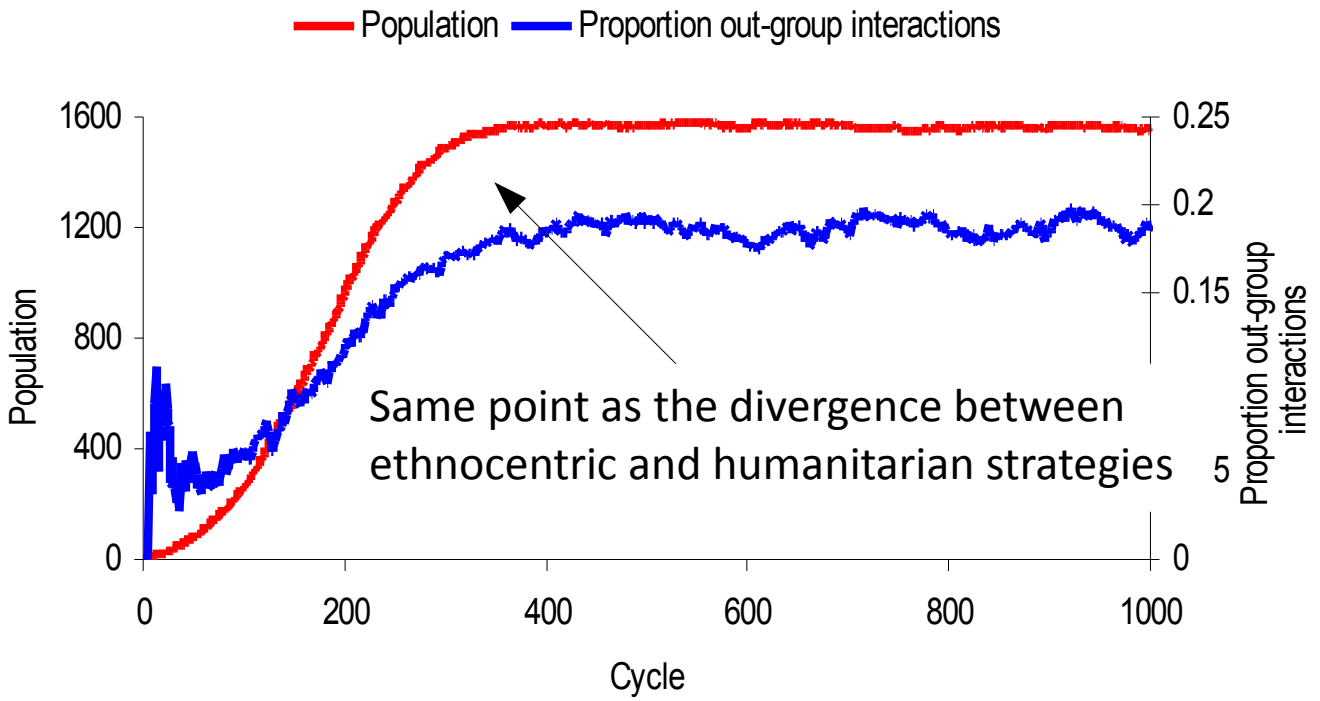
ptr = 0.12

death = 0.1

b = 0.03

c = 0.01

World Saturation



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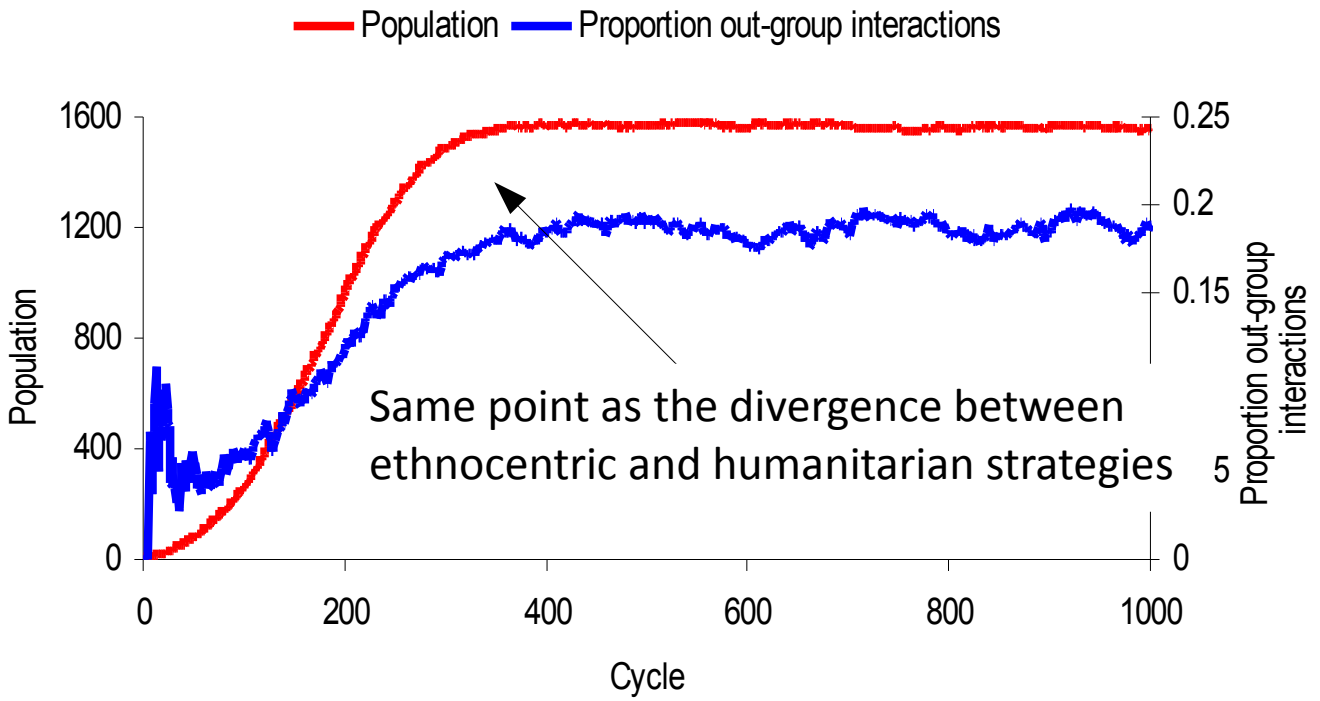

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Two main effects:

- Clusters with different tags collide and out-group strategy becomes important
- Free-space is most scares and thus competition most fears

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- Identify the key difference between this model and a purely inviscid one:

  (1) There are tags on which to base decisions

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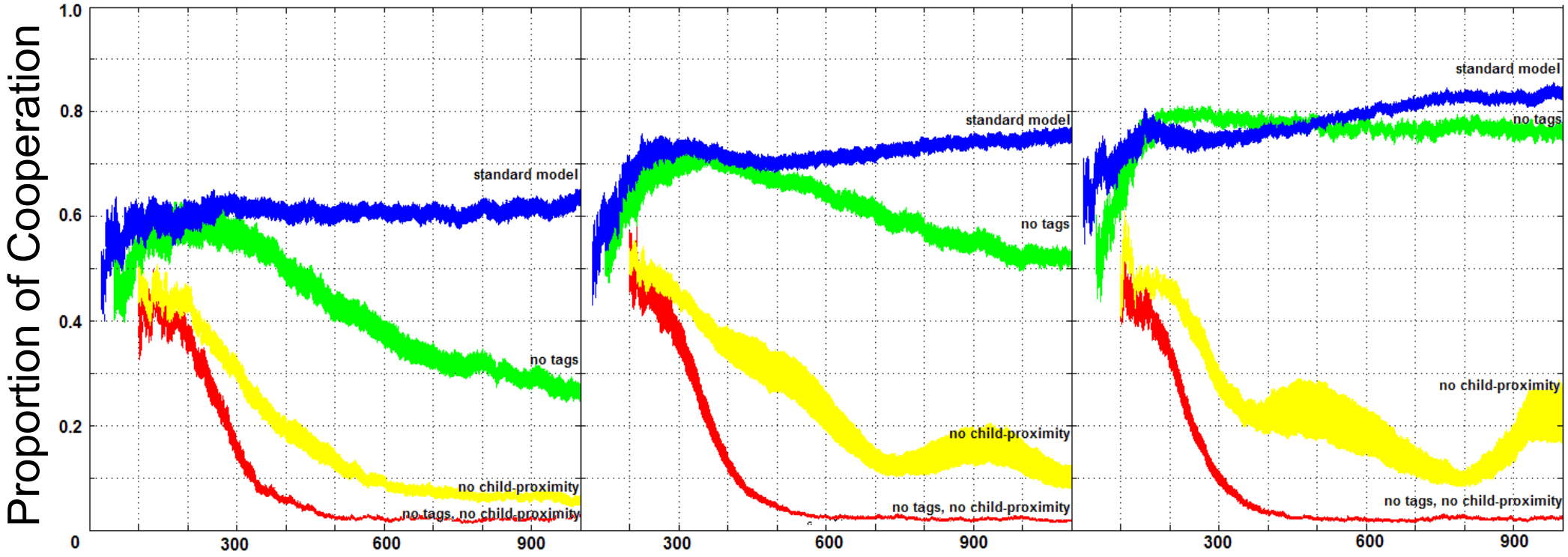
- Eliminate these differences and study the resulting dynamics

Restricted Models



b = 0.02

b = 0.03

b = 0.04

ptr = 0.1

death = 0.1

c = 0.01

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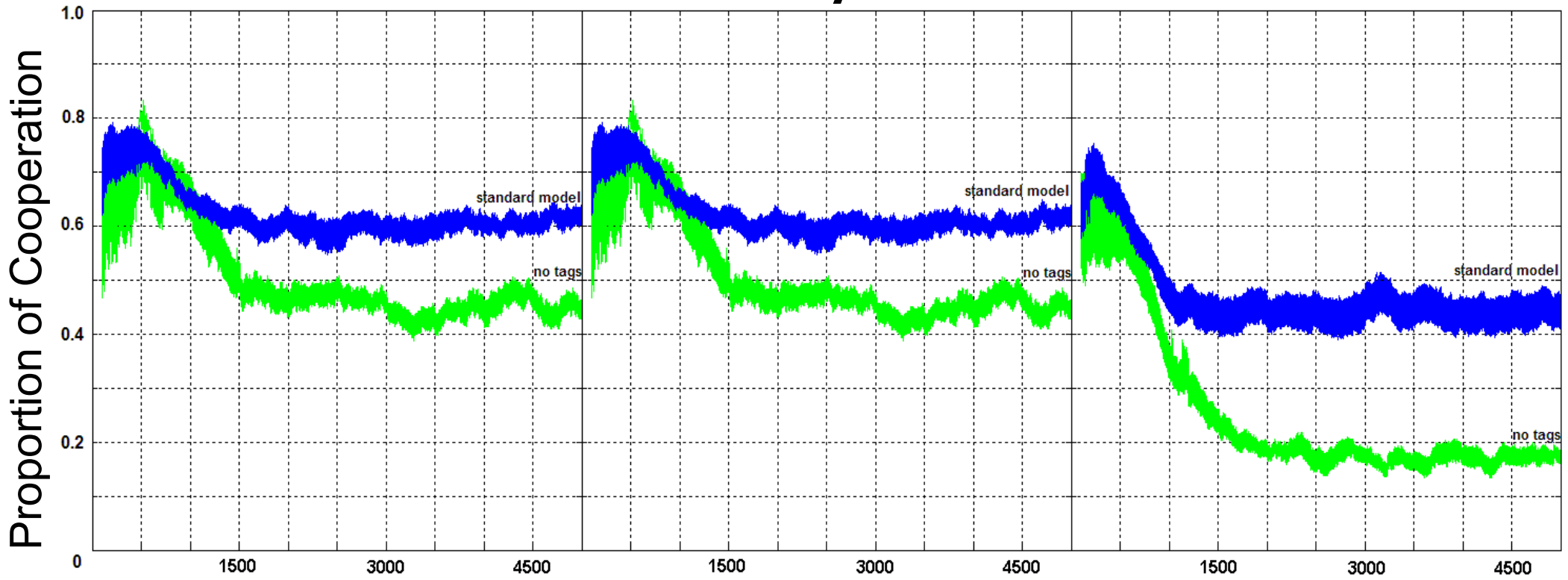
- What about the competition for free space?

Environmental Austerity



ptr = 0.1

ptr = 0.105
death = 0.1
b = 0.03
c = 0.02

ptr = 0.11

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Beer (2000) *Trends in Cognitive Sciences*

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- Ethnocentric agents are capable of categorical perception; a task that already merits a rich analysis.
- Can be seen as part of the biogenic approach to cognition

Beer (2000) *Trends in Cognitive Sciences*

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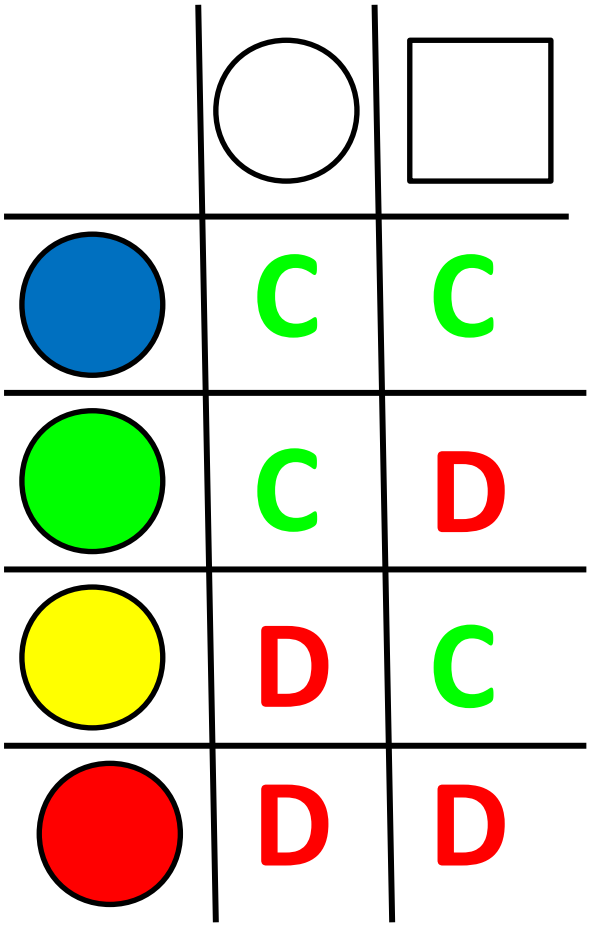
Lyon (2006) *Cognitive Processing*

Cognitive Complexity



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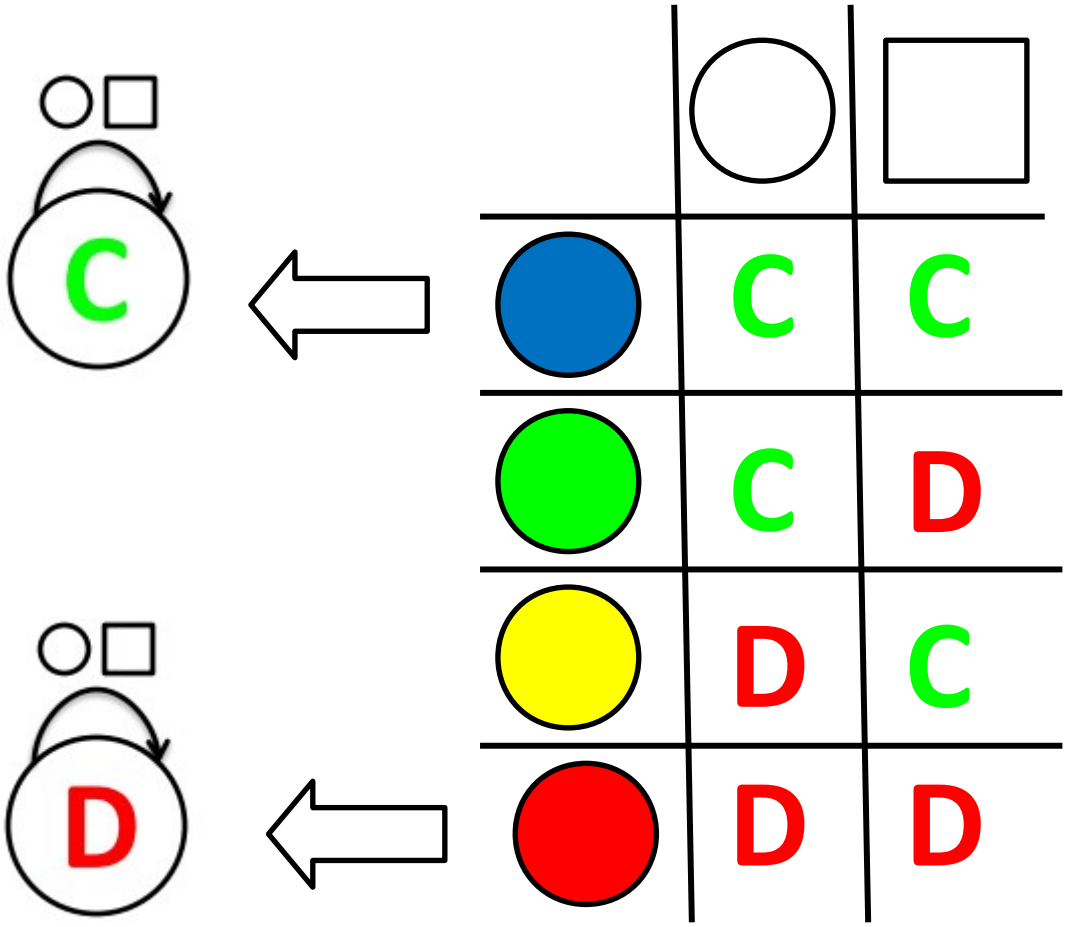

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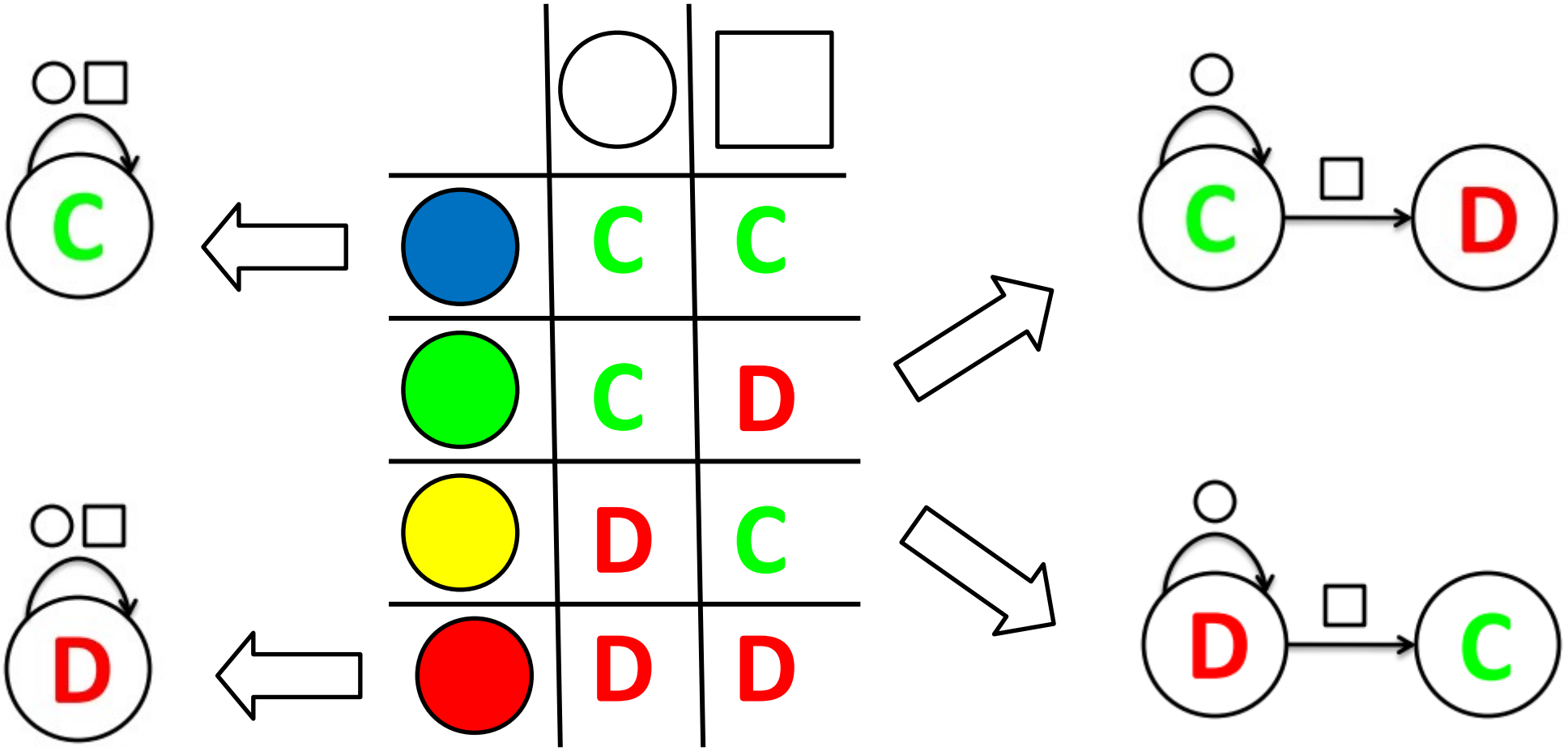
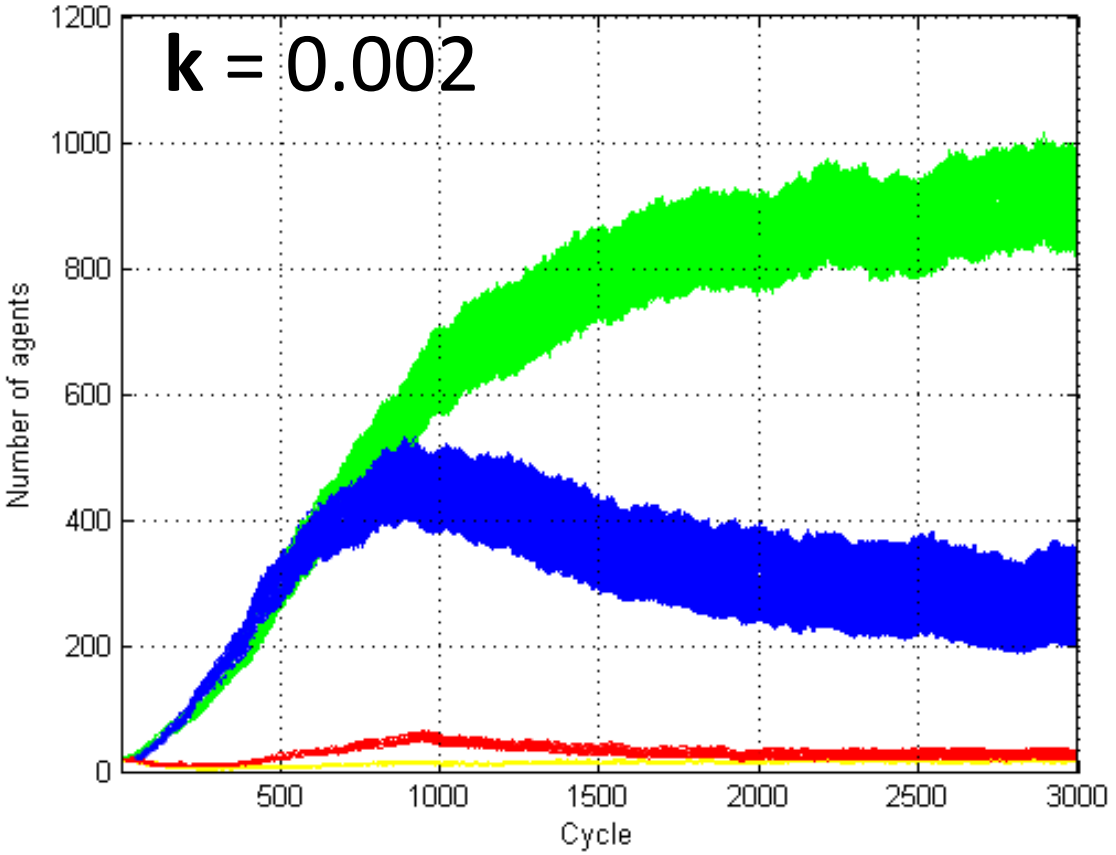


Associate a cost **k** with the extra complexity

Vary **k**



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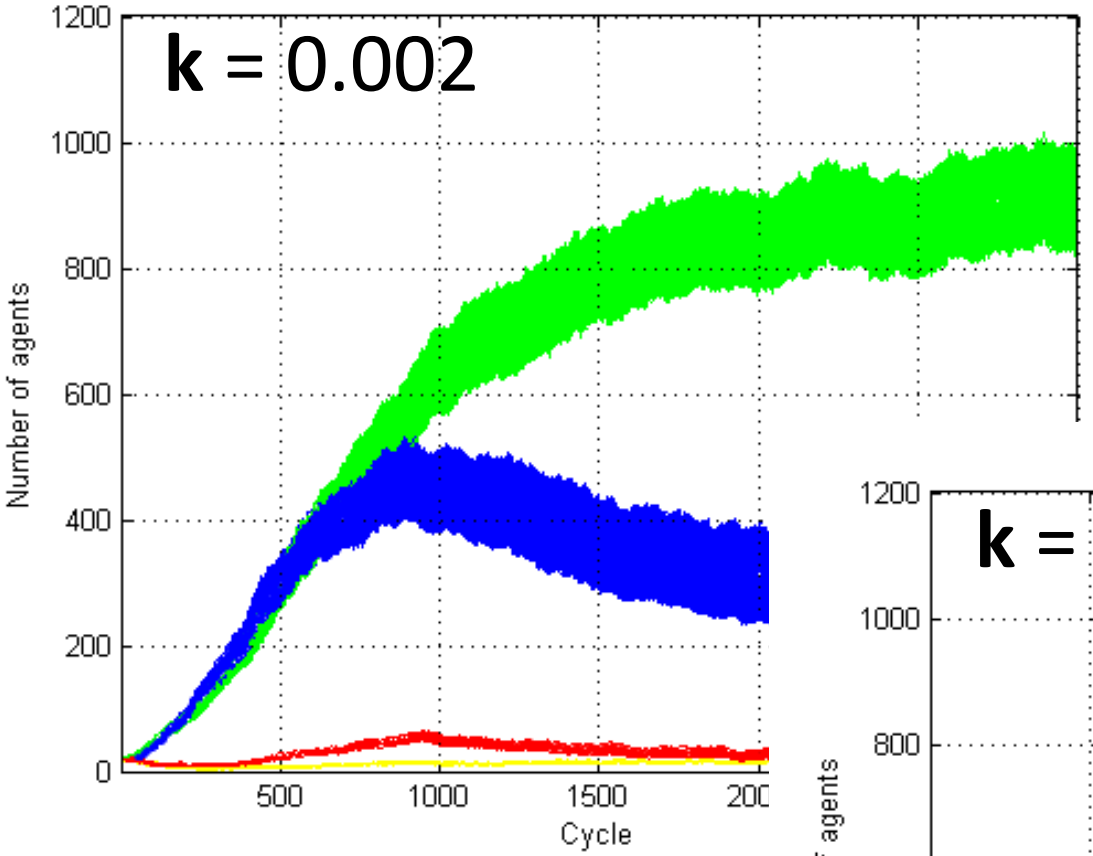
Vary **k**



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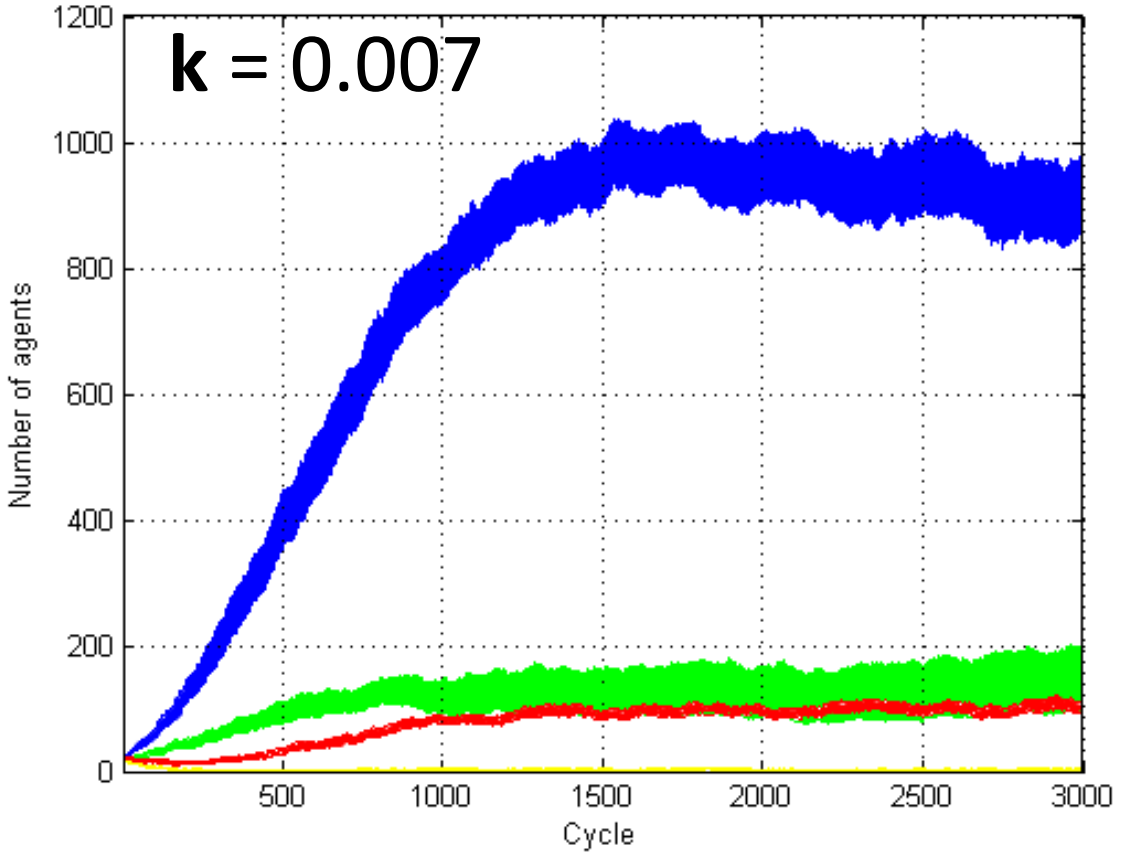

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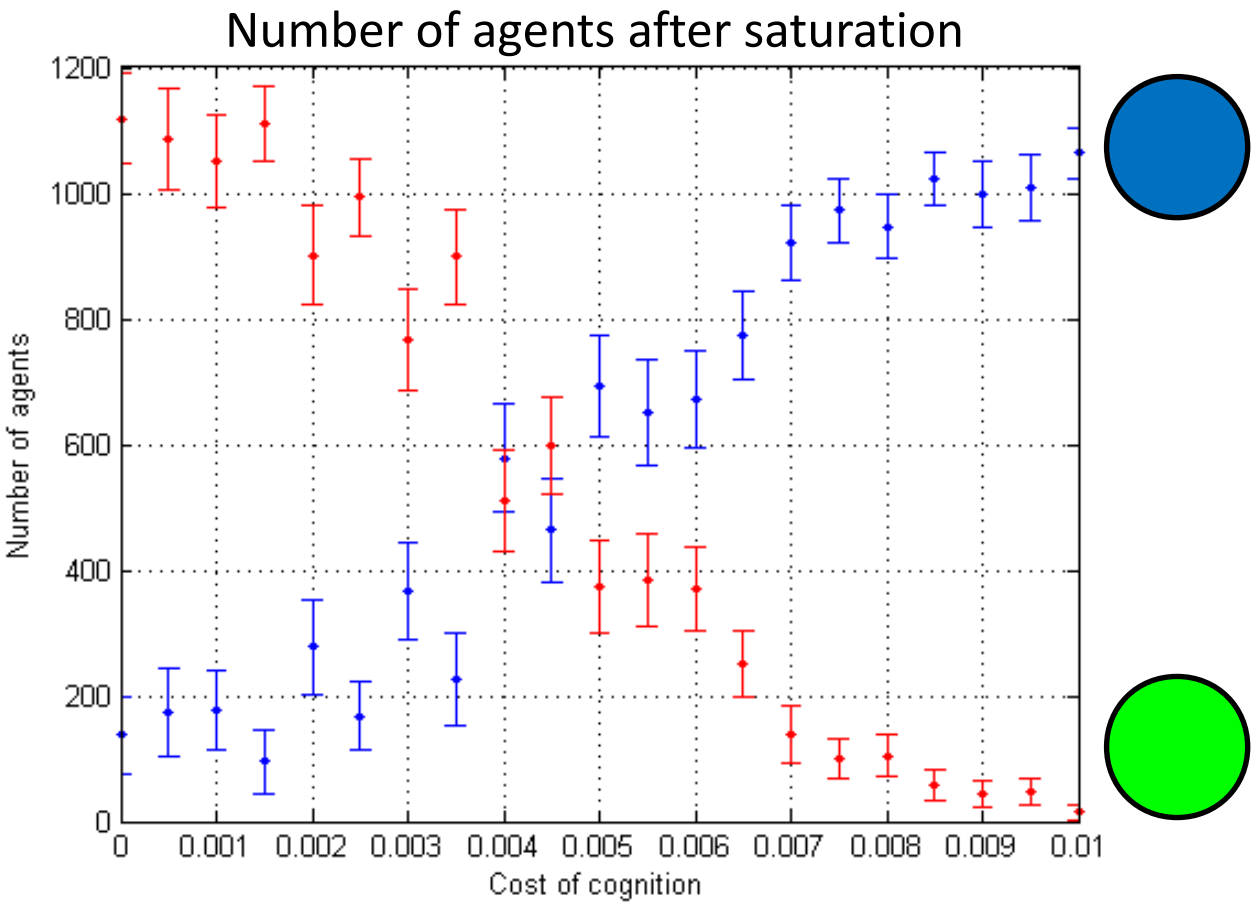

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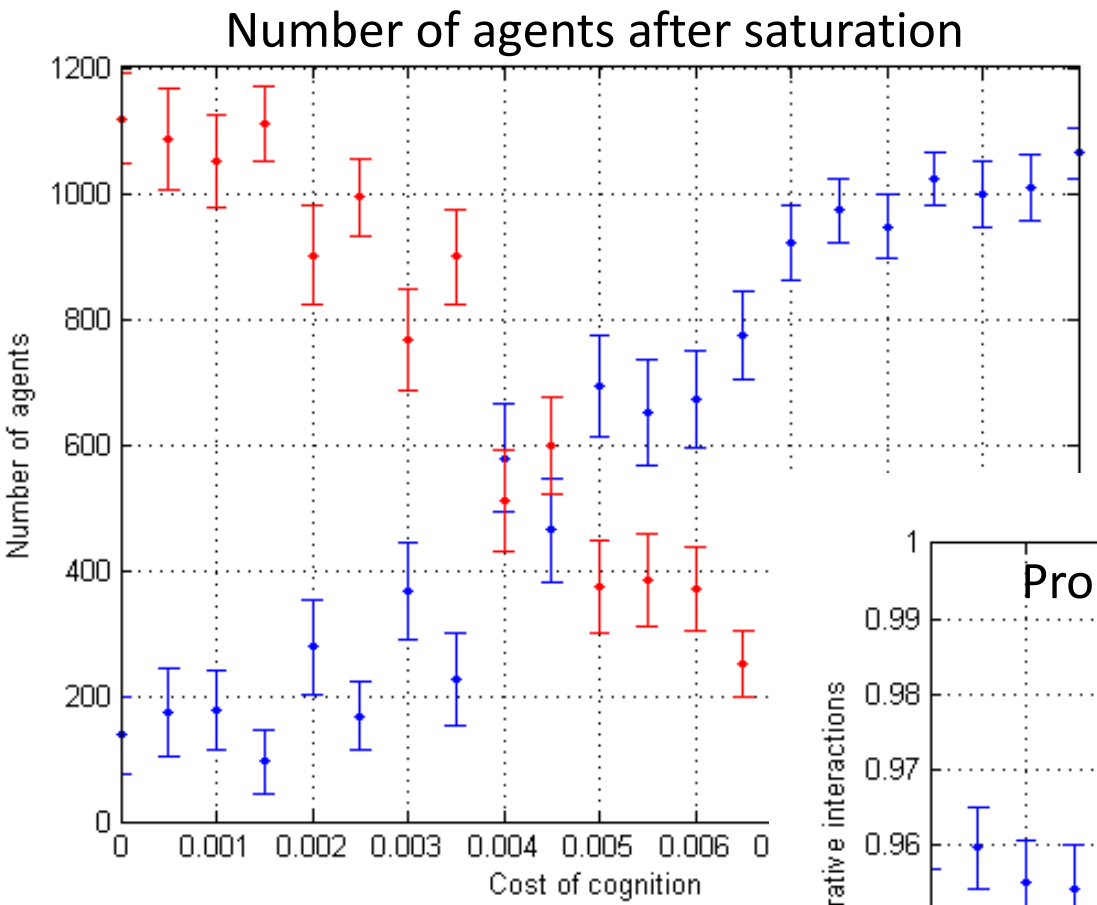

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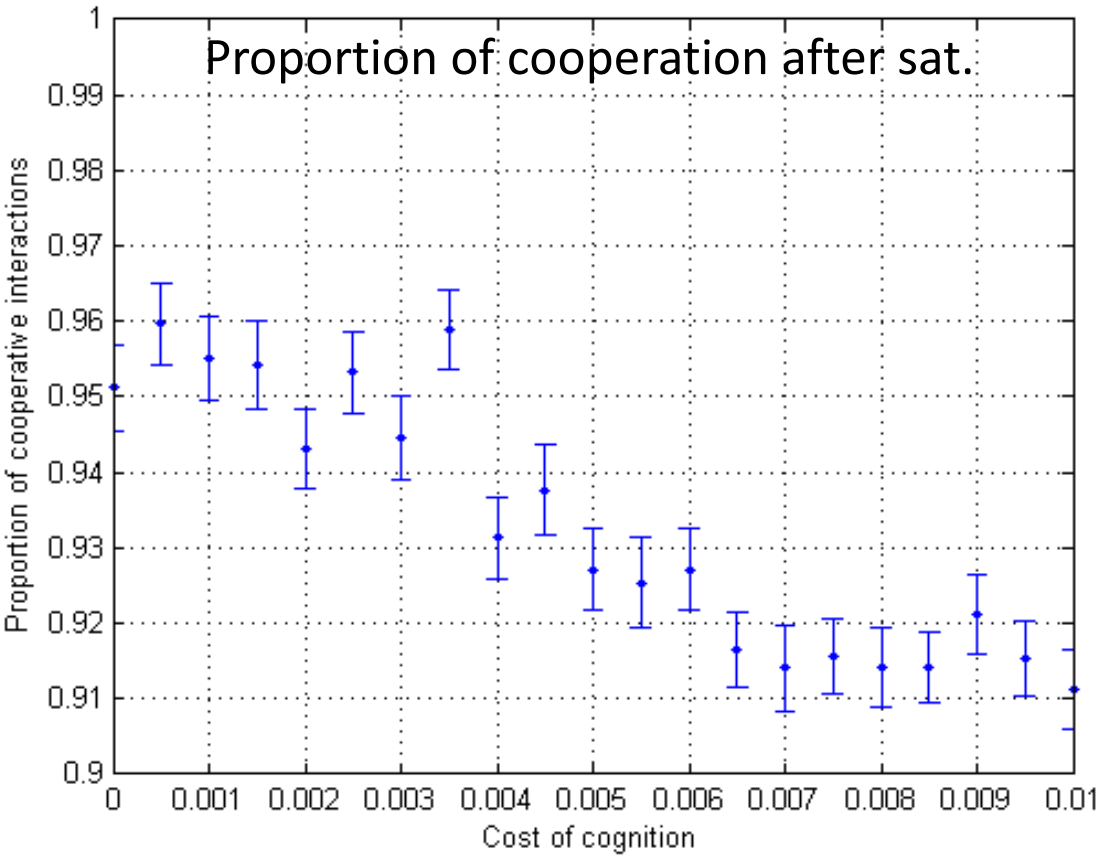

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- Cognitive mechanism must be
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- Ethnocentrism maintains higher levels of cooperative interactions: should we rethink or biases?

Importance of Robustness

- Difficult to identifying even the relative rankings of payoffs in nature

Milinski et al (1997) *Proc. Royal Soc. B*

Turner & Chao (1999) *Nature*

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- PD and HD can have drastically different effects in spatial structured populations
- Important to study all cooperate-defect games!

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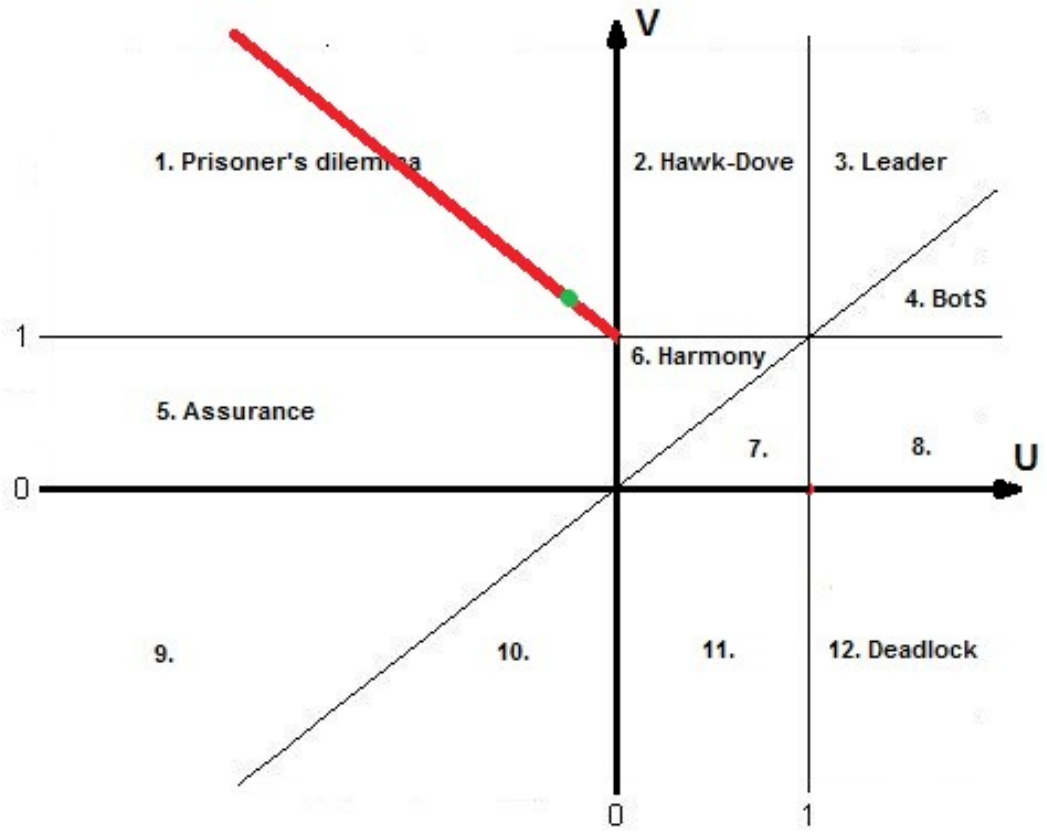
Game Space

$$\begin{bmatrix} 1 & U \\ V & 0 \end{bmatrix}$$



Game Space

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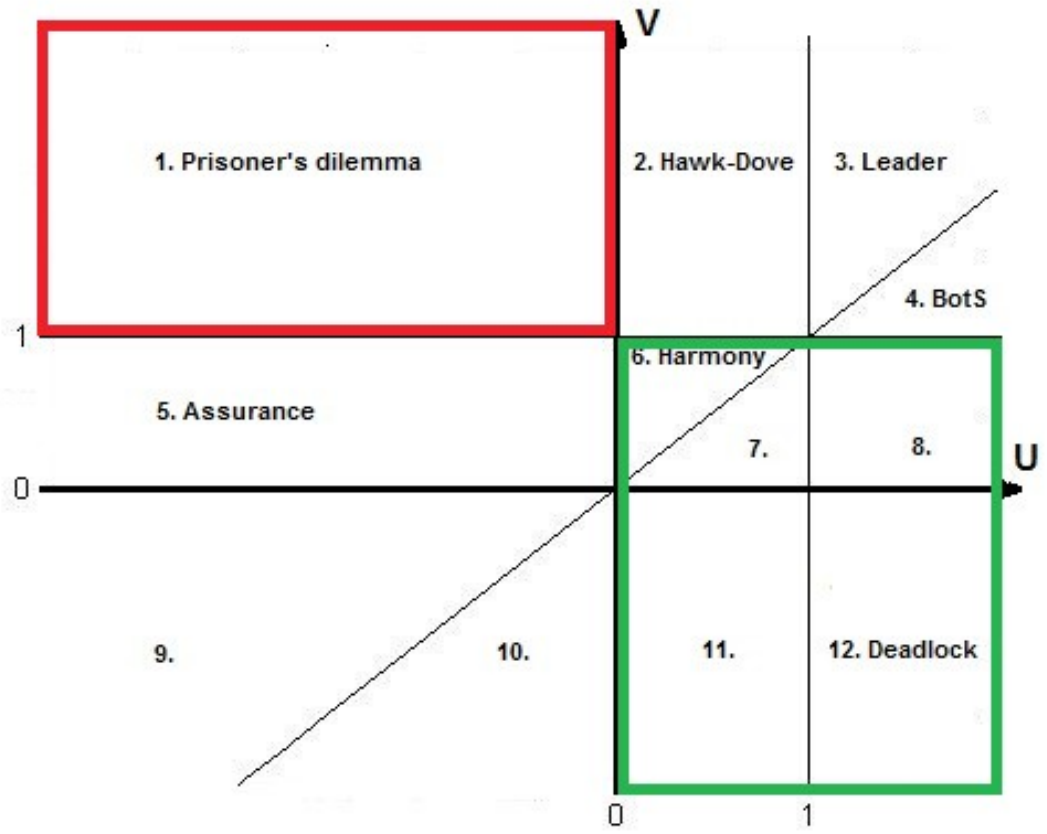
V < 1:
C is Nash/ESS

U < 0:
D is Nash/ESS



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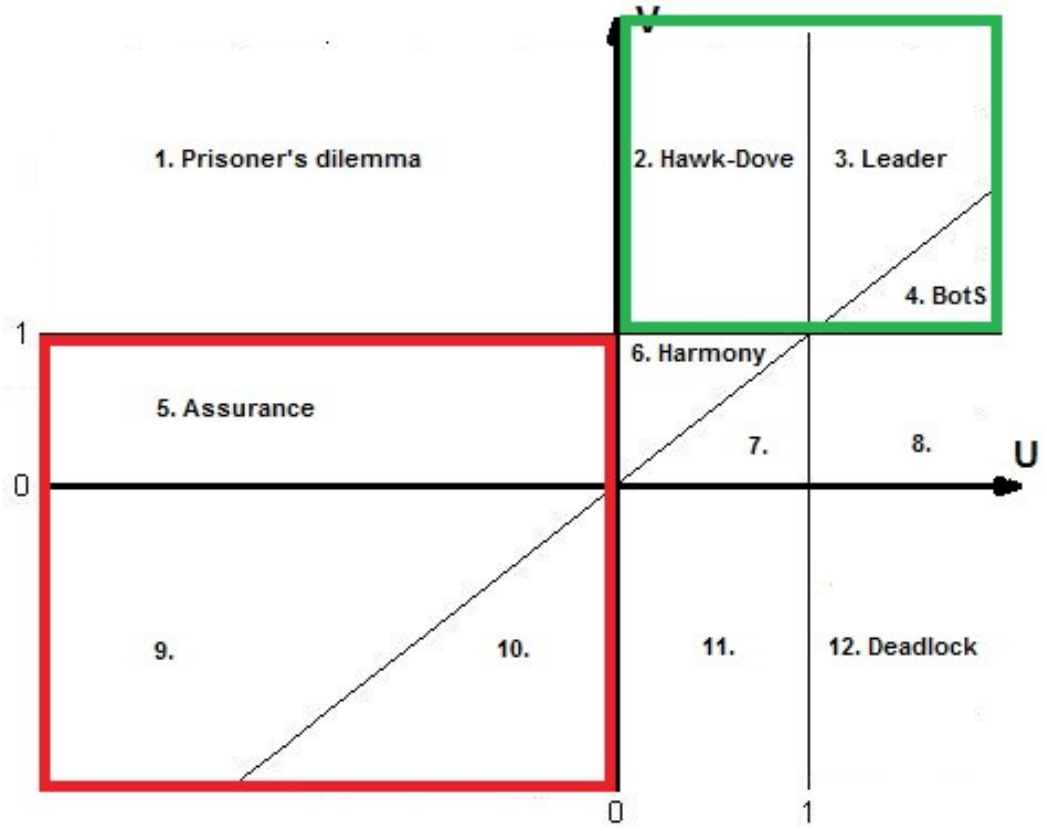

$$p^* = U/(U + V - 1)$$

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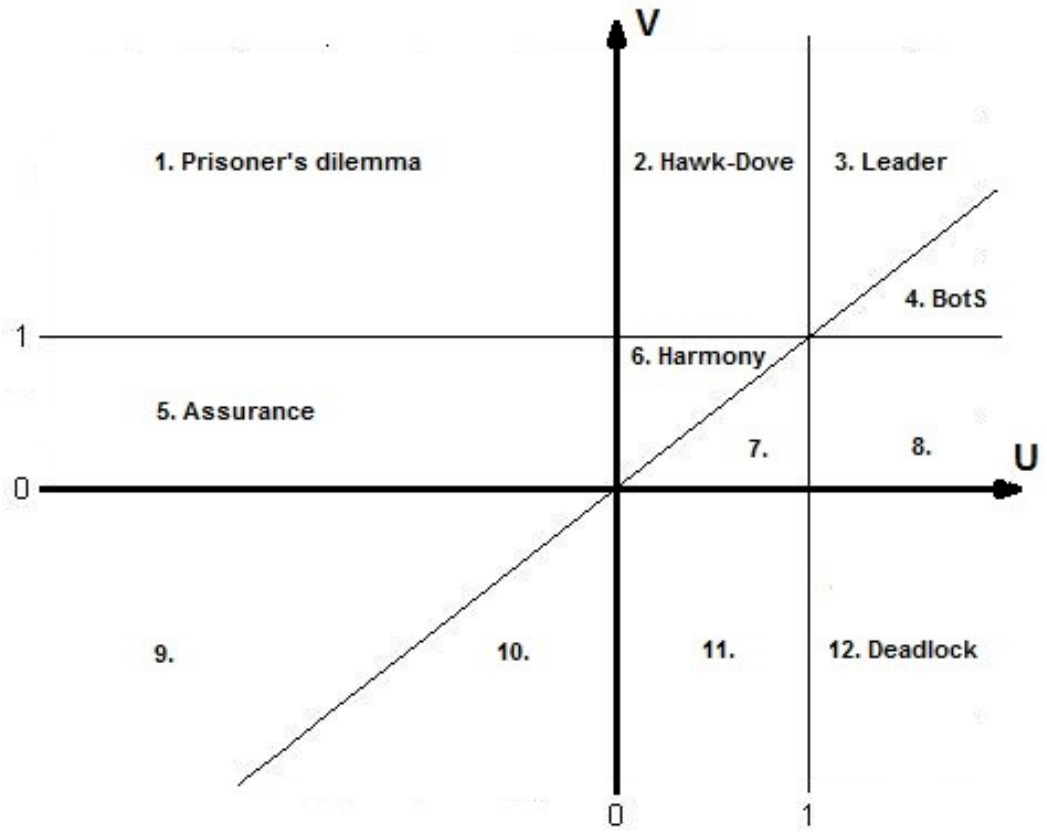
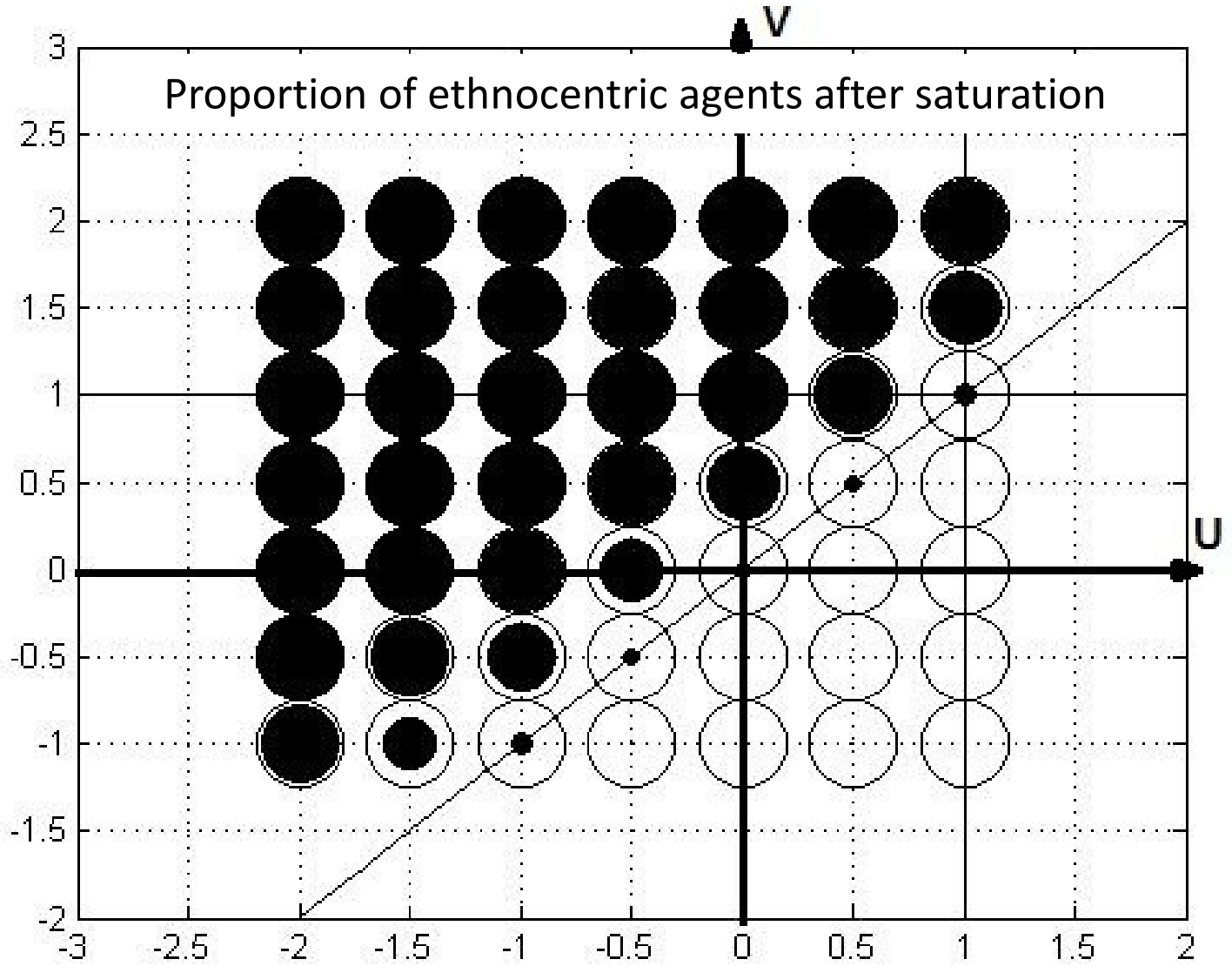


Results



$$\begin{bmatrix} 1 & U \\ V & 0 \end{bmatrix}$$

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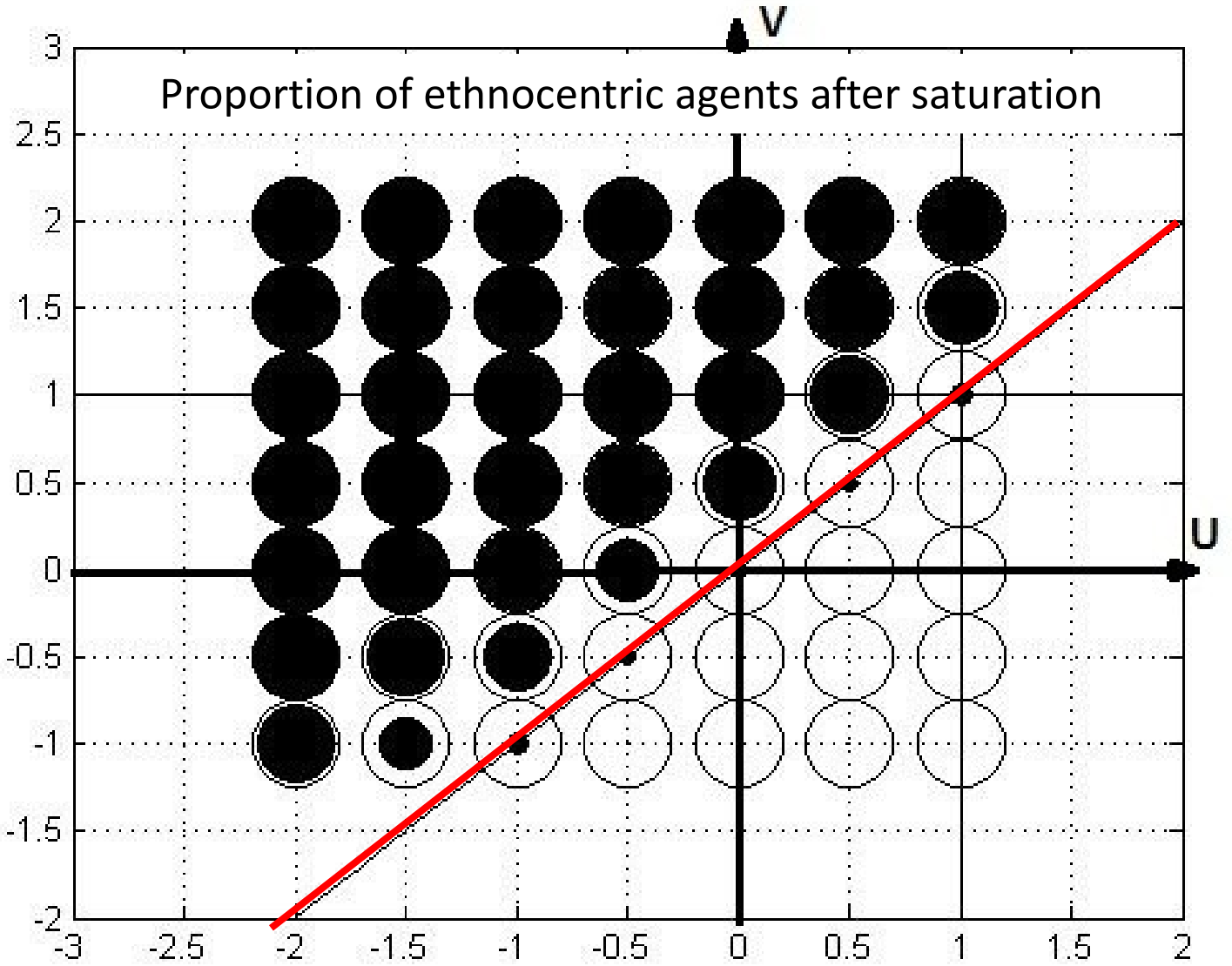

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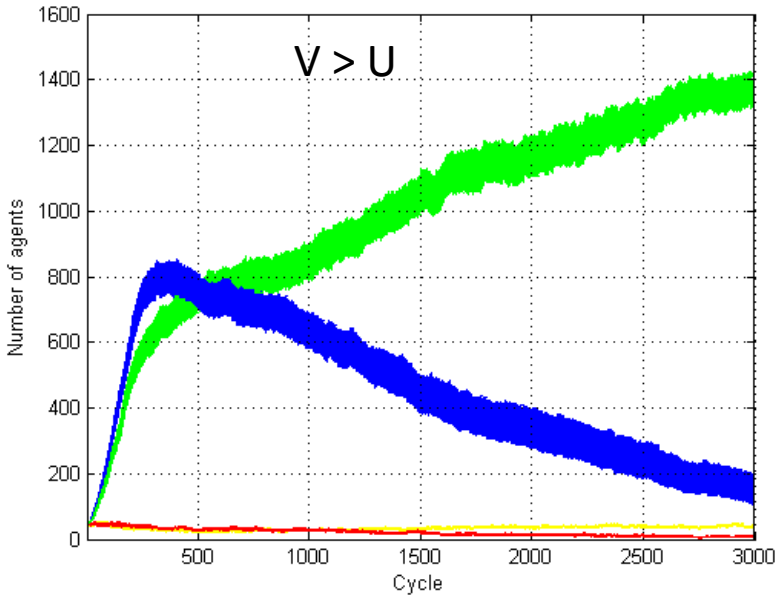

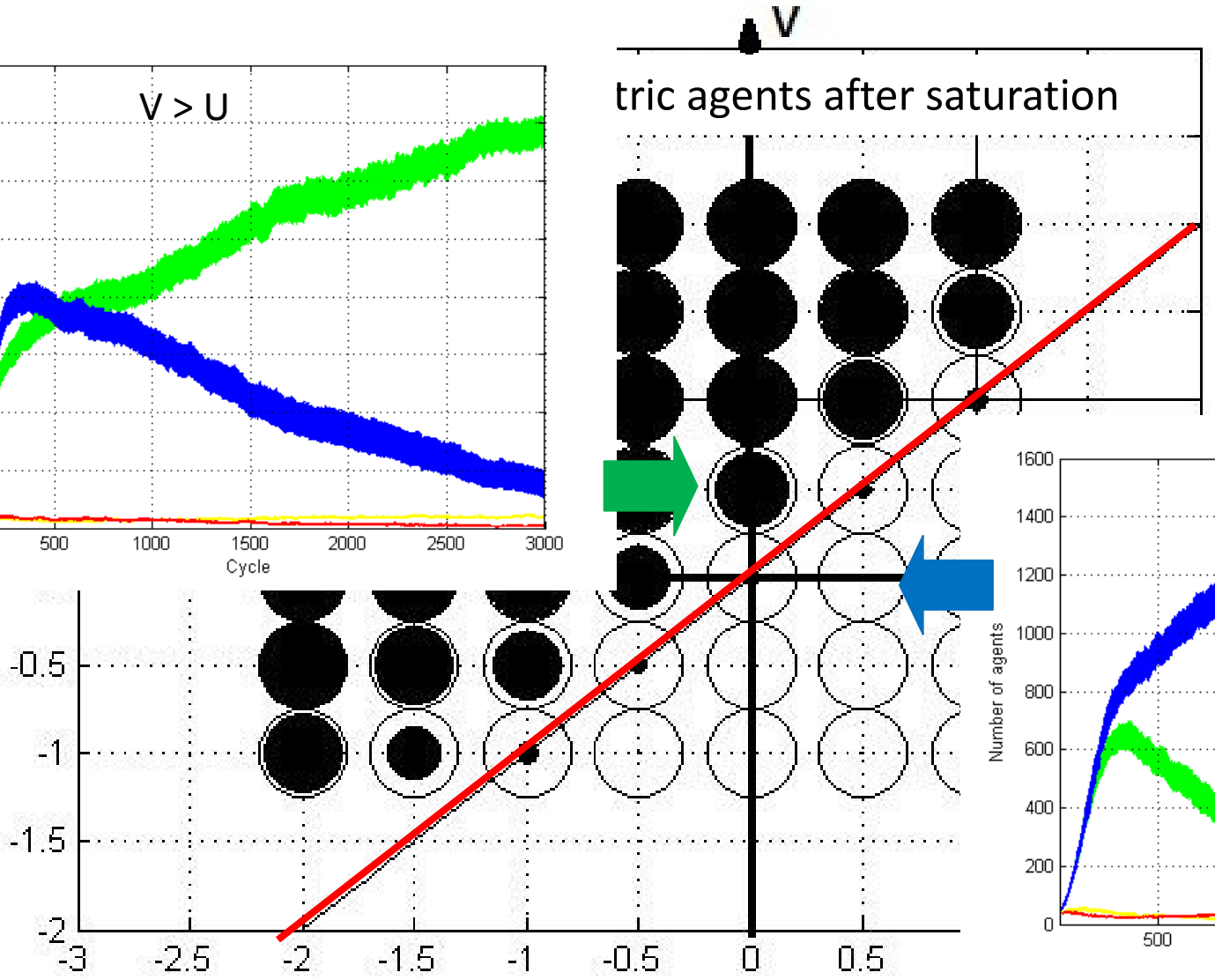

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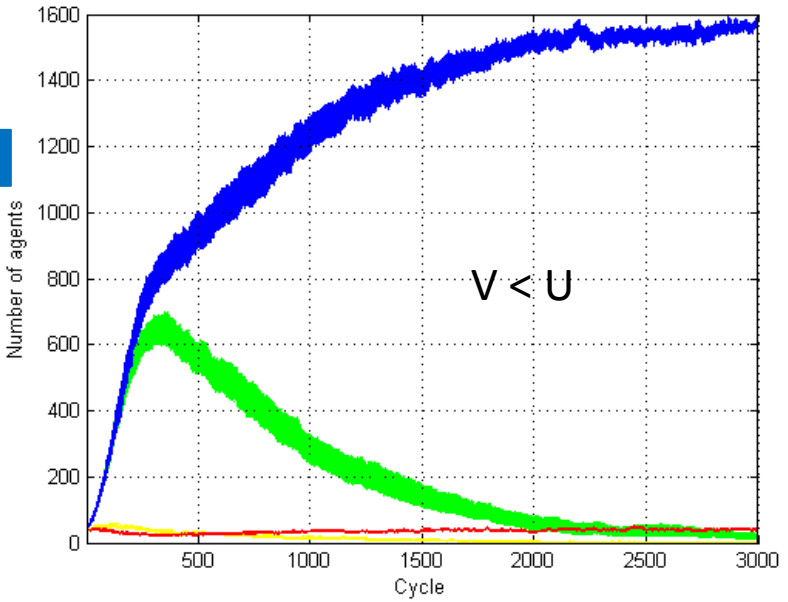

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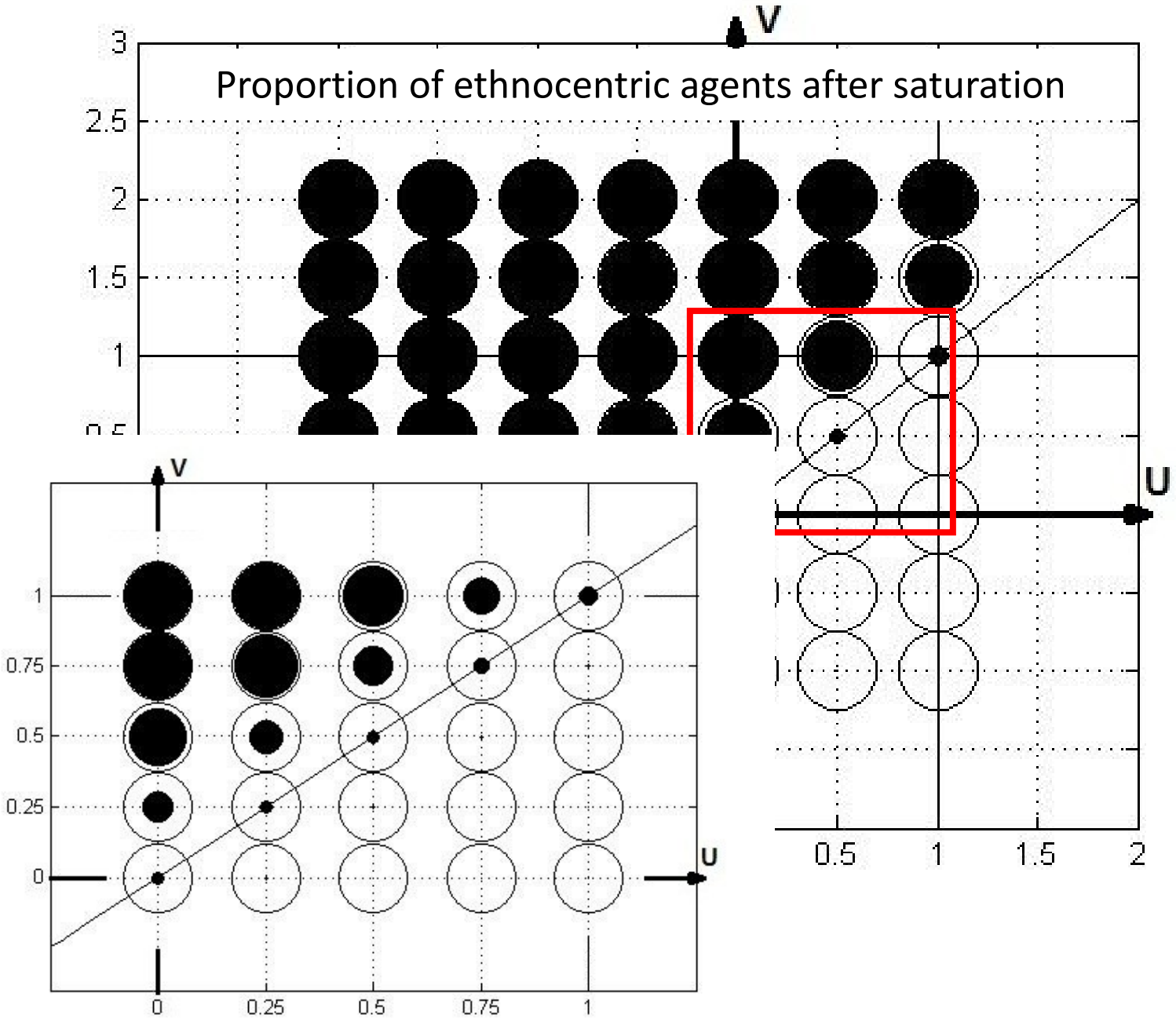

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Robustness of Ethnocentrism

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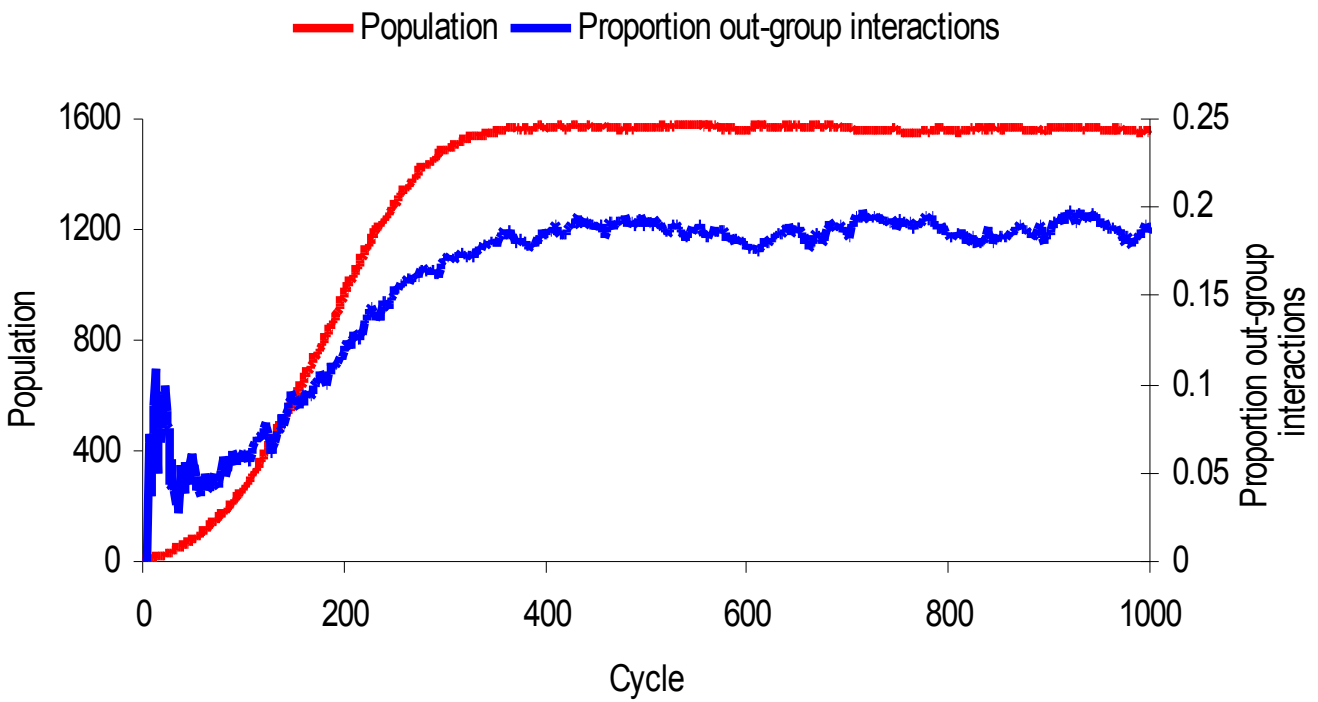
- Showed phase transition from ethnocentric ($V > U$) to humanitarian dominance ($V < U$)
- Ethnocentrism is robust against game variability
- Surprising to see ethnocentrism in the harmony game, where defection is irrational
  - Probably source: competition or free space
- Evolution of ethnocentrism can cause unexpected cooperative behavior, but also irrational hostility

Conclusion

- Showed the importance of world saturation on game dynamics



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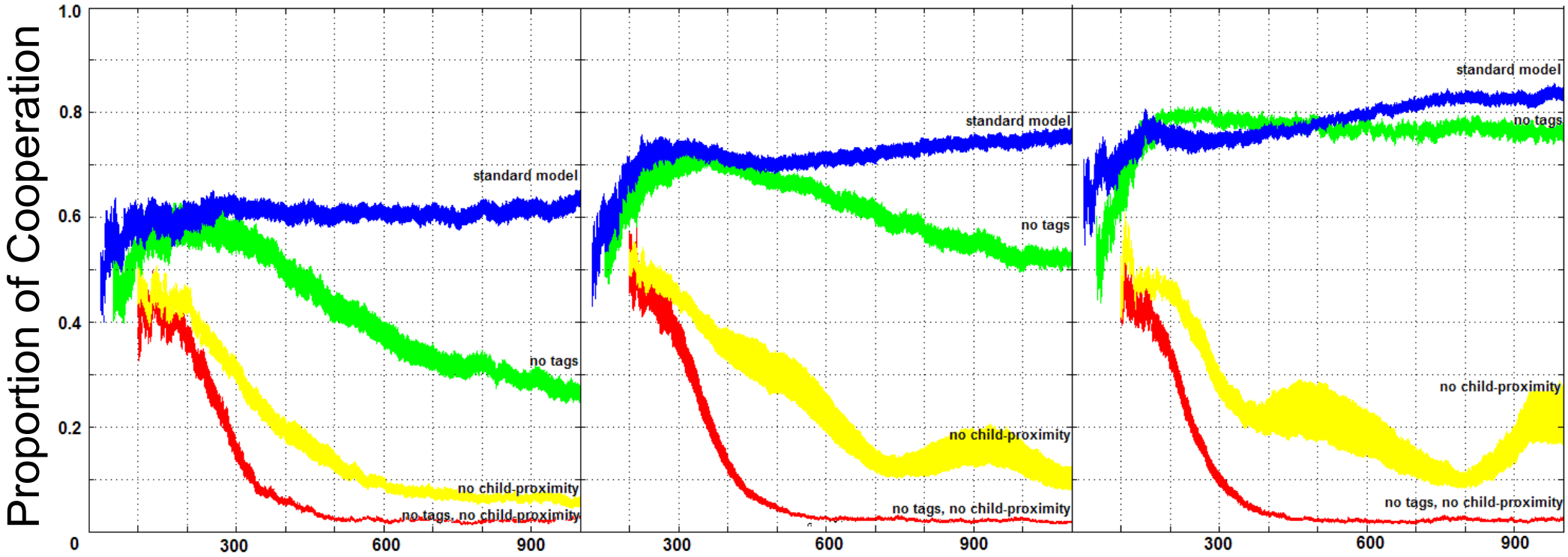

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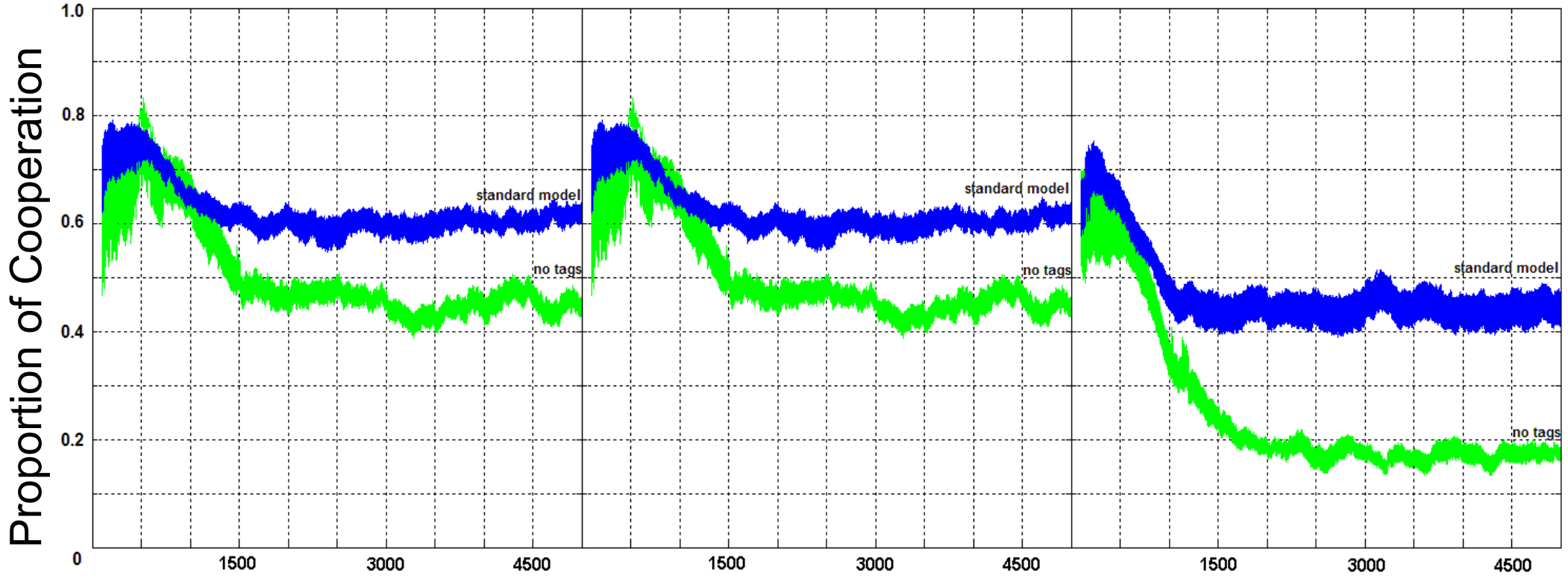

ptr = 0.1 **ptr** = 0.105 **ptr** = 0.11

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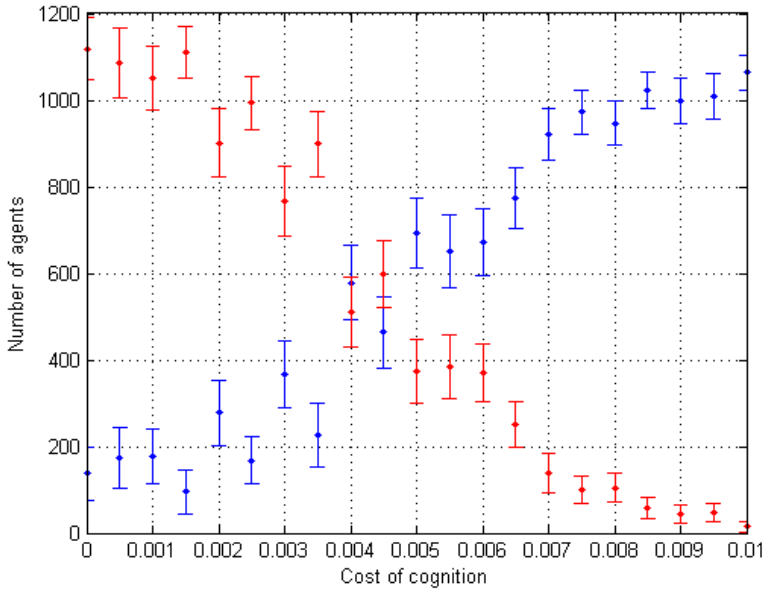

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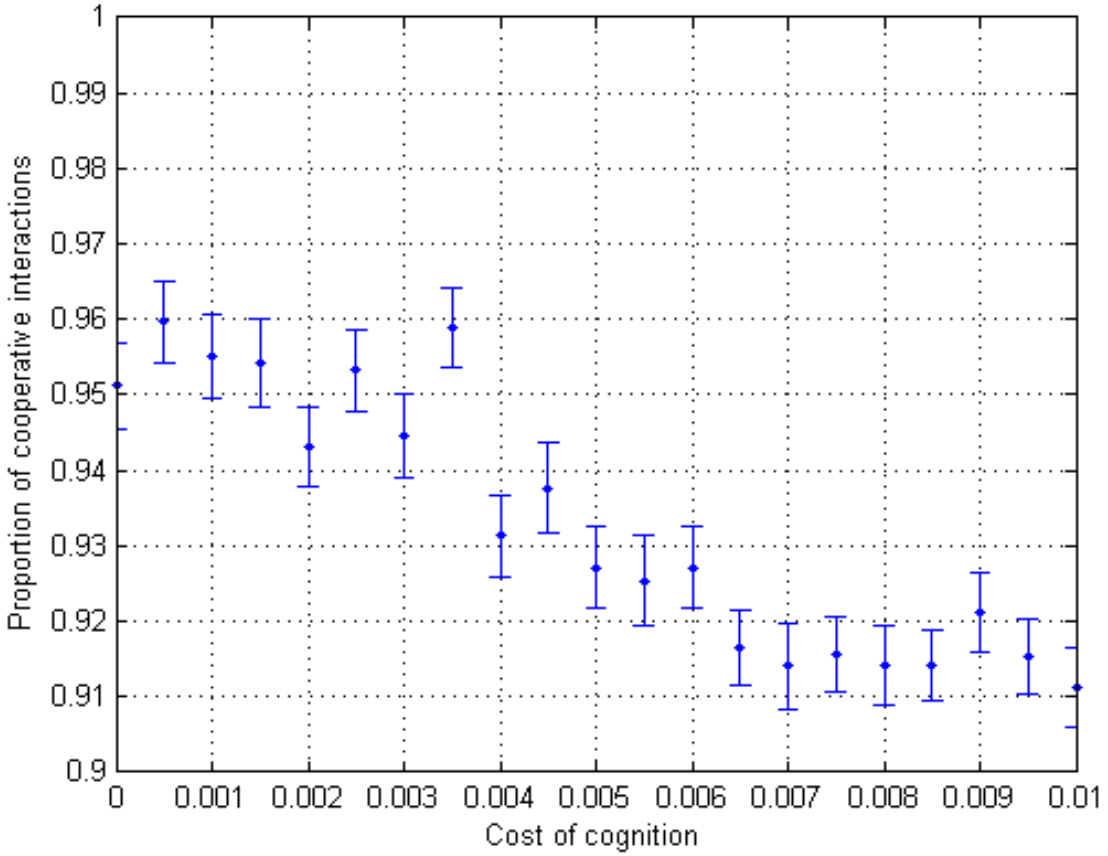

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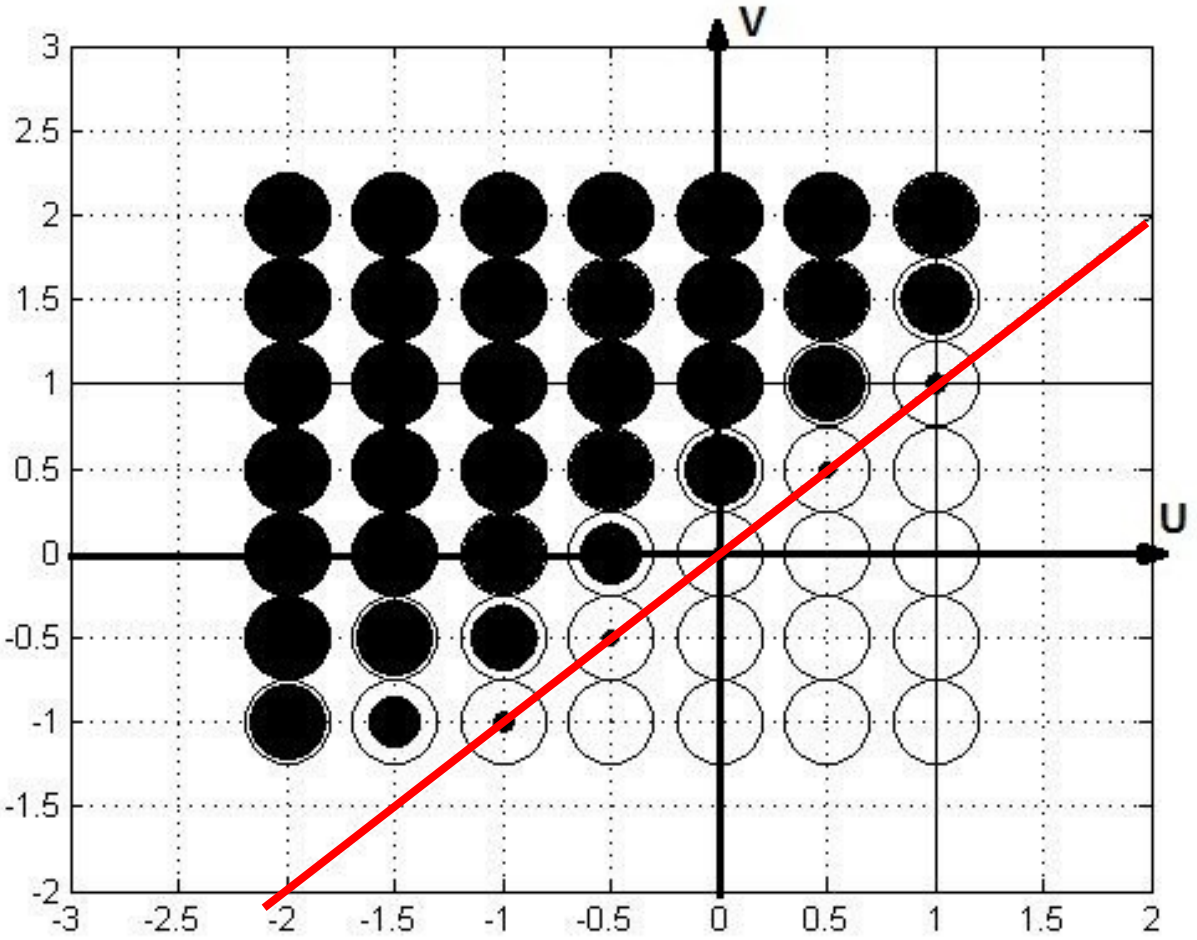

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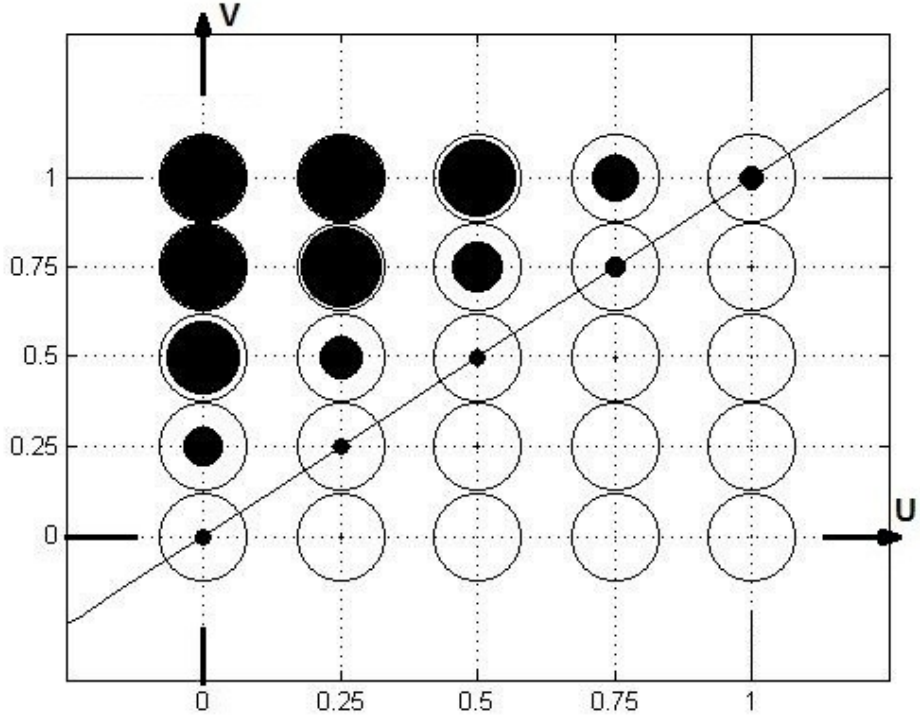

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