Evolution of ethnocentrism with minimal cognition in a spatially structured population

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Ethnocentrism

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

Cashdan (2001) *Current Anthropology*

Brown (2004) *Daedalus*

Ethnocentrism

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- Commonly thought to involve substantial cognitive ability

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LeVine & Campbell (1972) Ethnocentrism Hewstone, Rubin & Willis (2002) *A. Rev. of Psyc.*

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- Commonly thought to involve substantial cognitive ability
- But ethnocentrism is observed in individuals with minimal cognition!
  - Ants, microbes (Biology: known as Green-beard effect)

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Lenski & Velicer (2000) *Selection*

West et al (2006) *Nature Rev. Microbiology*

Ethnocentrism

- Seeing in-group as superior and out-groups as inferior
- Commonly thought to involve substantial cognitive ability
- But ethnocentrism is observed in individuals with minimal cognition!
  - Human placenta, ants, microbes (Biology: known as Green-beard effect)
- Ethnocentrism may have a basis in evolution

Cashdan (2001) *Current Anthropology*

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Based on

- Shultz, T. R., Hartshorn, M., & Hammond, R. A. (2008). Stages in the evolution of ethnocentrism. Proceedings of the 30th Annual Conference of the Cognitive Science Society.
- Shultz, T. R., M. Hartshorn, & Kaznatcheev, A. [2009] Why is ethnocentrism more common than humanitarianism? Proceedings of the 31st Annual Conference of the Cognitive Science Society.
- Kaznatcheev, A. [2010] The cognitive cost of ethnocentrism. Proceedings of the 32nd Annual Conference of the Cognitive Science Society.
- Kaznatcheev, A. [2010] Robustness of ethnocentrism to changes in inter-personal interactions. Complex Adaptive Systems - AAAI Fall Symposium.
- Kaznatcheev, A. & 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.
- Hartshorn, M., T.R. Shultz, Kaznatcheev, A. , and R.A. Hammond. [in prep] The evolutionary dominance of ethnocentric cooperation.

Method

- How can we answer theoretical questions about evolution?
- Build computational agent-based models
- Use tools from evolutionary game theory to model interactions between agents

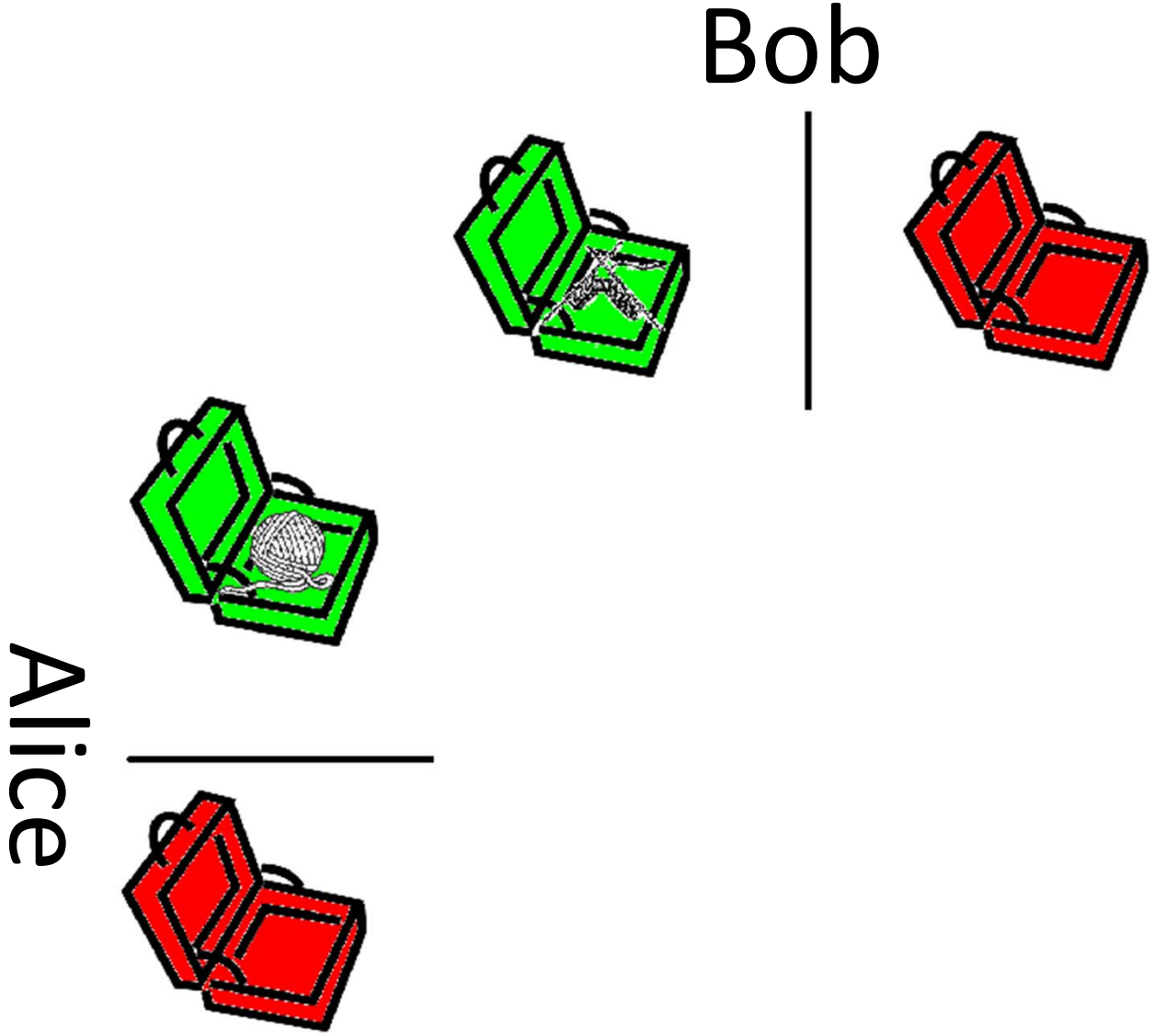
Competitive Environment

Prisoner's dilemma

Alice

Competitive Environment

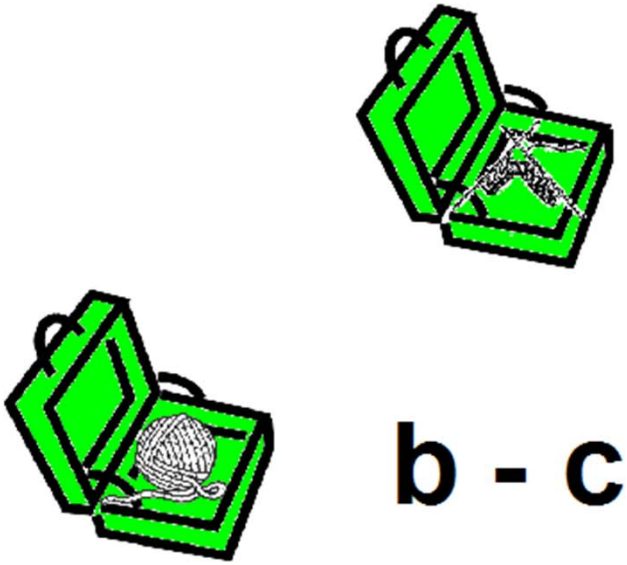
Prisoner's dilemma



Competitive Environment

Prisoner's dilemma

Bob



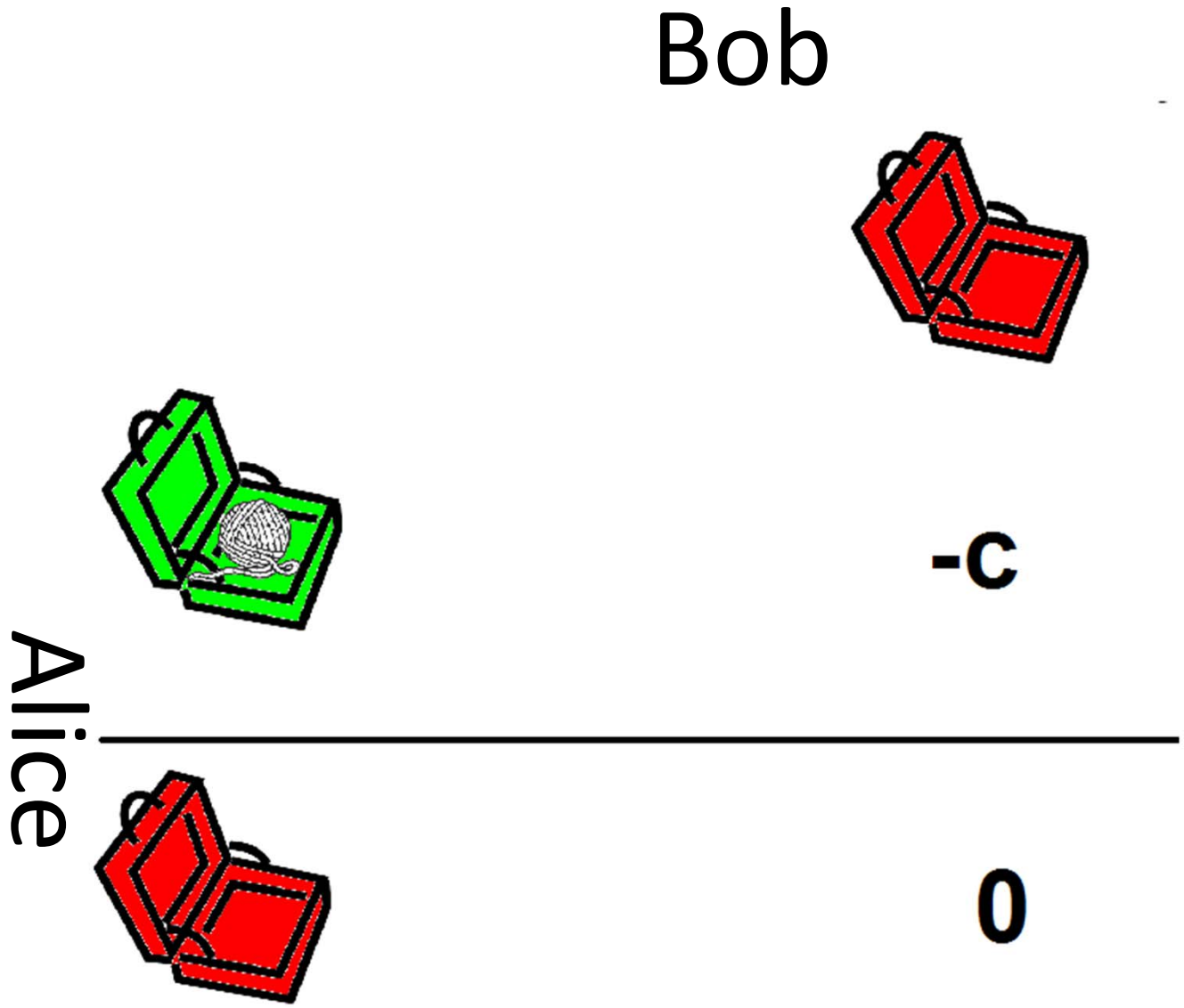
b - c

Alice

b

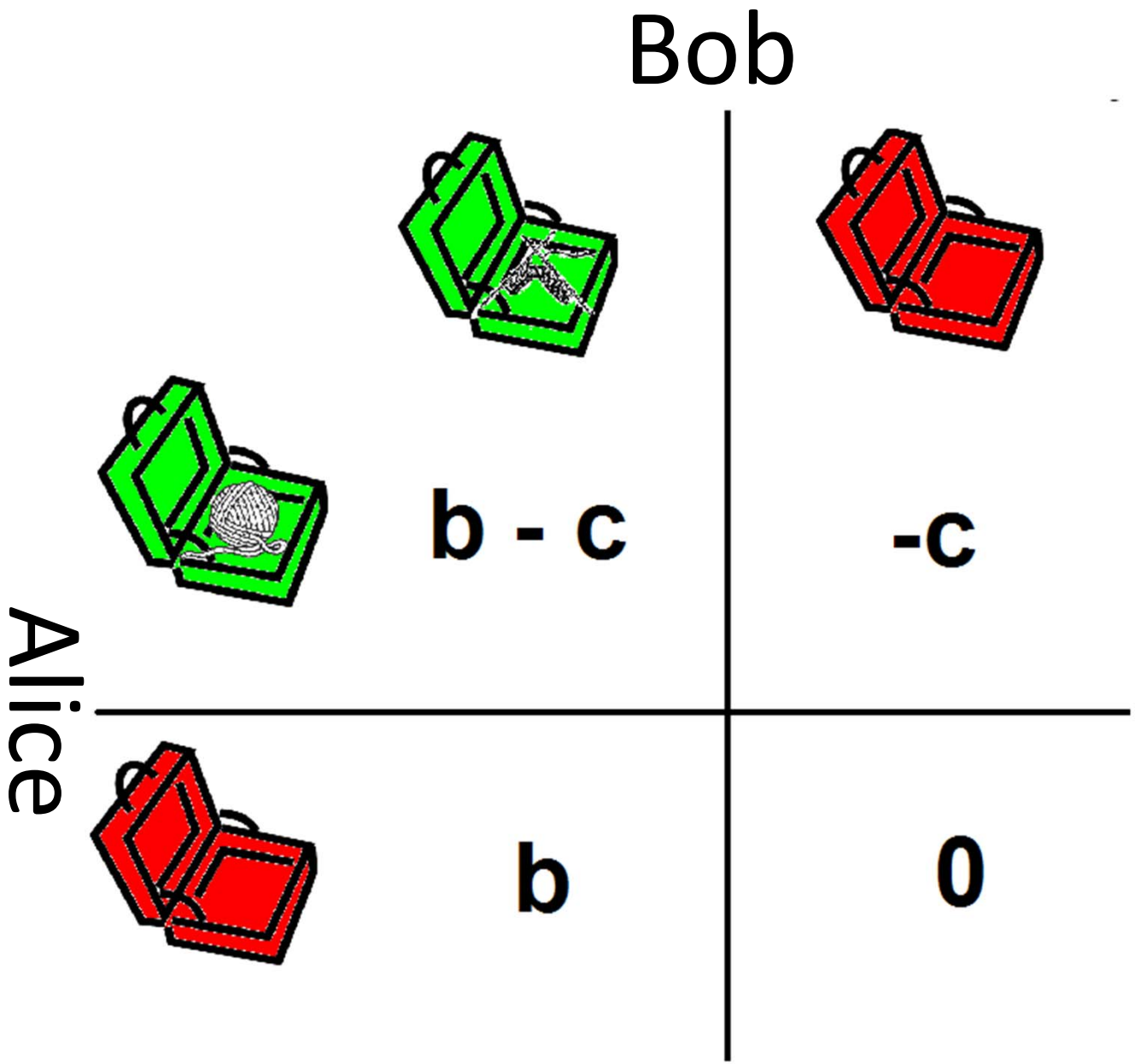
Competitive Environment

Prisoner's dilemma



Competitive Environment

Prisoner's dilemma

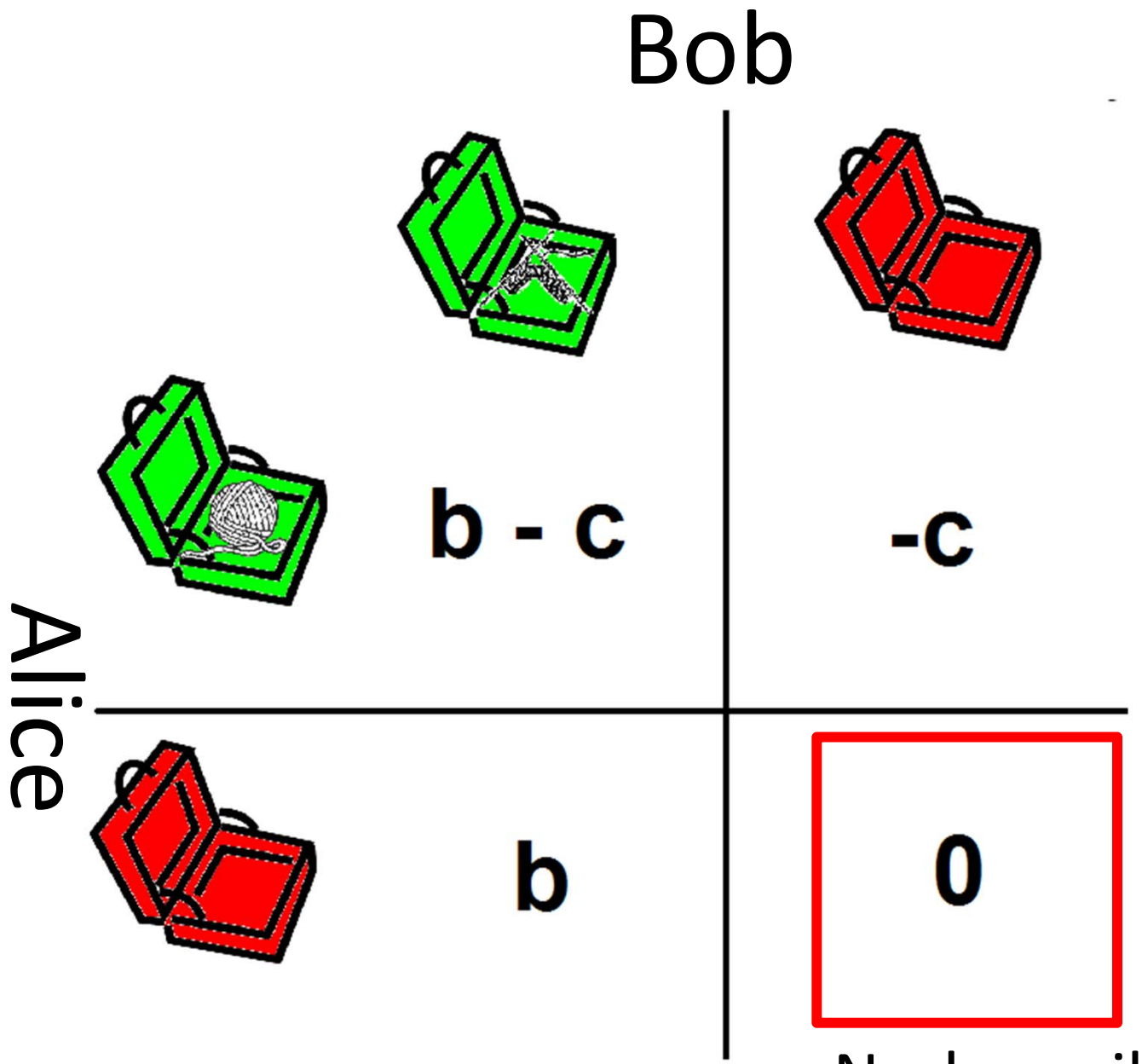


b: benefit of cooperation

c: cost of cooperating

Competitive Environment

Prisoner's dilemma



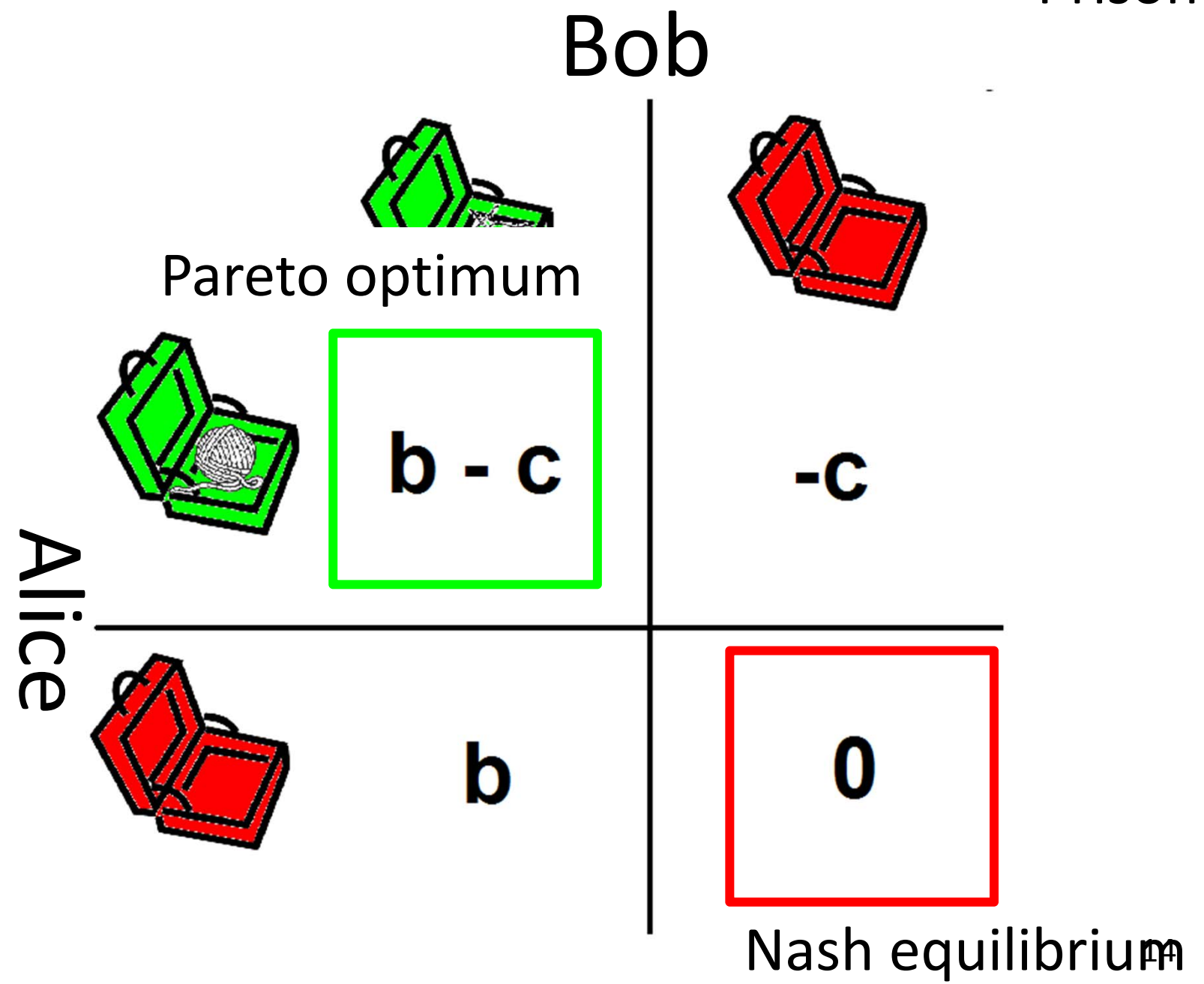
b: benefit of cooperation

c: cost of cooperating

Nash equilibrium

Competitive Environment

Prisoner's dilemma



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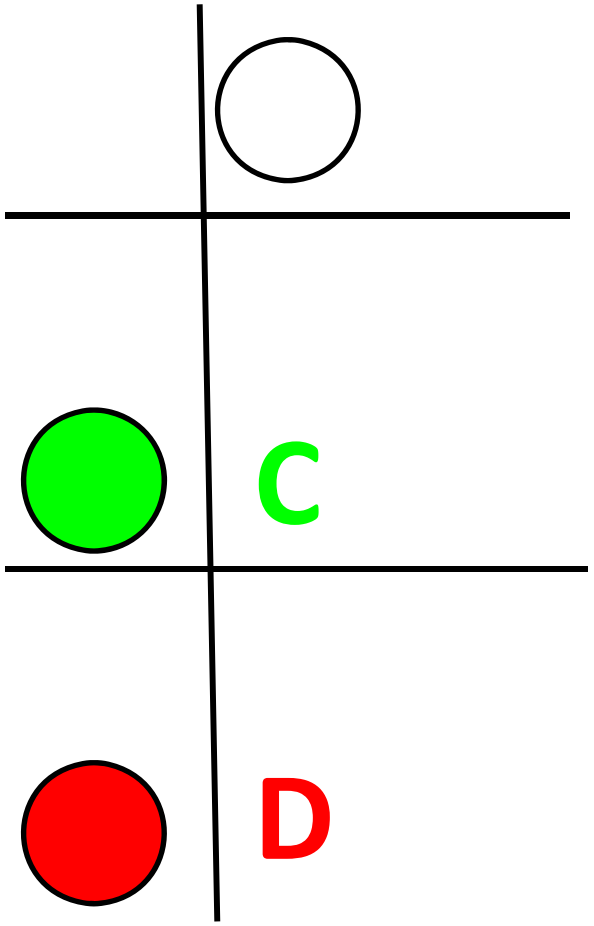
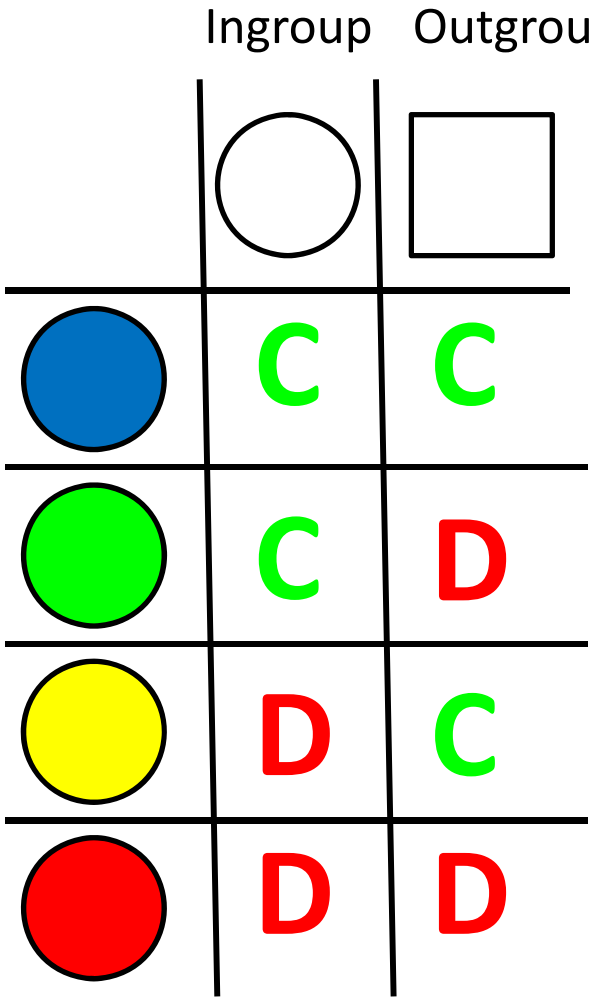
Strategy Space



Strategy Space



Humanitarian

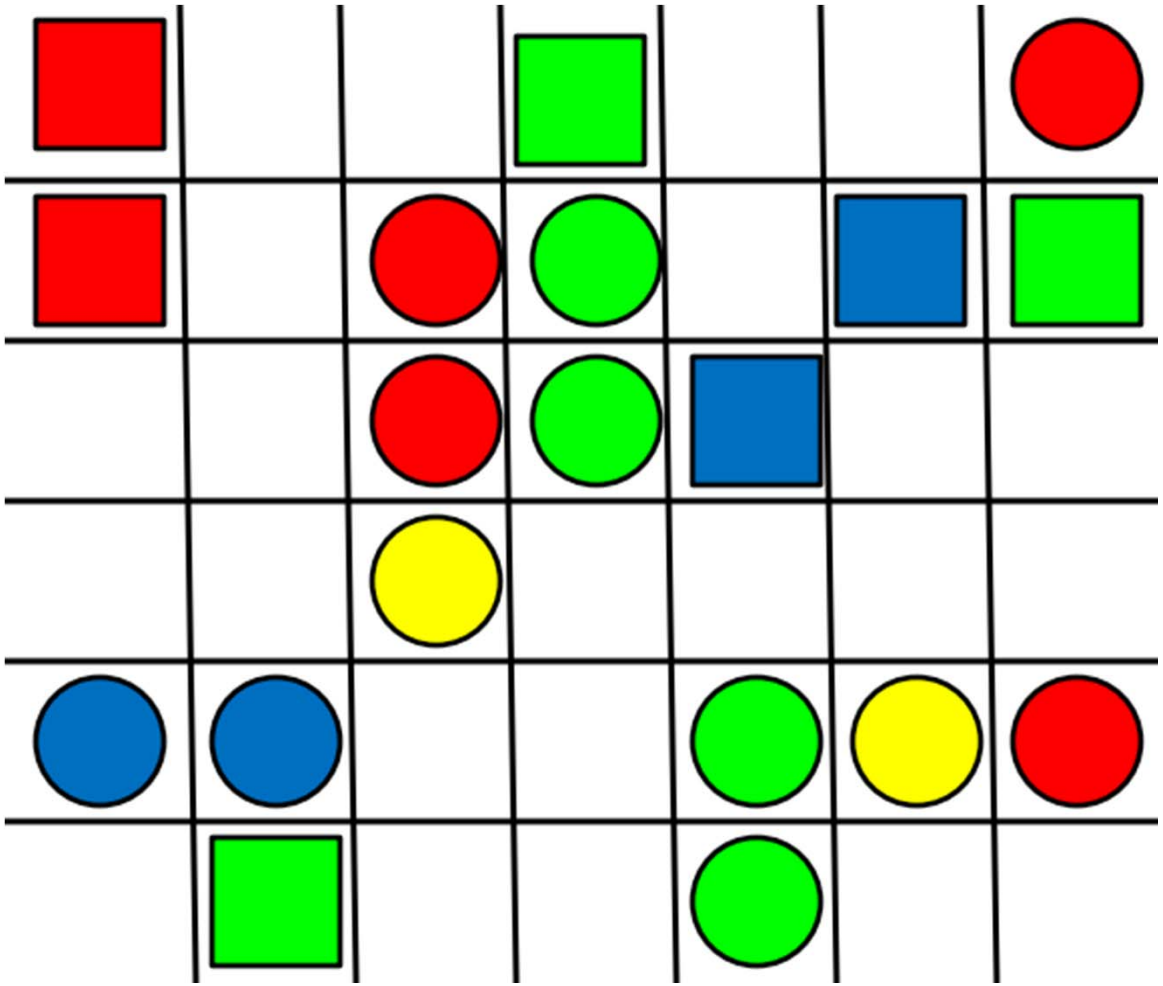
Ethnocentric

Traitor

Selfish

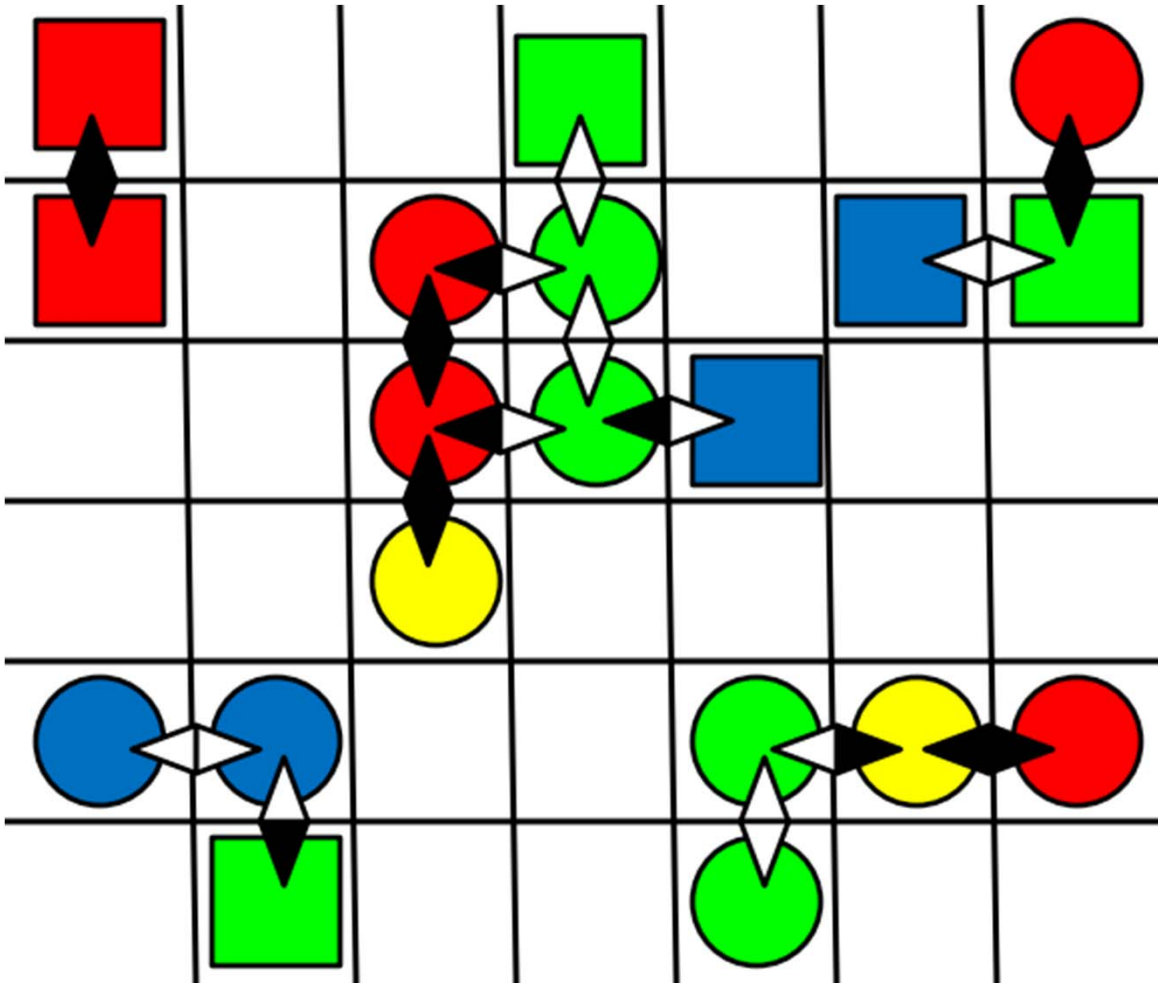
Spatial Model

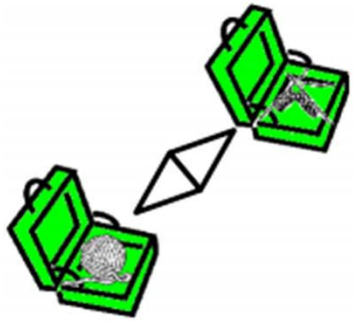
Initial configuration

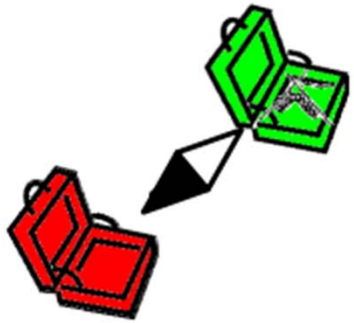


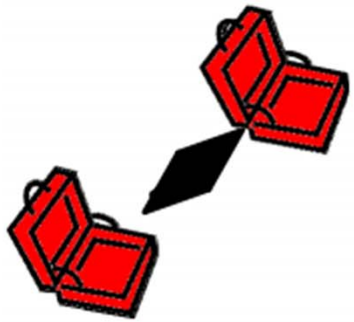
Spatial Model

Game interaction



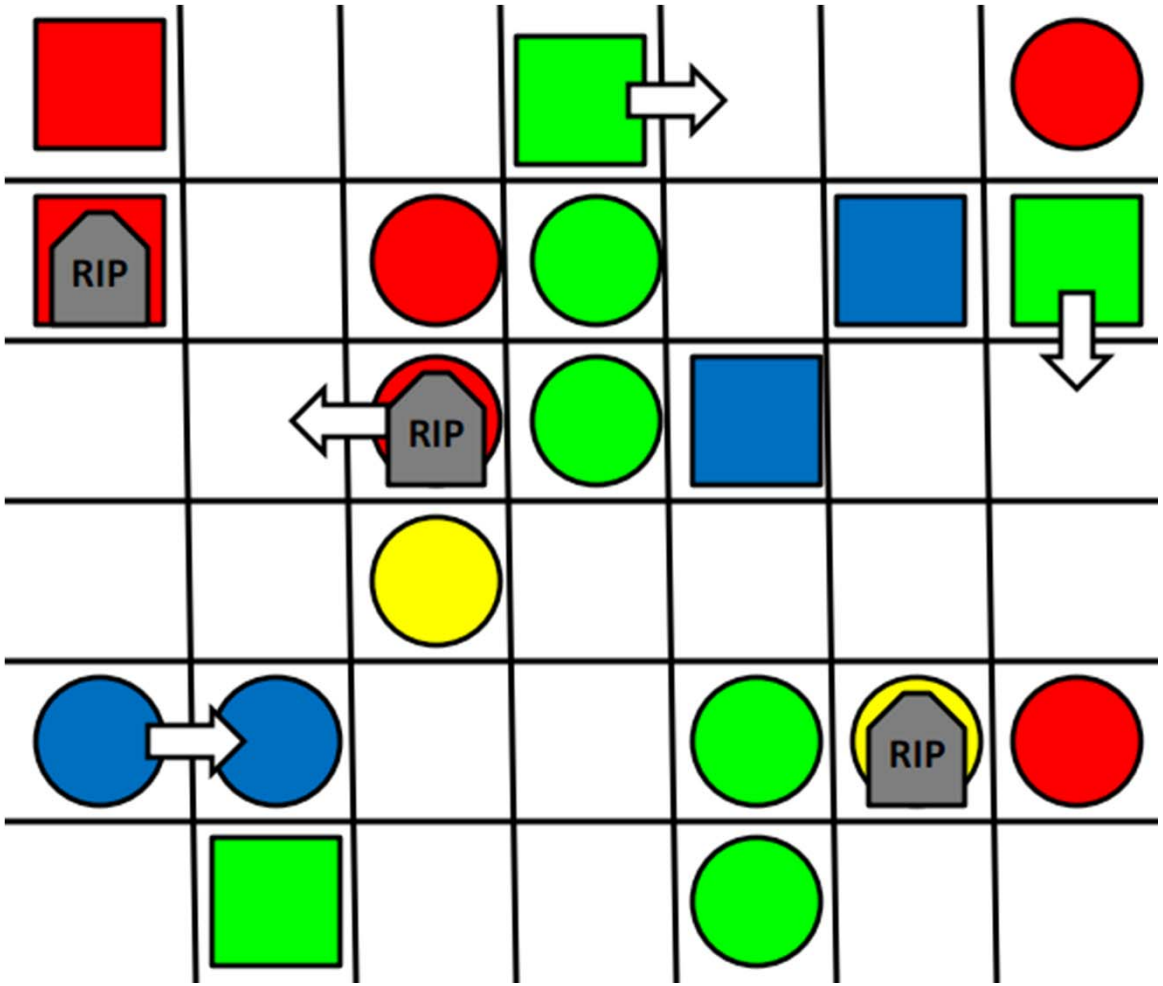






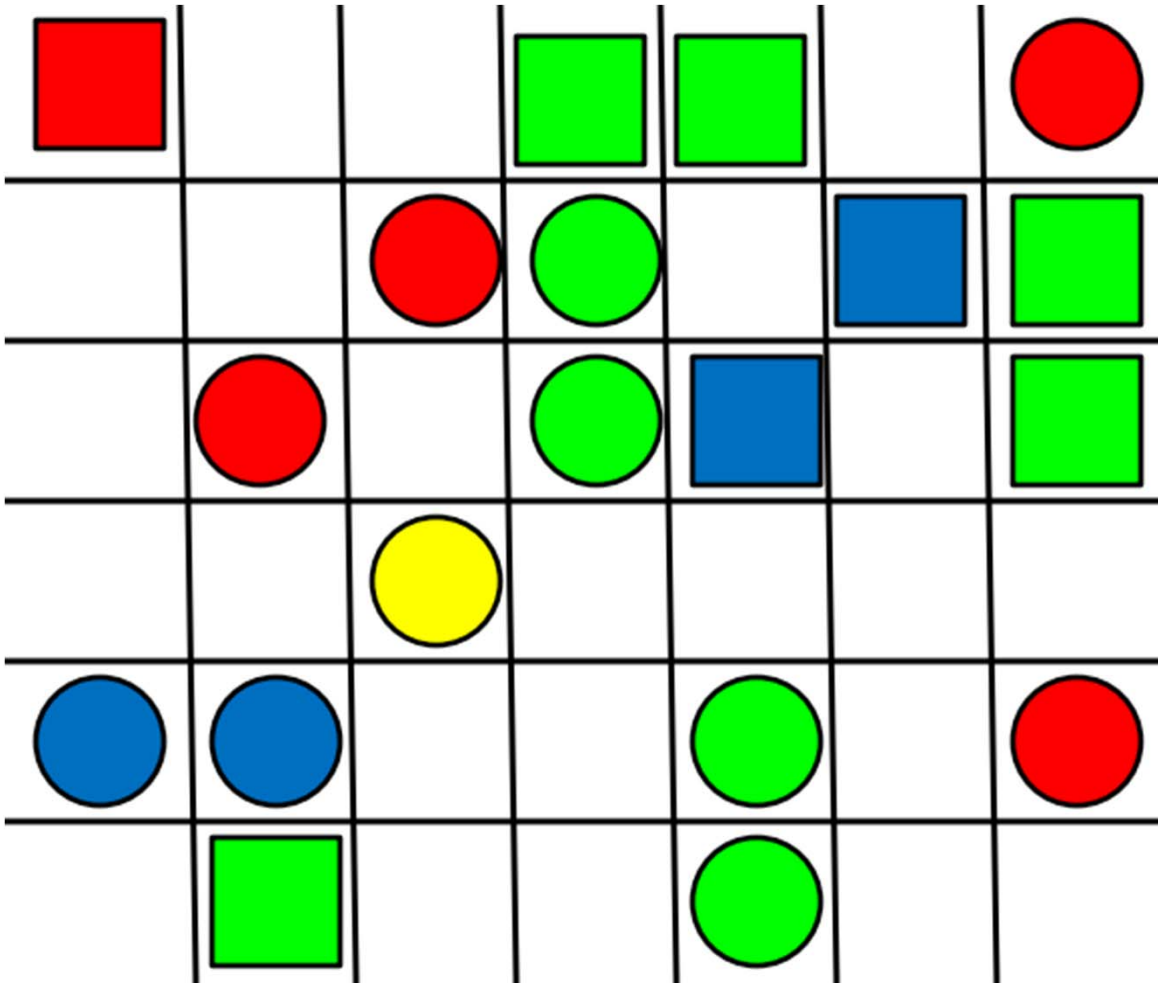
Spatial Model

Reproduction & Death



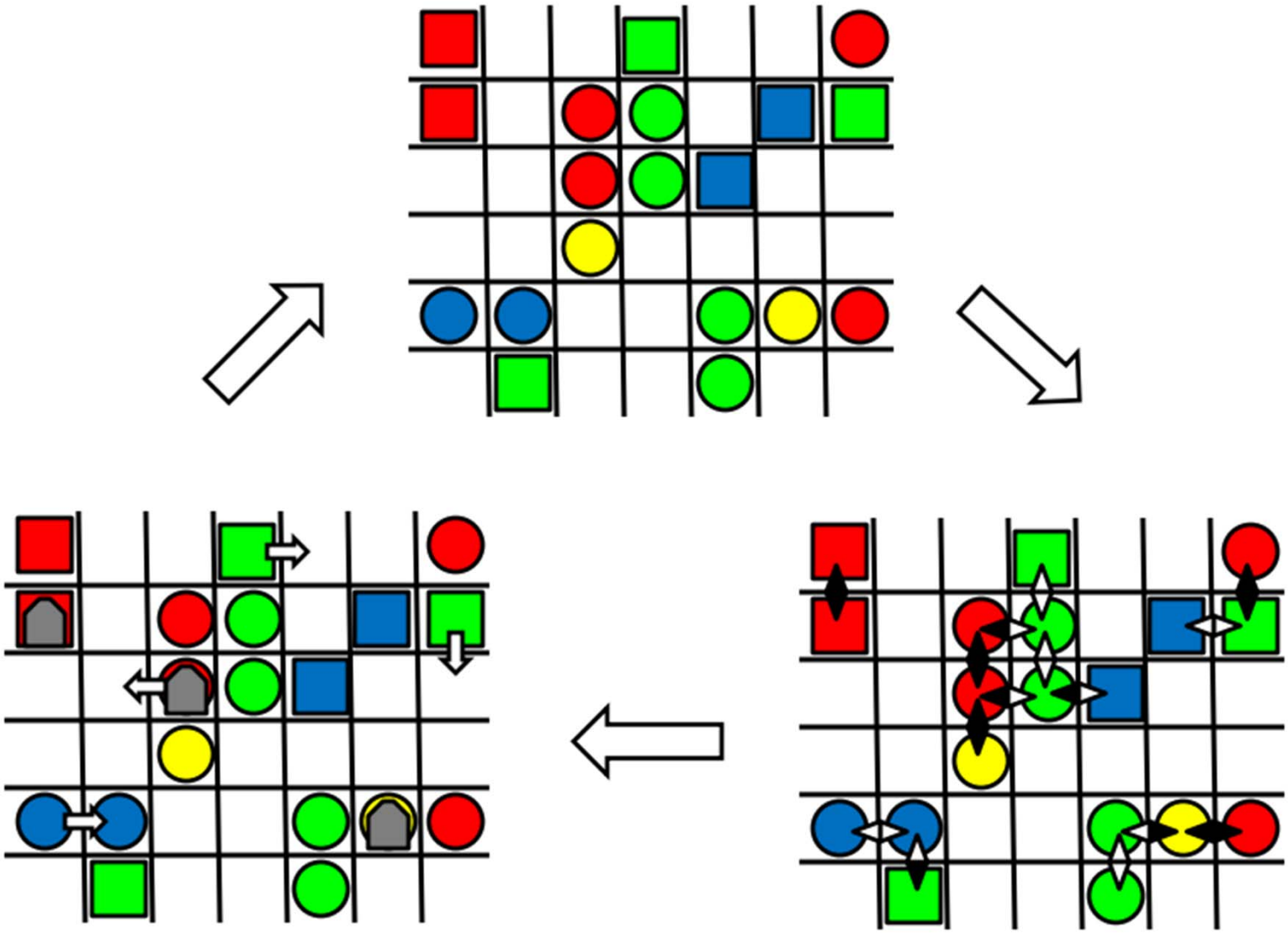
Spatial Model

Final configuration

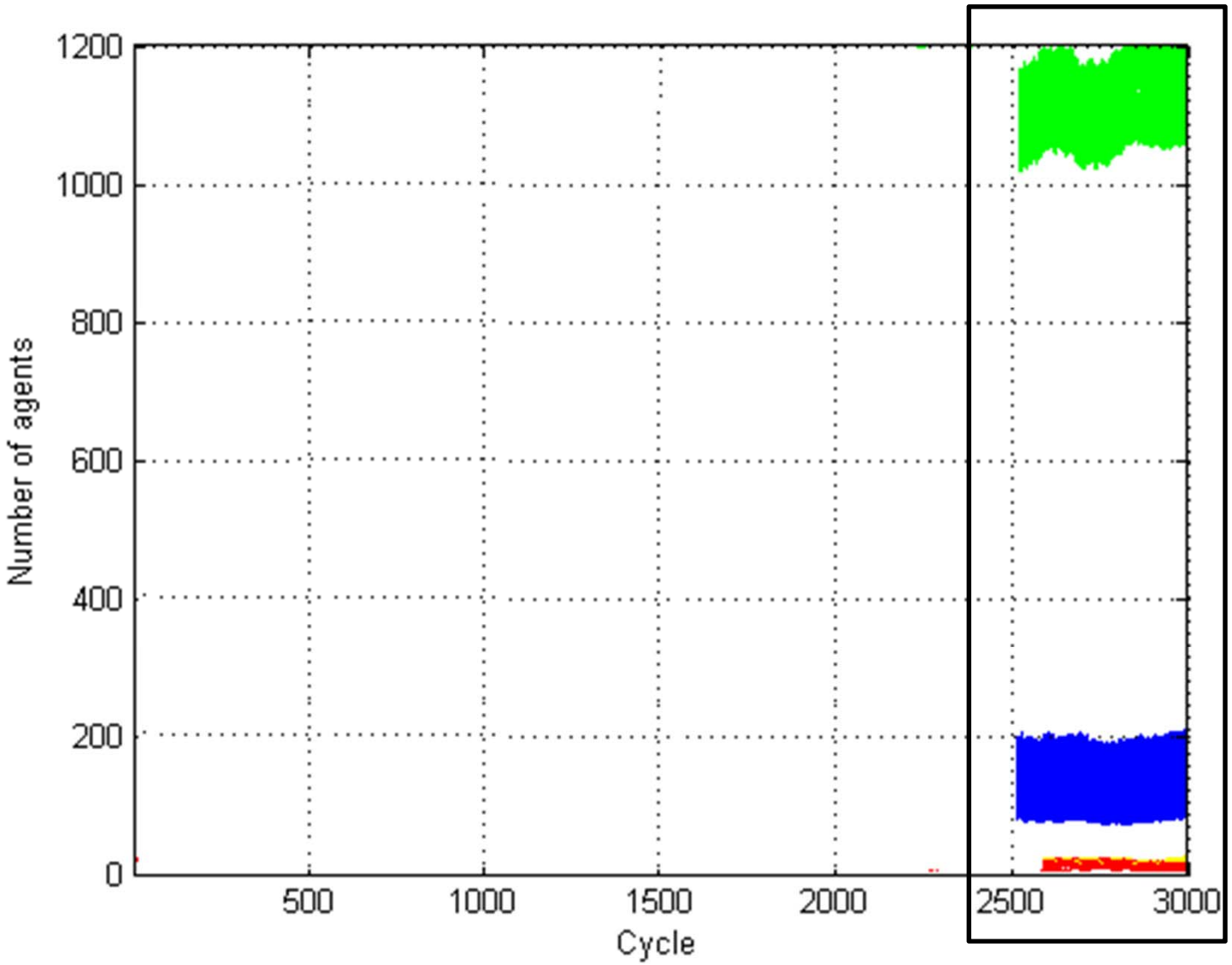


Spatial Model

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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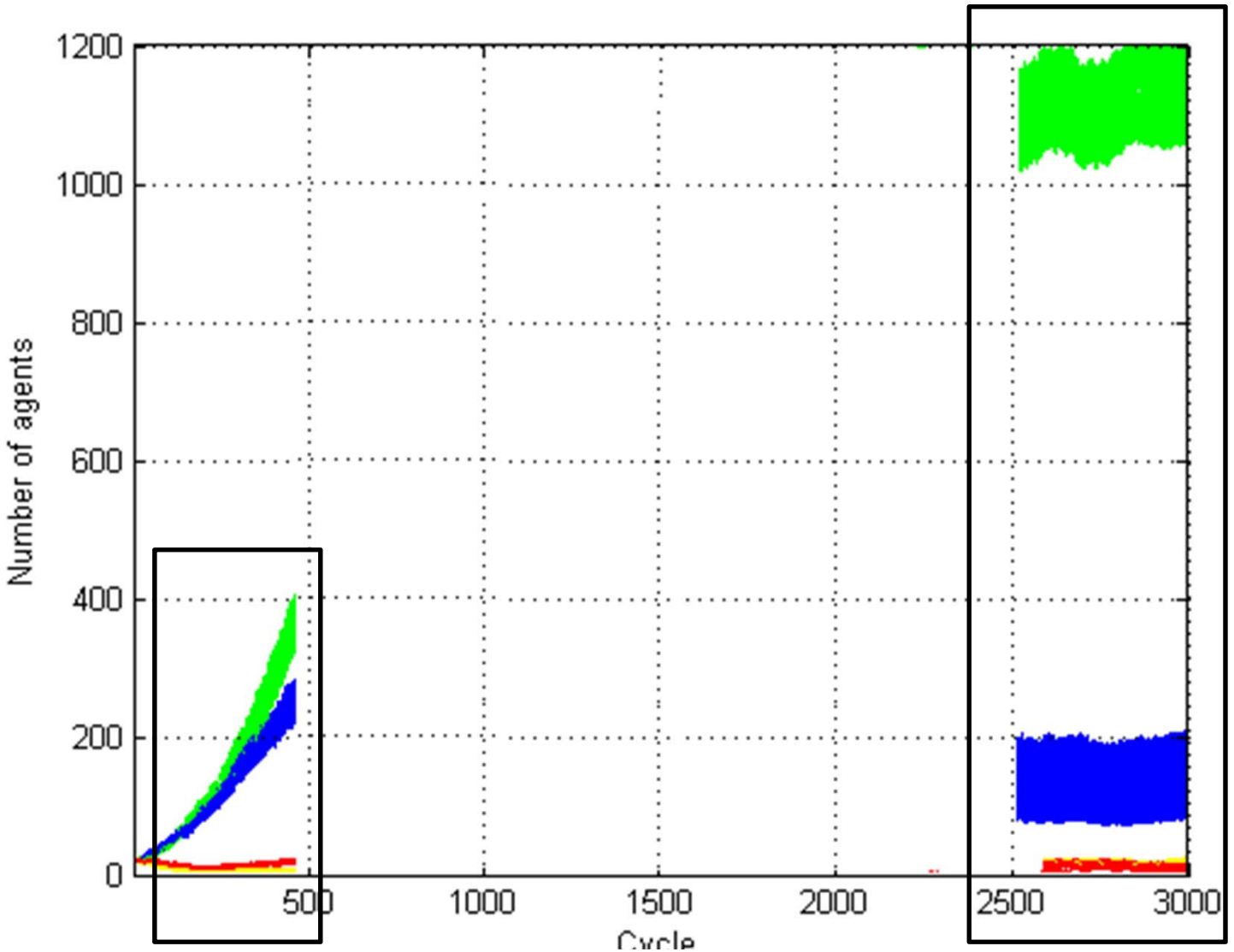

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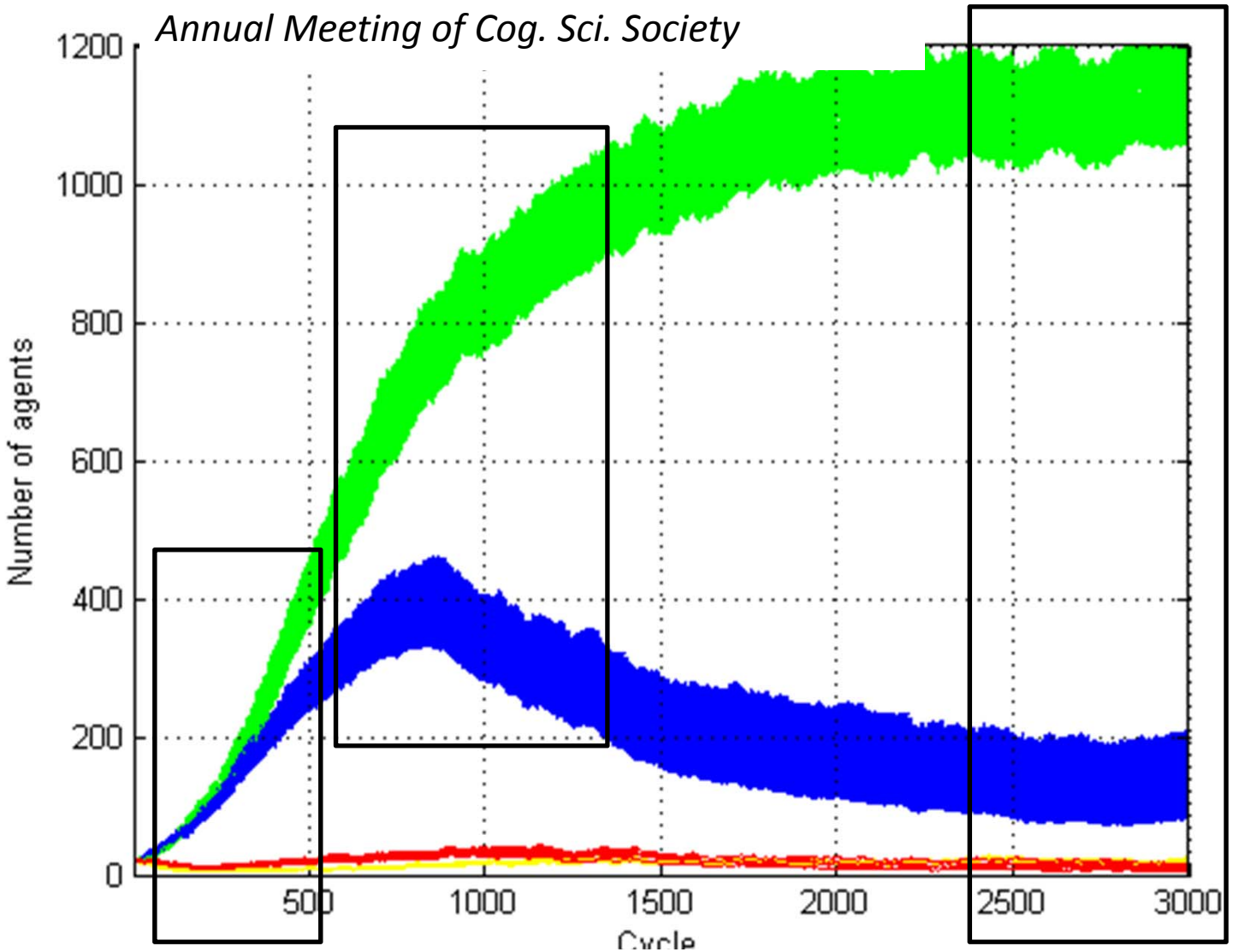
Shultz, Hartshorn & Hammond (2008) *30th Annual Meeting of Cog. Sci. Society*

Hammond & Axelrod (2006) *Journal of Conflict Resolution*

Previous Results

Shultz, Hartshorn & Kaznatcheev (2009) *31st Annual Meeting of Cog. Sci. Society*



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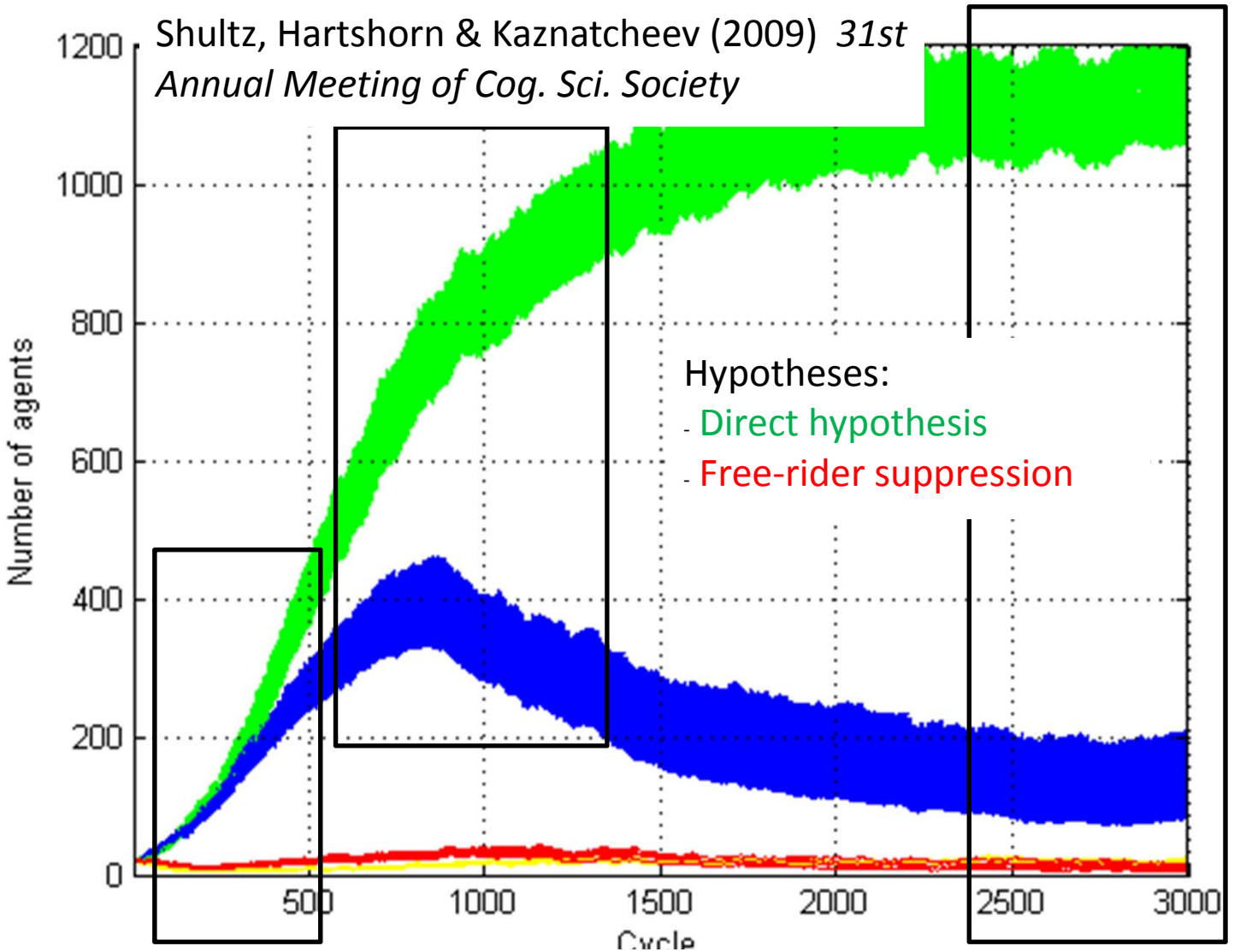

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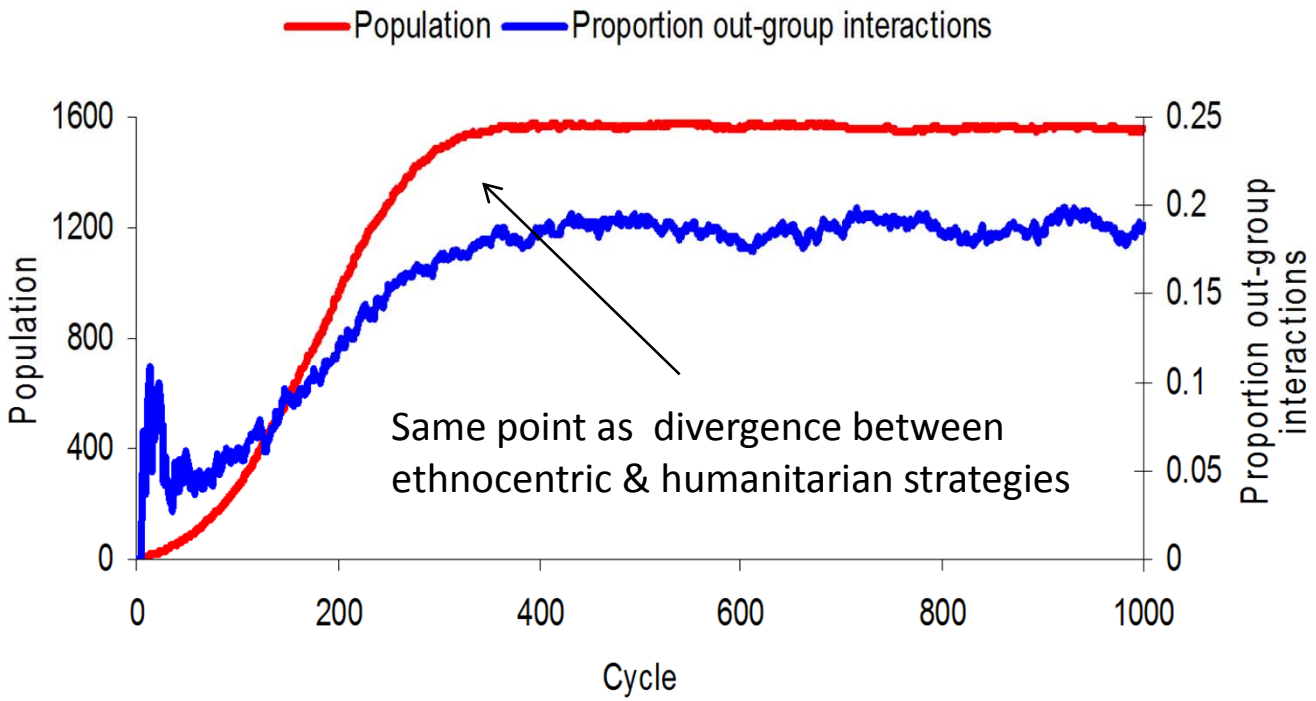
Two hypotheses

- 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 & traitorous agents
- Both predict ethnocentrics & humanitarians to diverge after world saturation

- Shultz et al. [2009] Proc. 31st Conf Cog Sci Soc

World Saturation



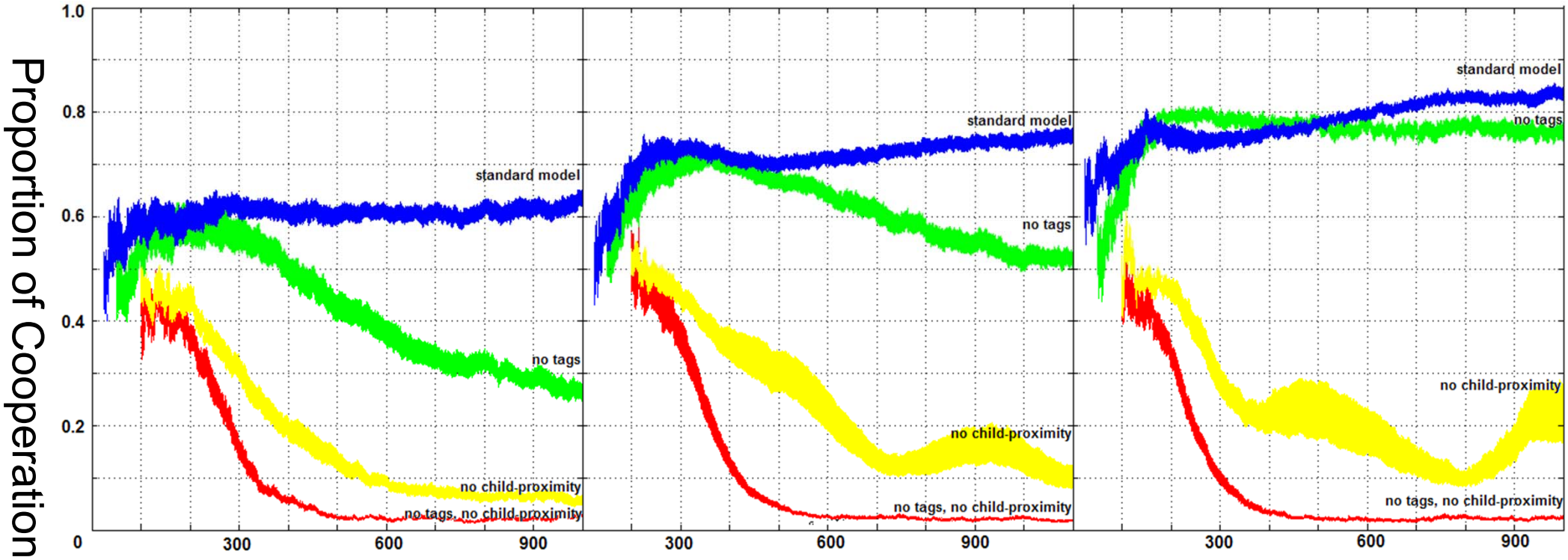
ptr = 0.12
death = 0.1
b = 0.03
c = 0.01

- Clusters with different tags collide & out-group strategy becomes important
- Free-space becomes scarce & thus competition intensifies
  - Shultz et al. [2009] Proc. 31st Conf Cog Sci Soc

What's important?

- Isolate factors essential for ethnocentrism
- Identify the key differences between standard model & an inviscid model. In standard model:
  - There are tags on which to base decisions
  - Children are placed locally & hence interactions are non-random
- Eliminate these factors in restricted models & study resulting dynamics
- Kaznatcheev & Shultz. [2011] Proc 33rd Conf Cog Sci Soc

Restricted Models: no tags, or no viscosity



b = 0.02

b = 0.03

b = 0.04

ptr = 0.1

death = 0.1

c = 0.01

- How does any of this relate to cognitive science?

Minimal Cognition

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- Cognition employed is minimal, but not beyond the scope of contemporary cognitive science

Beer (2000) *Trends in Cognitive Sciences*

van Duijn, Keijzer, & Franken. (2006) *Adaptive Behavior*

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Beer (2003) *Adaptive Behavior*

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Minimal Cognition

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- Ethnocentric agents are capable of conditional action & categorical perception; tasks that merit a rich analysis
- Can be seen as part of the biogenic approach to cognition

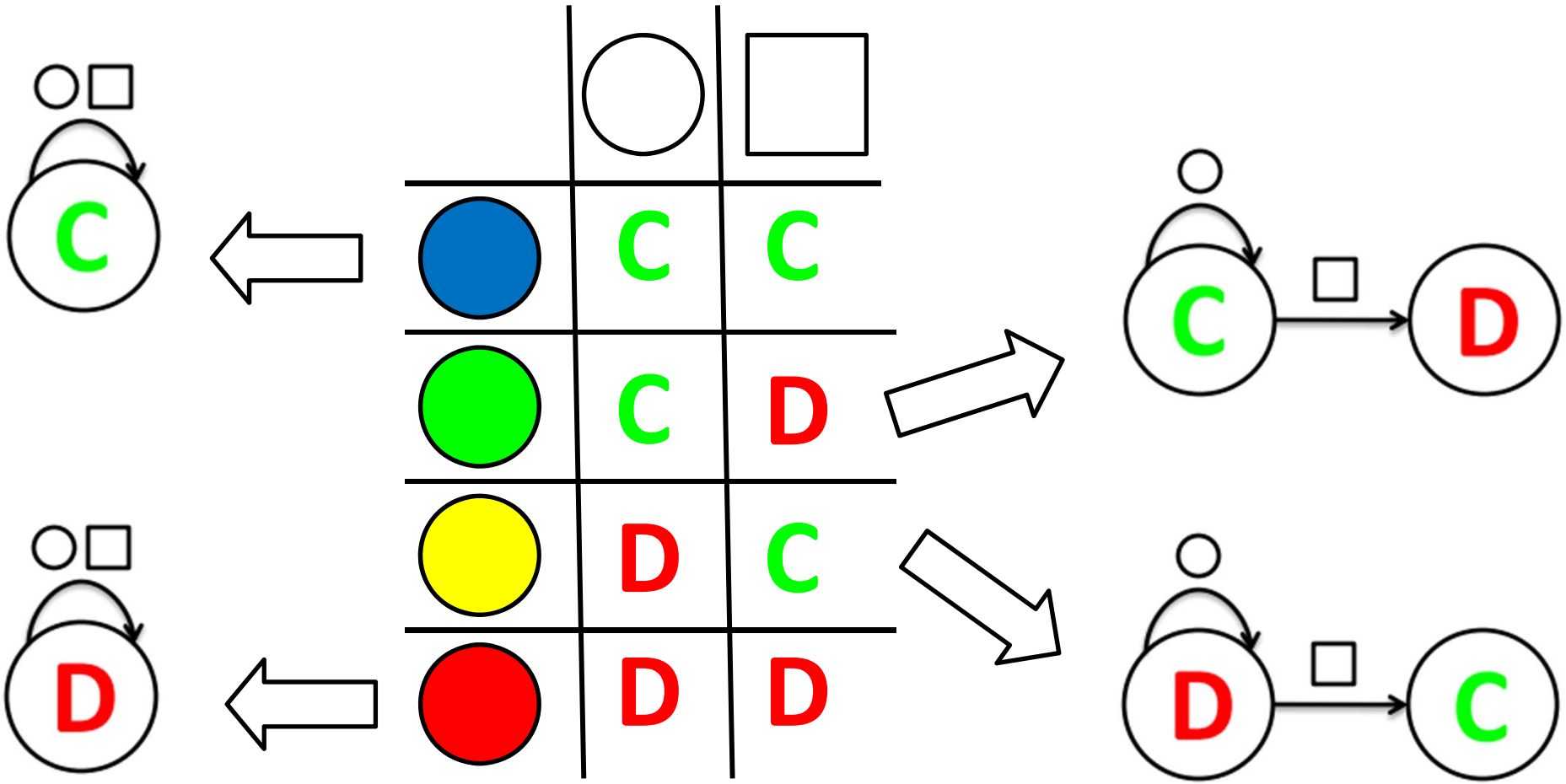
Beer (2000) *Trends in Cognitive Sciences*

Beer (2003) *Adaptive Behavior*

van Duijn, Keijzer, & Franken. (2006) *Adaptive Behavior*

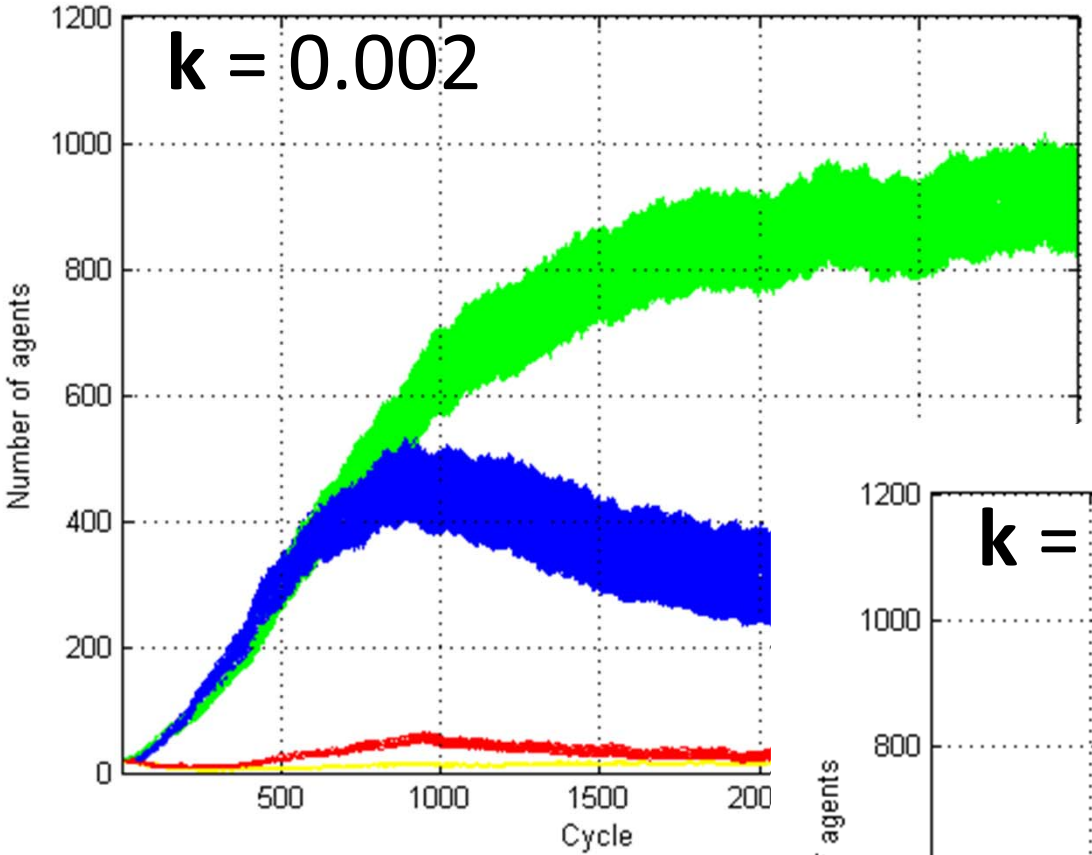
Lyon (2006) *Cognitive Processing*

Cognitive Complexity



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

Vary **k**



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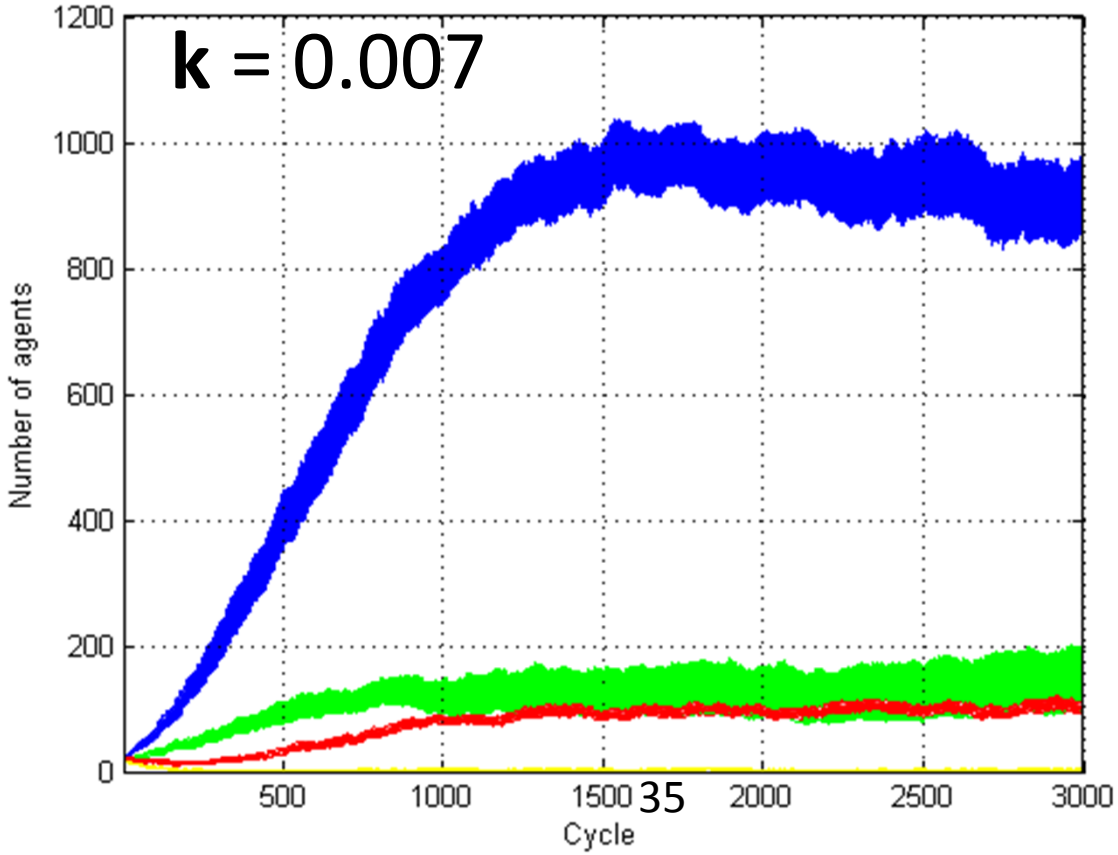
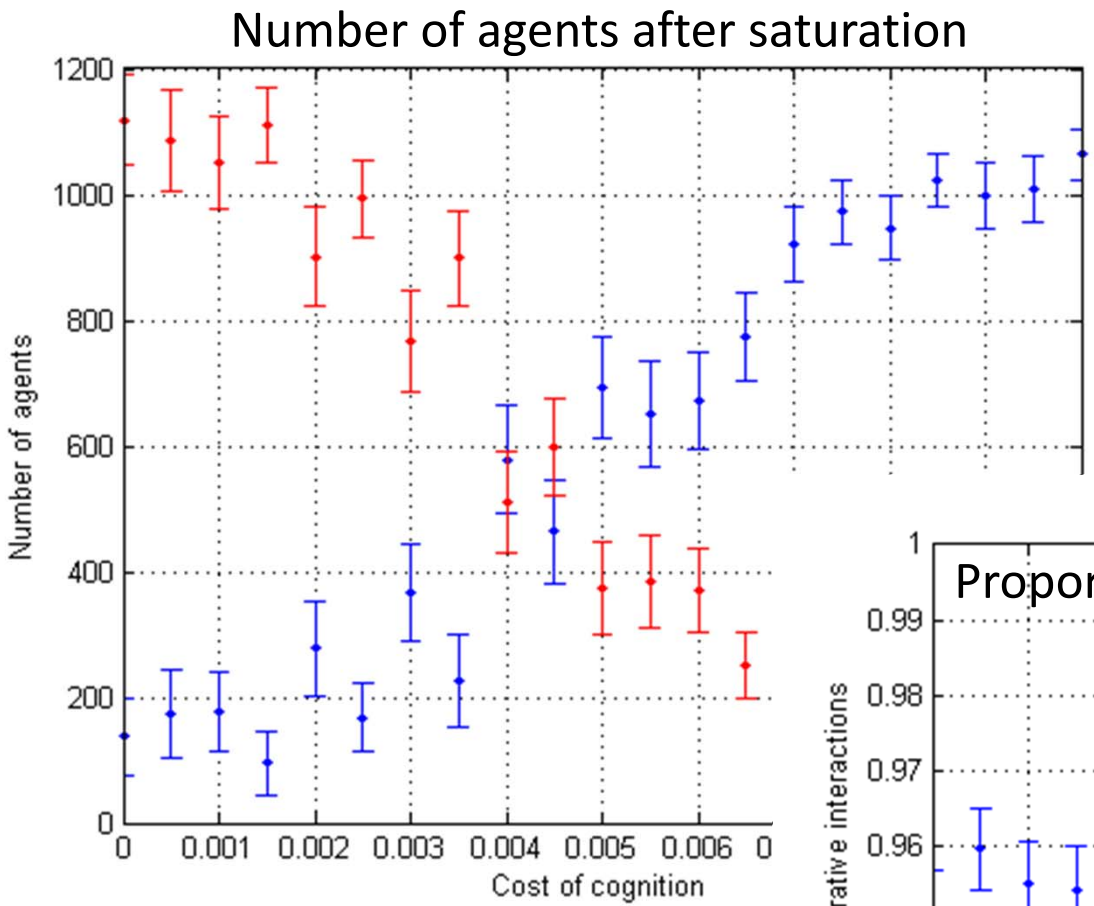


Kaznatcheev, A. [2010] Proc 32nd Conf Cog Sci Soc

Vary **k**



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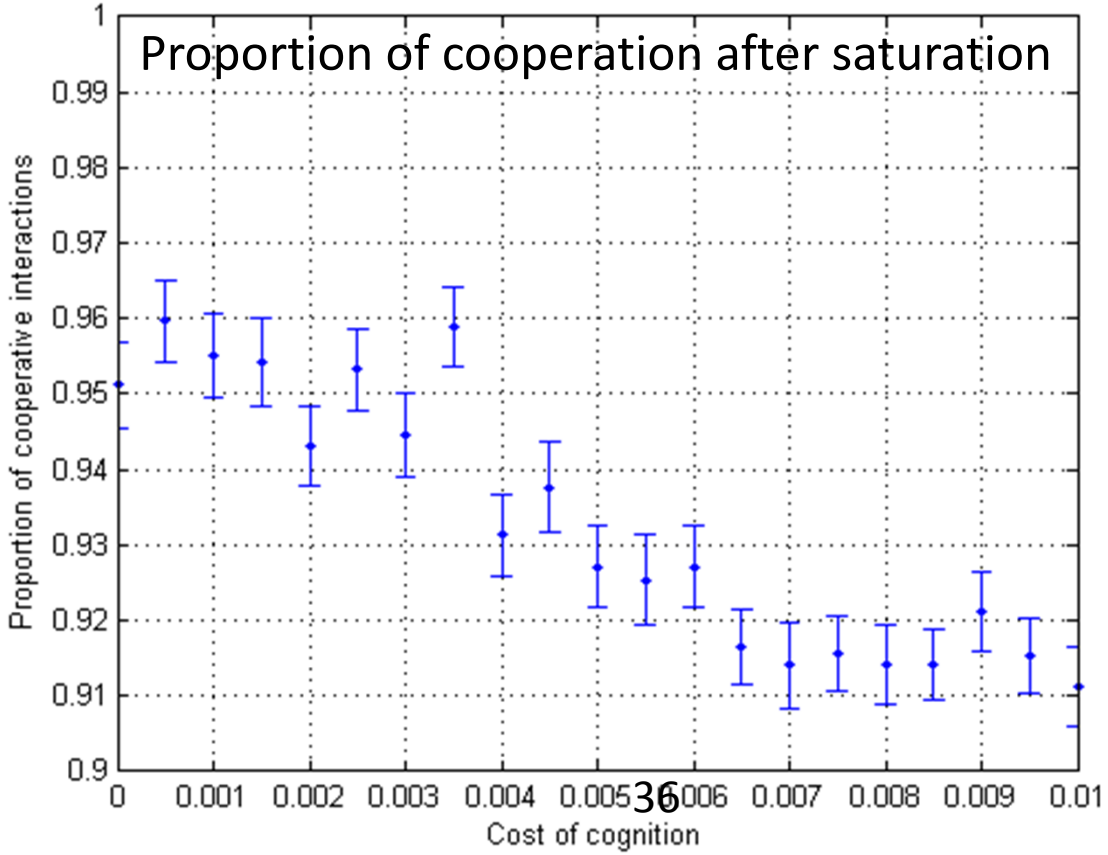

Cognitive complexity

- Low cost of cognition for phase transition suggests ethnocentrism is not robust against cognitive complexity
- Cognitive mechanism must be
  - Really inexpensive, or
  - Already in place

Importance of Robustness

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

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

Turner & Chao (1999) *Nature*

Importance of Robustness

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- Games like Hawk-Dove (HD) and Assurance often provide better models than PD for biological and social systems

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

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

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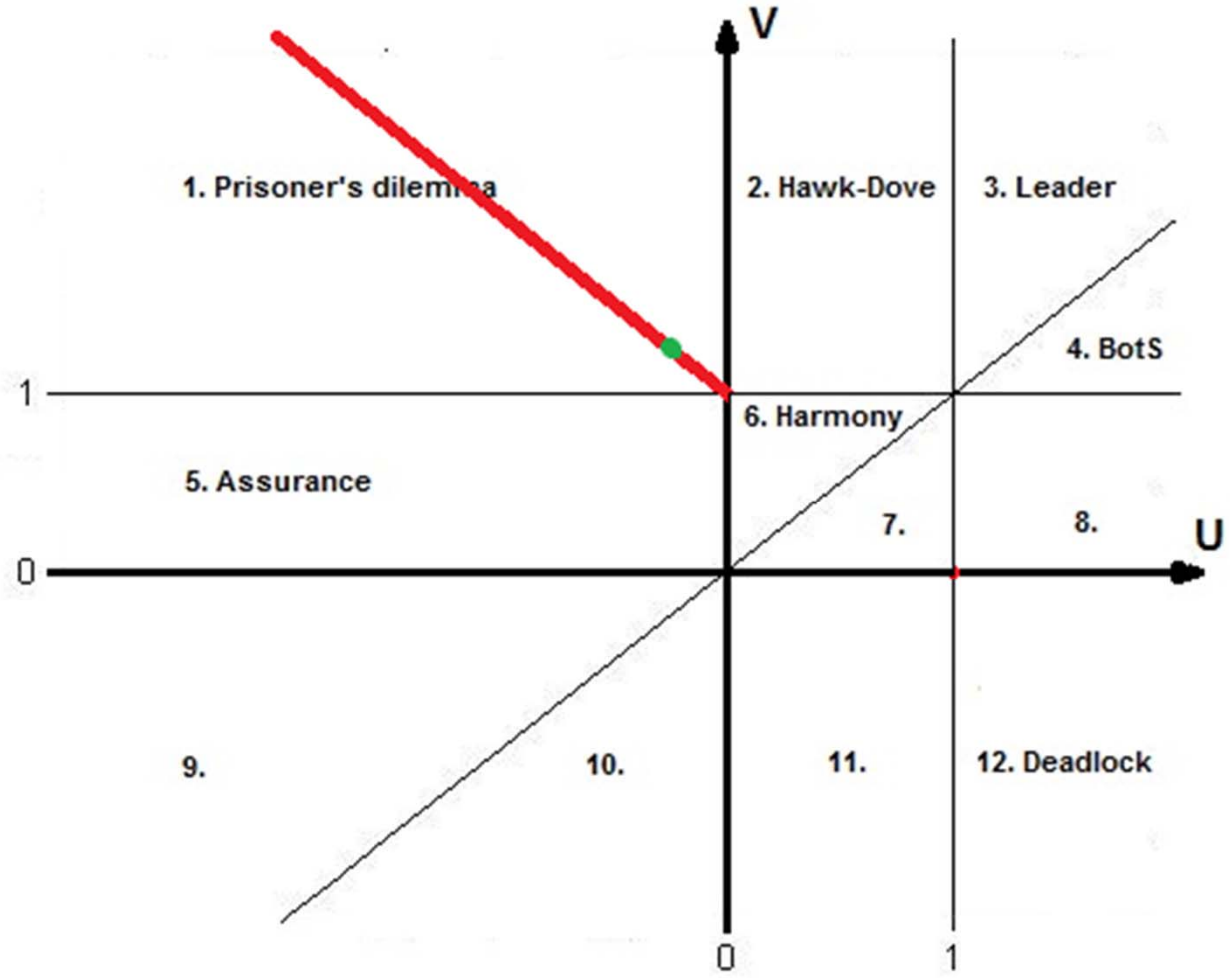
Game Space



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

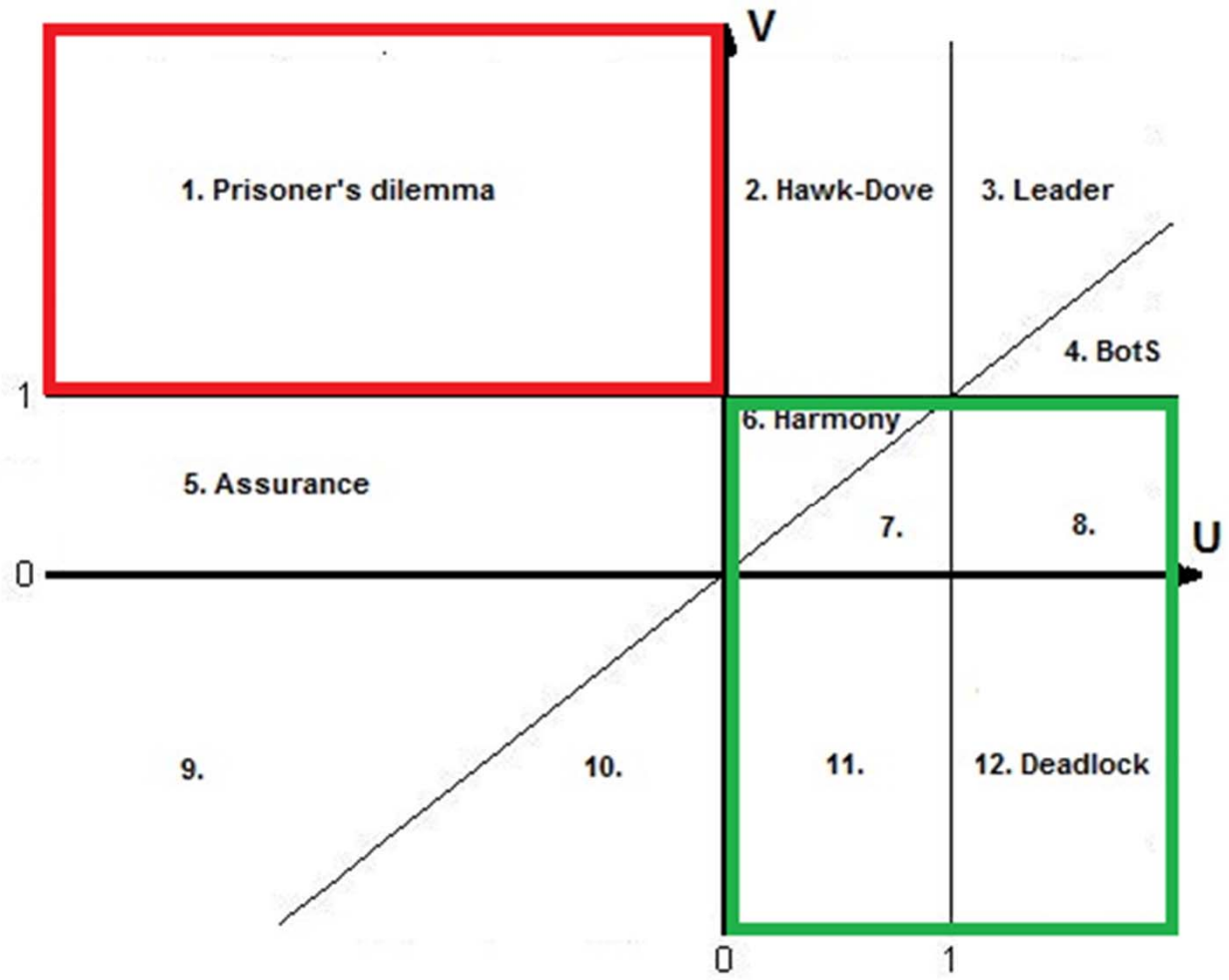
Kaznatcheev, A. [2010] Complex Adaptive Systems - AAAI Fall Symposium

Game Space

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

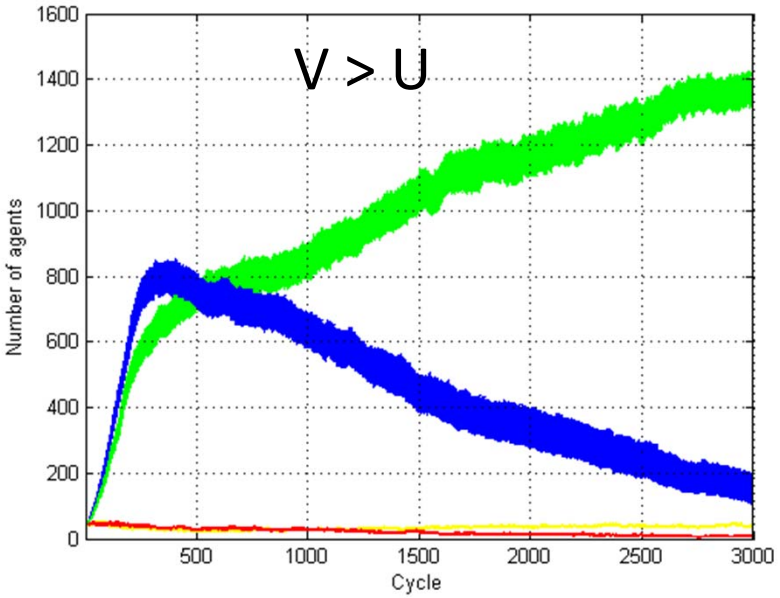
U < 0:
D is
Nash/ESS

V < 1:
C is
Nash/ESS

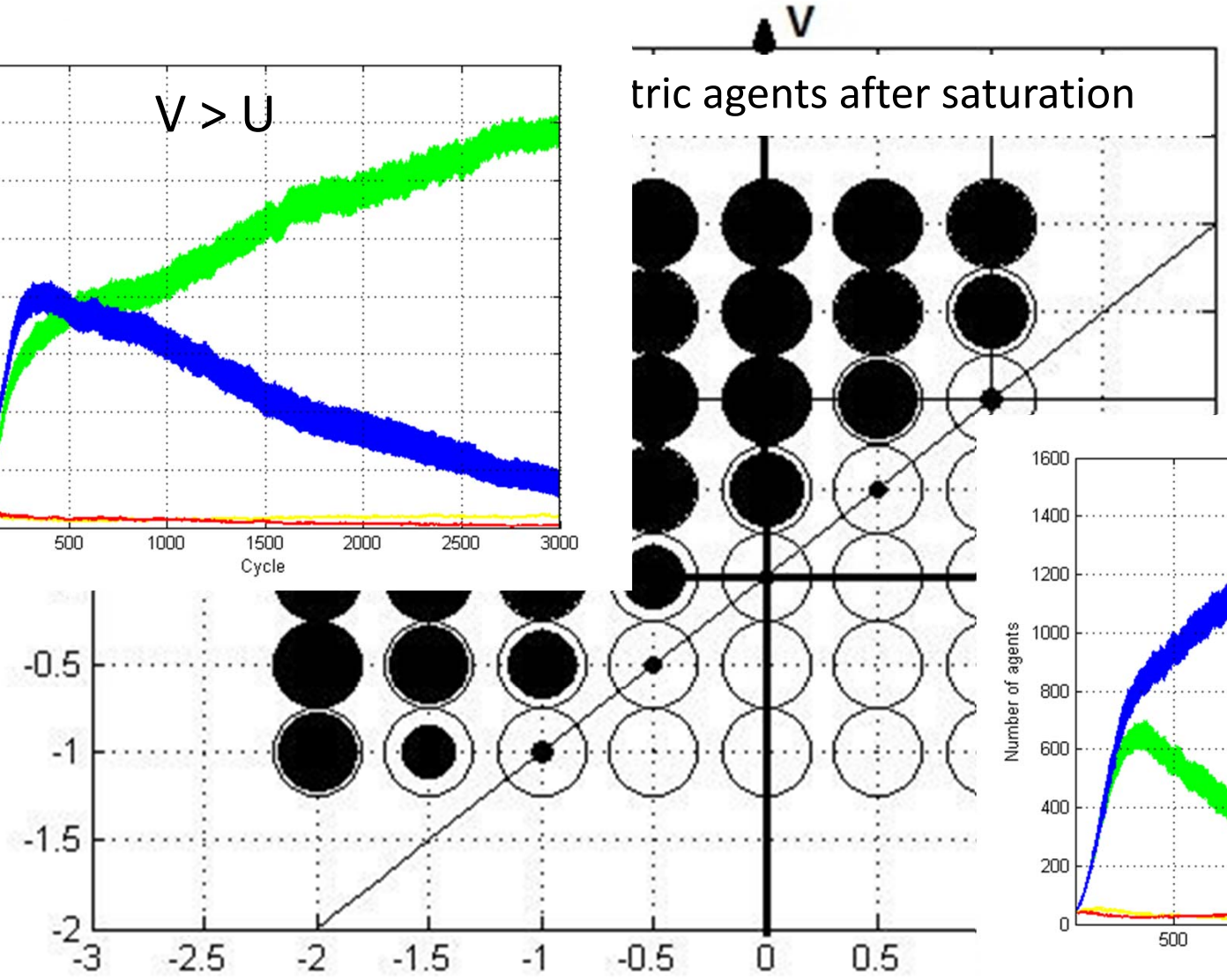


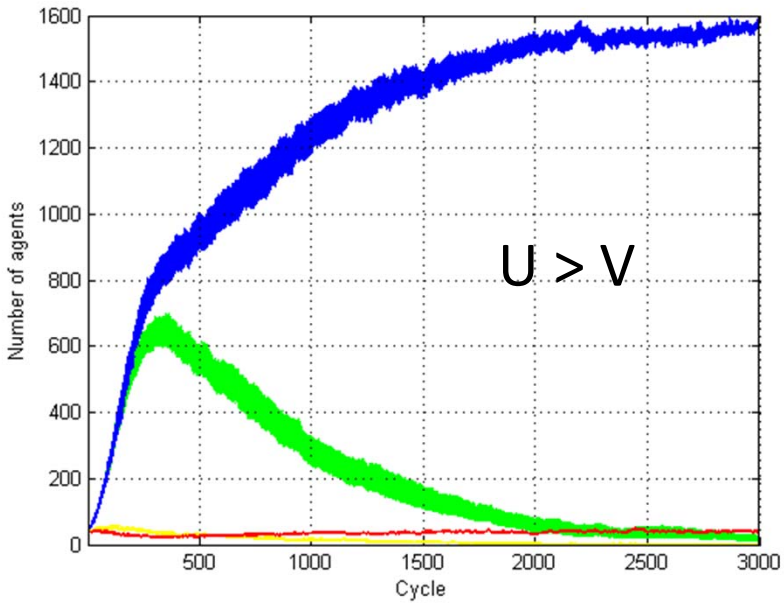
Results

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



tric agents after saturation





Conclusions

- Importance of world saturation for game dynamics
- Restricted models show that local-child placement drives cooperation, whereas tags maintain existing cooperation after saturation in competitive worlds with low b/c
- Cost of tags shows that minimal cognition must have been pre-existing or very cheap
- Ethnocentrism can support higher levels of cooperation than humanitarianism
- Ethnocentrism is robust across different games (if $V > U$)

Thank you!

University of Waterloo

McGill

Social Sciences and Humanities Research Council of Canada

Conseil de recherches en sciences humaines du Canada

Canada

NSERC CRSNG

Advertising plug

- Poster @ CogSci meeting on viscosity findings
- Saturday 5:45-7
- Poster # 947