UNIVERSITY OF MARYLAND

Understanding Norm Change: An Evolutionary Game-Theoretic Approach

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Joint work with:

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SOCIAL NORMS

Human societies all around the world interact and accomplish different tasks by developing and maintaining social norms.

Examples:

- Walking on a specific side of the pavement
- Right of way while driving
- Shaking hands when meeting someone new

SOCIAL NORMS

Empirical studies show marked differences in the strength of social norms around the globe.

Tight Societies:
High norm-adherence. High punishment of norm deviations.
E.g. Indonesia

Loose Societies:
Weaker norms. More tolerance for deviations from norms.
E.g. Netherlands

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How do such norms emerge & change in different societies?

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How do such norms emerge & change in different societies?

- How/when will a society become unstable?
- How can we predict a shift in norms?
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First work to provide a model of how cultural differences affect norm change

EVOLUTIONARY GAME THEORY (EGT)

Application of game theory to **evolving populations**

Recently being used to model the evolution of cultural characteristics

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Setting (for this talk):

- Large population **structured on a network**:
  - Individuals arranged on the nodes
  - Edges represent social connections

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Game Strategies → Possible Behaviors

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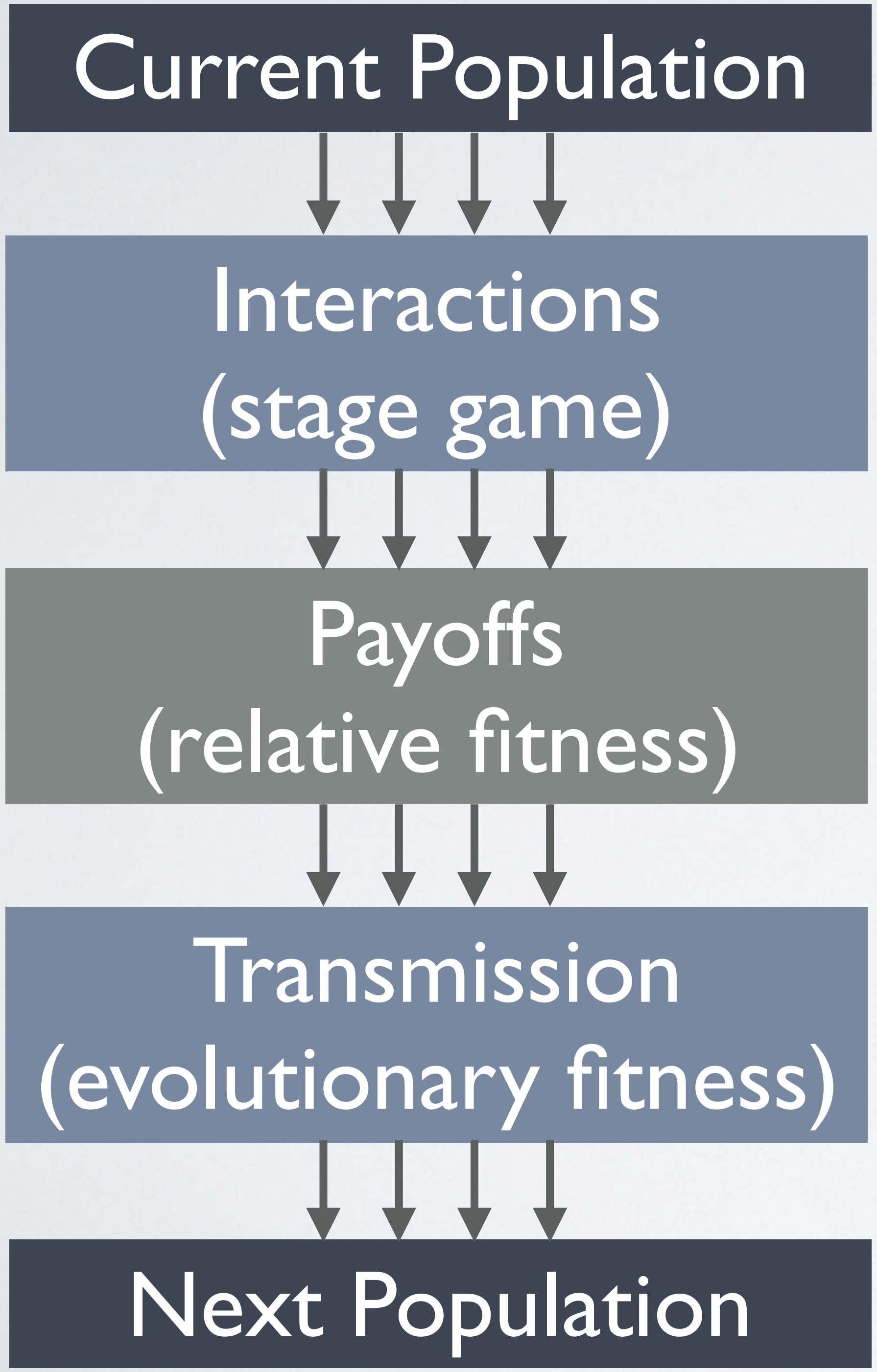
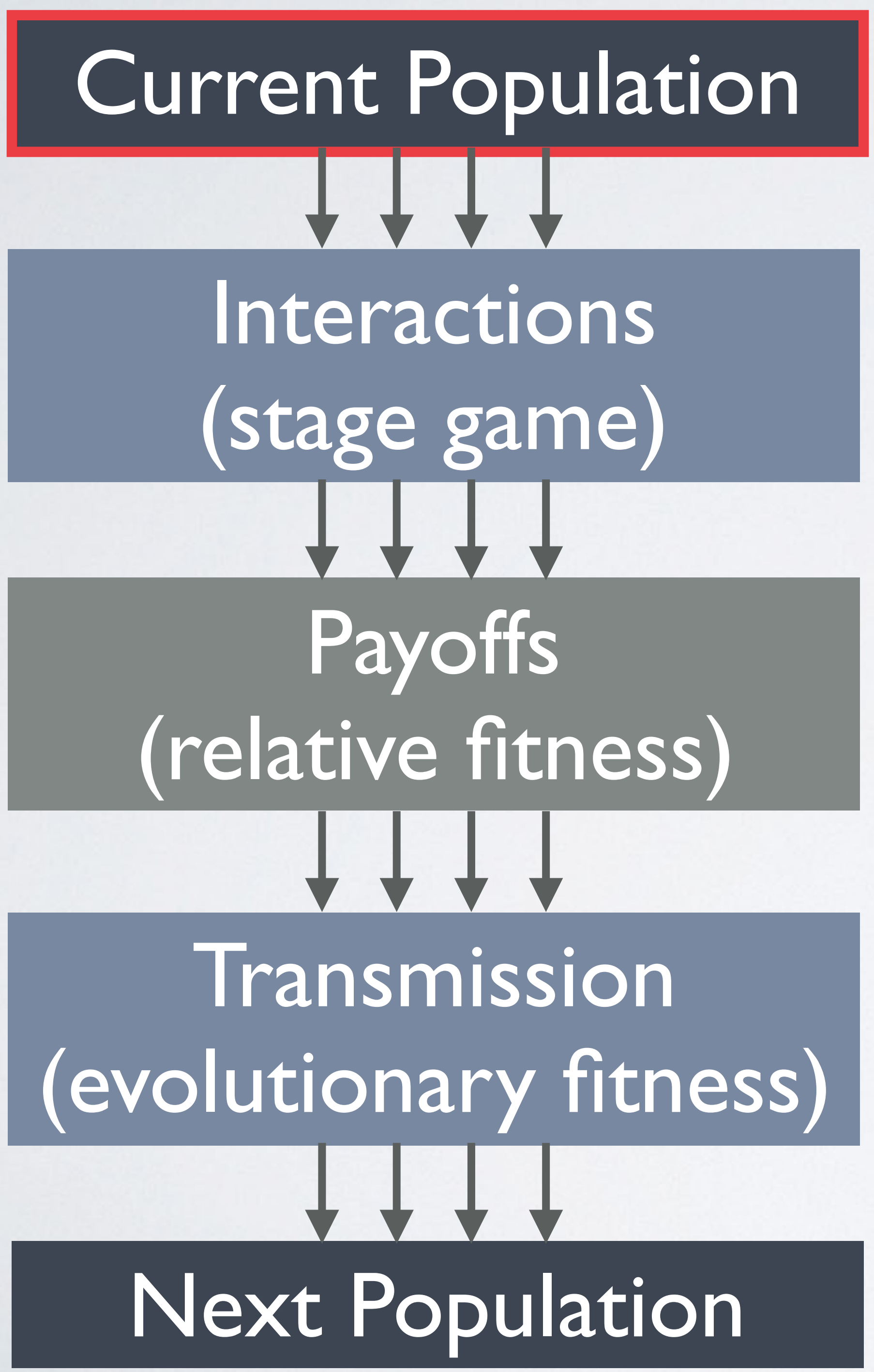
  Game Strategies → Possible Behaviors
- ✦ Individuals observe neighbors' strategies and payoffs and imitate/learn from them

FRAMEWORK



Current Population
Interactions
(stage game)
Payoffs
(relative fitness)
Transmission
(evolutionary fitness)
Next Population

FRAMEWORK



Each strategy used by some proportion of the population

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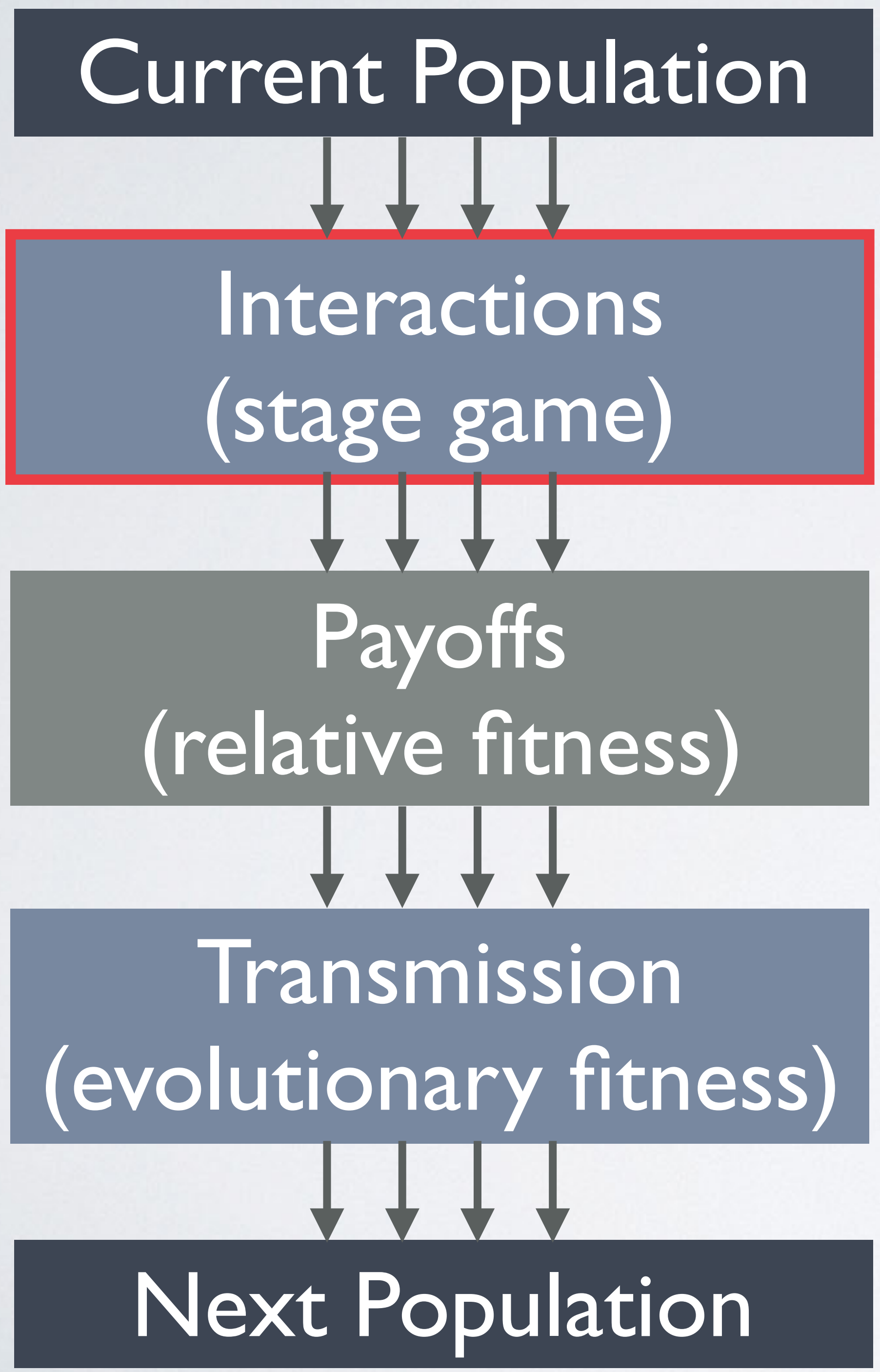

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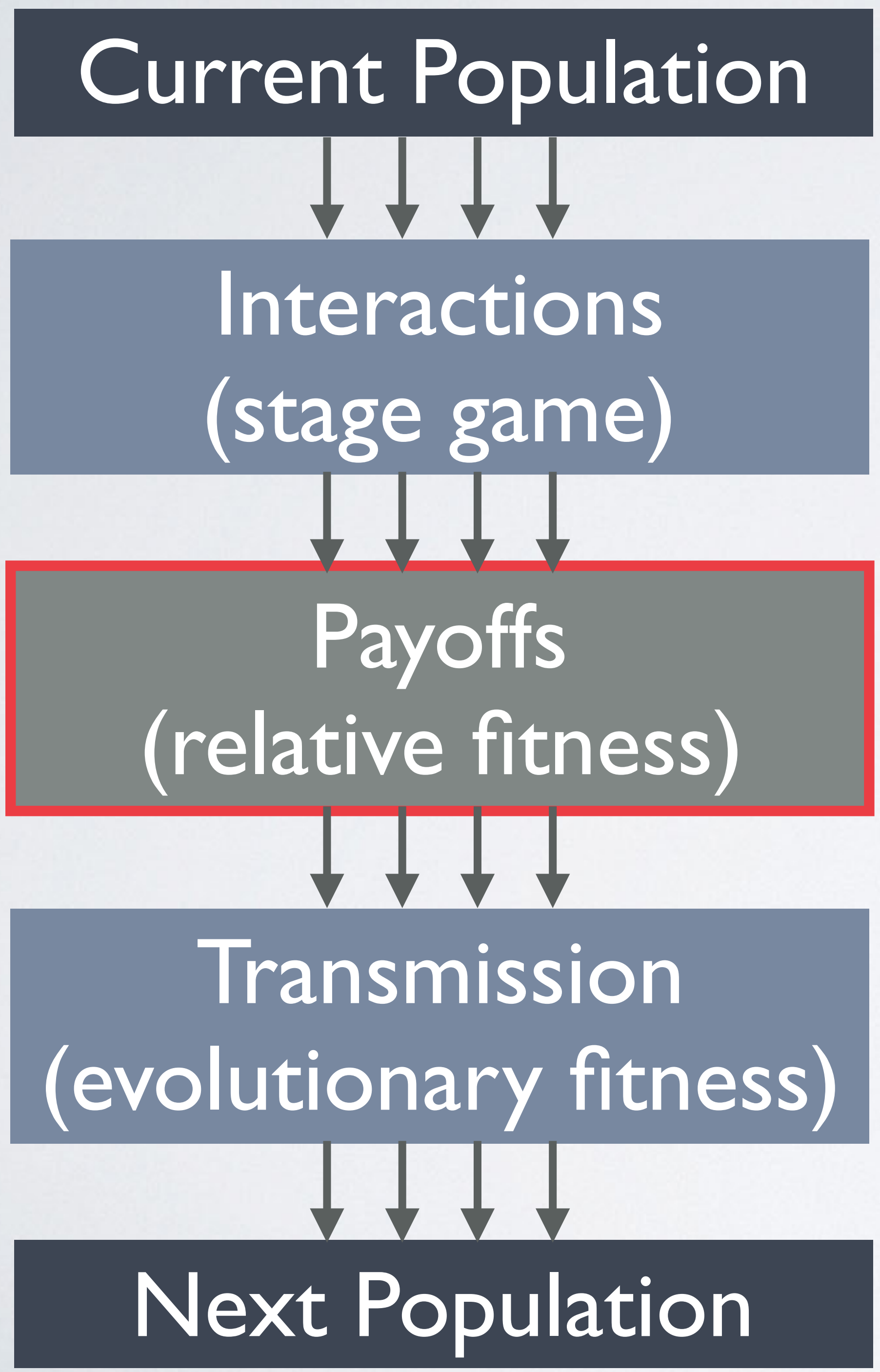

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Payoffs depend on both the individual's strategy and neighbors' strategies;
Total payoff = sum of individual payoffs

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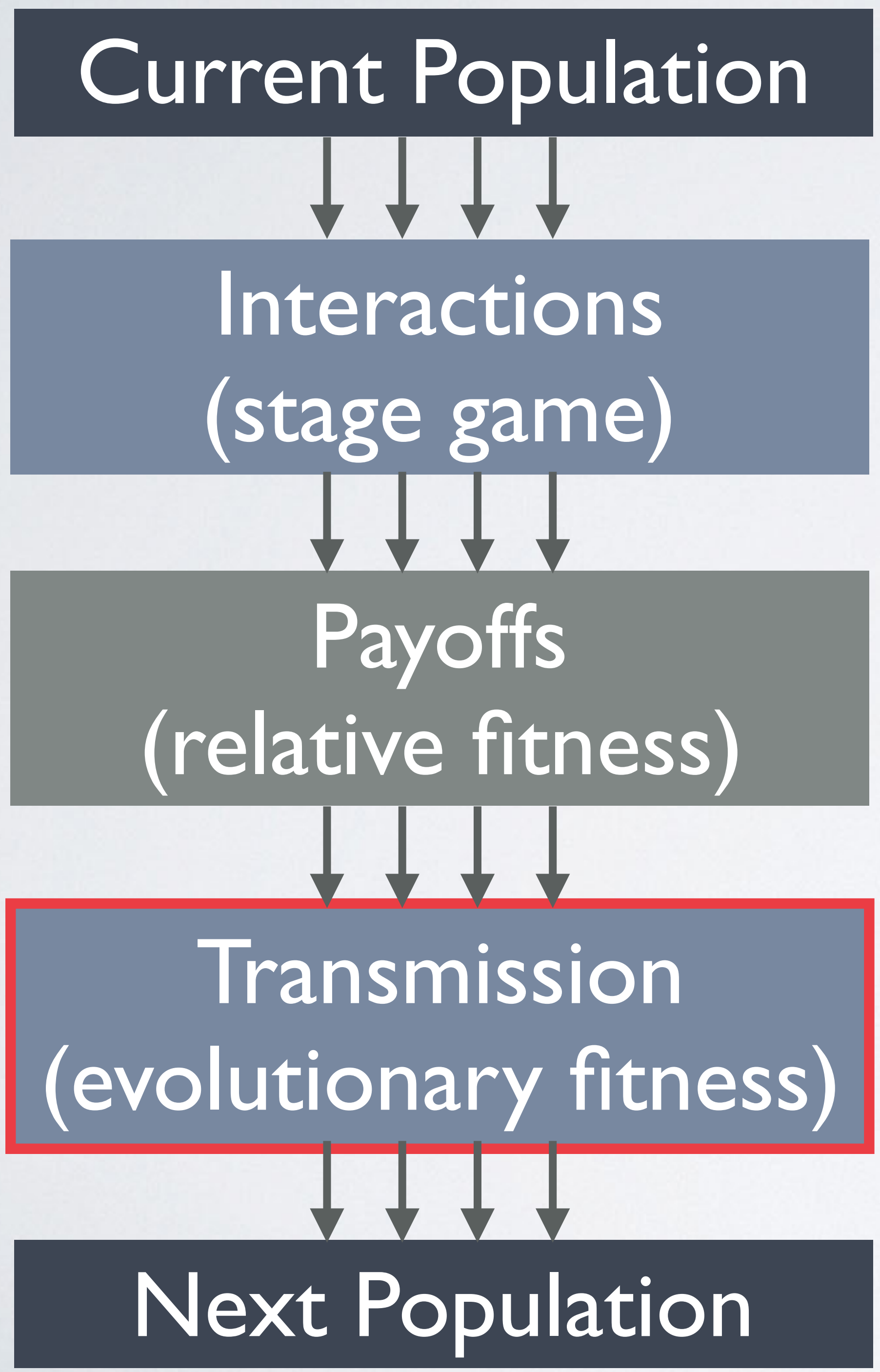

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Successful strategies are more likely to be adopted by others (more on this later)

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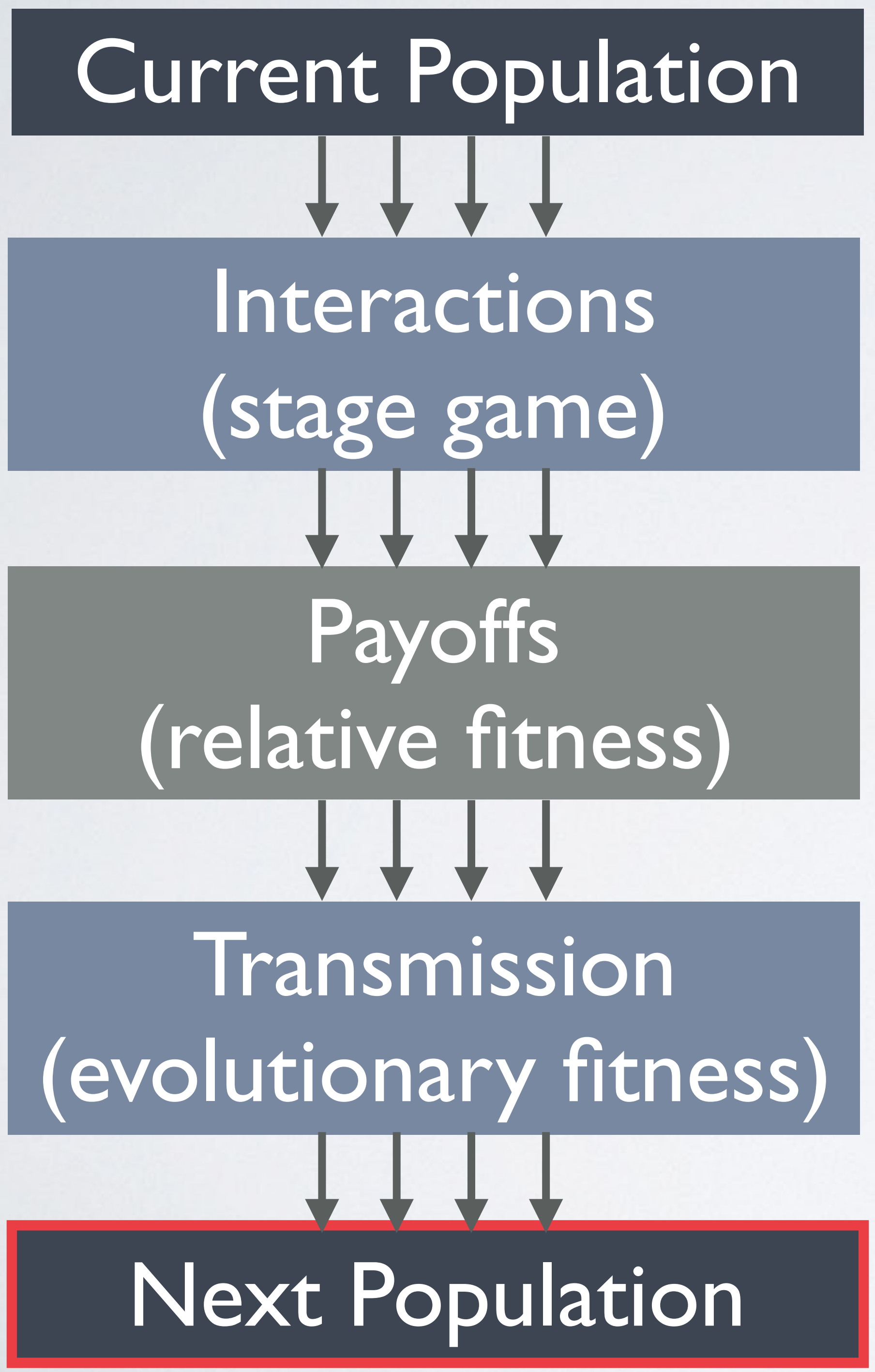

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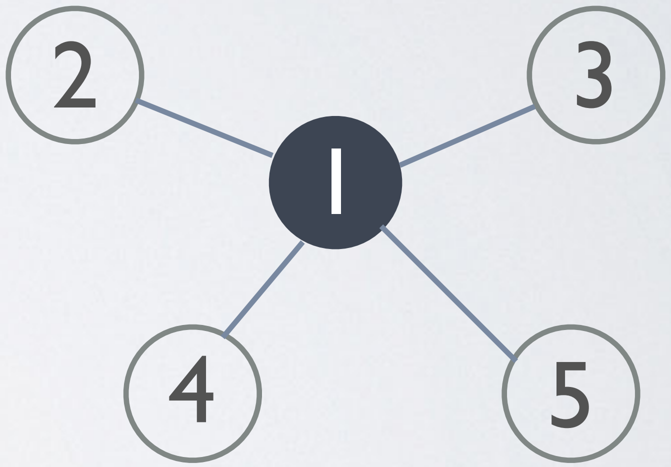
Interpret game-theoretic payoffs as reproductive fitness

Fermi Rule

Each individual compares its payoff to a randomly chosen neighbor



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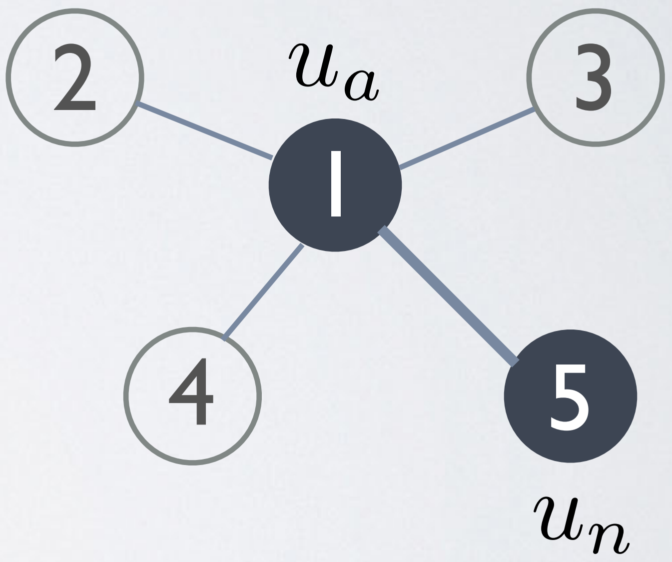

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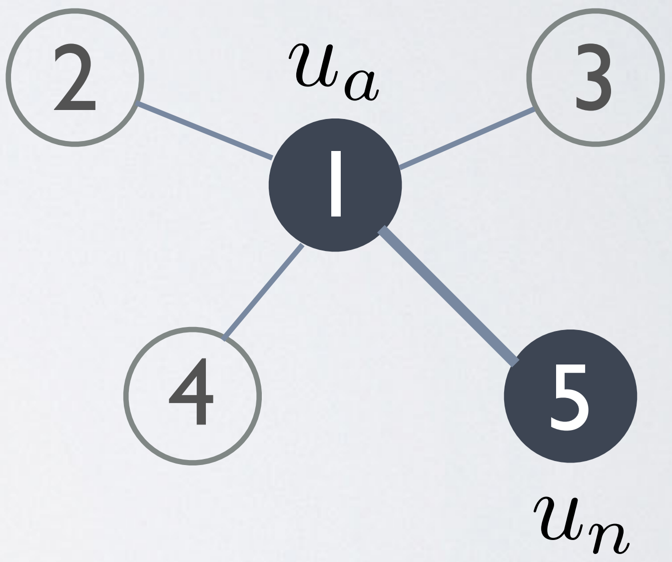
- Each individual compares its payoff to a randomly chosen neighbor
- Individual switches to neighbor's strategy w.p. depending on the difference in payoffs:



$$p = \frac{1}{1 + \exp(s(u_a - u_n))}$$

u_a, u_n = individual's and neighbor's payoffs
$s \geq 0$ is the selection strength

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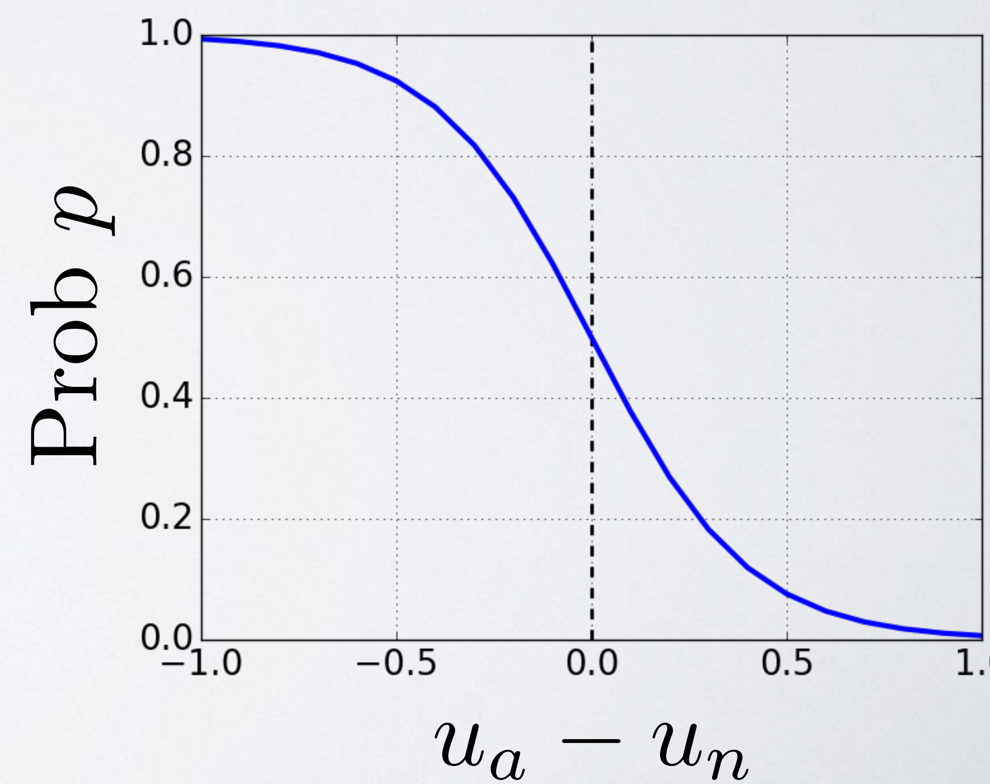

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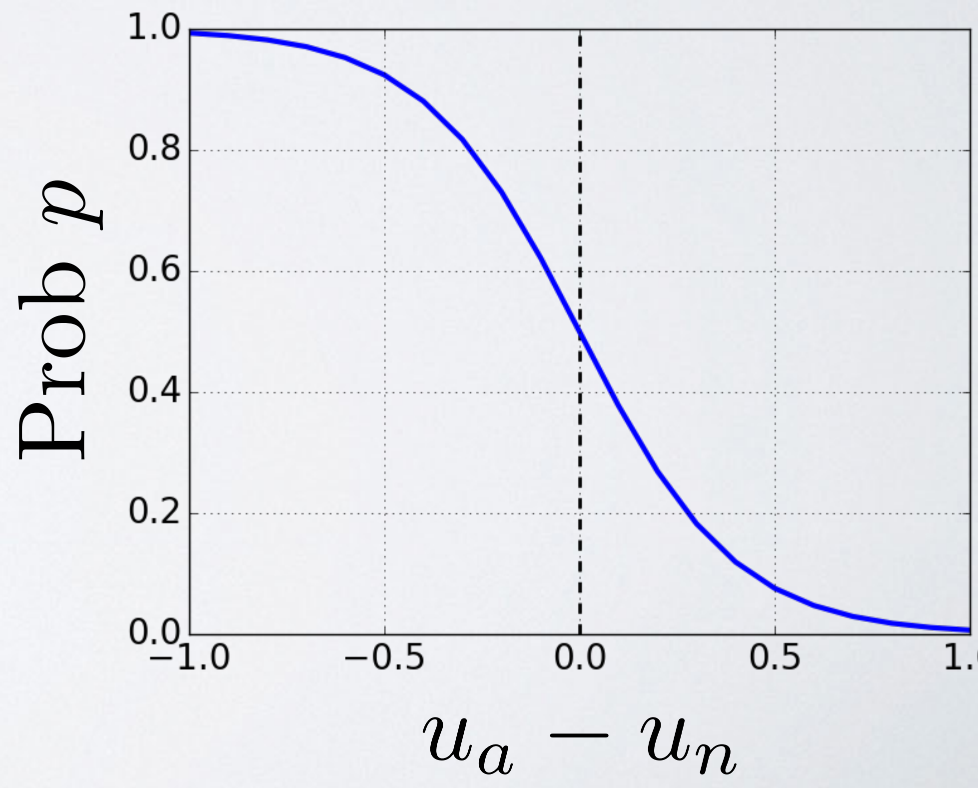

Proportion of agents using a strategy shrinks/grows depending on how well it performs (in terms of payoffs)

EXPLORATION

Individuals don’t always learn from neighbors

Sometimes, they try out a **completely new behavior** to see how it does

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Modeled by modifying the Fermi Rule:

Let S = {all available strategies}

At each step, each agent chooses a strategy *s* at random from S with a small probability μ

- regardless of whether strategy *s* is currently successful
- regardless of whether any agent is currently using strategy *s*

WHAT CAN THIS ACCOMPLISH?

- Human interactions are very complicated
  EGT models use highly simplified abstractions
- Designed to capture only the essential nature of the interactions
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But…

- It can provide explanations of the underlying dynamics
- Establish support for causal relationships and identify trends
- Evolution of human culture over time virtually impossible to study in lab settings or field studies. EGT can help out!

STUDYING NORM CHANGE IN TIGHT & LOOSE SOCIETIES

Denote possible norms as **actions in a game**

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Use a closely-related concept:

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Need For Coordination

Tight societies:

High need for coordination

Payoffs depend much more on strategies of neighbors

Loose societies:

Low need for coordination

Individualistic agents. Payoffs depend less on neighbors.

STUDYING NORM CHANGE IN TIGHT & LOOSE SOCIETIES

Tight societies: High need for coordination	Loose societies: Low need for coordination

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Game-theoretic model of
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Study how the need for coordination
affects norm change in societies

PROPOSED MODEL

Assume two possible norms denoted by *A* and *B*

Extreme Tight Society

M_c	A	B
A	a, a	$0, 0$
B	$0, 0$	b, b

Coordination Game

Extreme Loose Society

M_f	A	B
A	a, a	a, b
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Fixed-Payoff Game

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$$M = c\,M_c + (1\text{-}c)\,M_f$$

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c denotes the level of tightness

HOW TO STUDY NORM CHANGE?

Using this model, how do we study norm change in societies?

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We look at two key aspects of norm change:

- **Cultural Inertia**:
  amount of resistance of a society to changing a norm

- **Exploration Rate**:
  how willing are agents to try out new behaviors at random

CULTURAL INERTIA

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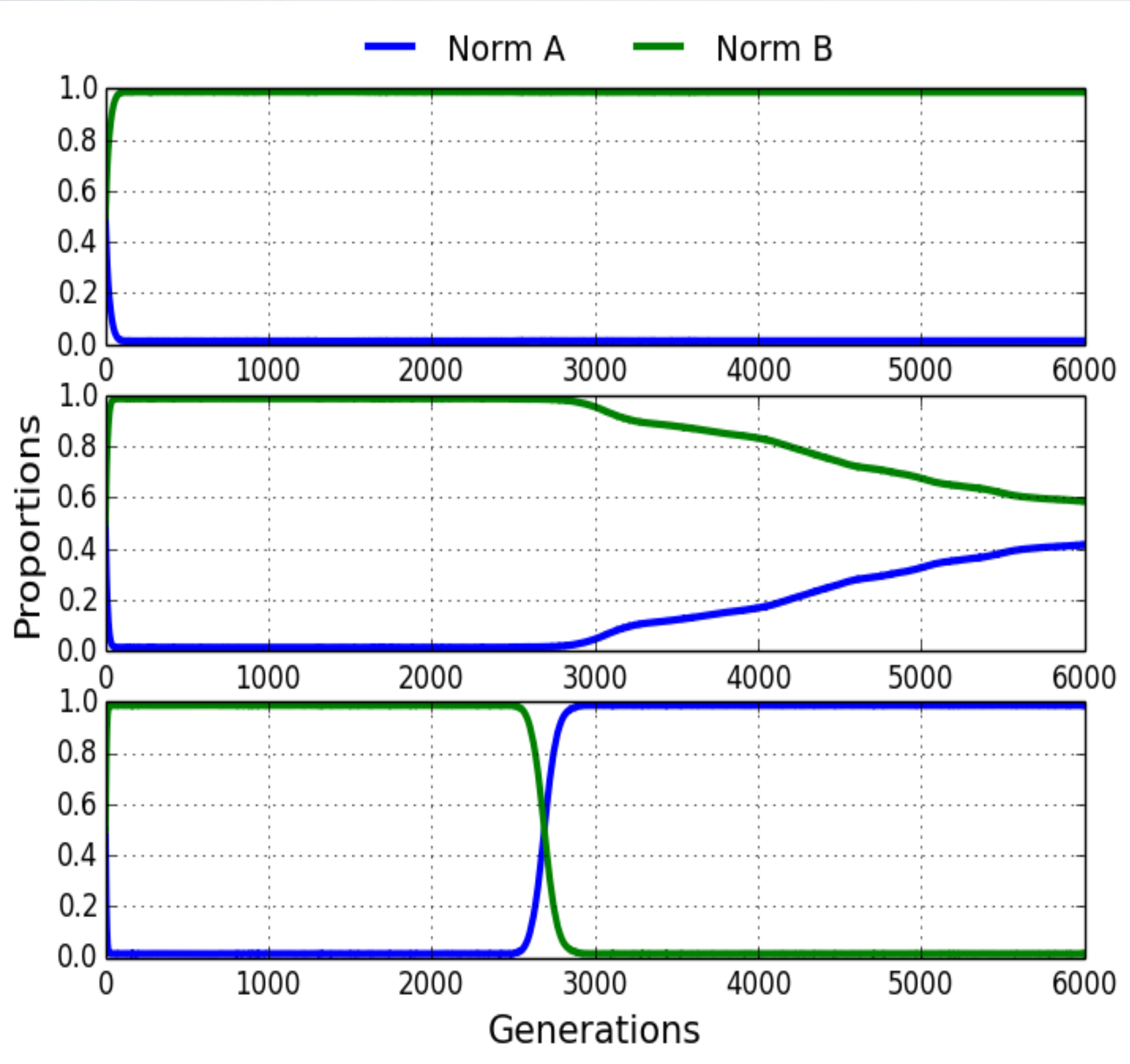
How does a tight/loose society react?

CULTURAL INERTIA

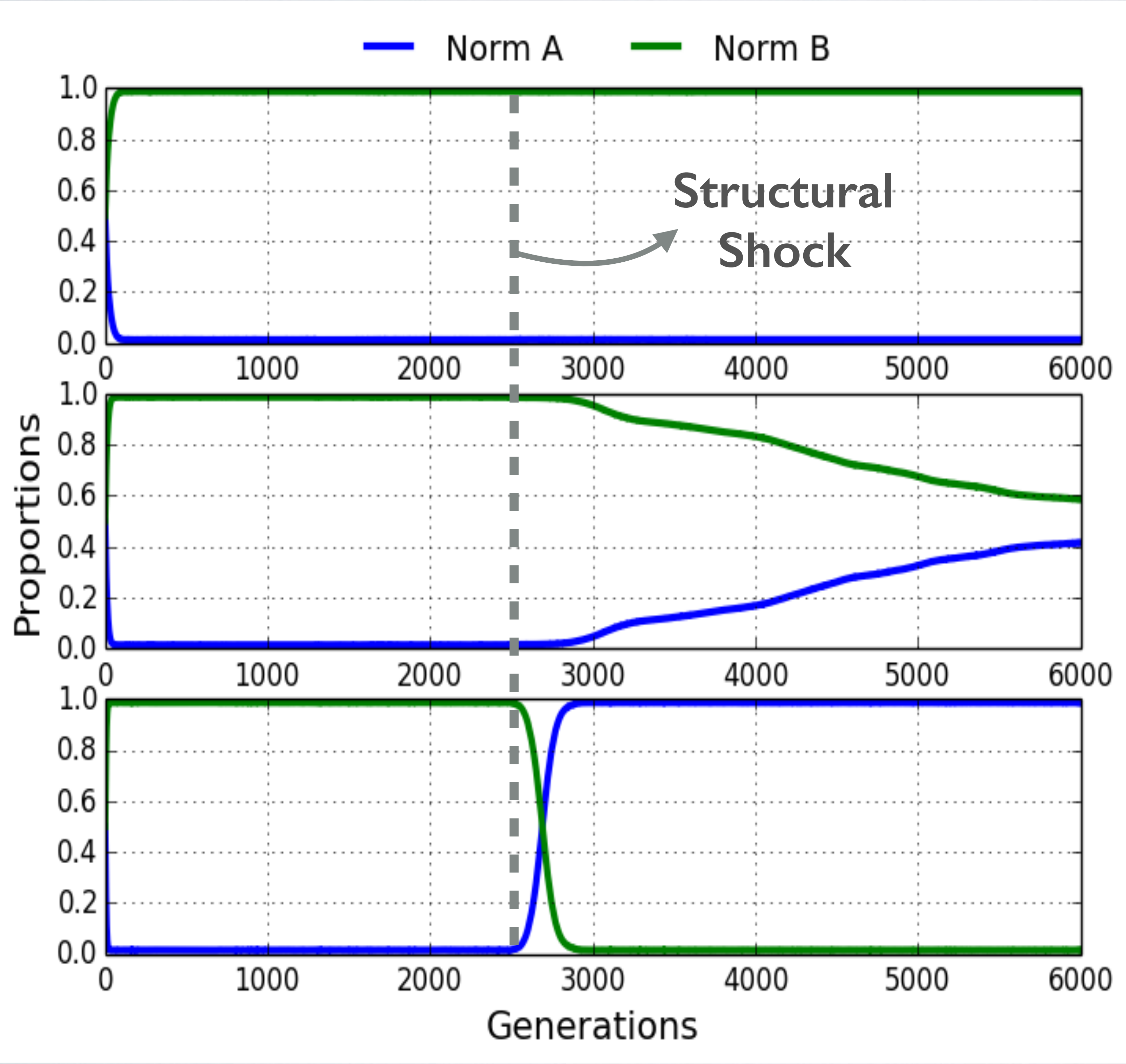


Tight

Intermediate

Loose

CULTURAL INERTIA



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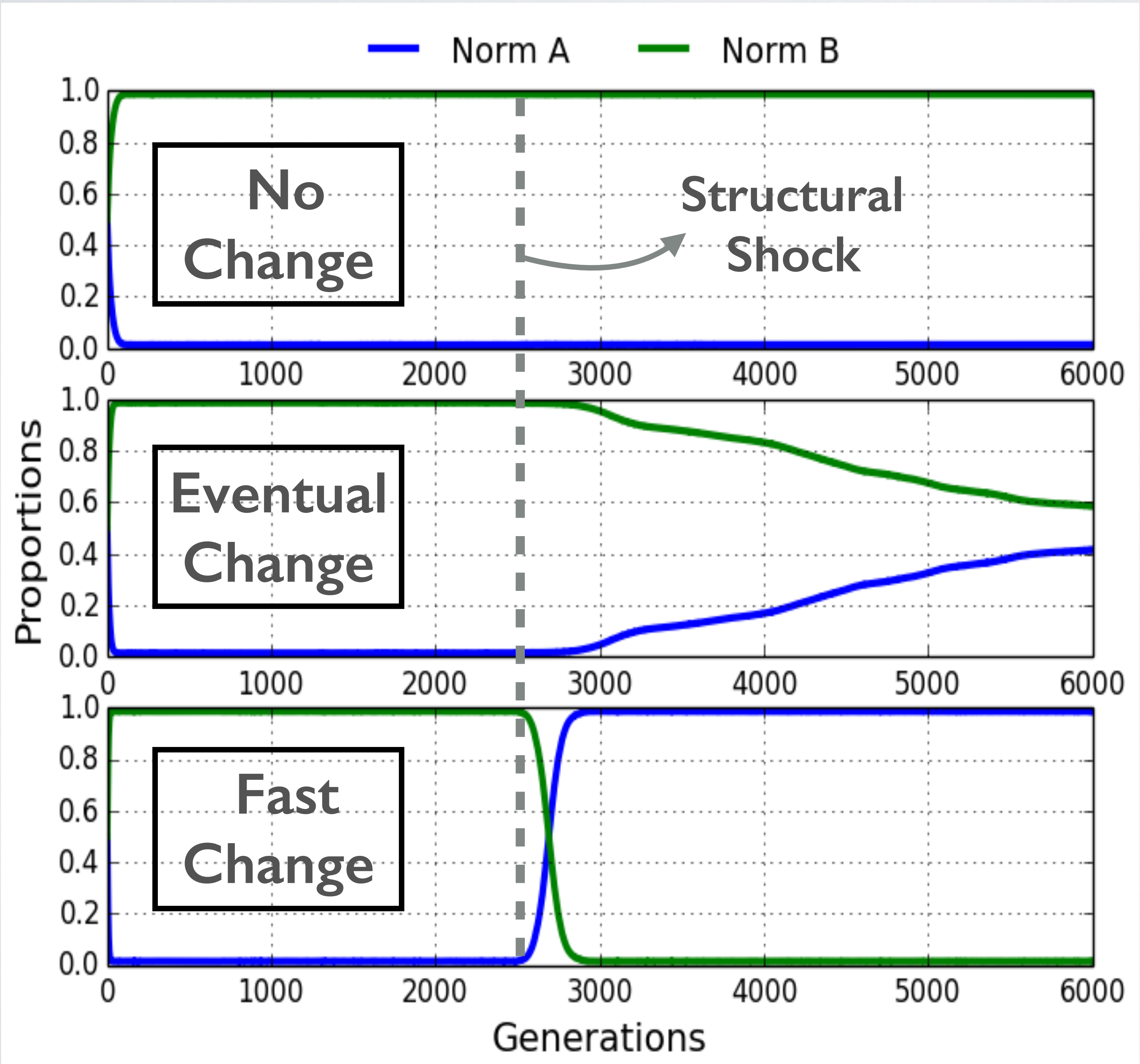

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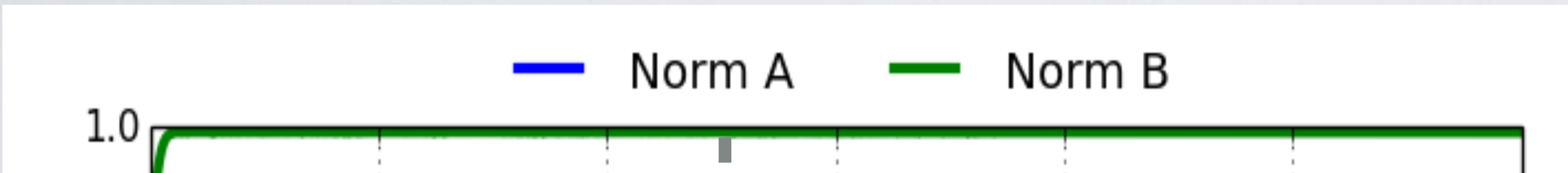
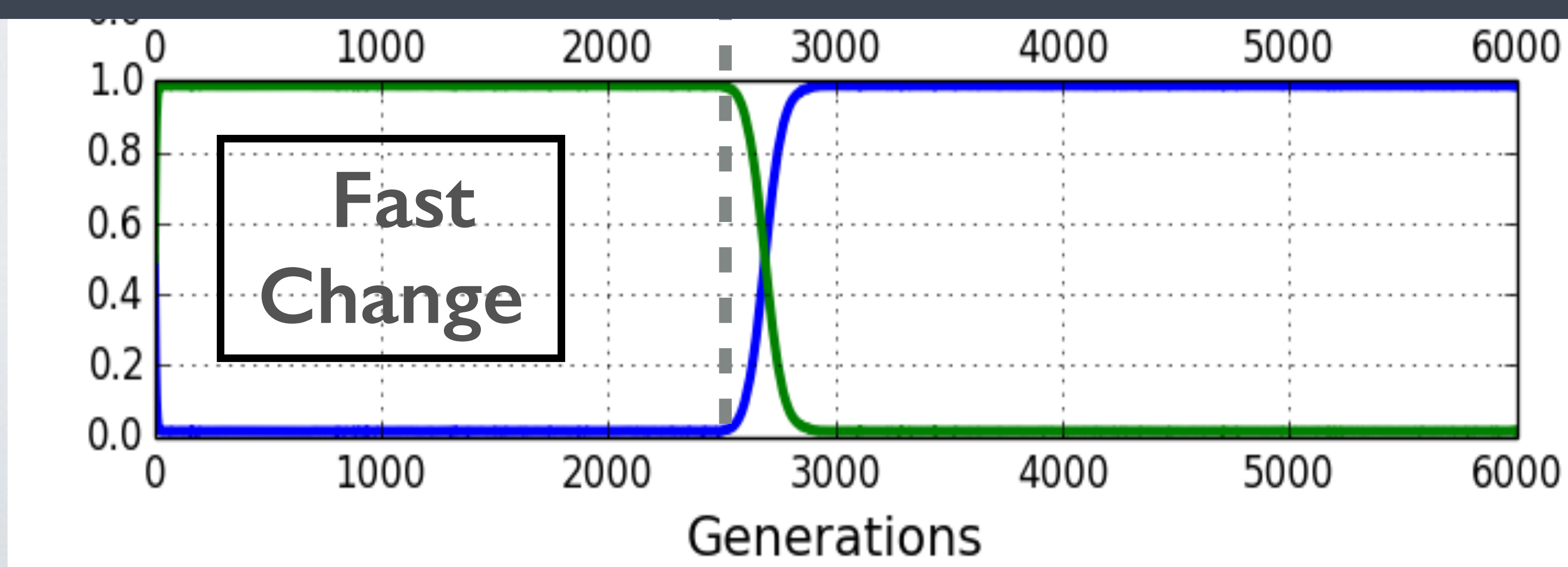


Higher needs for coordination
(tighter societies)

↓

Higher cultural inertia



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EXPLORATION RATES

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Why study exploration rates?

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Study evolution in a changing environment using regular structural shocks

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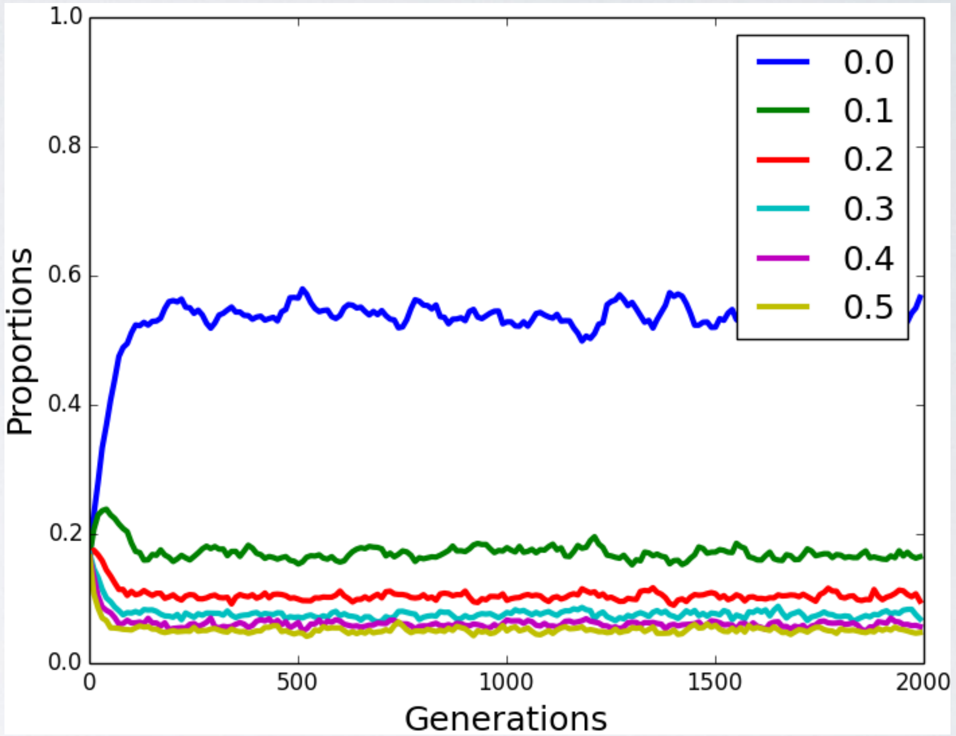
In a static environment, no exploration is always better in the long run

EVOLVING EXPLORATION RATES

Same experiment with agents on a grid using Fermi Rule

Now we introduce structural shocks at regular intervals of 75 generations

Agents can choose an exploration rate from the set {0.0, 0.1, 0.2, 0.3, 0.4, 0.5} as part of their strategy



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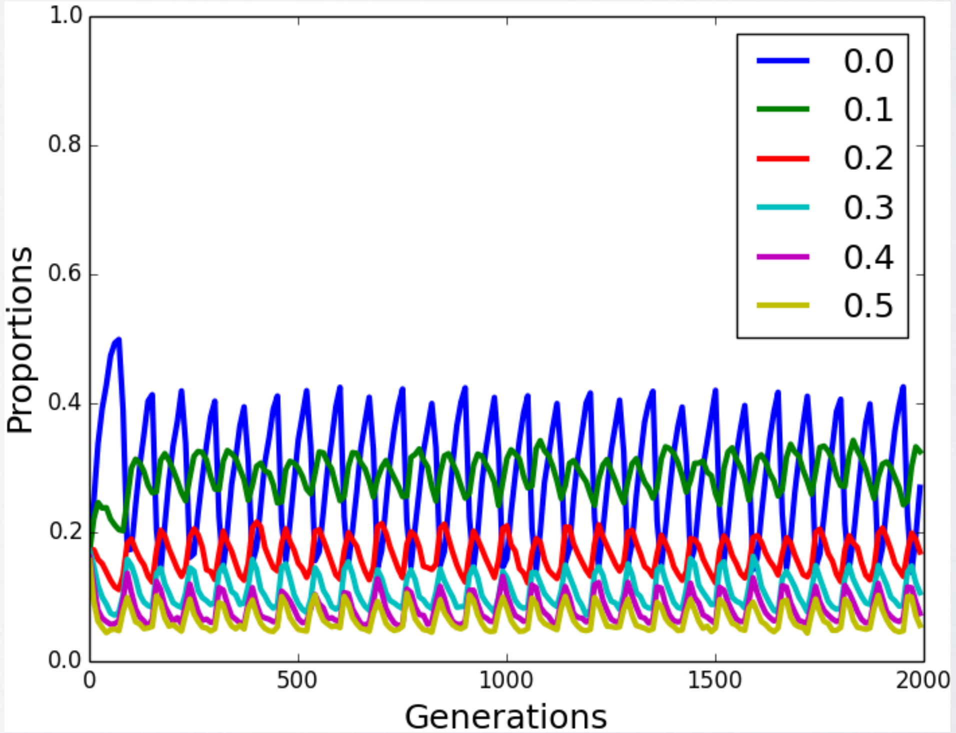

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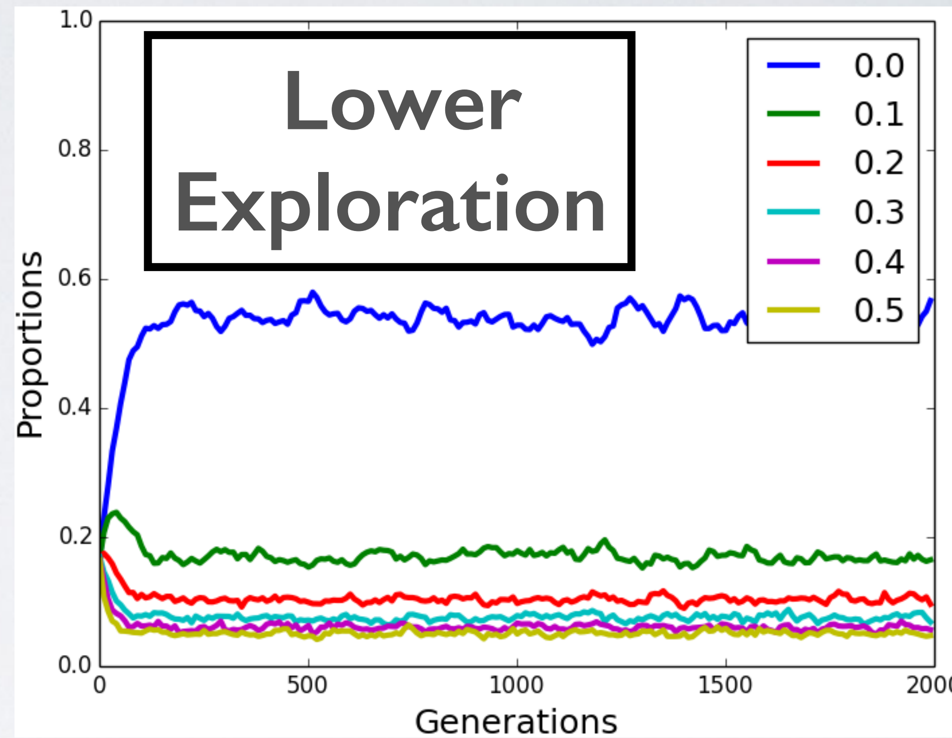

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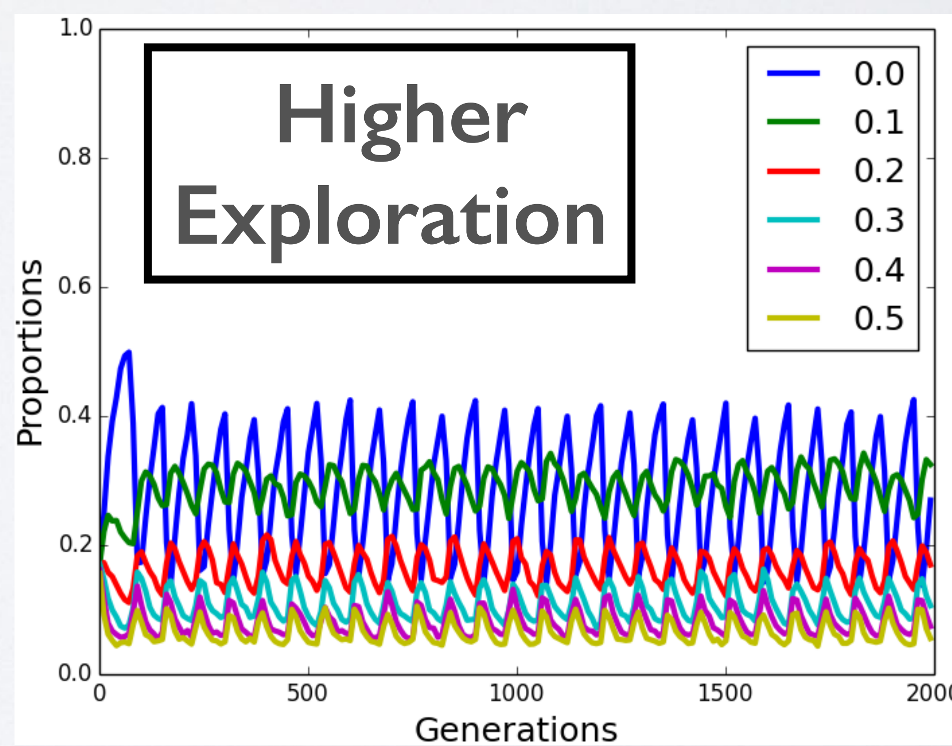

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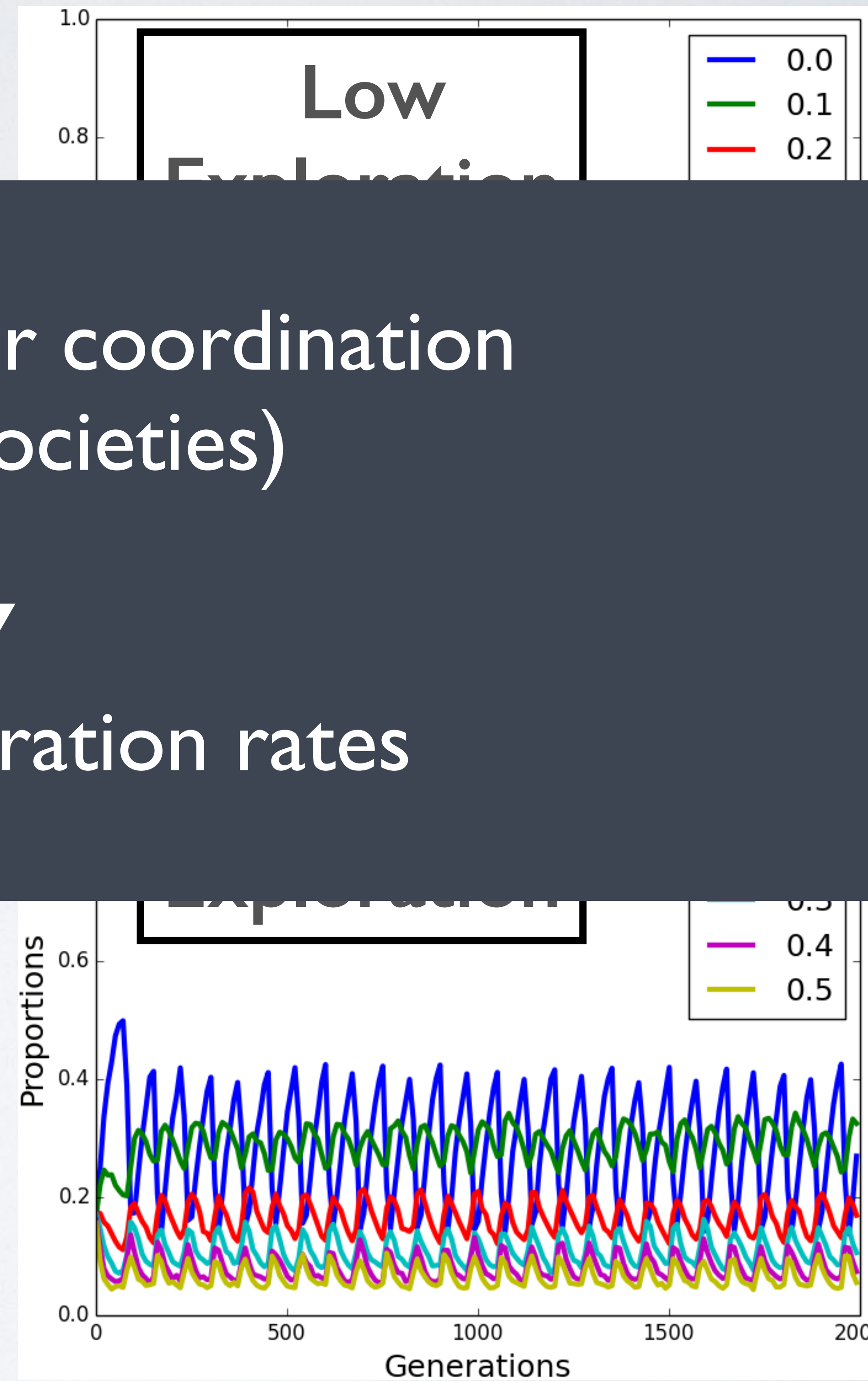

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- **Broader Takeaway**:

  Previous work have not accounted for the *substantial societal differences* in how individuals interact and influence each other.

  Incorporating concepts from the social and behavioral sciences, and modeling them using game theory can lead to better insights!

THANKS!

Feel free to get in touch!

Extended version on arXiv:
https://arxiv.org/pdf/1704.04720.pdf

email: sohamde@cs.umd.edu
website: https://cs.umd.edu/~sohamde/

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