Discrimination and Collaboration in Science

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Big Picture

Hannah and I look at the dynamics of discrimination and collaboration in epistemic communities.

Motivations

Social scientists have observed that:

1) In some fields women are less likely to have prestigious first and last author positions (West et al., Sugimoto et al.)
2) In some fields women and people of color are less likely to collaborate, and are more likely to collaborate with in-group members.

Motivations

In previous work, Justin Bruner and I found that discrimination, hashed out as inequitable credit sharing in academic work, could disincentivize collaboration between actors in different social groups.

Social/Feminist Epistemology

One assertion from social epistemology is that cognitive diversity is important for science (Zollman 2007, 2010, Thoma 2016, etc.)

Feminist epistemologists further argue that personal diversity is an important source of cognitive diversity in some arenas (Longino 1990, Haraway 1989, Okruhlik 1999).

Social/Feminist Epistemology

Our results suggest that inasmuch as this is true, discrimination has the potential to decrease the effective diversity of research teams in a way that might impede epistemic progress.

Roadmap

1) Methodological Overview
2) Results 1 – Fixed Network, Evolving Bargaining
3) Results 2 – Fixed Bargaining, Evolving Network
4) Results 3 – Co-evolution of Bargaining and Collaboration

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Agent Based Modeling

We use game theory and evolutionary game theory – branches of modeling designed to represent strategic interactions between agents.

Discrimination and Collaboration

We consider agent-based models of actors playing the Nash demand game on a network.

Nash Demand Game

Finite Nash demand game

Following previous authors, we use a finite version of the game.

$L+H = 10$, $0<L<5<H<10$, (i.e., 4, 5, and 6)

Player 2

		Low	**Med**	**High**
	Low	L,L	L,5	L,H
Player 1	**Med**	5,L	5,5	0,0
	High	H,L	0,0	0,0

Finite Nash demand game

Following previous authors, we use a finite version of the game.

Player 2

Player 1		**Low**	**Med**	**High**
	Low	L,L	L,5	L,H
	Med	5,L	5,5	0,0
	High	H,L	0,0	0,0

Finite Nash demand game

Following previous authors, we use a finite version of the game.

‘Fair’

Player 2

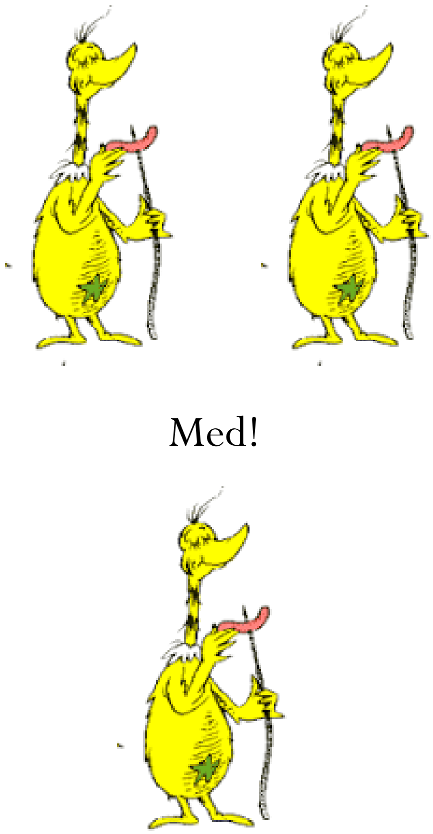
		Low	**Med**	**High**
	Low	L,L	L,5	L,H
Player 1	**Med**	5,L	5,5	0,0
	High	H,L	0,0	0,0

‘Unfair’

Nash Demand and Discrimination

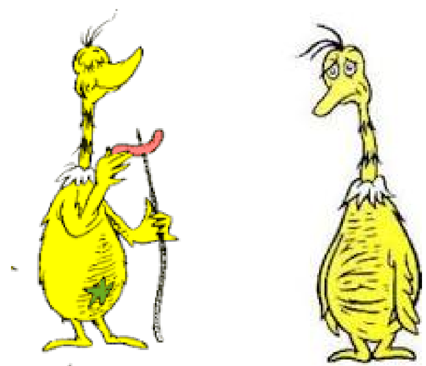
In particular, we consider models with two types of cultural actors (men and women, or blacks and whites, or professors and graduate students, etc.)

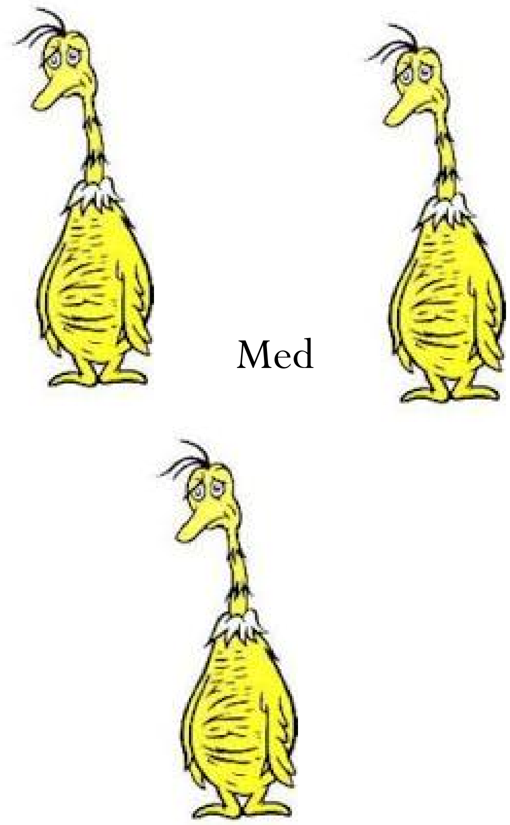
When we observe patterns of behavior where one side consistently makes a High demand and the other Low, we can use this as a representation of discrimination between groups (Axtell et al. 2000).



Med!

High! Low!





Med

Nash Demand and Collaboration

The NDG is a game of resource division, but can also be used as a representation of both joint action and resource division (Wagner, 2012). Assume the resource is formed first through joint action.

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We focus, in the paper, on the interpretation of this game as representing academic collaboration and division of credit, but the results are general to situations of division.

The Collaboration Game

Under the academic interpretation collaborators produce a resource (publishable research) which exceeds that they could produce independently. But, they must bargain (sometimes implicitly) to determine 1) who does what research and how much and 2) who gets credit in the form of author order.

Inequity vs. Inequality

The best way to interpret outcomes in this case is as representing a demand for author position relative to work done. This means the Med-Med outcome could be unequal, but equitable. We are then worried about the emergence of inequity, not inequality.

Equitable

Player 2

		Low	**Med**	**High**
Player 1	**Low**	L,L	L,5	L,H
	Med	5,L	5,5	0,0
	High	H,L	0,0	0,0

Inequitable

Networks

We model agents playing bargaining games on networks. Nodes of the network represent academics. Links of the network represent collaborative endeavors.

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Motivation

Discriminatory norms emerge on networks with actors from different social categories (Poza et al. 2010).

Do we observe a minority disadvantage?

The Cultural Red King Effect

When minority and majority groups interact to bargain, minority members can be disadvantaged by dint of size (Bruner, WP, O'Connor and Bruner, WP, O'Connor WP).

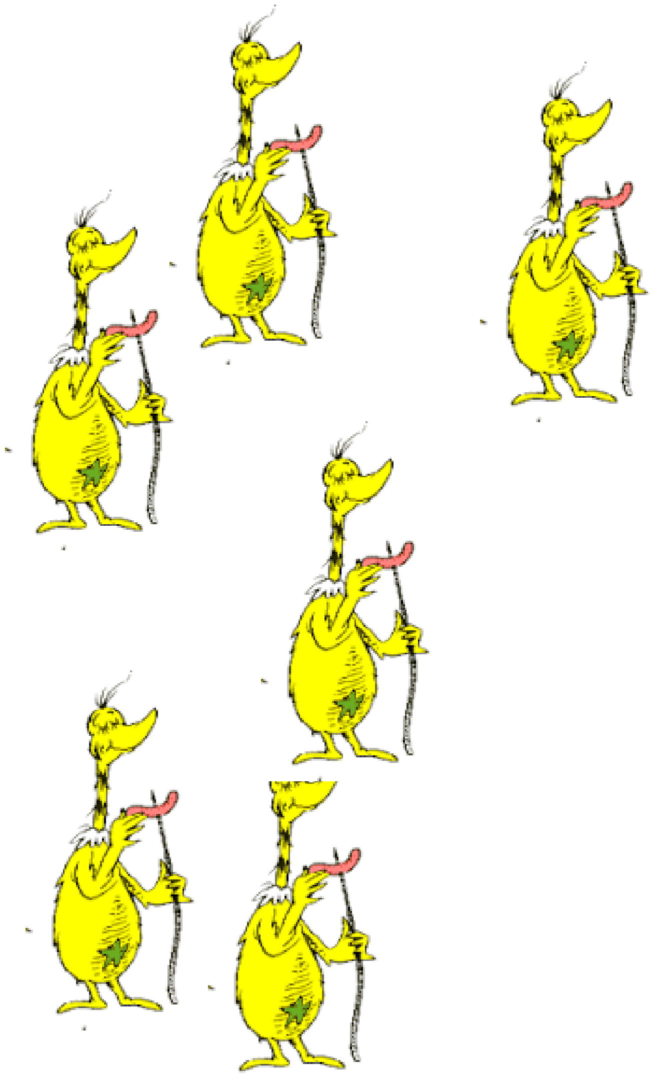
This occurs because minority types meet majorities with high frequency, whereas the reverse is not true. Minority types learn more quickly how to interact with the majority, which often means accommodating them.

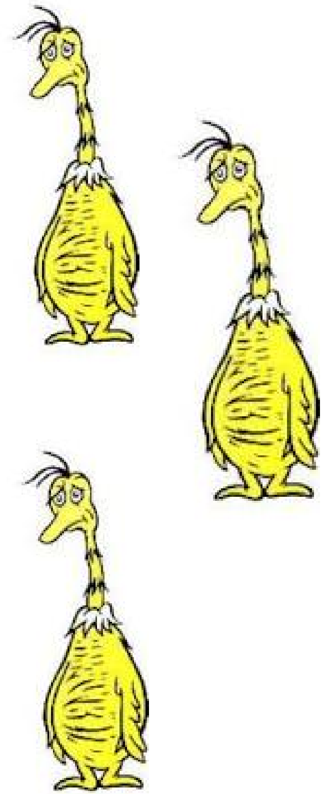
Fixed Network, Evolving Bargaining

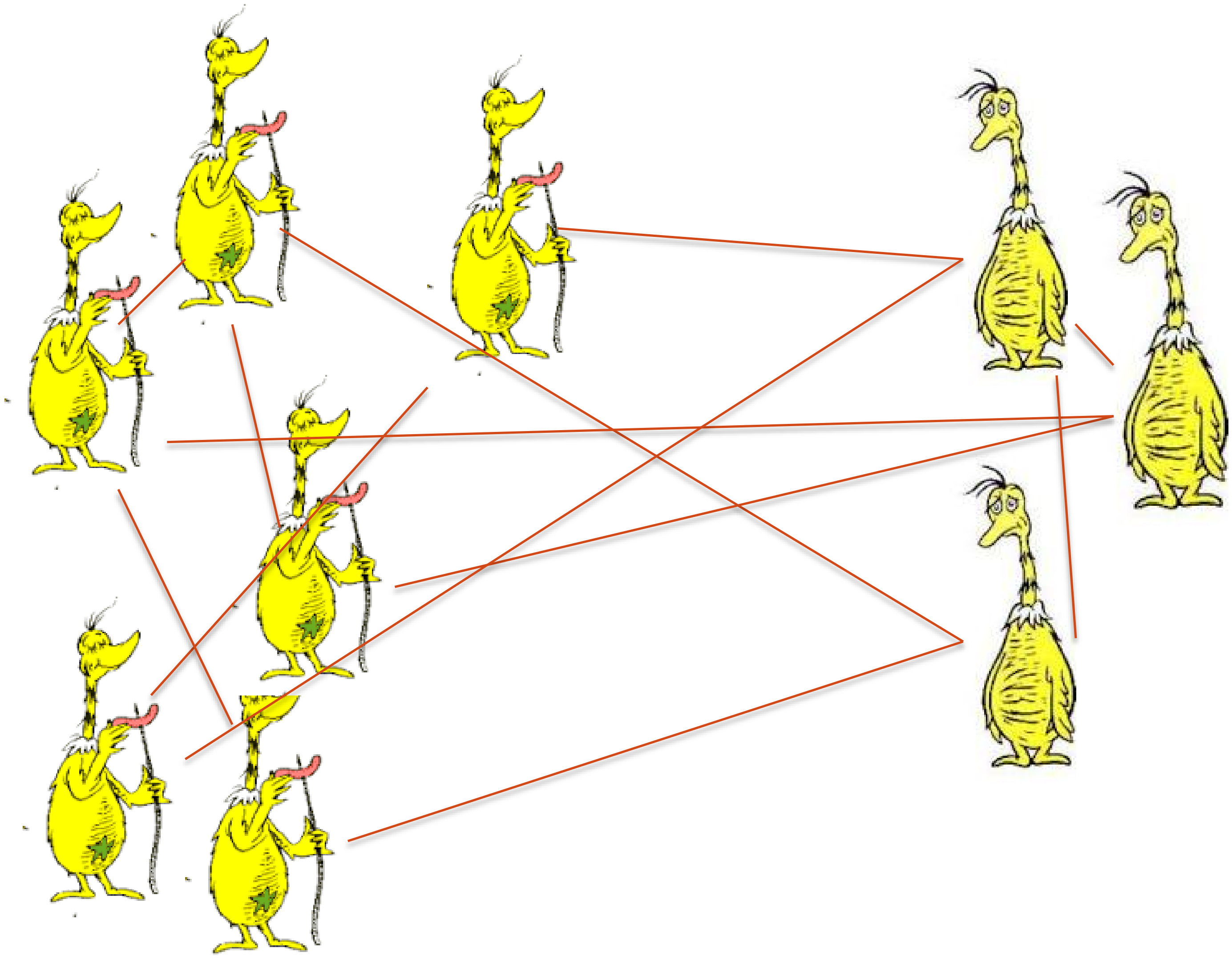
Network is formed randomly (details available upon request).

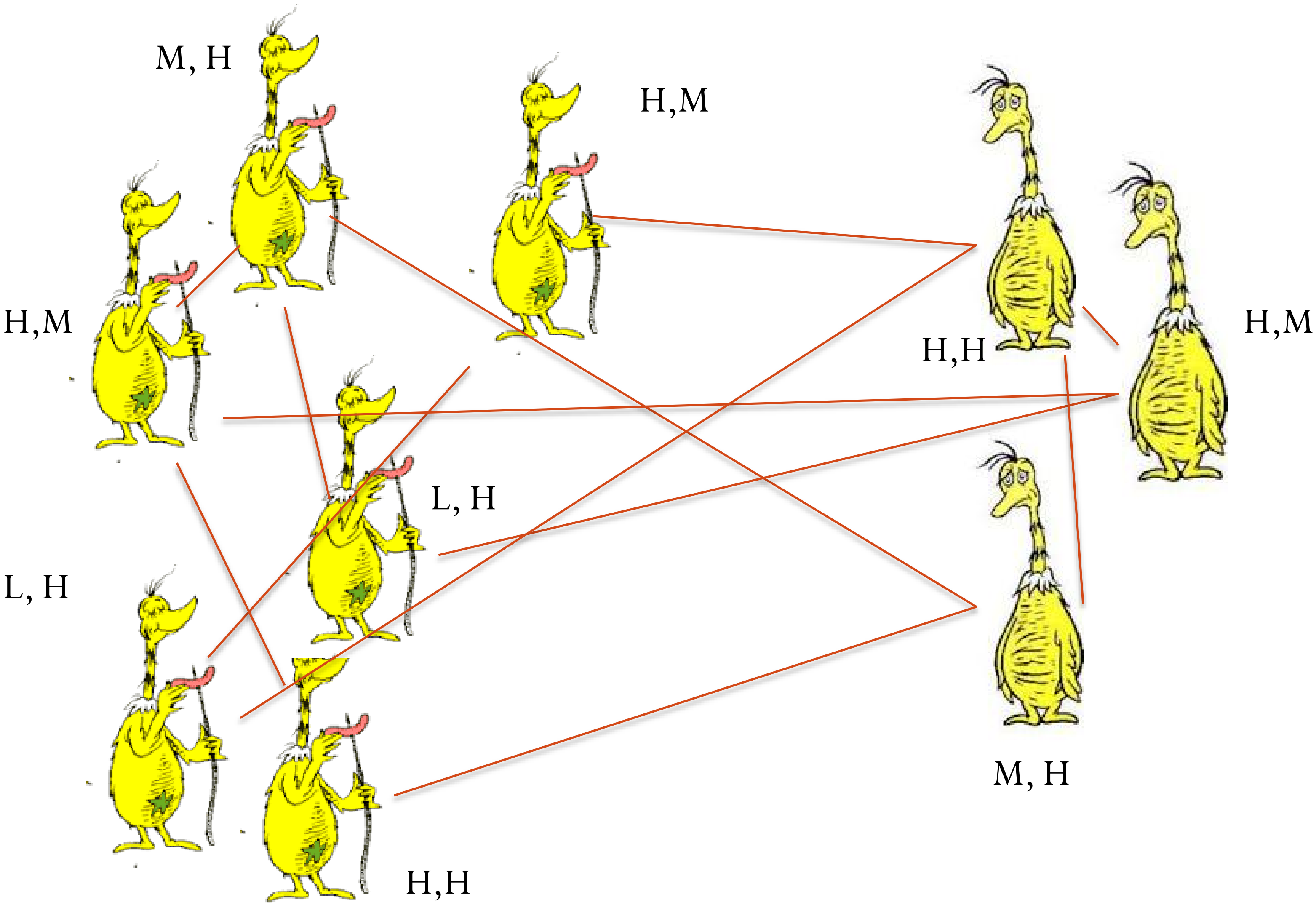
Initial random assignment of in-group/out-group strategies.

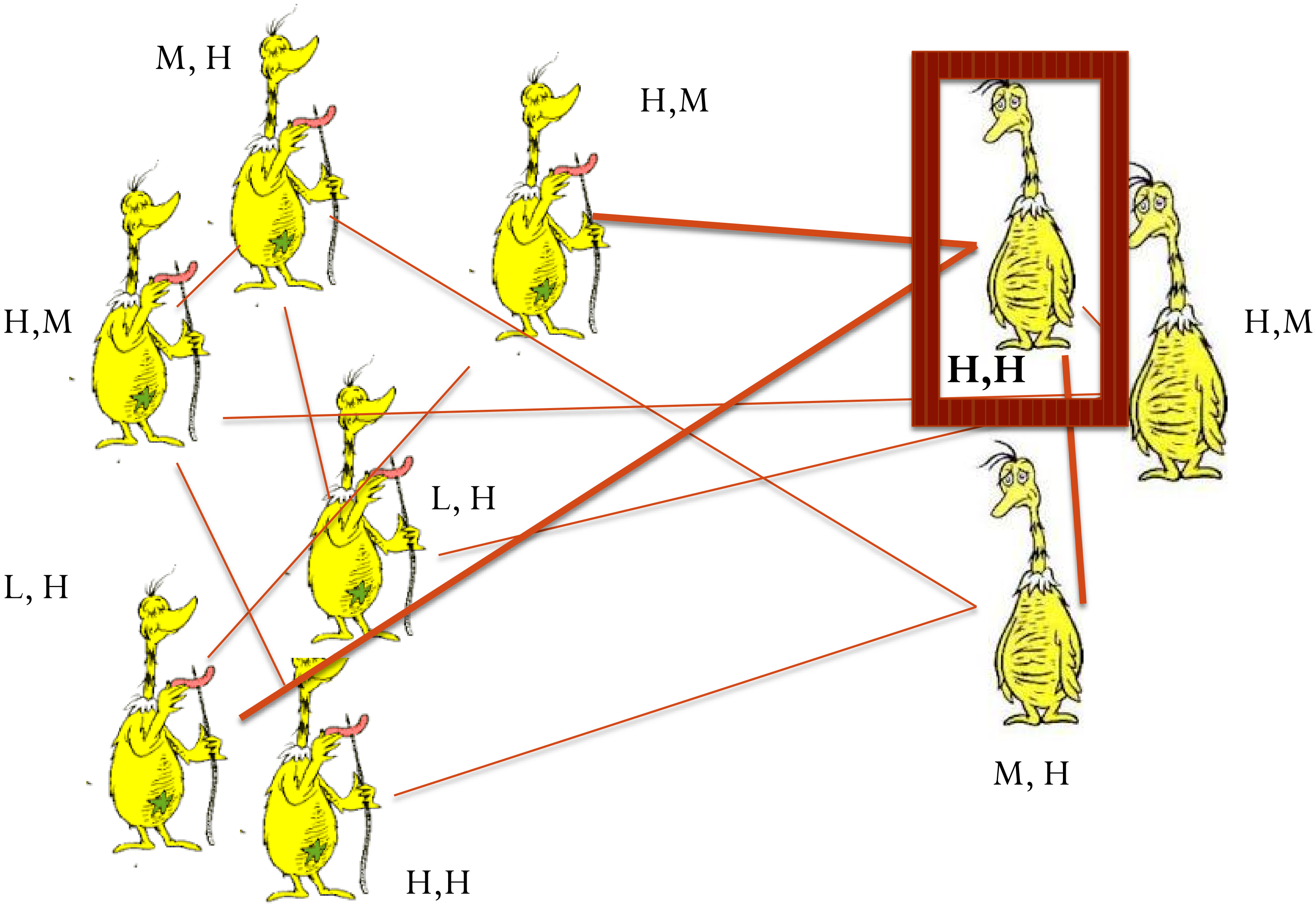
Each round, with some small probability, each agent updates their strategy via myopic best response.








M, H
H,M
H,M
H,H
H,M
L, H
L, H
M, H
H,H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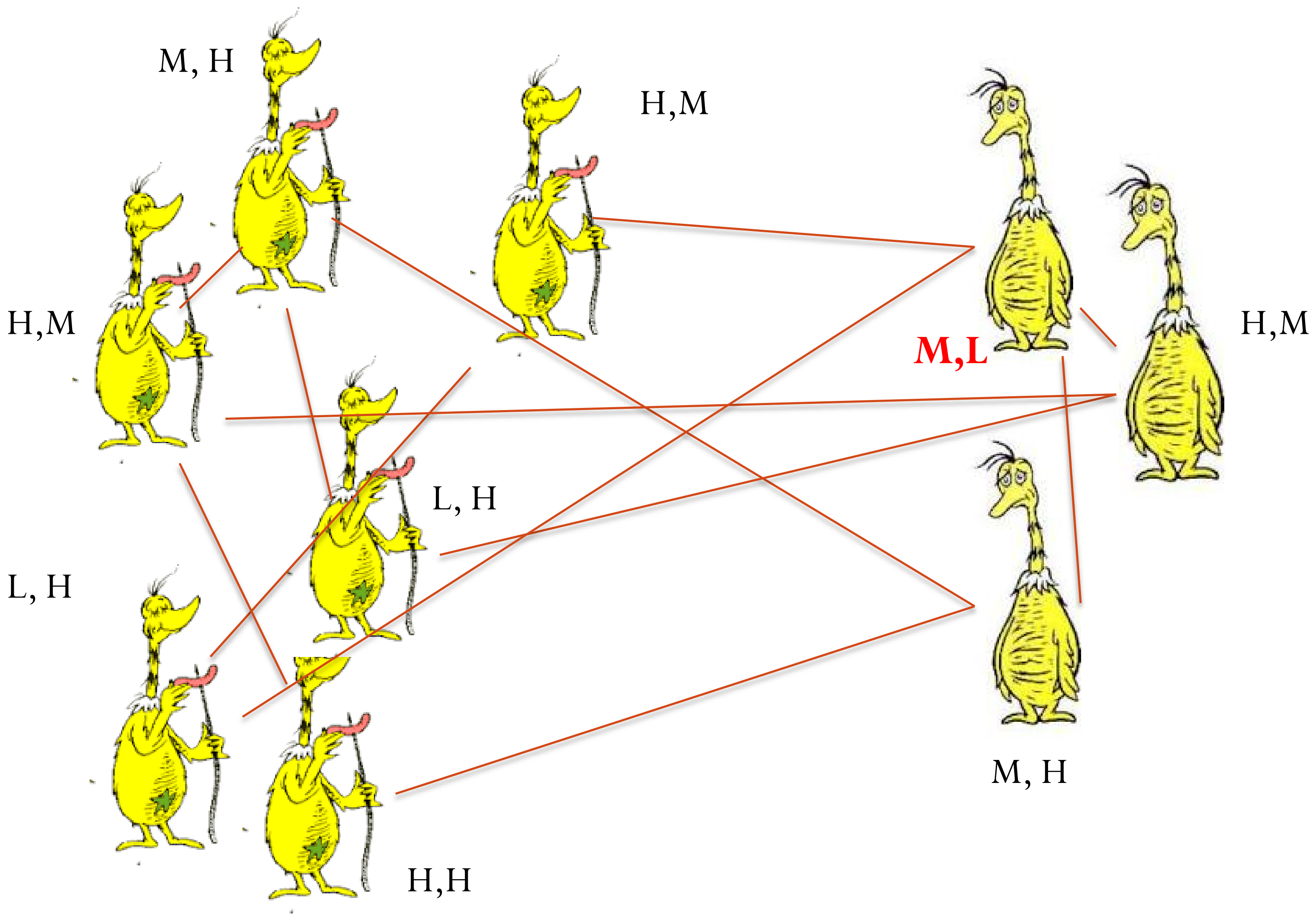
M, H


M, H
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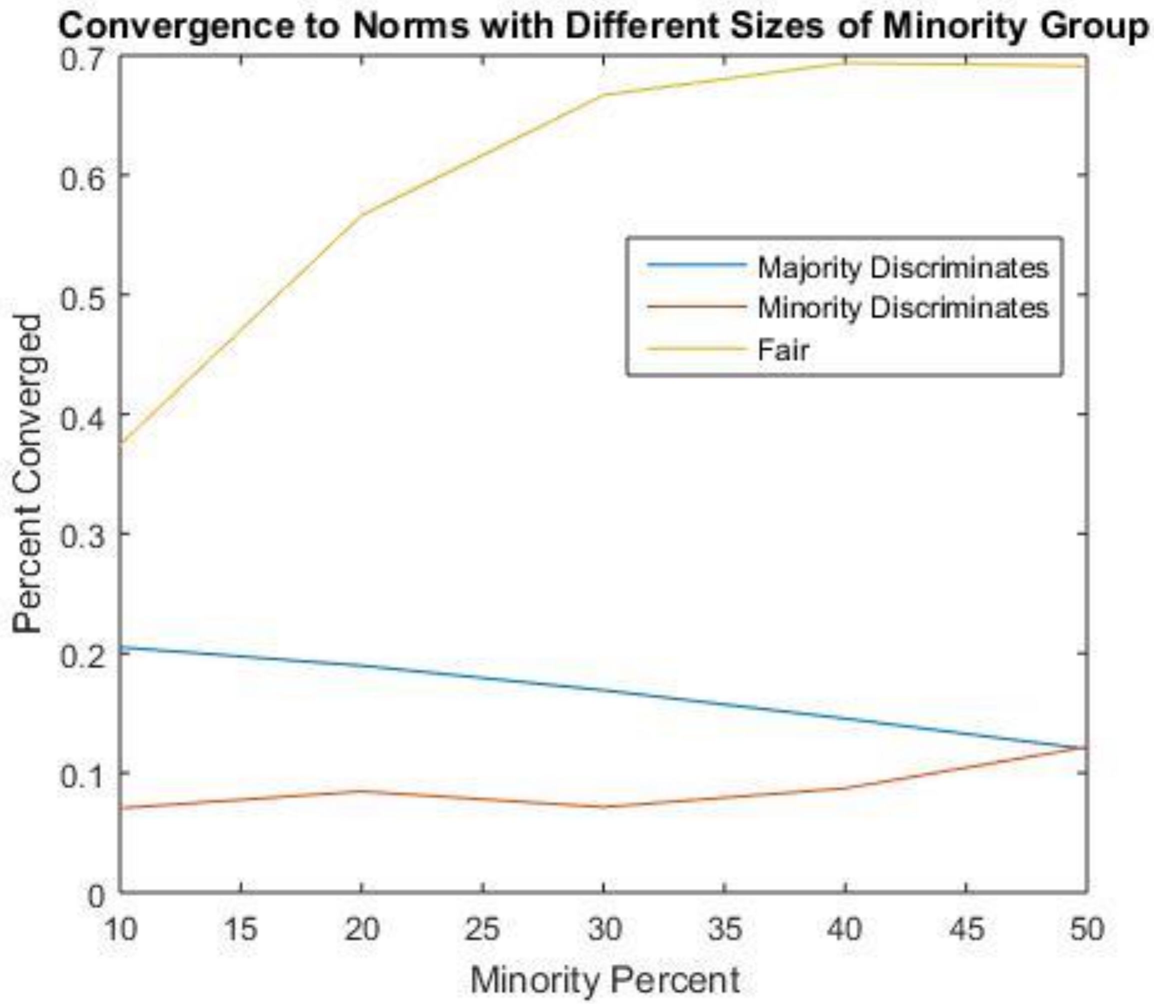
H,M
M,L
H,M
L, H
L, H
M, H
H,H

Results

Agents learn the equitable demand with in-group members.

This is also most common with out-group members, though a significant proportion of simulations go to inequitable norms.

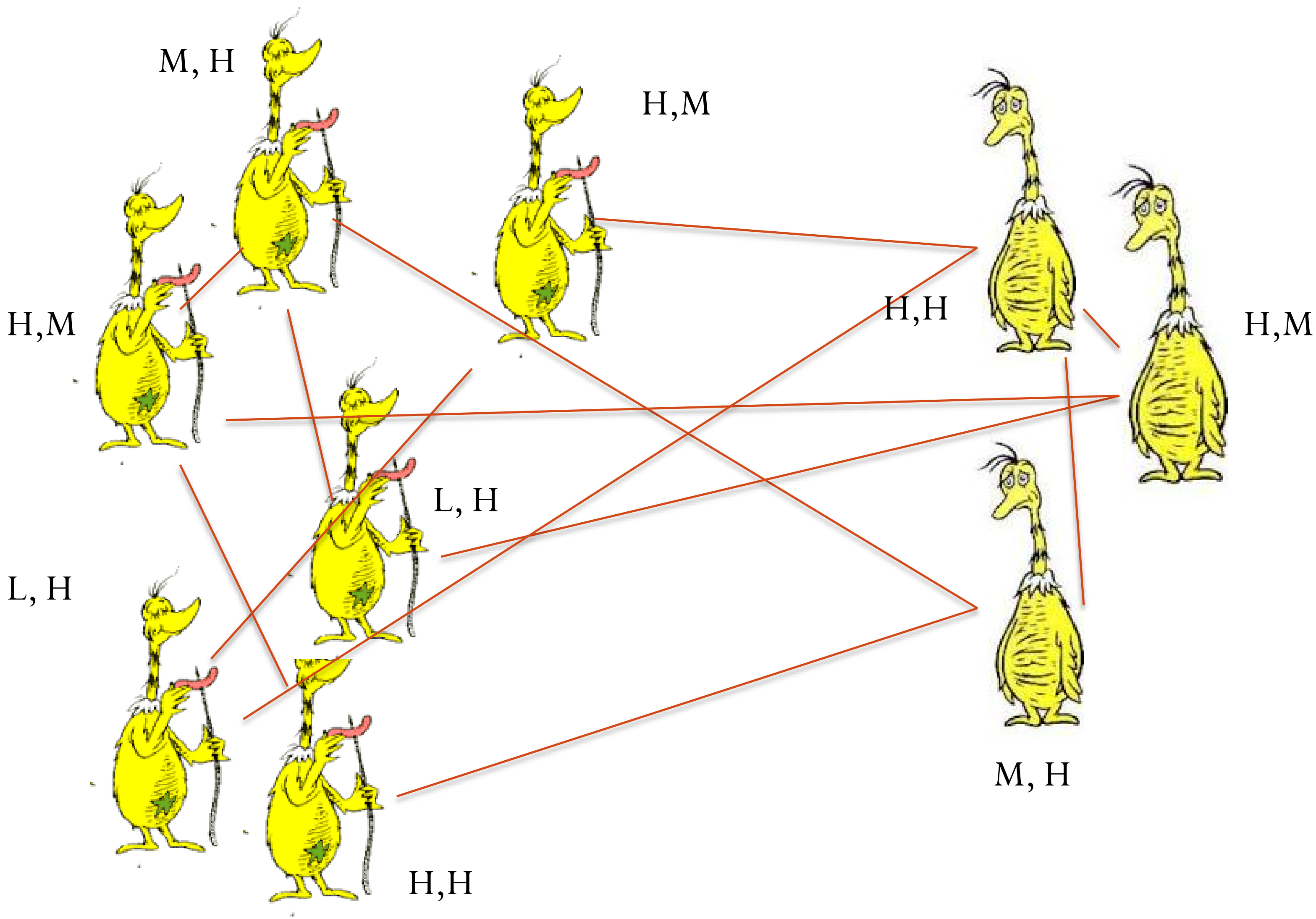
Minority status can lead to a disadvantage.



For H = 6. Averaged over: n = 20-100 (by 20); p_{in} = .4, p_{out} =.2-.8 (by.1)

Why?

Given the number of between group links, n, majority members will have fewer and minority members more.


M, H
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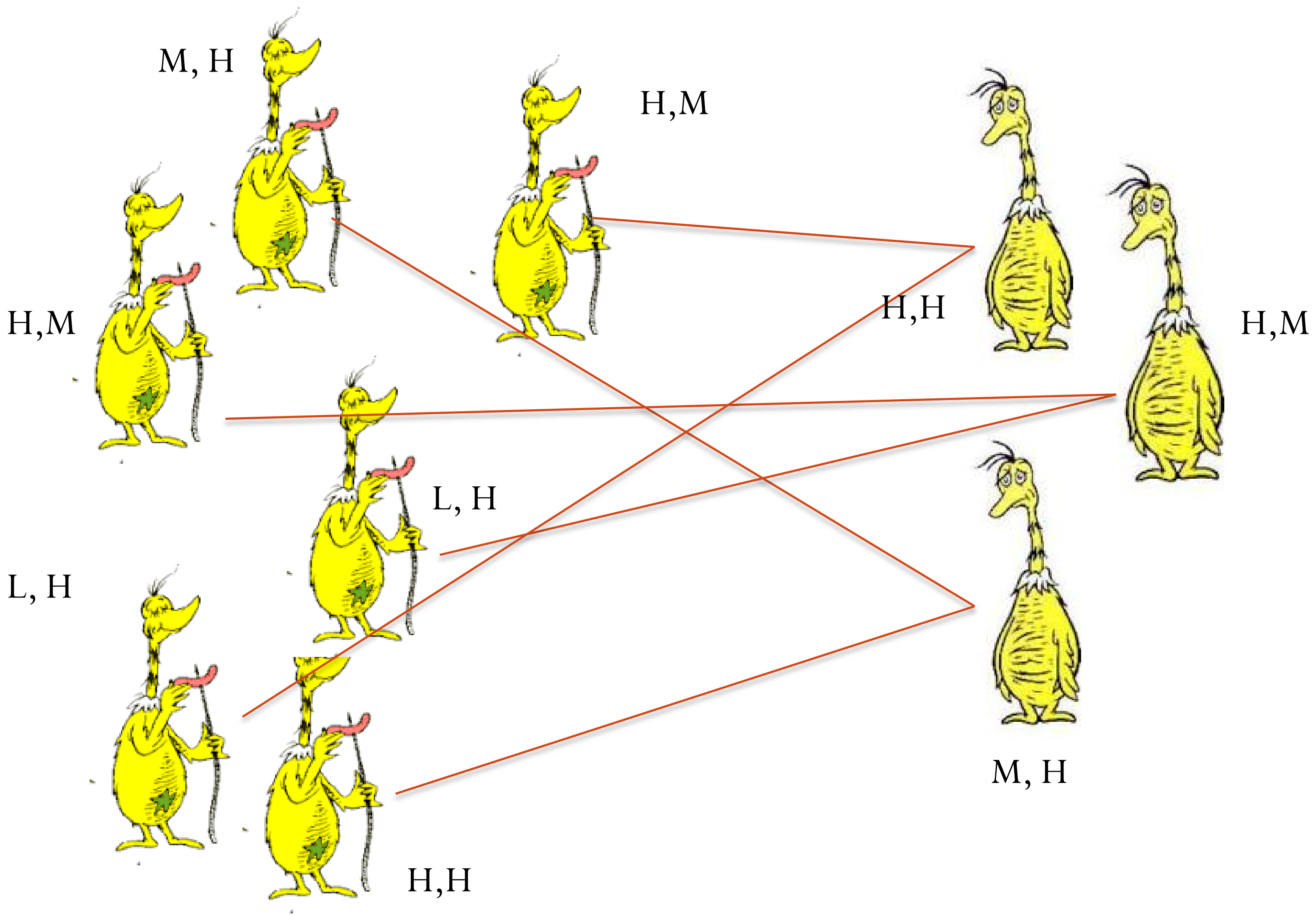
H,H


M, H
H,M
H,M
H,H
H,M
L, H
L, H
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H,H

Why?

For some number of between group links, *n*, majority members will have fewer and minority members more.

It is more likely that Low is a best response and less likely that High is a best response for the minority.

Why?

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It is more likely that Low is a best response ($^5/_9 > ^1/_3$) and less likely that High is a best response ($^1/_9 < ^1/_3$) for the minority.

Take-Away

On networks, as in mixing populations, minority status can lead to disadvantage in the emergence of bargaining norms.

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Fixed Bargaining, Evolving Network

Start with a discriminatory norm.

Fixed Bargaining, Evolving Network

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In particular, we assume agents get a payoff of 5 for in-group collaboration, the majority get 6 for out-group collaboration, and the minority gets 4. (These numbers don't matter as long as L<5<H.)

Fixed Bargaining, Evolving Network

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In particular, we assume agents get a payoff of 5 for in-group collaboration, the majority get 6 for out-group collaboration, and the minority gets 4. (These numbers don't matter as long as L<5<H.)

Then, form network using a procedure from Watts (2001).

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- The network begins with no links.
- In each time step, two agents are chosen randomly – one updater and one a potential or current collaborator.

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    - If they both have available links, they do.
    - If they have maximum links, they link if the new collaboration provides better payoff than their current lowest-payoff collaboration does.

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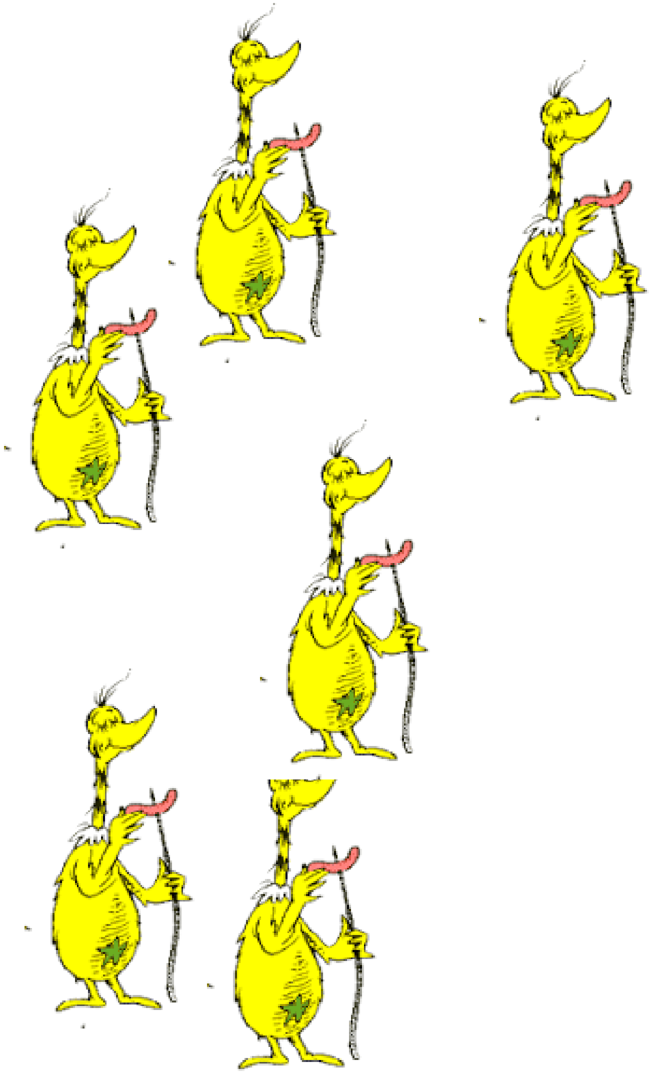
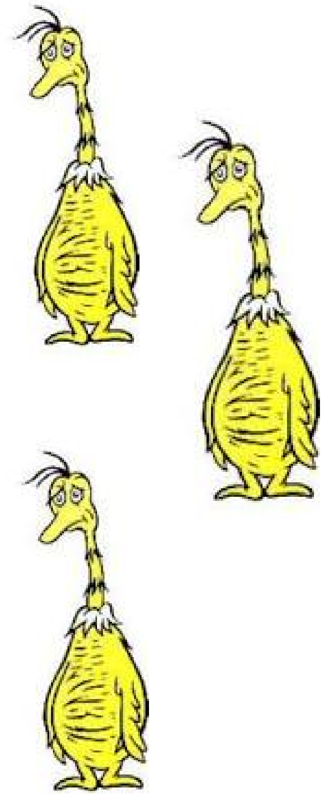
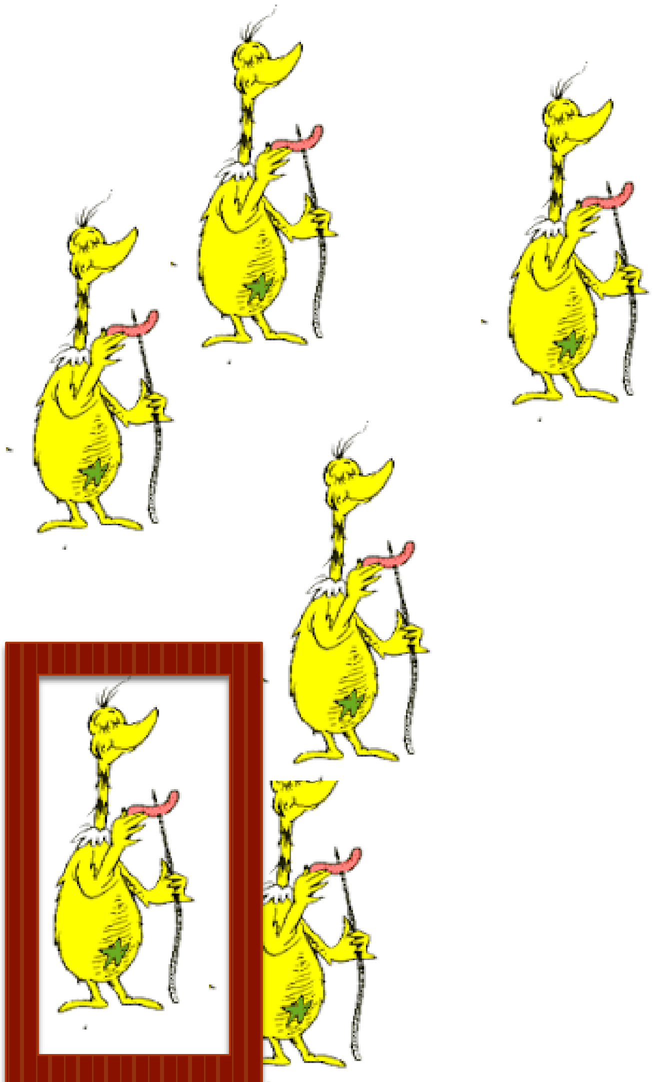
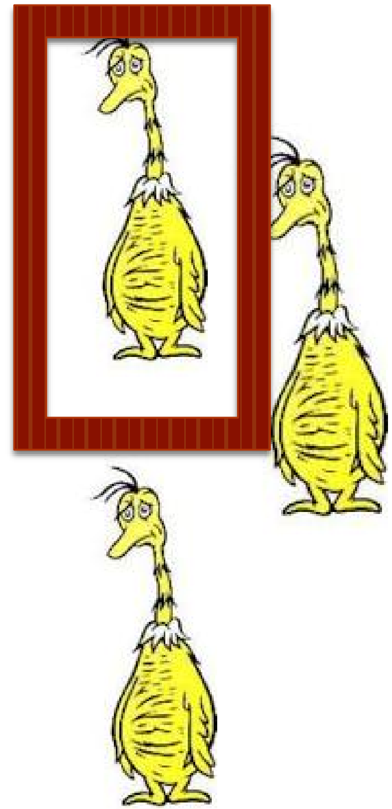
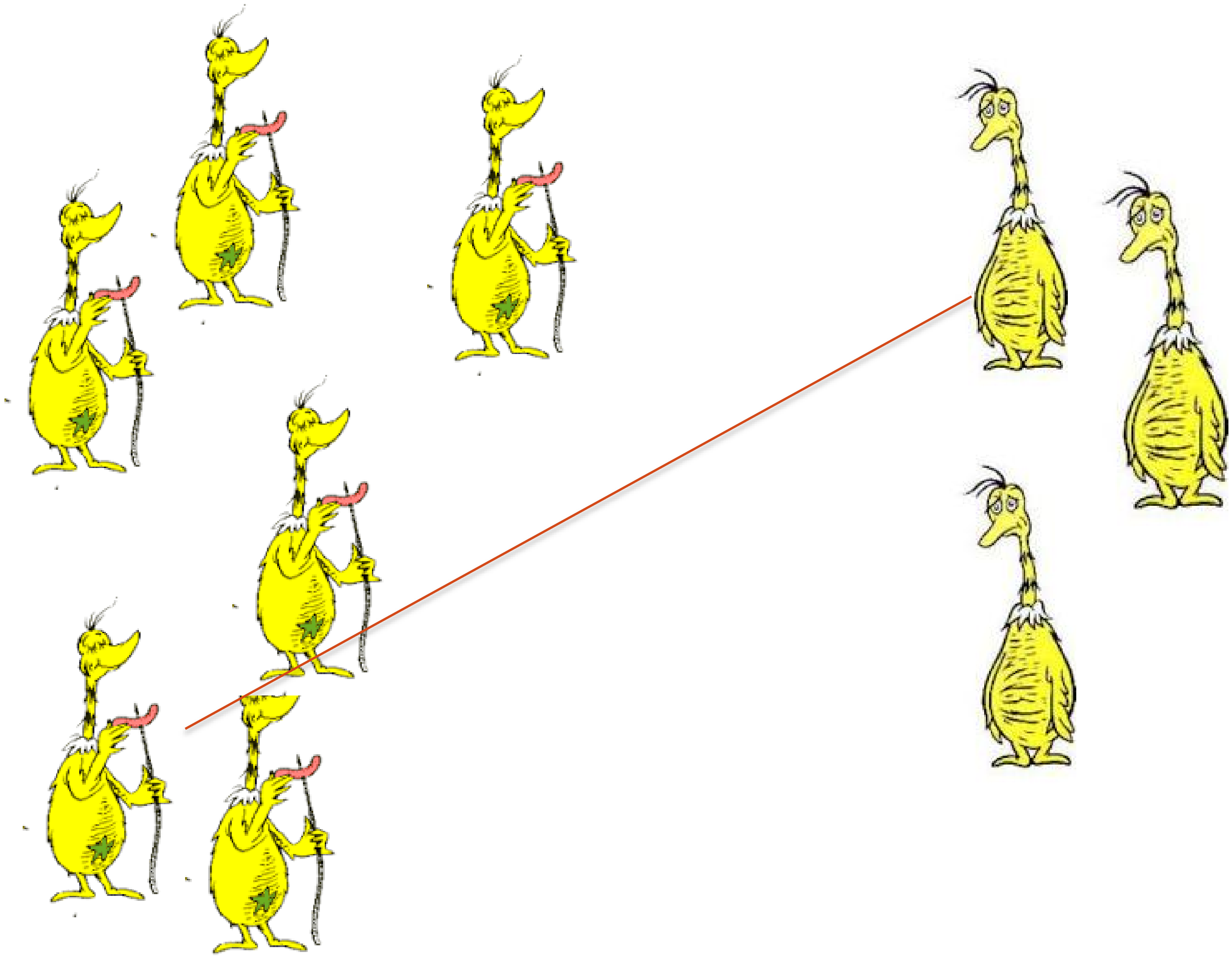
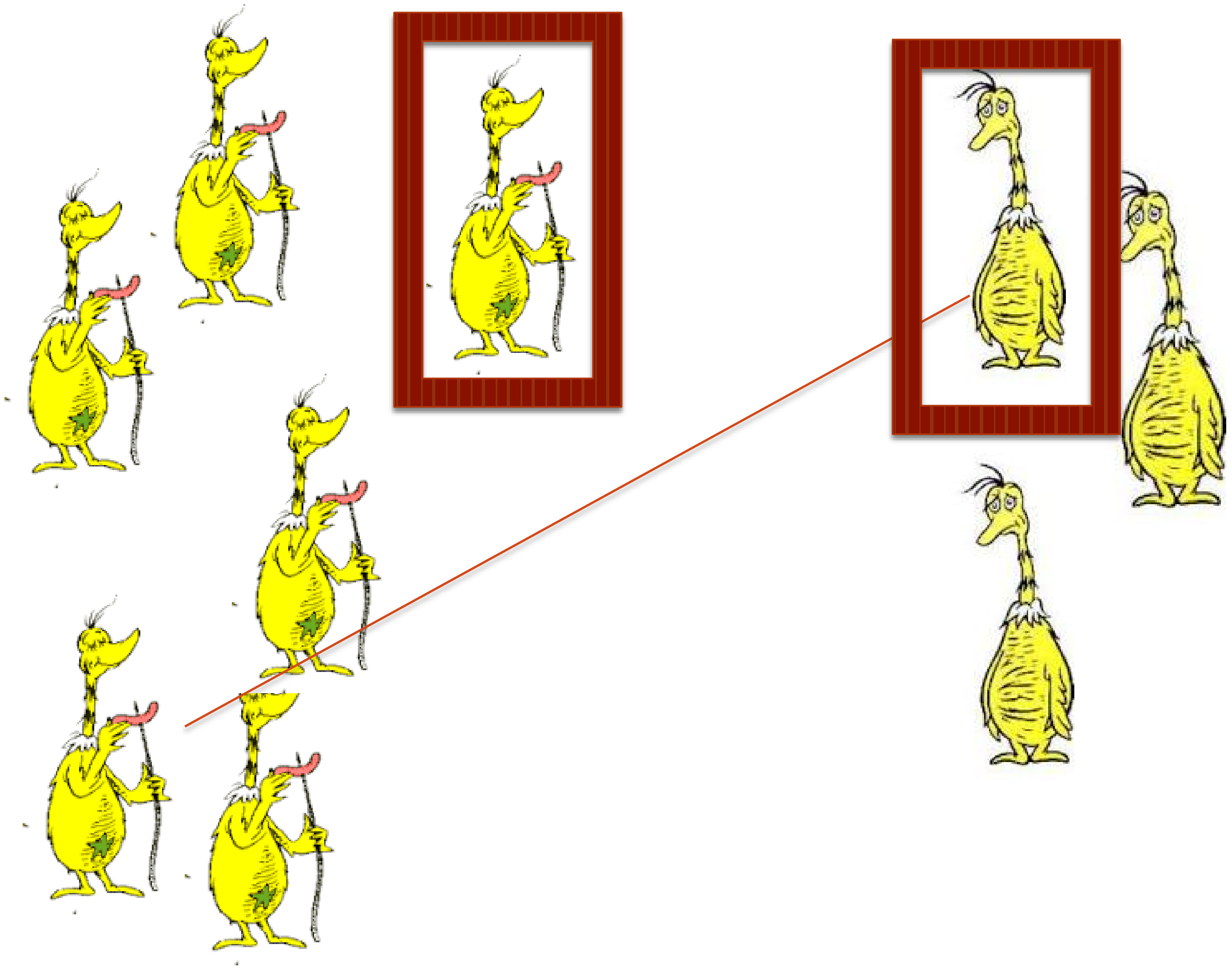
    - If they both have available links, they do.
    - If they have maximum links, they link if the new collaboration provides better payoff than their current lowest-payoff collaboration does.
  - If current collaborator, the agent compares them to a random potential collaborator and breaks the link if they can form a better one.

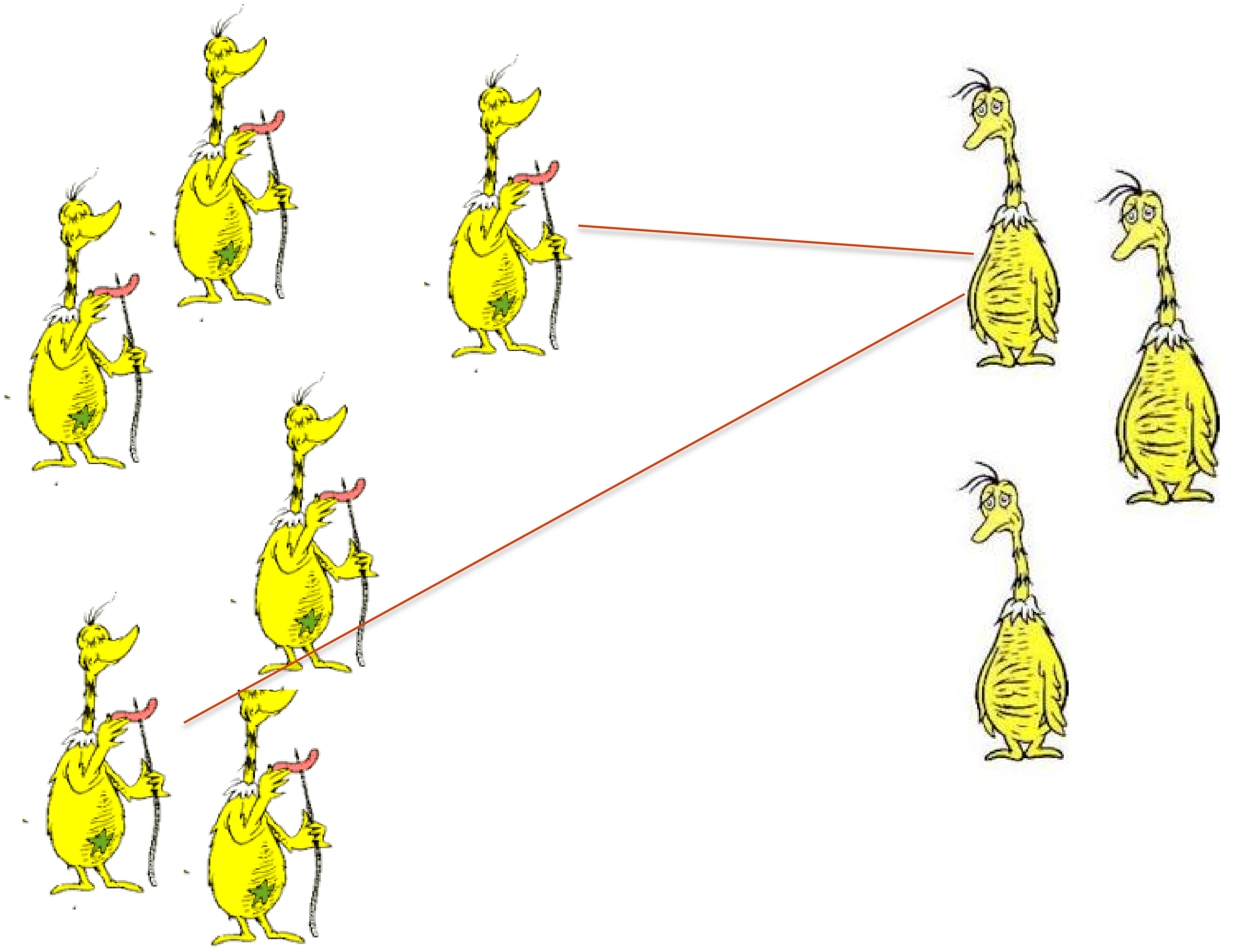


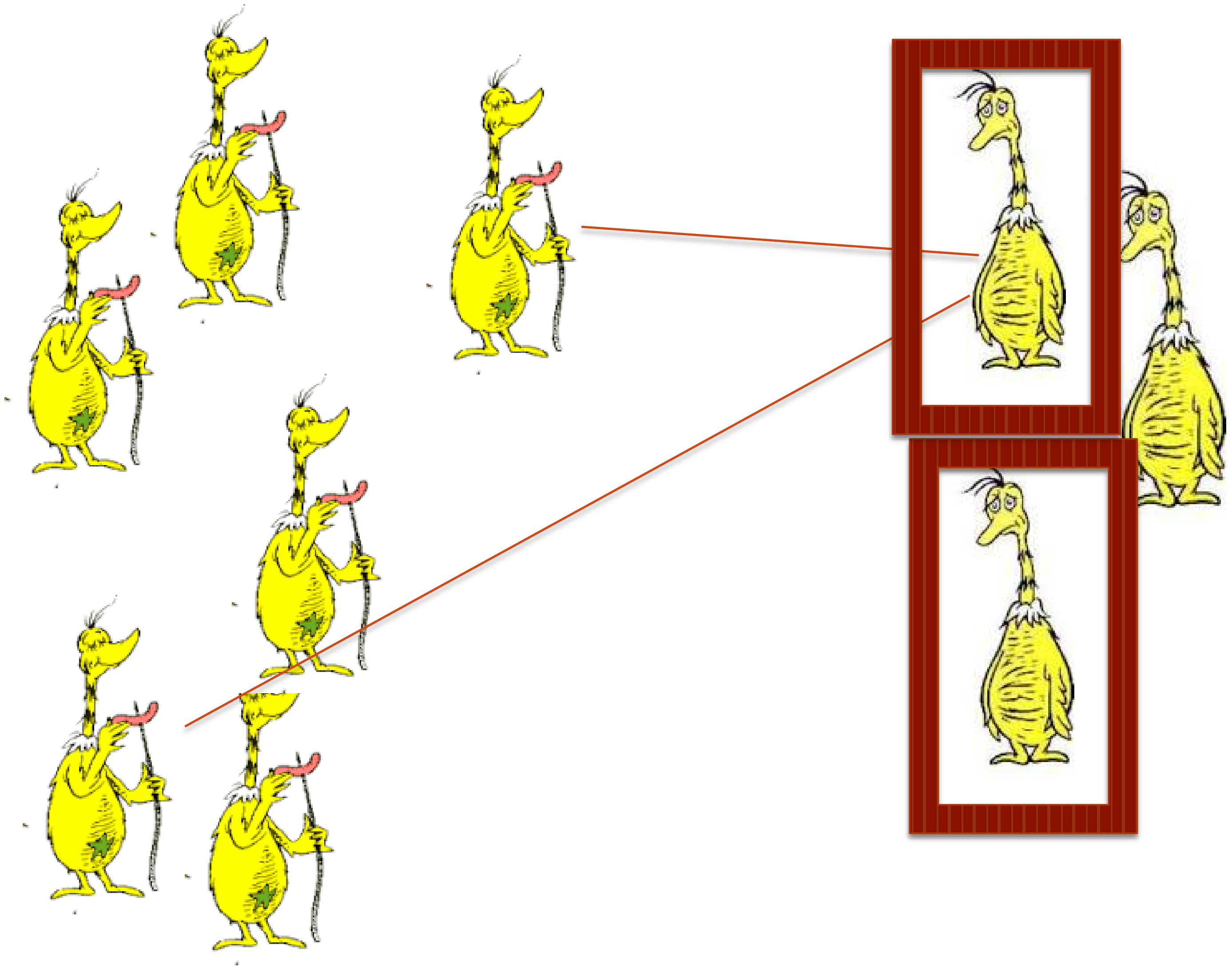


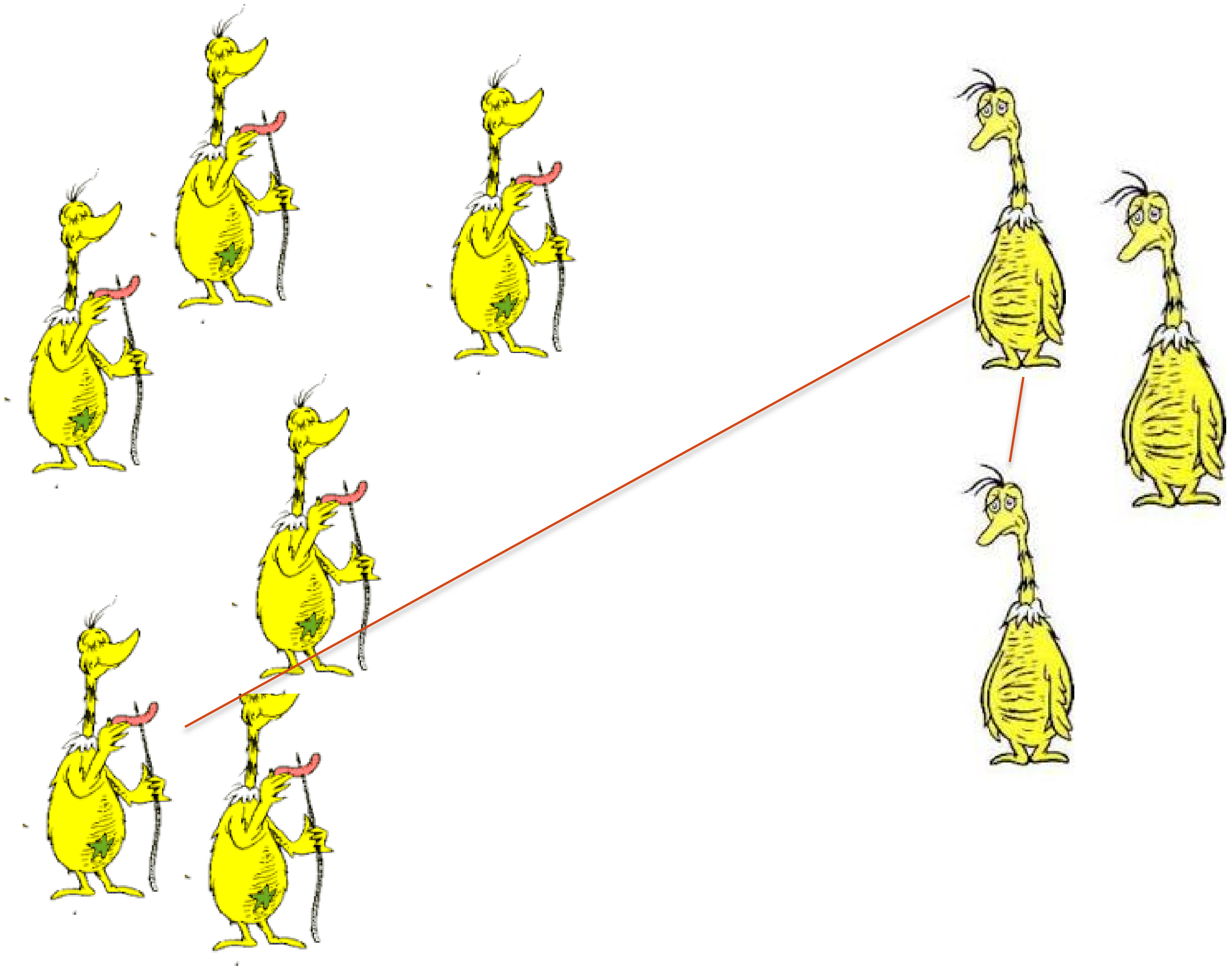



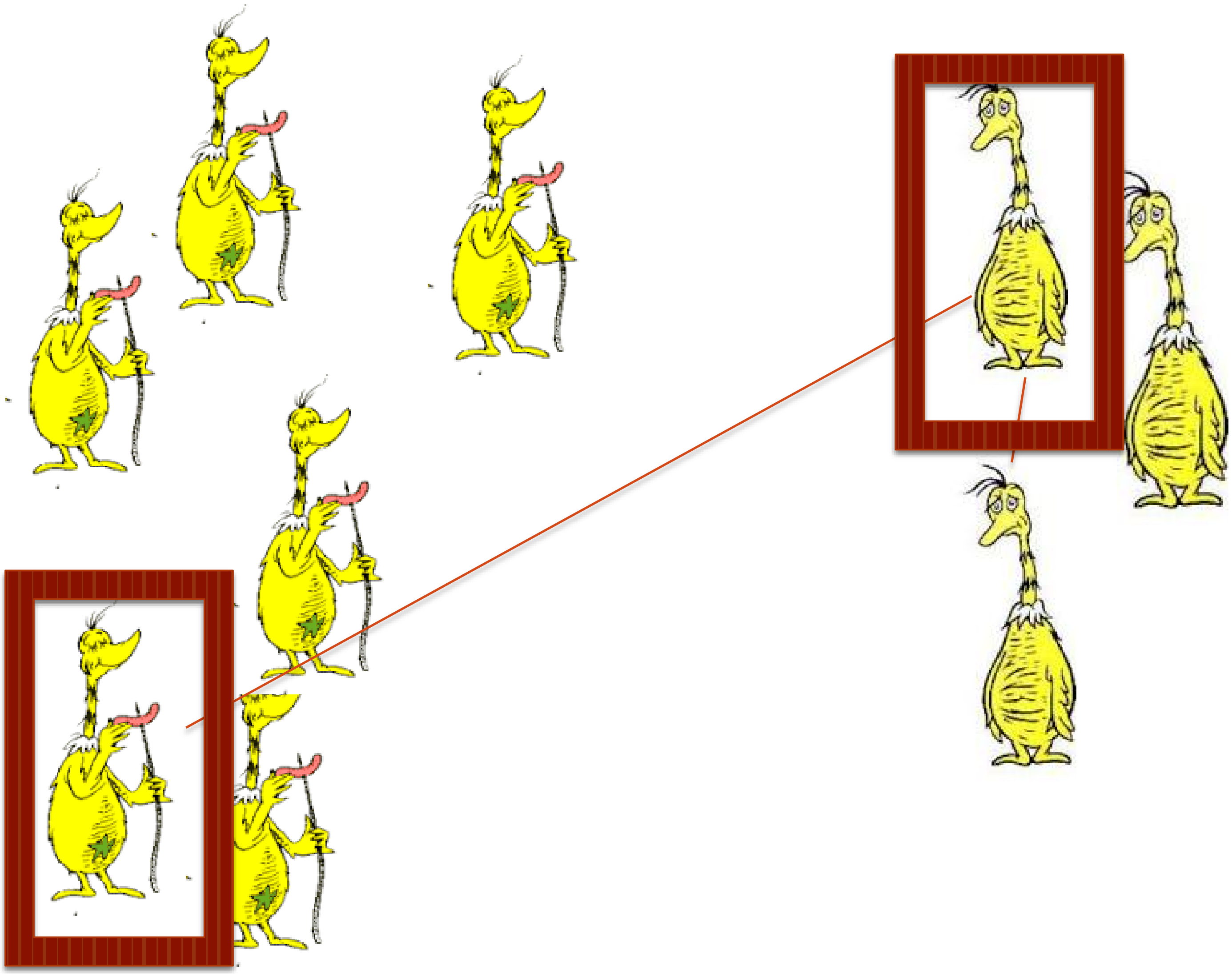


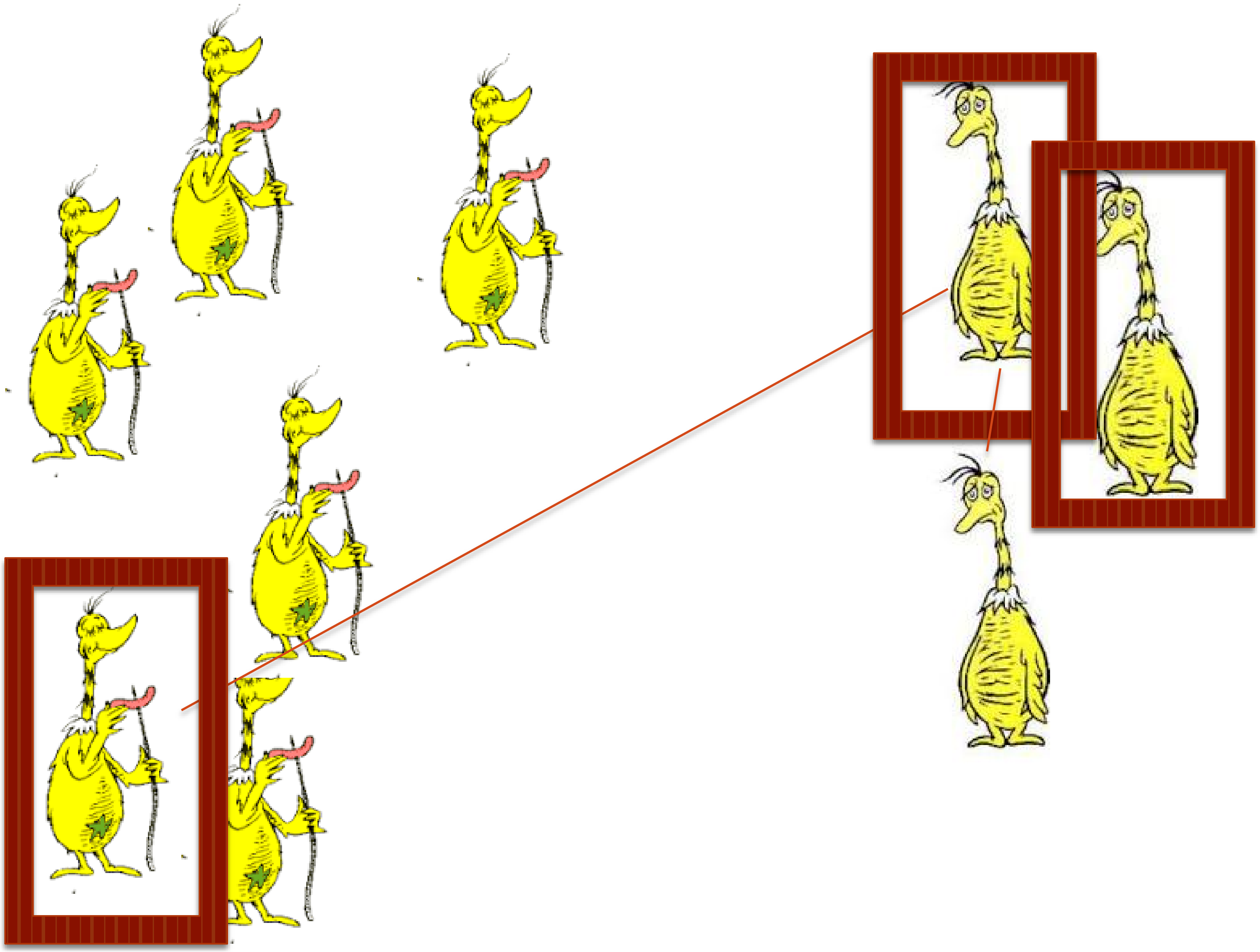


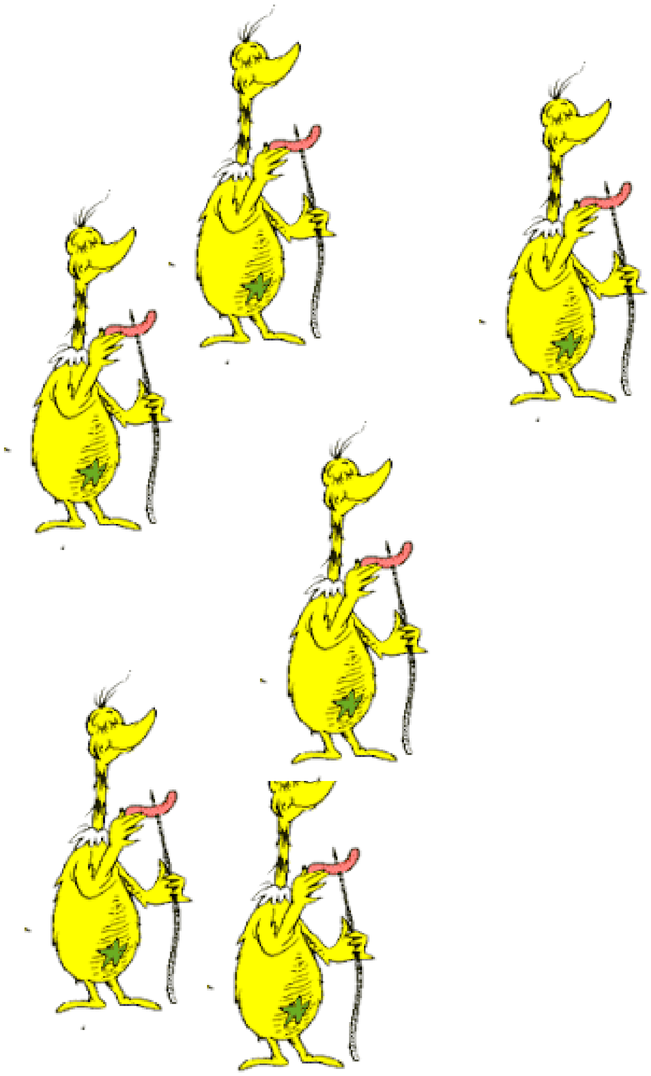
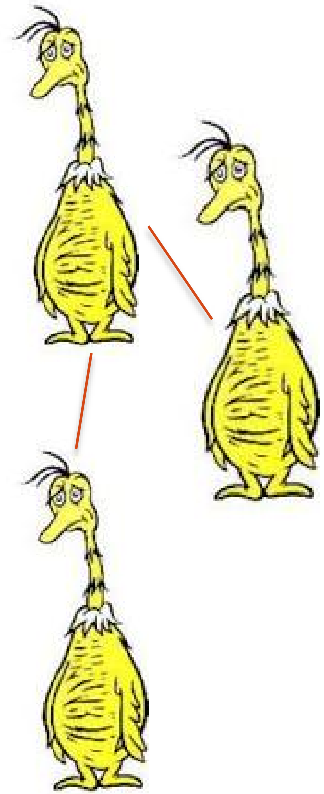






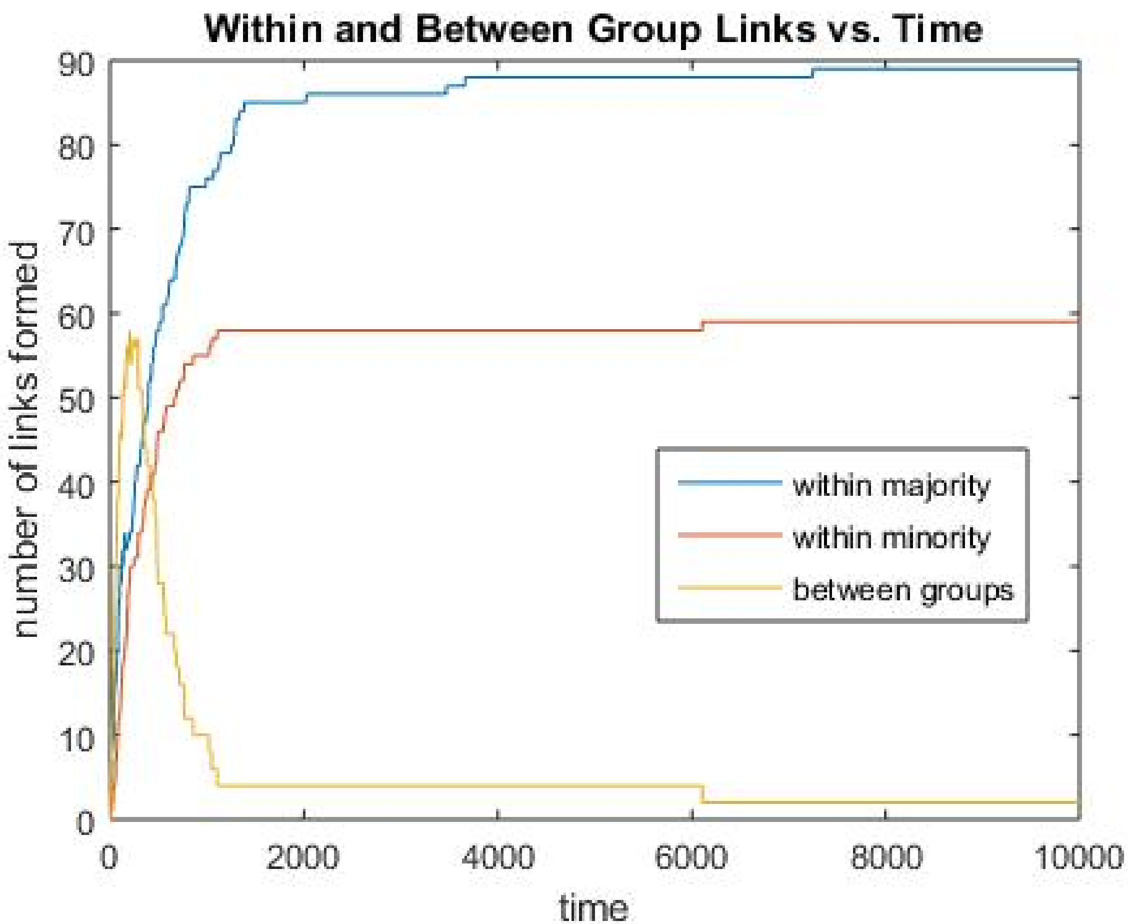




Results

Eventually all between-group links will be broken because minority members prefer to form within group links.



For n= 100, minority group size = 40%, maximum links = 3

Take-Away

Discrimination may lead to segregation in networks of joint action and collaboration.

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Co-Evolution

We allow both bargaining and network structure to update simultaneously.

Co-Evolution

Initial random strategies and empty network.

In each round, each agent takes action with a small probability – either updating strategy or links.

These updates happen via the methods described in the last two sections.

Results

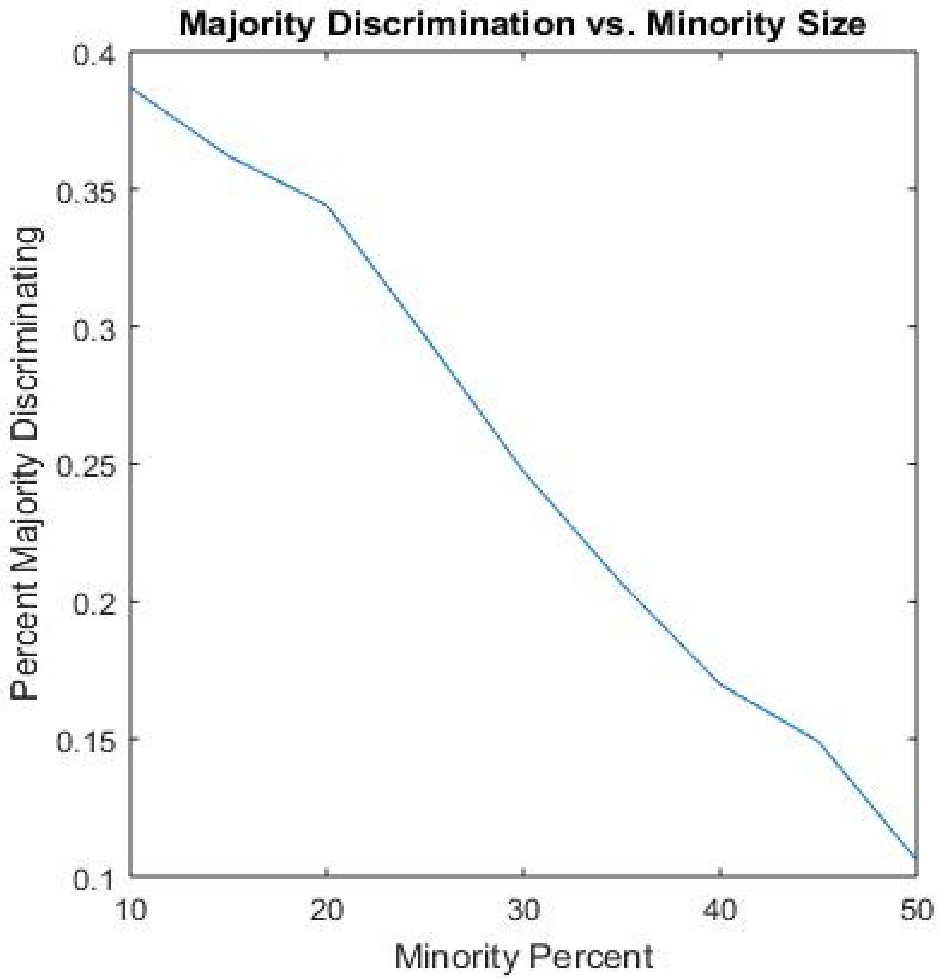
Within groups tend towards fair norms. Between groups, there are sub-pockets of fair and discriminatory behavior between groups.

The fair links are maintained, and discriminatory ones are broken.

We get a partially segregated network, where fair treatment is occurring, though some still have (unused) discriminatory strategies.

Results

Do discrimination and effective diversity vary with minority group size?



For n= 100, H=6, p_{update} = .1, p_{link} = .2. Averaged over maximum links = 6,9.

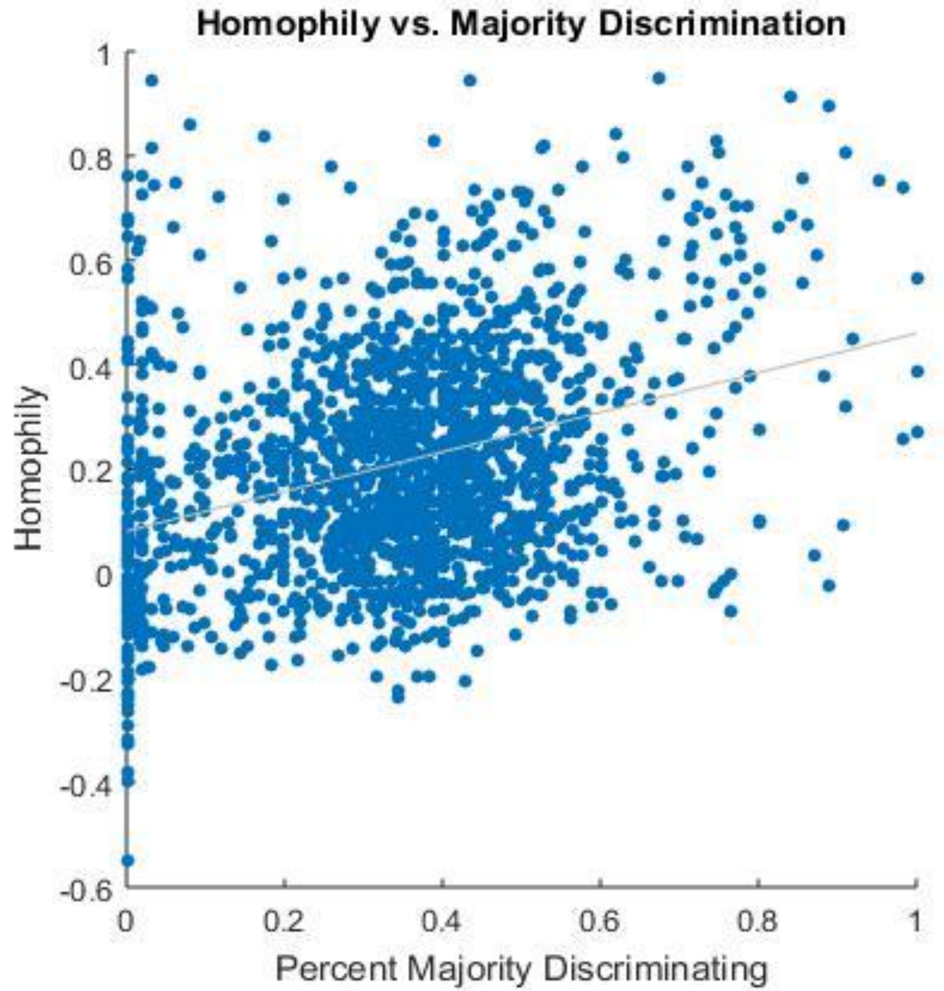
Homophily

$$IH = \frac{H_i - w_i}{1 - w_i}$$

H_i = proportion of links that are within group

w_i = the fraction of the population

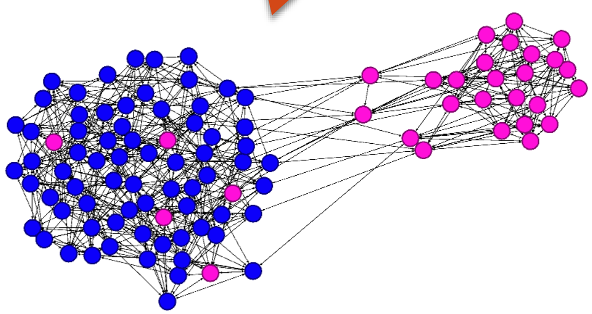
(Currarini et al. 2009)



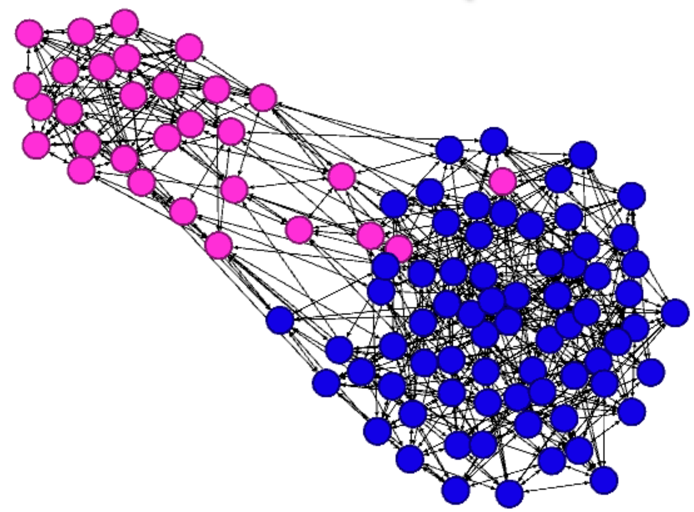
For n= 100, H=6, p_{update} = .1, p_{link} = .2, maximum links = 6,9, minority group size = 10-50% (by 5%)

Network Outcomes

More discrimination



Less discrimination



Take-Aways

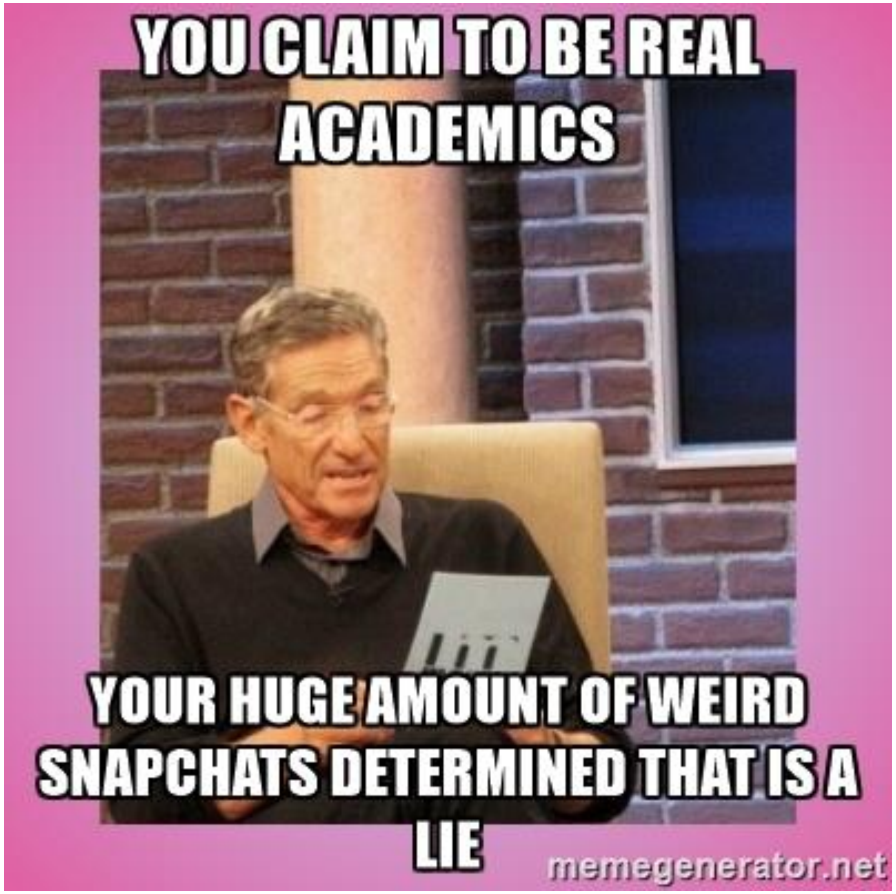
An evolving network allows for a variety of bargaining behaviors to co-exist in the population.

In a co-evolving population, we expect majority discrimination and homophily, but to a lesser degree than in the fixed network or bargaining condition.

Summing Up

1) On networks, minority status can confer a bargaining disadvantage
2) Our results predict homophily based on social group membership in collaboration networks
3) As discussed, this may impact academic progress

Thank you!



Thanks to the UC Irvine social dynamics seminar for comments on this work. This work is funded by NSF grant 1535139.

Analogue of the Red King

For some number of between group links, *n*, majority members will have fewer and minority members more.

When H = 6, what are the best responses?

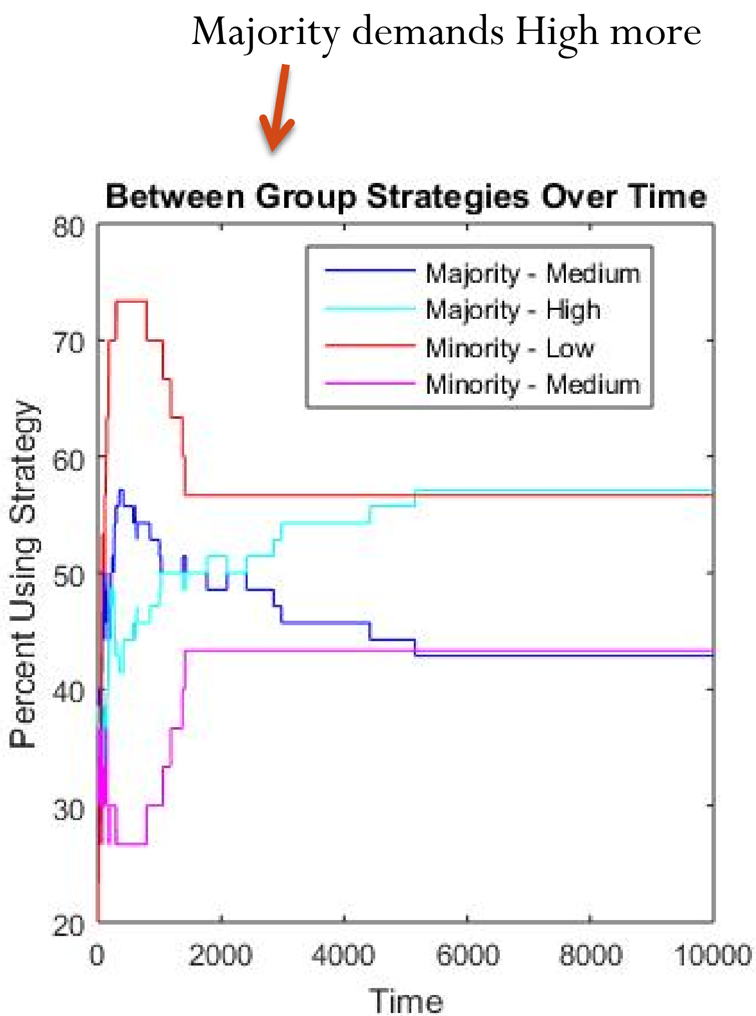
Pr(H)=$^1/_9$	**Pr(M)=$^1/_3$**	**Pr(L)=$^5/_9$**	**Pr(H)=$^1/_3$**	**Pr(M)=$^1/_3$**	**Pr(L)=$^1/_3$**
LL	LM	LH	L	M	H
	ML	HL			
	MM	MH			
		HM			
		HH			

No analogue of the Red Queen

For some number of between group links, *n*, majority members will have fewer and minority members more.

When H = 9, what are the best responses?

Pr(H)=$^1/_3$	**Pr(M)=$^5/_9$**	**Pr(L)=$^1/_9$**	**Pr(H)=$^1/_3$**	**Pr(M)=$^1/_3$**	**Pr(L)=$^1/_3$**
LL	LM	HH	L	M	H
LH	ML				
HL	MM				
	MH				
	HM				


Majority demands High more
Between Group Strategies Over Time
Majority - Medium
Majority - High
Minority - Low
Minority - Medium
Percent Using Strategy
Time
80
70
60
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40
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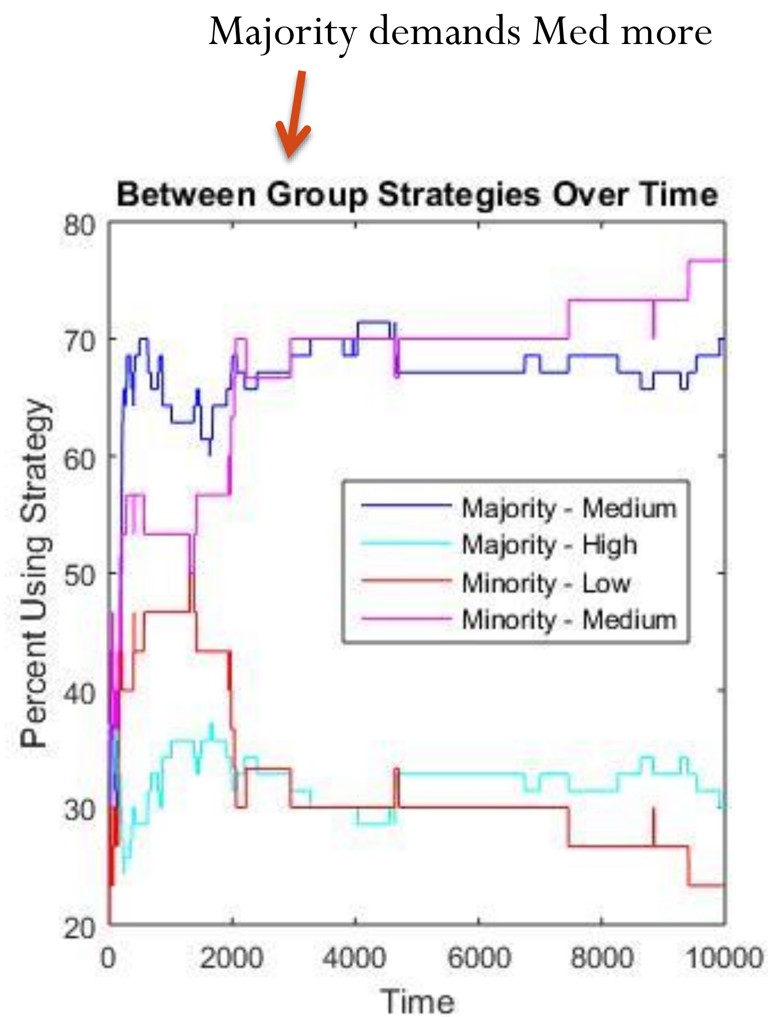
20
0
2000
4000
6000
8000
10000


Majority demands Med more
Between Group Strategies Over Time
Majority - Medium
Majority - High
Minority - Low
Minority - Medium
Percent Using Strategy
Time
80
70
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20
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