Homophily and minority-group size explain perception biases in social networks

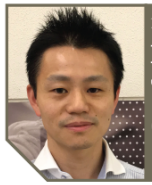
Eun Lee, Fariba Karimi, Claudia Wagner, Hang-Hyun Jo, Markus Strohmaier & Mirta Galesic

Eurasian Summit for Models of Society, 2021 **Program**

Tokyo Tech

WRHI

March 1, **Computational Social Science,** Chair: Petter Holme.



10:00 PM, Tokyo; 2:00 PM, Paris
Kazutoshi Sasahara
Tokyo Tech, Japan
Online echo chamber: What is it and how to break out of it

10:30 PM, Tokyo; 2:30 PM, Paris
Carolina Mattsson
Leiden University, The Netherlands
Tracing the movement of money with transaction data

11:00 PM, Tokyo; 3:00 PM, Paris
Talayeh Aledavood
Aalto University, Finland
Quantifying social activity, sleep, and mental health from digital traces

11:30 PM, Tokyo; 3:30 PM, Paris
Talal Rahwan
New York University Abu Dhabi
Hiding communities and relationships in a social network

0:00 AM, Tokyo; 4:00 PM, Paris
Meeyoung Cha
KAIST & IBS, Korea
The presence of unexpected biases in online fact-checking

0:30 AM, Tokyo; 4:30 PM, Paris
Fredrik Liljeros
Stockholm University, Sweden
How elites can reproduce complex interaction patterns over generations

March 2, **Evolutionary Game Theory,** Chair: Marko Jusup.

10:00 PM, Tokyo; 2:00 PM, Paris
Hisashi Ohtsuki
Sokendai, Japan
Evolution of coordinated cooperation

10:30 PM, Tokyo; 2:30 PM, Paris
Hyejin Park
APCTP, Korea
Why is cyclic dominance so rare?

11:00 PM, Tokyo; 3:00 PM, Paris
Unai Alvarez-Rodriguez
University of Zürich, Switzerland
Evolutionary dynamics of higher-order interactions in social networks

11:30 PM, Tokyo; 3:30 PM, Paris
Valerio Capraro
Middlesex University, UK
The evolution of honesty

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The Anh Han
Teesside University, UK
A social and regulation dilemma in artificial intelligence development

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Fernando P. Santos
Princeton University, USA
Cooperation dynamics in collective index insurance

March 3, **Network Theory,** Chair: Alain Barrat.

10:00 PM, Tokyo; 2:00 PM, Paris
Fariba Karimi
CSH & CEU, Austria
Mixing patterns in networks and their impact on minorities

10:30 PM, Tokyo; 2:30 PM, Paris
Teruyoshi Kobayashi
Kobe University, Japan
The switching mechanisms of densification in temporal networks

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Giovanni Petri
ISI Foundation, Italy
Social contagion and norm emergence on simplicial complexes and hypergraphs

11:30 PM, Tokyo; 3:30 PM, Paris
Claudio Castellano
CN-CNR, Italy
Eigenvector localization of the adjacency and nonbacktracking matrices in networks

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Nelly Litvak
U. of Twente, The Netherlands
Green light red light online solution for random walks on graphs

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Marton Karsai
CEU, Austria
Threshold driven contagion on weighted, multiplex, and temporal networks

MINORITY [mai - no - ruh - tee]

[noun]

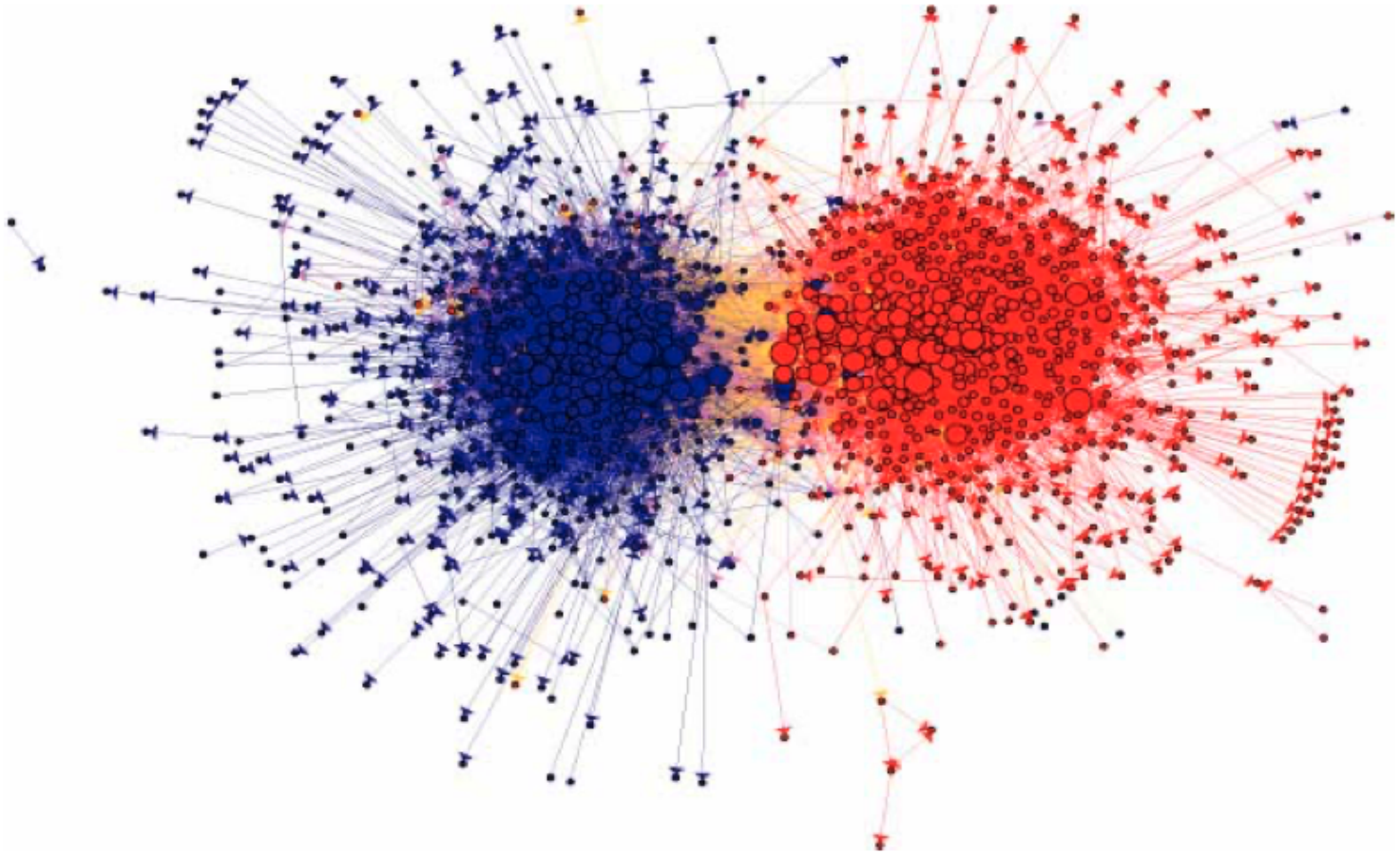
1. the smaller number or part, especially a number or part representing less than half of the whole.

HOMOPHILY [huh - mof - uh - lee]

[noun]

1. the tendency to form strong social connections with people who share one's defining characteristics, as age, gender, ethnicity, socioeconomic status, personal beliefs, etc.:

The political blogosphere and the 2004 election: Divided they blog



PERCEPTION [puh - sep - shn]

[noun]

1. the way in which something is regarded, understood, or interpreted.

People's perceptions of their social worlds determine their own personal aspirations[1] and willingness to engage in different behaviours, from voting[2] and energy conservation[3] to health behaviour[4], drinking[5] and smoking[6]. Yet, when forming these perceptions, people seldom have an opportunity to draw representative samples from the overall social network, or from the general population. Instead, their samples are constrained by the local

What is the effect of different network properties on social perceptions?

Homophily

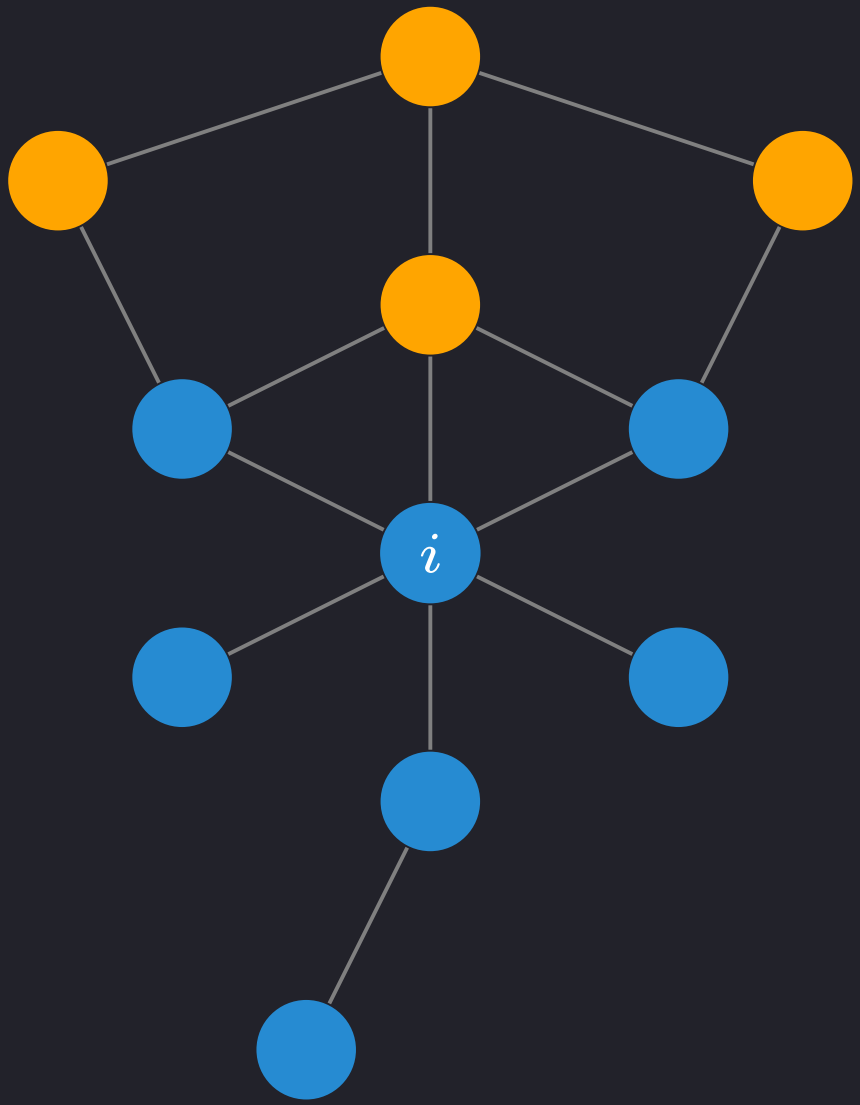
Assymetric Homophily

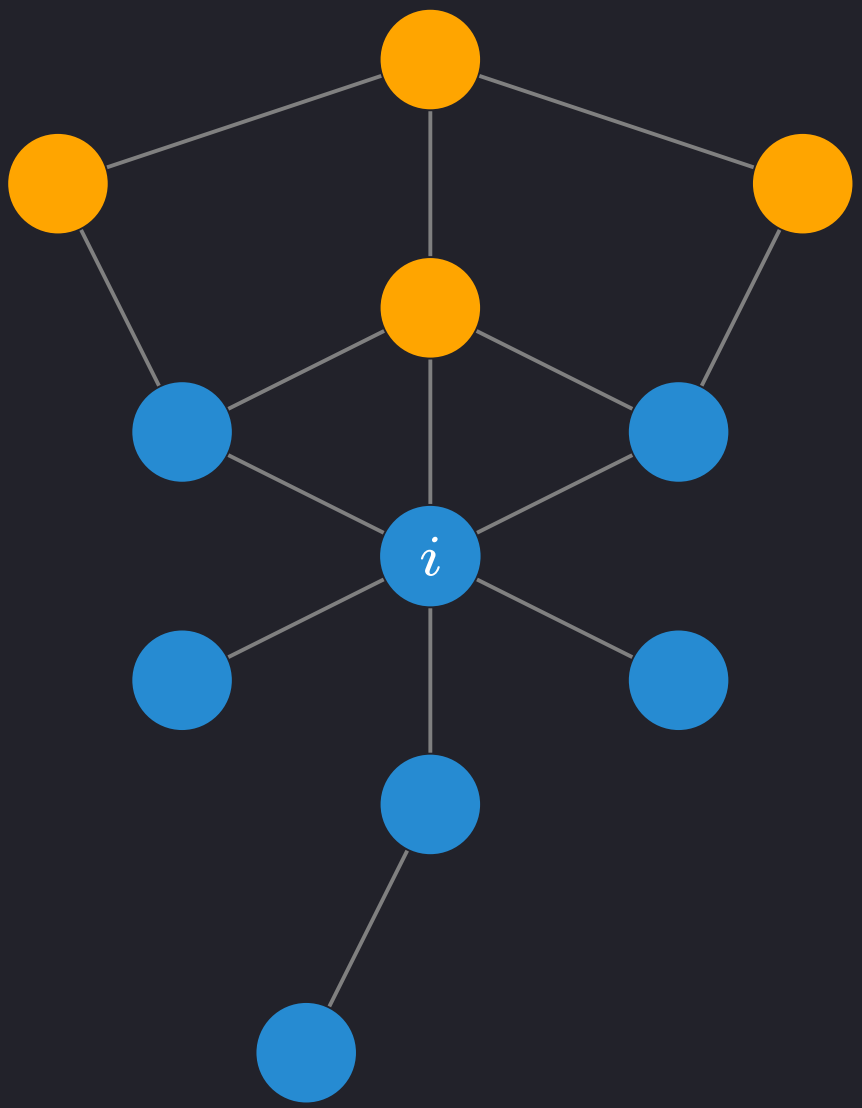
Group Size of the minority

Survey

Network Model

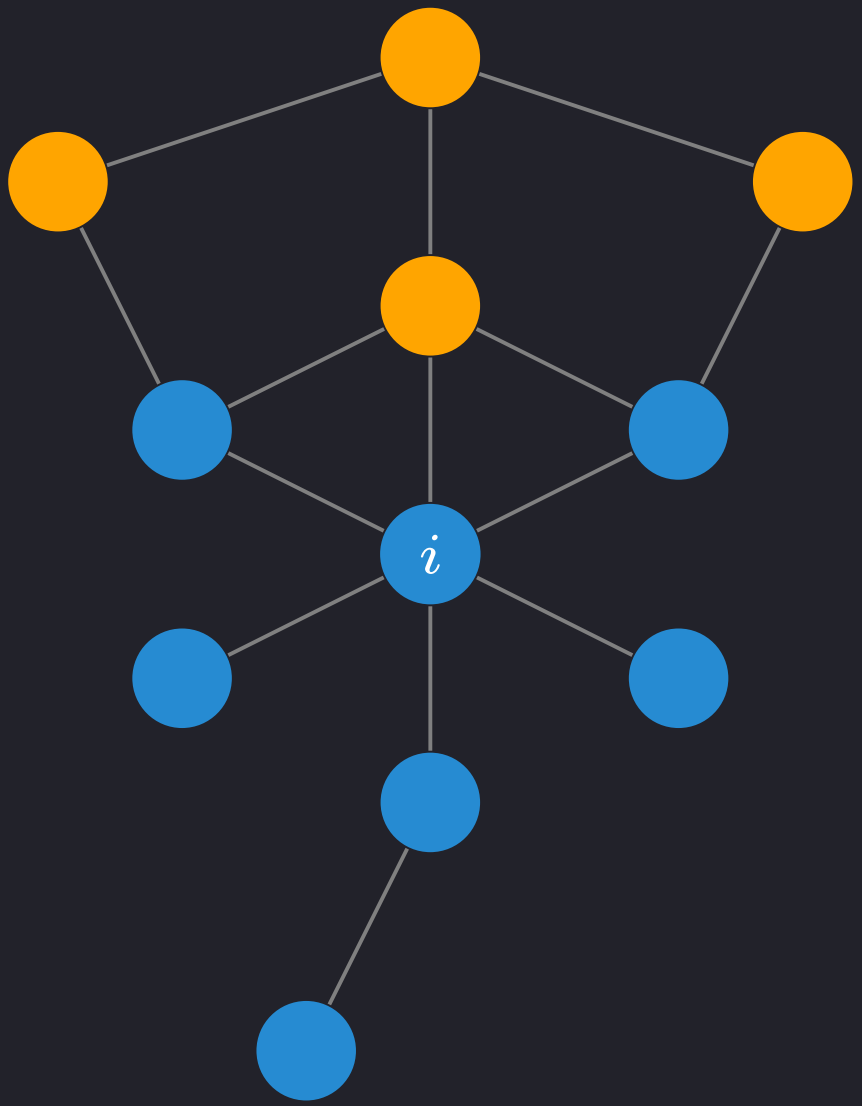
Real World Networks


i



$$B_{\mathrm{indv},i} = \frac{1}{f_m} \frac{\sum_{j \in \Lambda_i} x_j}{k_i}$$

$$B_{\mathrm{group}} = \frac{1}{|N_g|} \sum_{i \in N_g} B_{\mathrm{indv},j}$$



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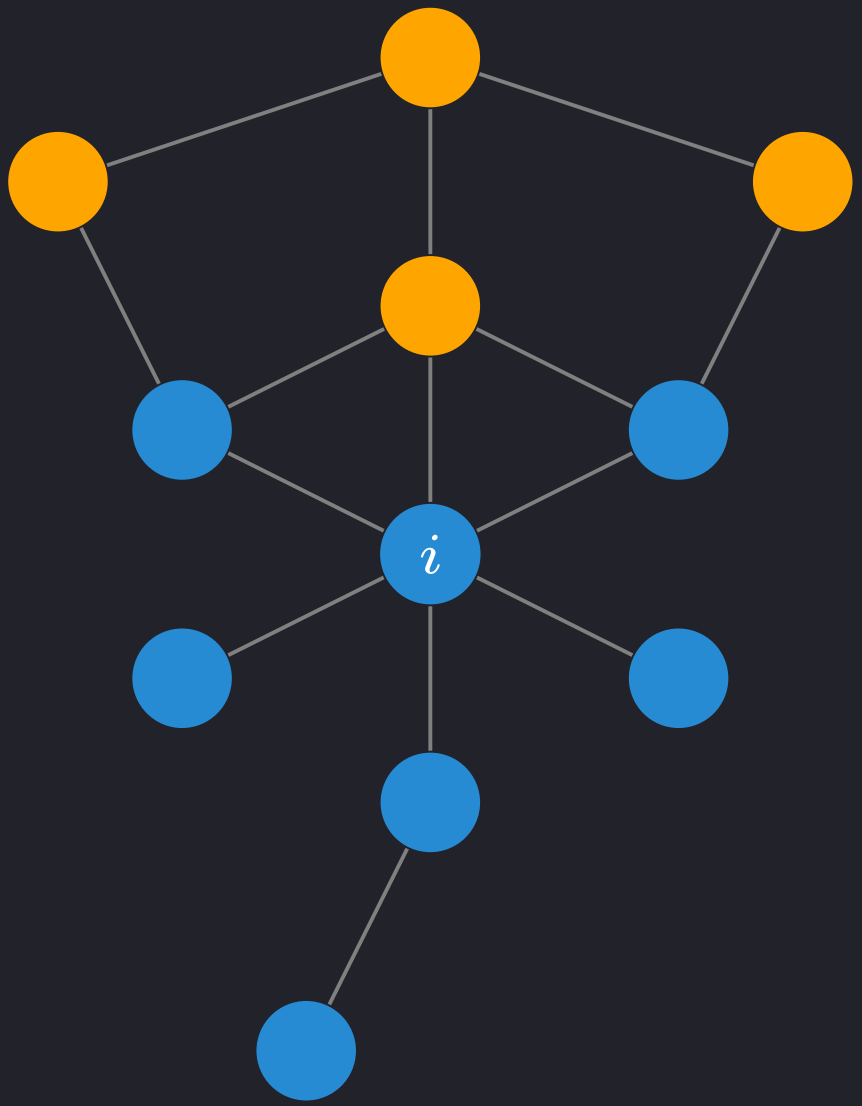
$$f_m \approx 0.33$$

$$B_{\text{indv},i} \approx \frac{0.16}{0.33} \approx 0.5$$



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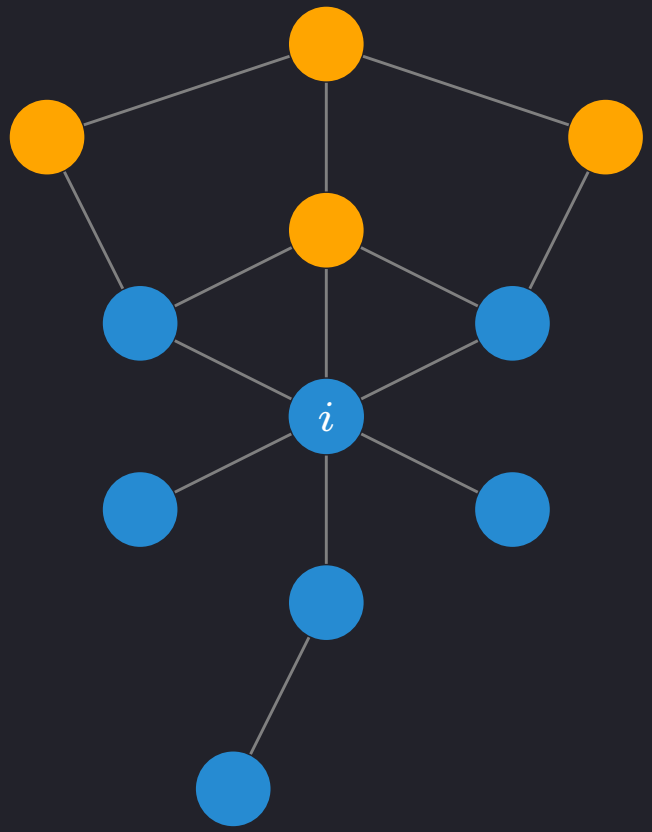

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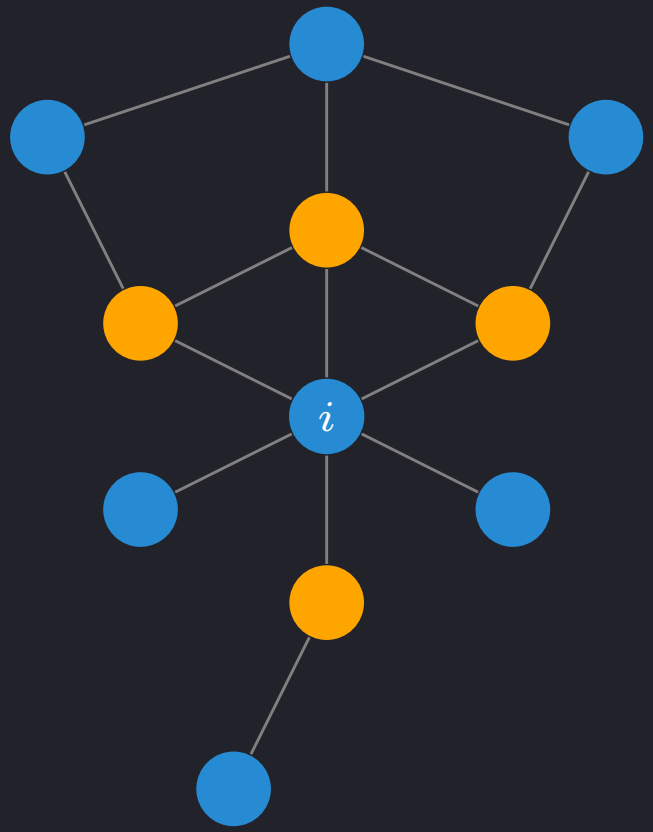
$$B_{\text{group}} \approx \frac{0.15}{0.33} \approx 0.45$$



$$B_{\text{indv},i} \approx \frac{0.66}{0.33} \approx 2$$

$$B_{\text{group}} \approx \frac{0.52}{0.33} \approx 1.6$$

Survey

$n = 99$

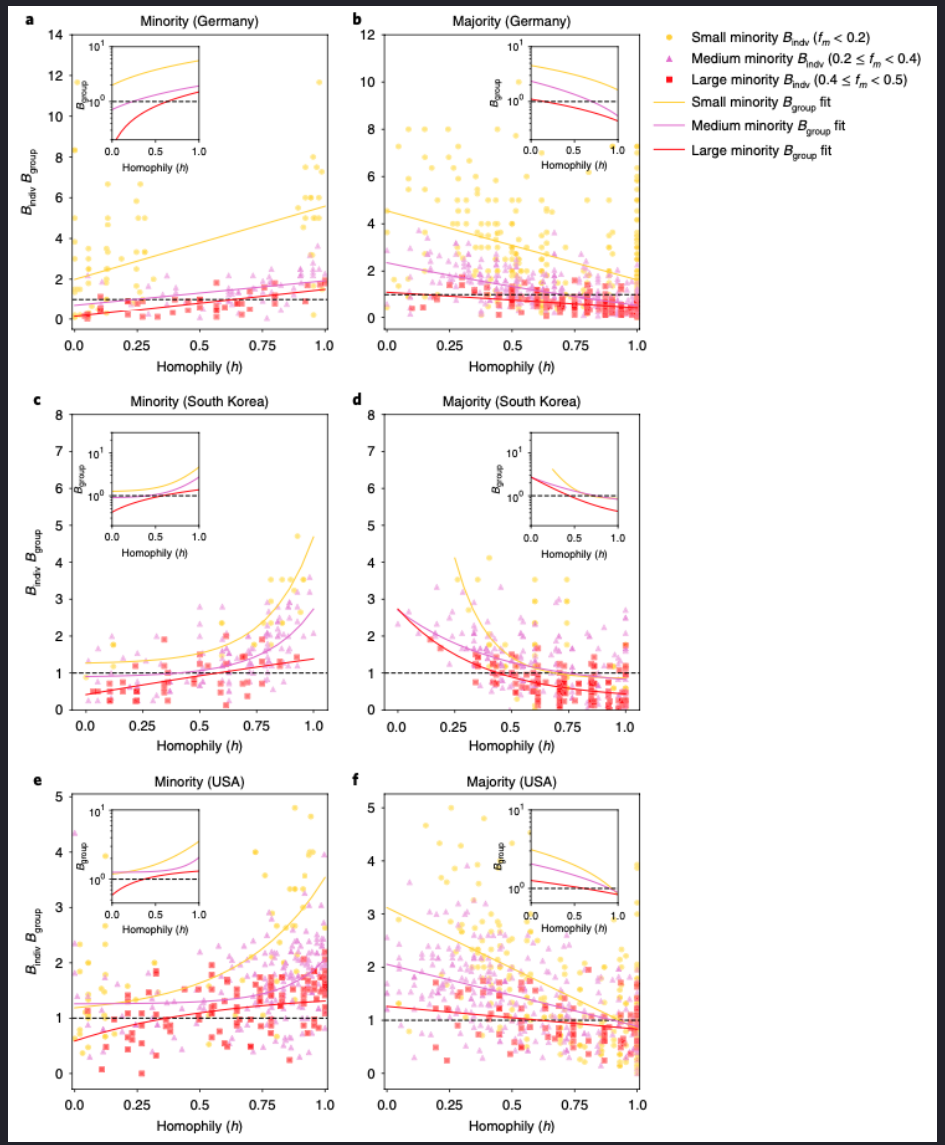
$n = 100$

$n = 101$

1. Do you smoke? $\rightarrow i$

1. Do you smoke? $\rightarrow i$
2. How many of your friends smoke? $\rightarrow h$

1. Do you smoke? $\rightarrow i$
2. How many of your friends smoke? $\rightarrow h$
3. What is the percentage of people in your country who smoke? $\rightarrow$ perception of m

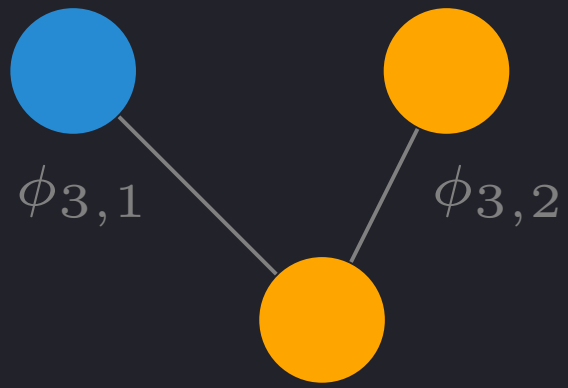

a
Minority (Germany)
b
Majority (Germany)
c
Minority (South Korea)
d
Majority (South Korea)
e
Minority (USA)
f
Majority (USA)
B_{indiv}, B_{group}
Homophily (h)
B_{group}
Small minority B_{indv} ($f_m < 0.2$)
Medium minority B_{indv} ($0.2 \leq f_m < 0.4$)
Large minority B_{indv} ($0.4 \leq f_m < 0.5$)
Small minority B_{group} fit
Medium minority B_{group} fit
Large minority B_{group} fit

Network Model

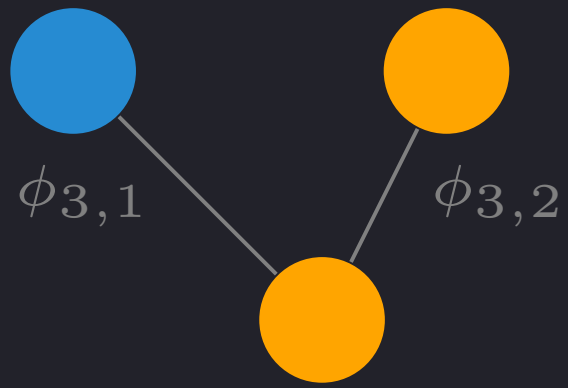
Network Model

Network Model

Network Model

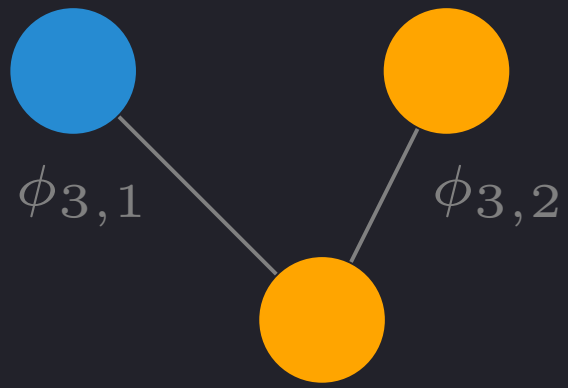


Network Model



$$\phi_{wv} = \frac{h_{wv} k_v}{\sum_{v \in \{G\}, v \neq w} h_{wv} k_v}$$

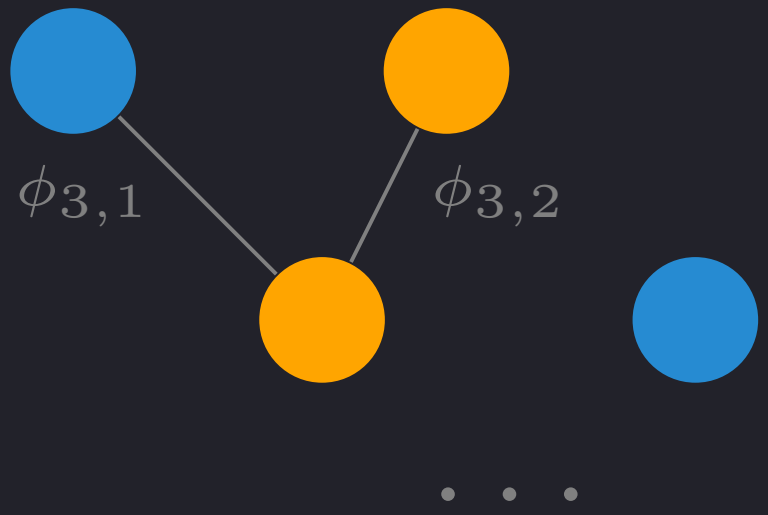
Network Model



$$\phi_{wv} = \frac{h_{wv} k_v}{\sum_{v \in \{G\}, v \neq w} h_{wv} k_v}$$

$$\lambda = 2$$

Network Model



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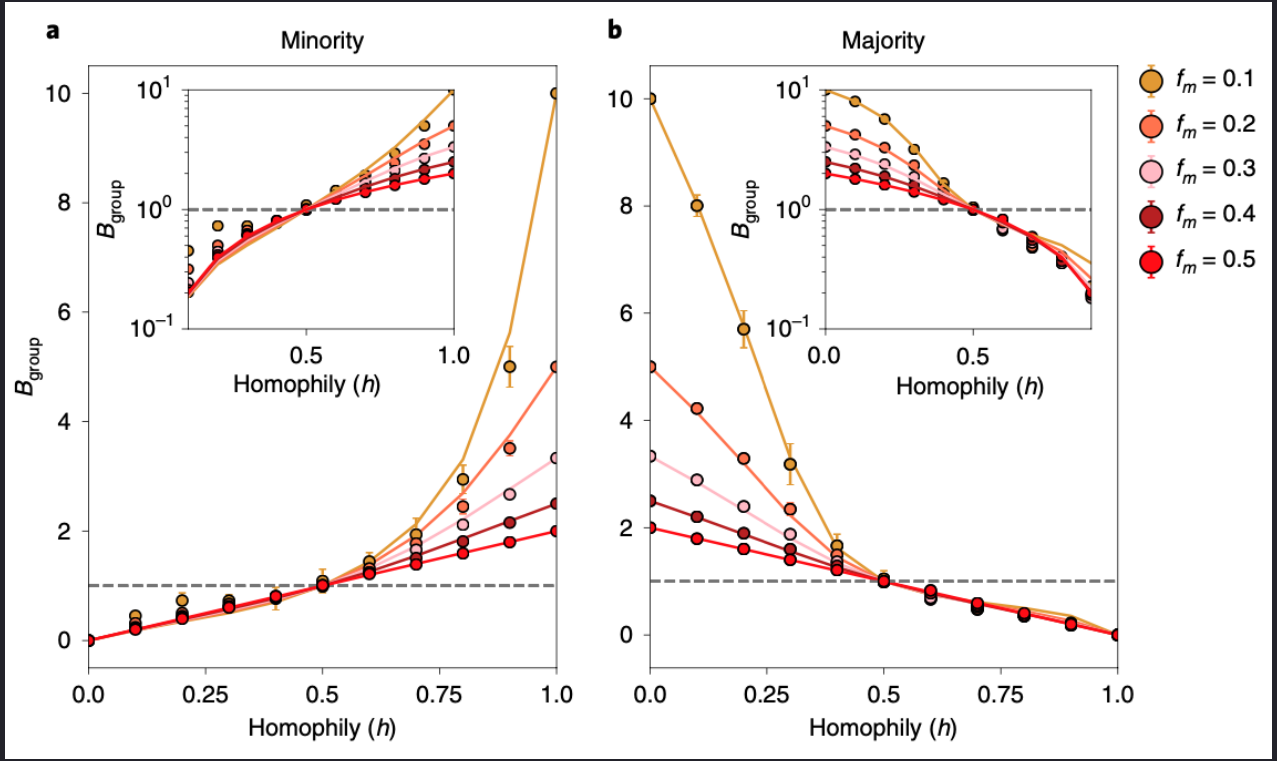
$$\lambda = 2$$

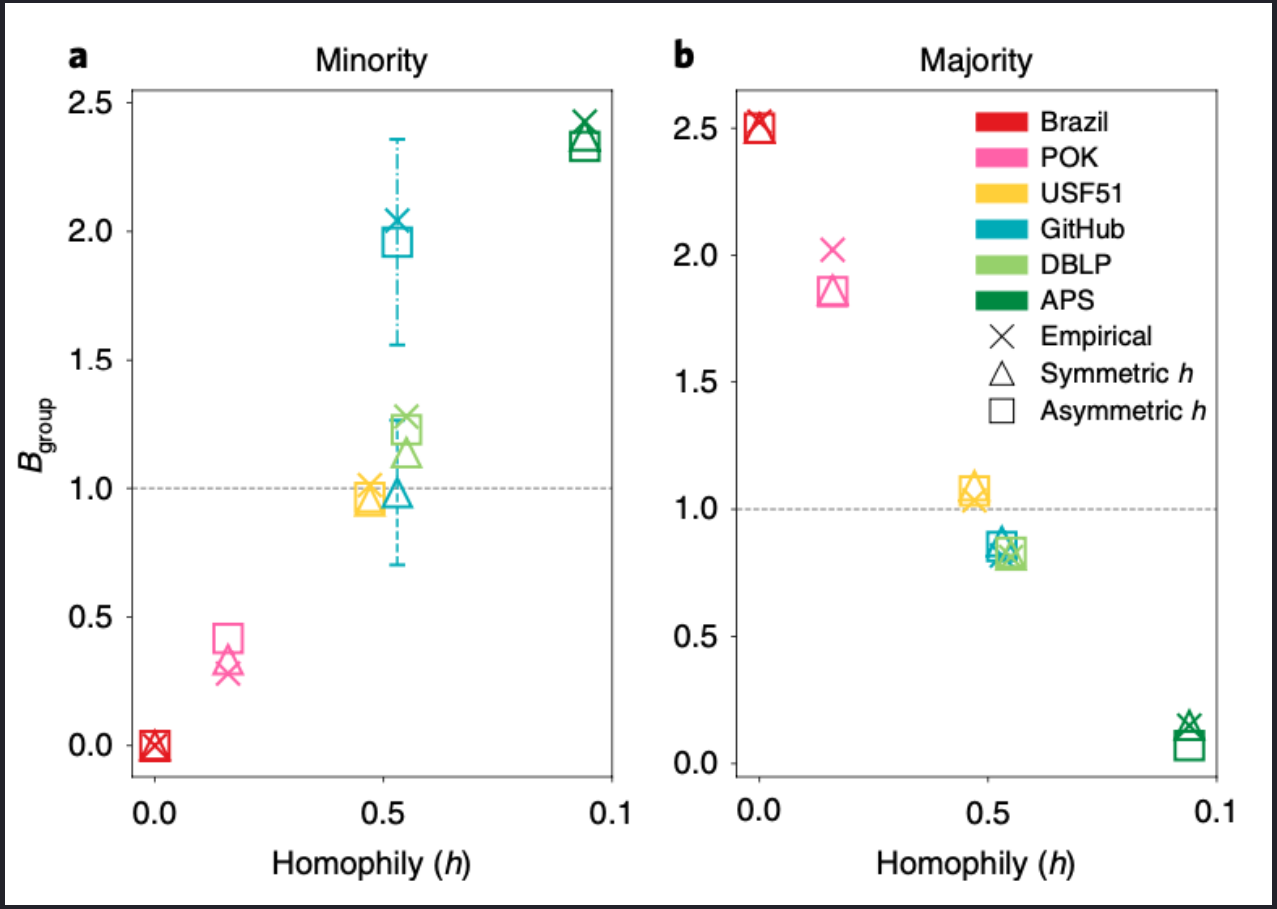

a
Minority
b
Majority
B_{group}
Homophily (h)
$f_m = 0.1$
$f_m = 0.2$
$f_m = 0.3$
$f_m = 0.4$
$f_m = 0.5$

Real World Networks

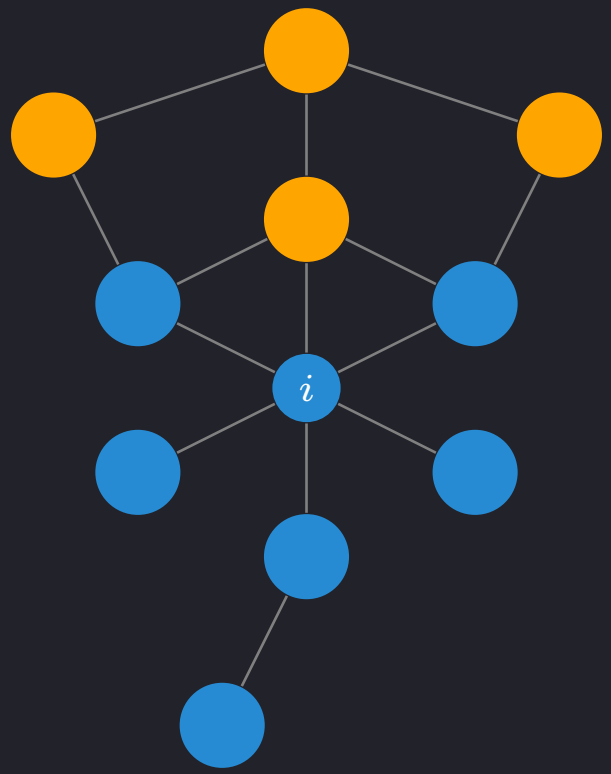
Table 1 | Characteristics of the empirical networks.

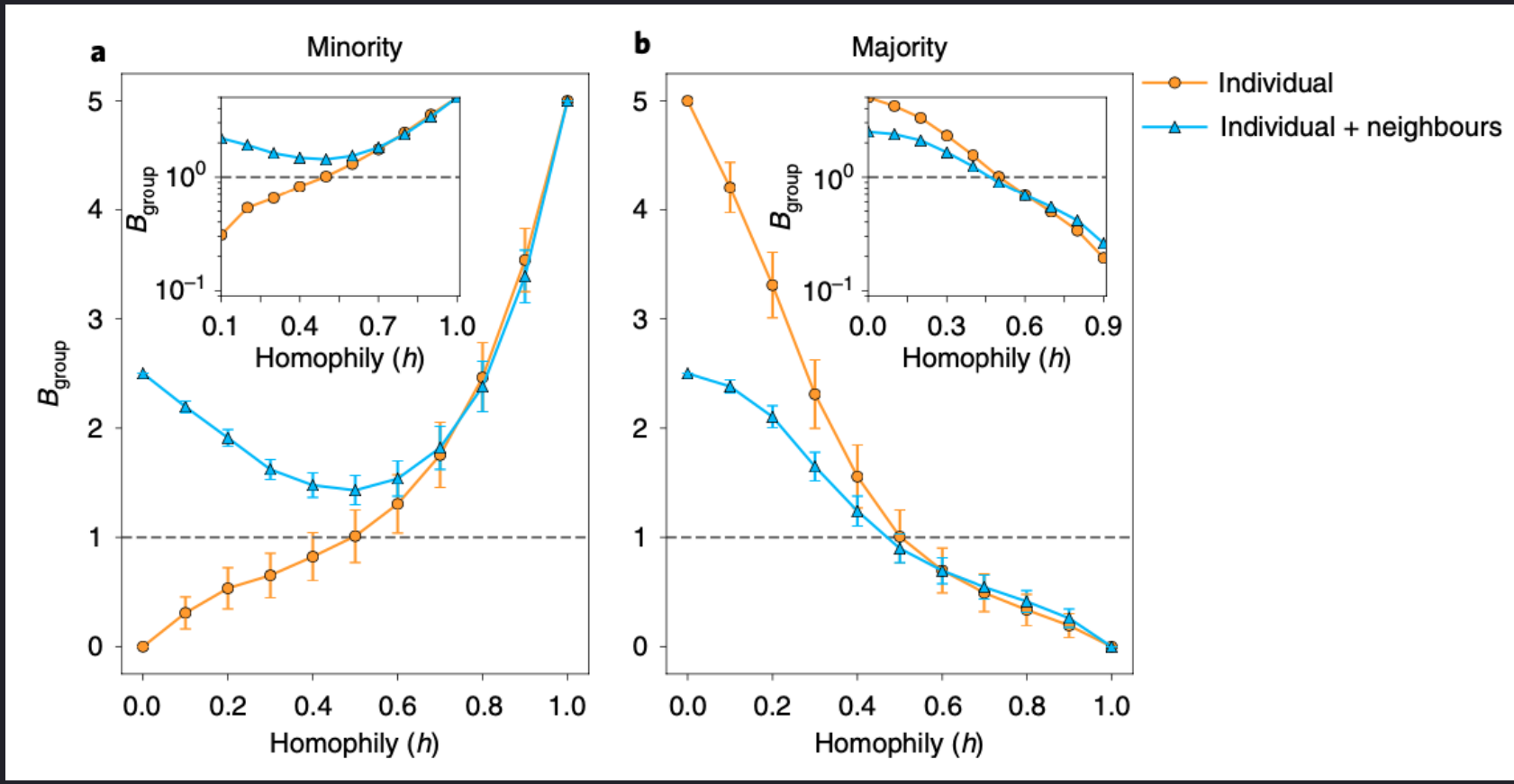
Data	Number of nodes	Minority, *n* (%)	Majority (*n*)	Symmetric *h*	Asymmetric *h* (minority, majority)
Brazil	16,730	Sex sellers 6,624 (40%)	Sex buyers 10,106	0.0	0, 0
POK	29,341	Minority gender 12,868 (44%)	Majority gender 16,473	0.17	0.2, 0.17
USF51	6,200	Male 2,603 (42%)	Female 3,597	0.47	0.48, 0.47
GitHub	119,275	Female 6,730 (5.6%)	Male 112,545	0.53	0.69, 0.54
DBLP	280,200	Female 63,356 (22%)	Male 216,844	0.55	0.57, 0.56
APS	1,853	CMS 696 (37%)	QSM 1,157	0.92	0.9, 1.0

Each network contains nodes with binary attributes and has a minority and a majority group (see Methods for more details). The calculations of symmetric and asymmetric values of the homophily are based on the derivations described in Methods. The data can be found online at https://github.com/frbkrm/NtwPerceptionBias


a
Minority
b
Majority
B_{group}
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
0.1
Homophily (h)
Brazil
POK
USF51
GitHub
DBLP
APS
Empirical
Symmetric h
Asymmetric h

Reducing social perception biases




a
Minority
b
Majority
Individual
Individual + neighbours
B_{group}
Homophily (h)
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5
10^0
10^{-1}
0.1
0.4
0.7
1.0
0.3
0.9

Summary