

Inequalities in social networks

Joint work with:

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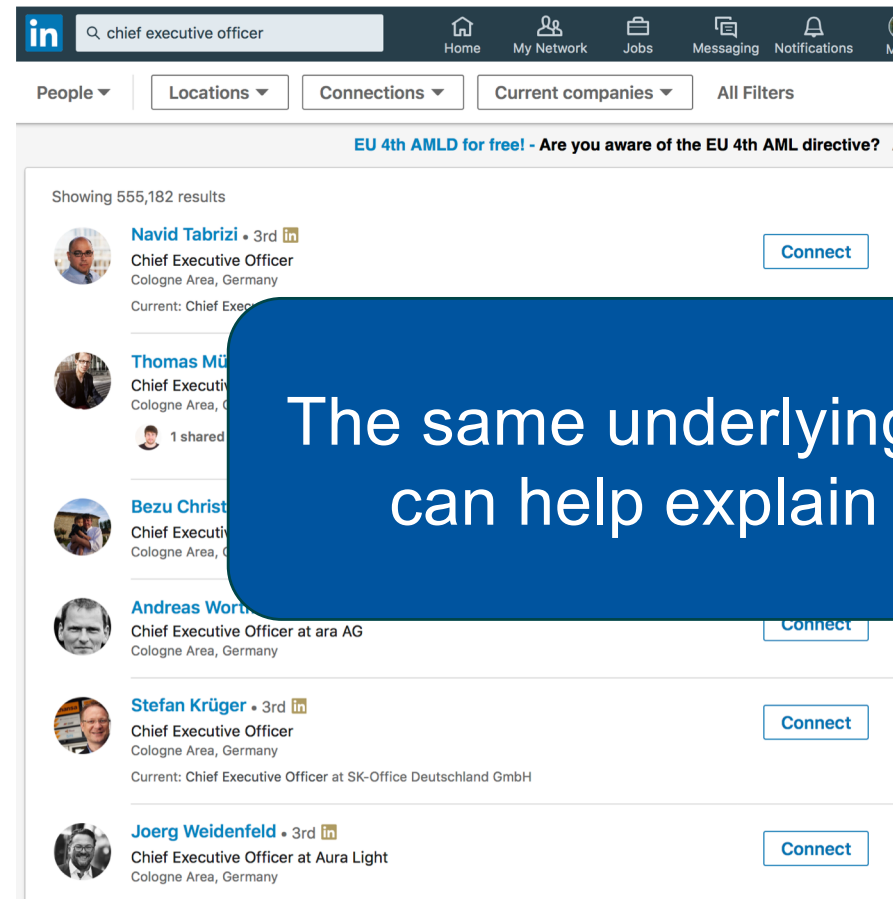


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for the Social Sciences

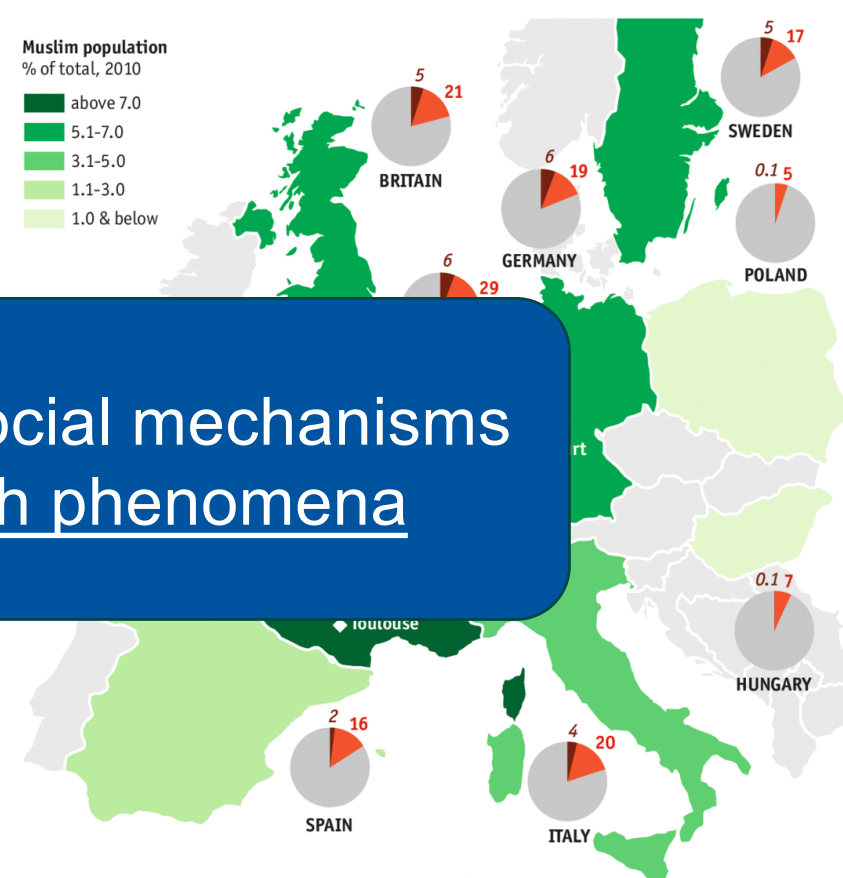


Minorities in social networks: Importance

Ranking of minorities



Perception biases



Two „universal“* laws governing social networks:

1) Preferential Attachment (Yule 1925, Simon 1955, Price 1976)

The tendency of nodes to preferentially attach to nodes of high degree

→ yielding scale-free networks

2) Homophily: Lazarsfeld and Merton (1954)

The tendency of similar nodes to attach to each other

→ yielding communities

What is Homophily

Paul F. Lazarsfeld and Robert K. Merton (1954)
Friendship as Social Process; A Substantive and Methodological Analysis
FREEDOM AND CONTROL IN MODERN SOCIETY

Oddly enough, the English language lacks a word to signify...

Value
homophily

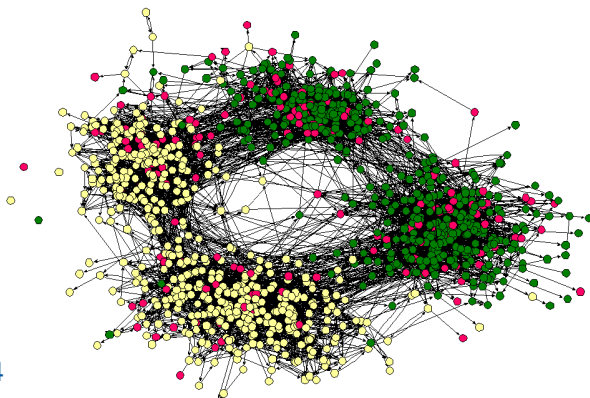
“a tendency for friendships
to form between those who are alike
in some designated respect”

Status
homophily

*useful, to speak of “degrees of homophily,” as measured by indices of
positive correlation between the attributes of friends*

$$h = \frac{f_o - f_e}{f_e} * 100$$

f_o ... observed freq. of friendships
 f_e ... expected freq. of friendships



friendship networks based on race
(Moody 2001)

Overview of this talk:

- **Part I: Ranking of minorities in social networks**
Does homophily influence ranking of minorities?
- **Part II: Perception of minorities in social networks**
Does homophily influence perception of minorities?
- **Part III: Conclusions**

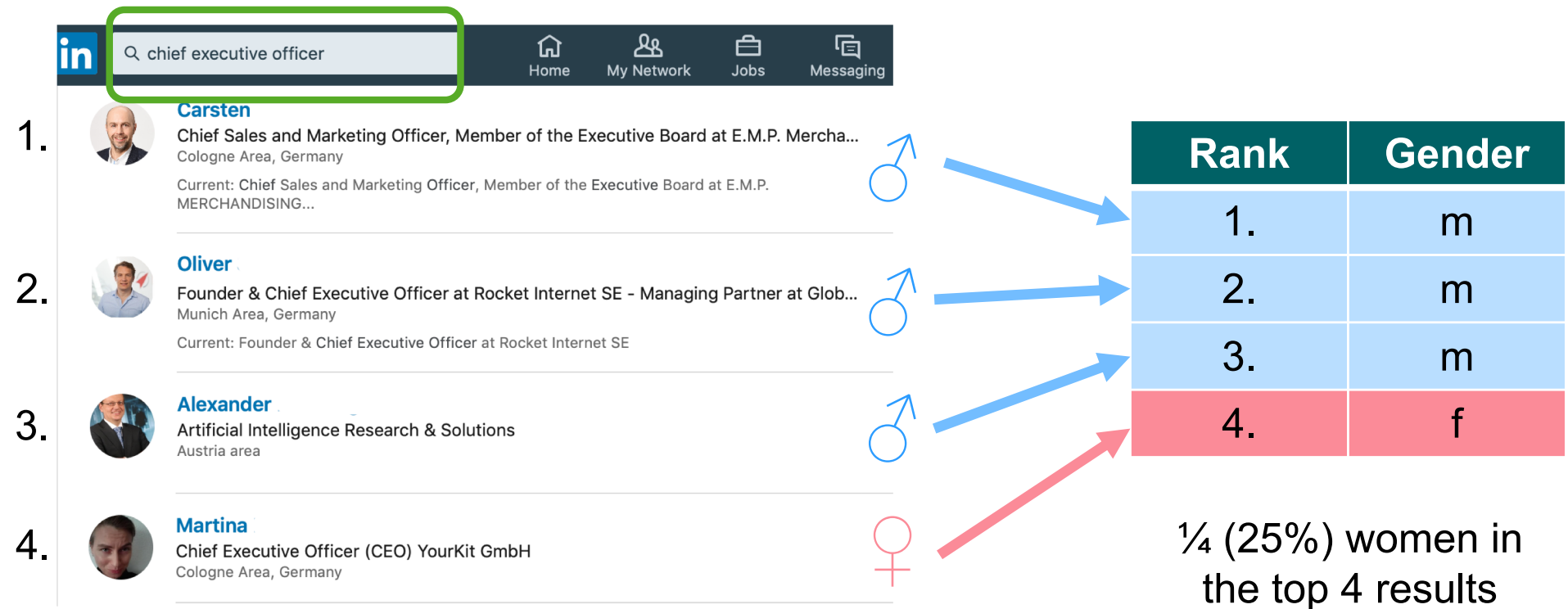
Part I: Ranking of minorities in social networks

Does homophily influence ranking of minorities?

Karimi, F., Génois, M., Wagner, C., Singer, P. and Strohmaier, M., 2018.
Homophily influences ranking of minorities in social networks. *Scientific Reports*, 8.

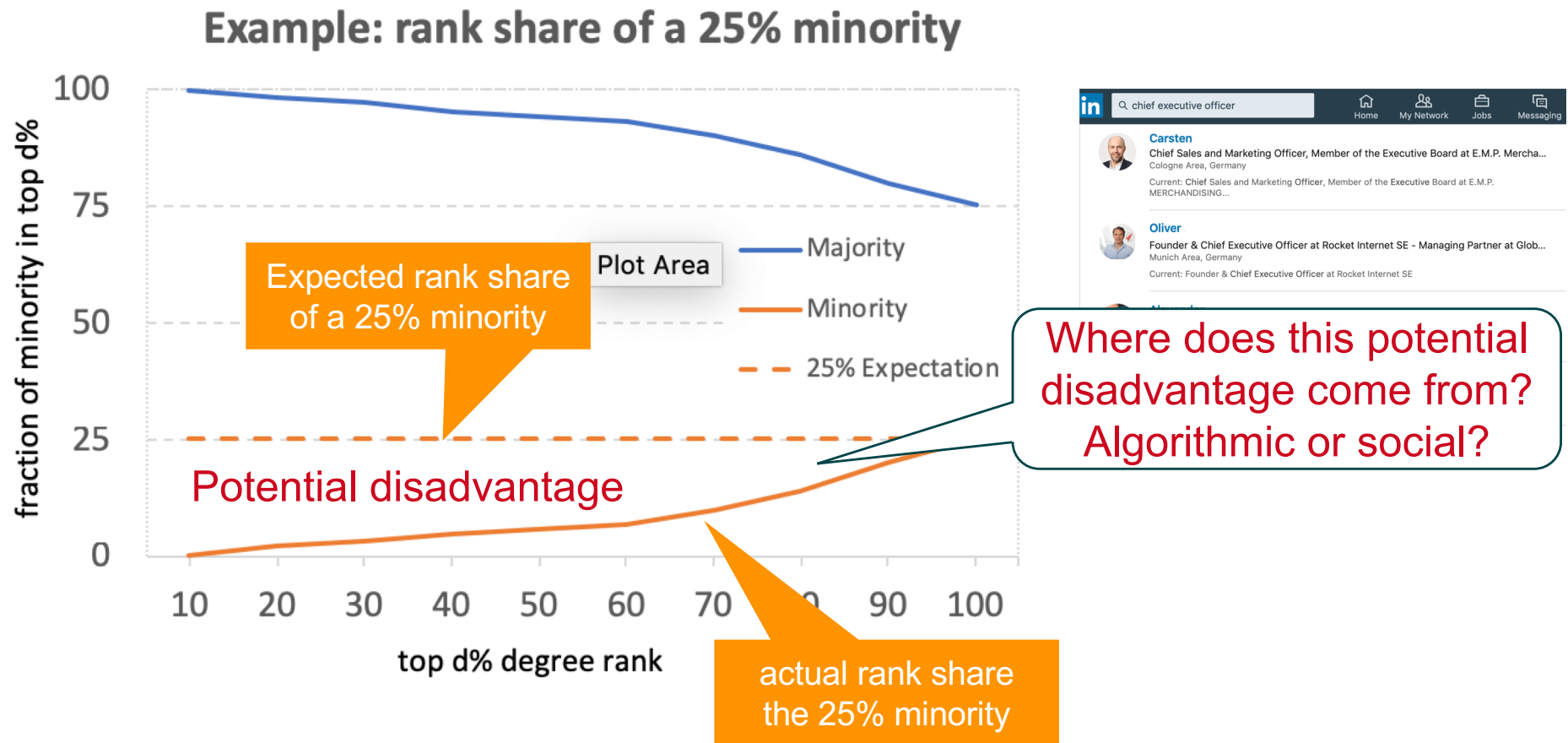
Example: LinkedIn

Ranking of people in online social networks



Minorities in social networks

How visible are minorities in rankings?



Main take-away

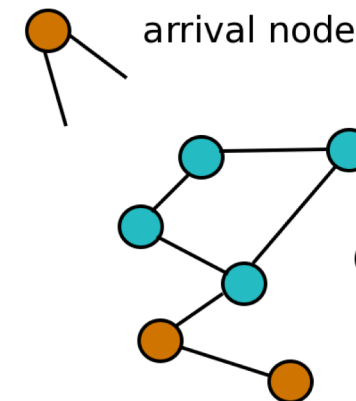
SOCIAL MECHANISMS LIKE
HOMOPHILY AND PREF. ATTACHMENT
ALONE
can create disadvantages for
minorities in social networks

Combining Preferential Attachment and Homophily

via an adapted Barabasi-Albert network generation model

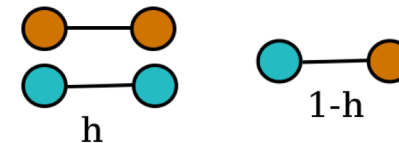
Arrival nodes connect to existing nodes based on

- preferential attachment (k)
- homophily (h)



$$p_{\text{connect}} \sim h \cdot k$$

$$0 \leq \text{homophily } (h) \leq 1$$



Simplest case with 2 groups

- minority / majority

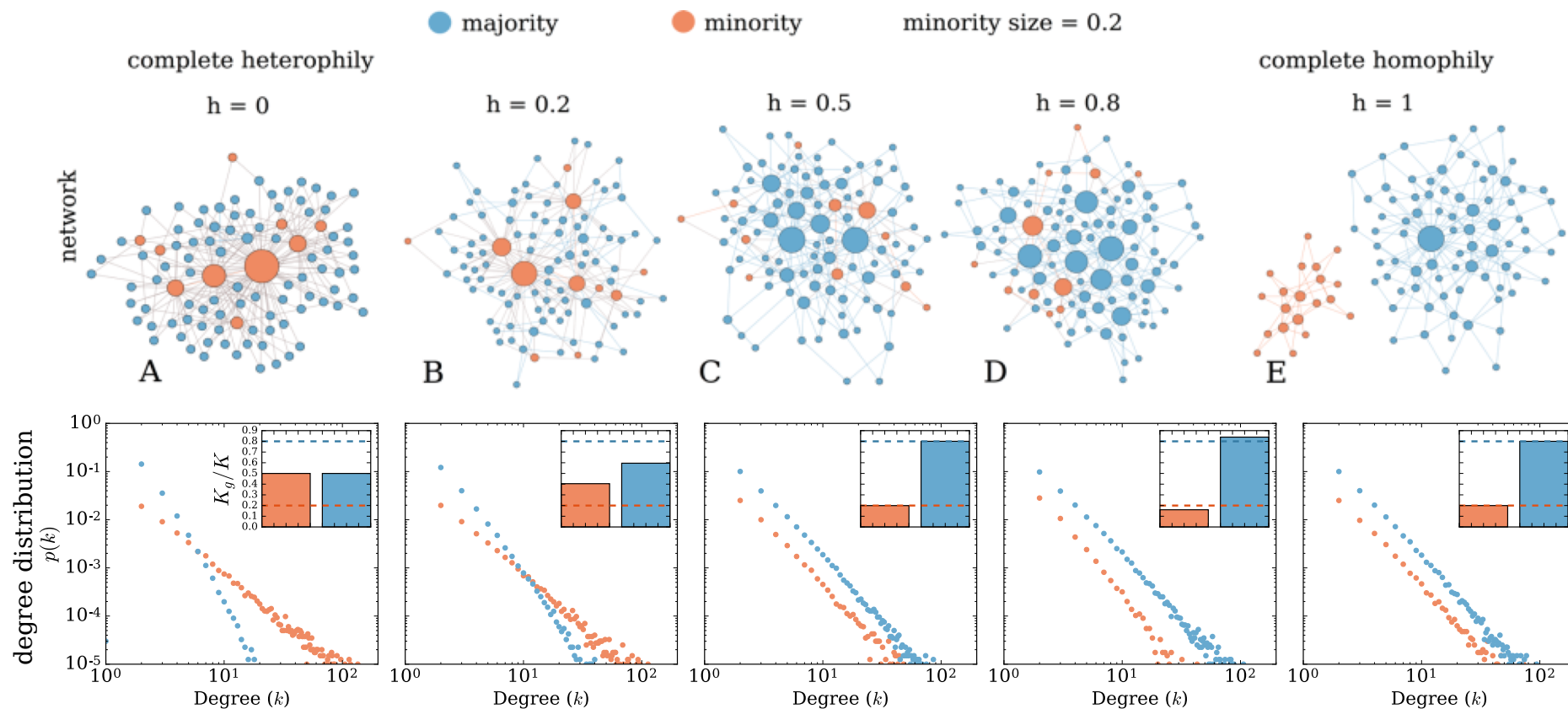
Visual demo:

<https://maxohn.github.io/networkgeneration/>

Homophily and preferential attachment in social networks

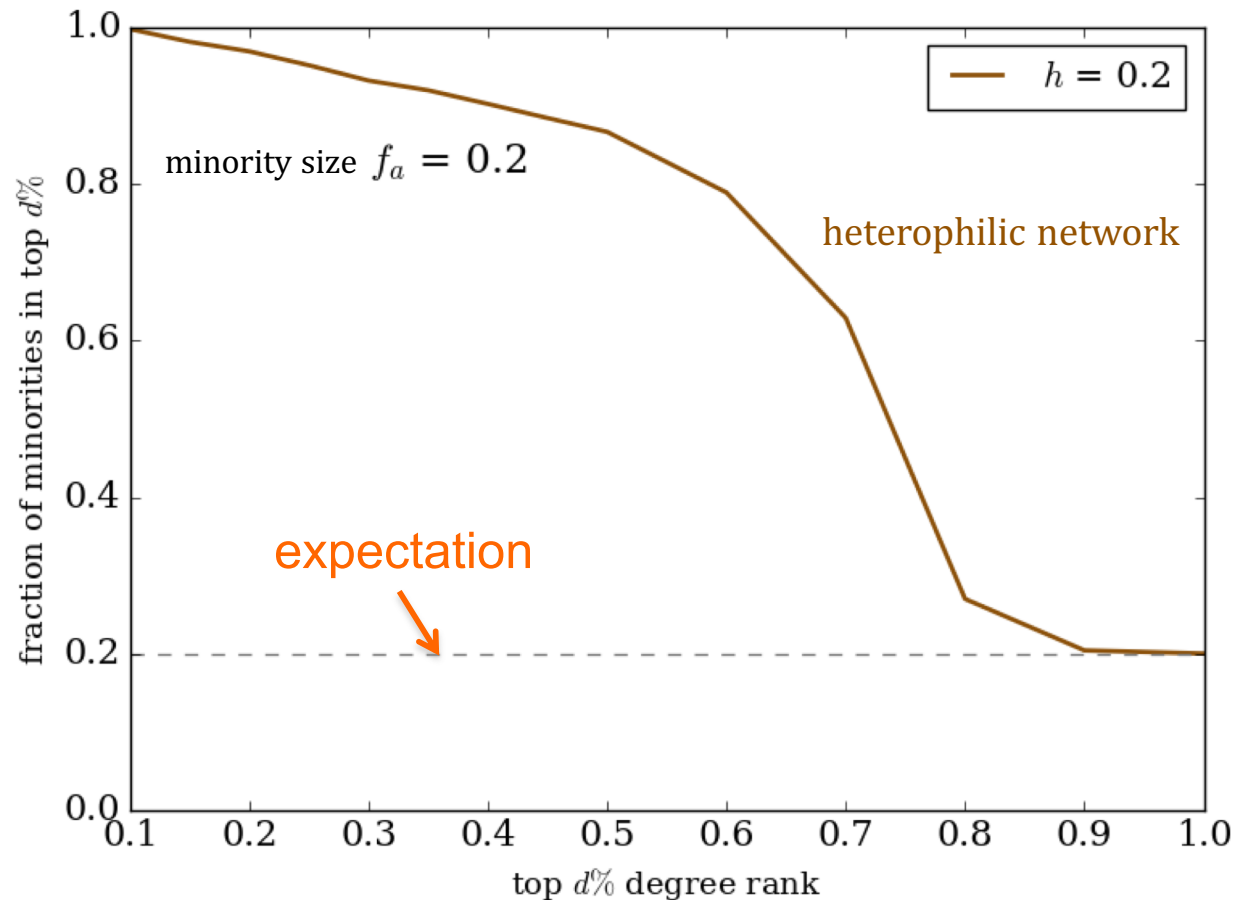
How does homophily influence degree distributions of minorities?

- Barabasi-Albert model with a homophily parameter



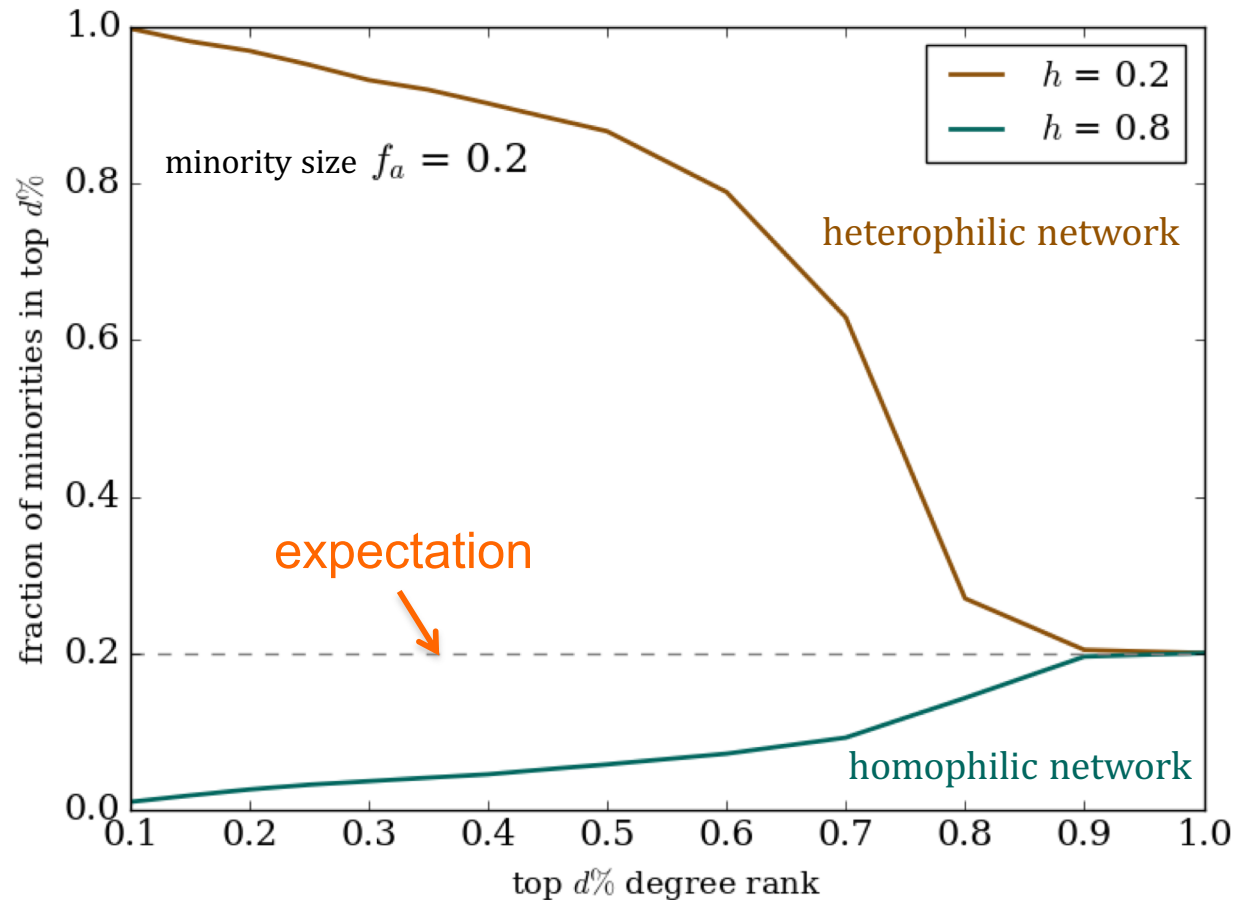
Ranking of minorities in social networks

Visibility of minority in top d%



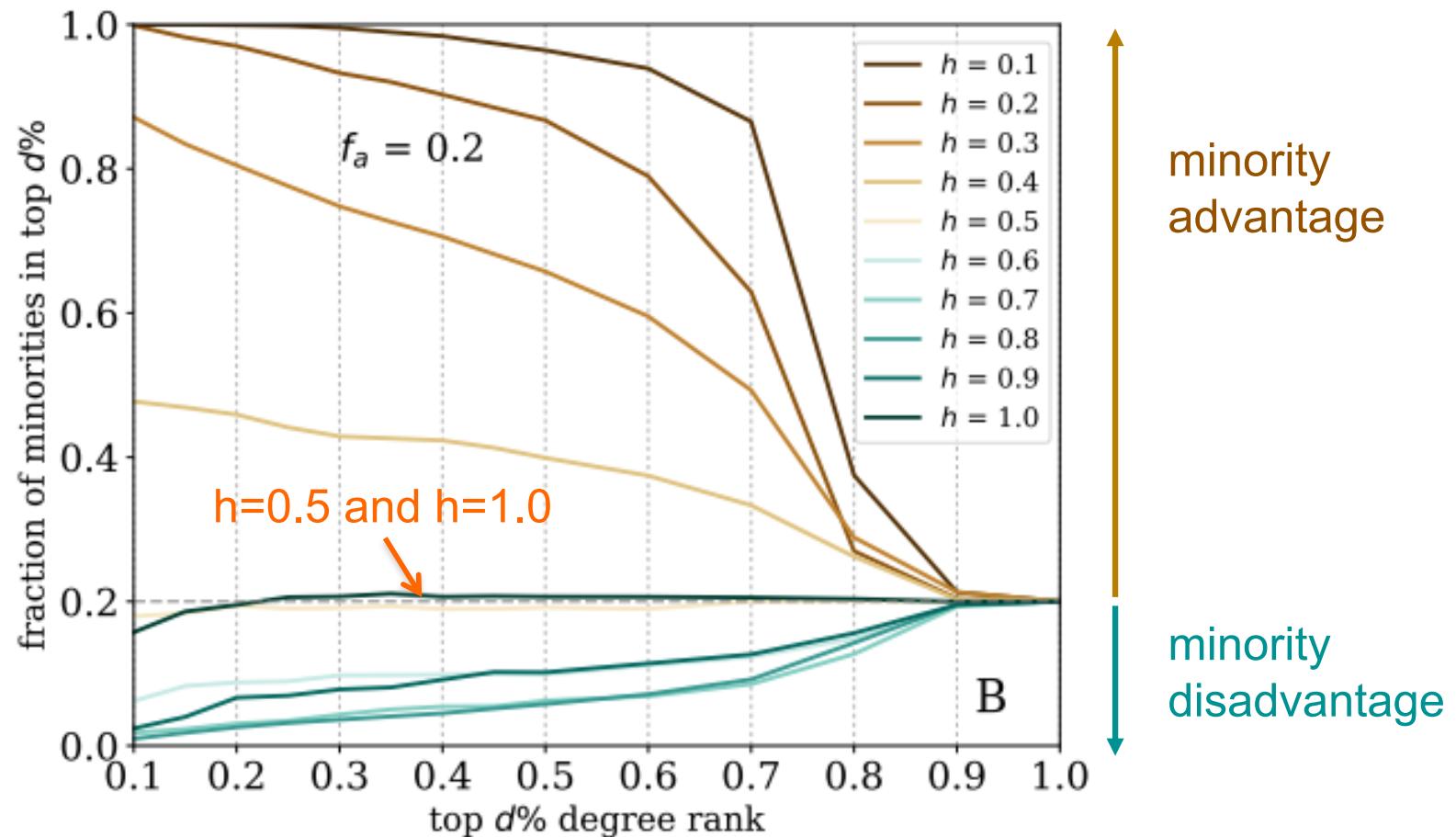
Ranking of minorities in social networks

Visibility of minority in top d%



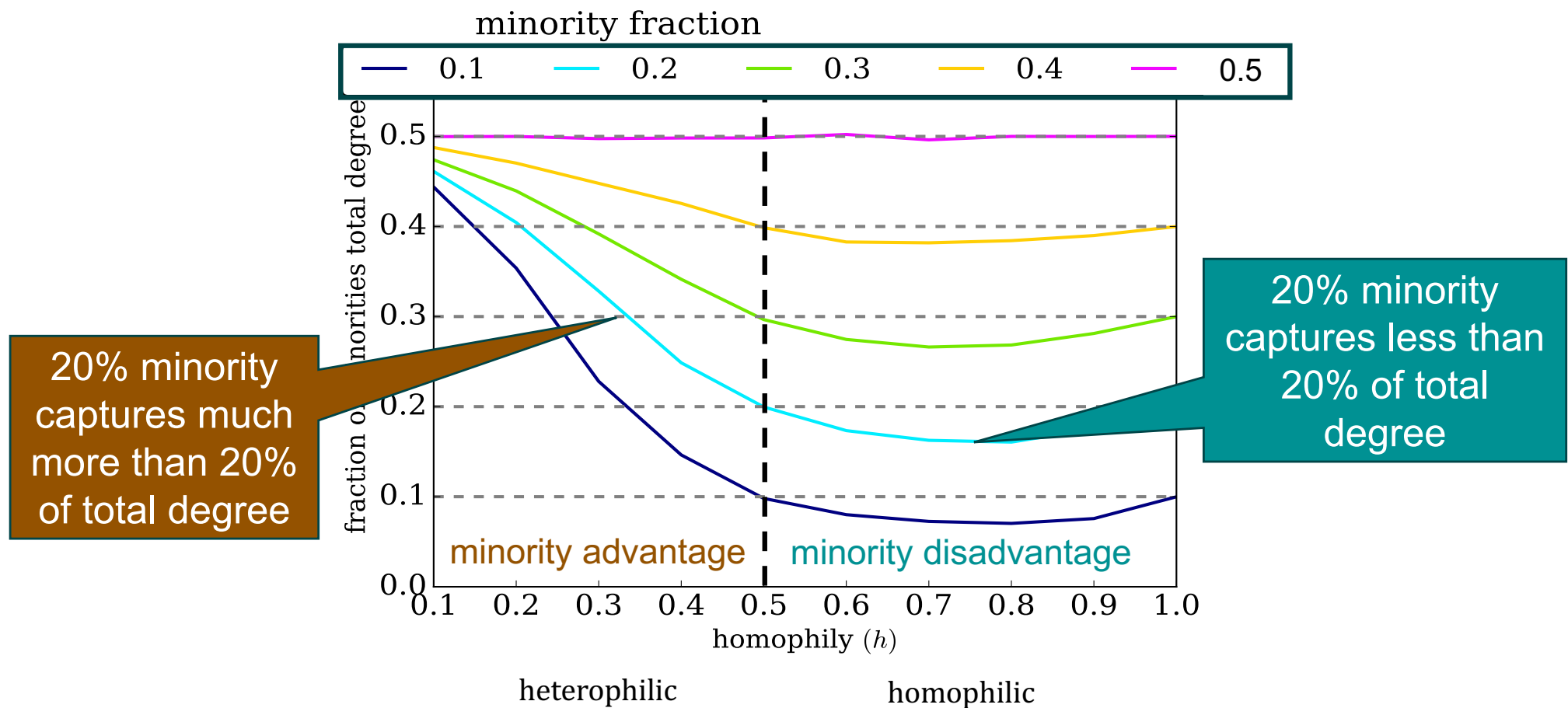
Ranking of minorities in social networks

Visibility of minority in top d%



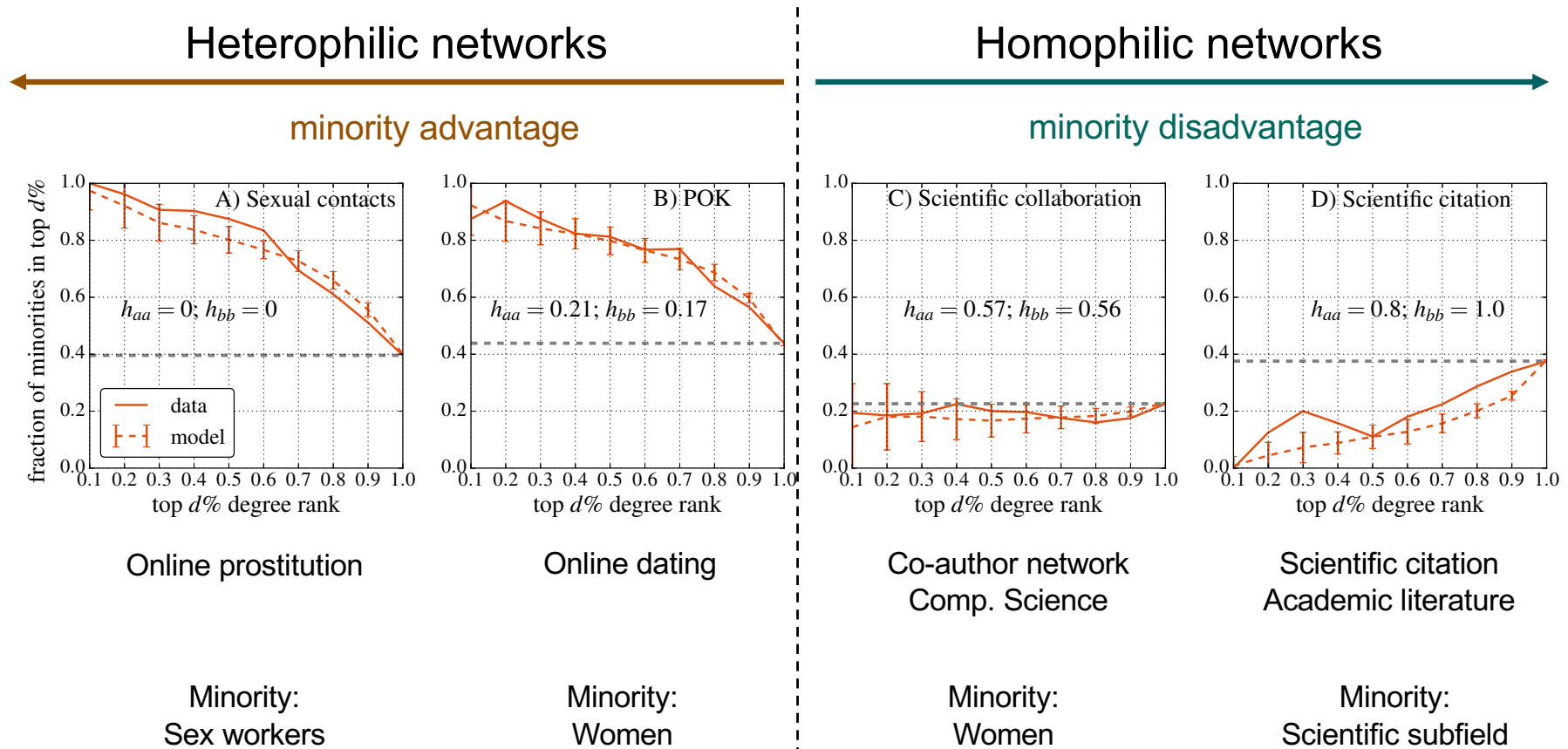
Ranking of minorities in social networks

Fraction of minorities total degree vs. homophily



Ranking of minorities in social networks

What about empirical datasets?

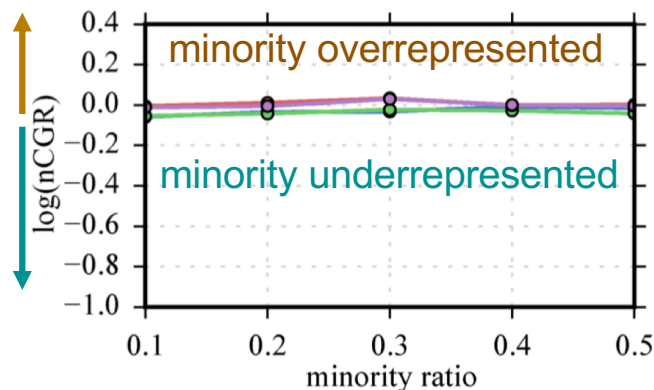


Ranking of minorities in social networks

Practical implications: Sampling (sampling size 10%, $k=100$)

node sampling edge sampling rw sampling snowball sampling

minority underrepresented



minority overrepresented



(b) Neutral ($h = 0.5$)

nCGR: normalized Cumulative Group Relevance
(a measure to quantify over/underrepresentation of groups)

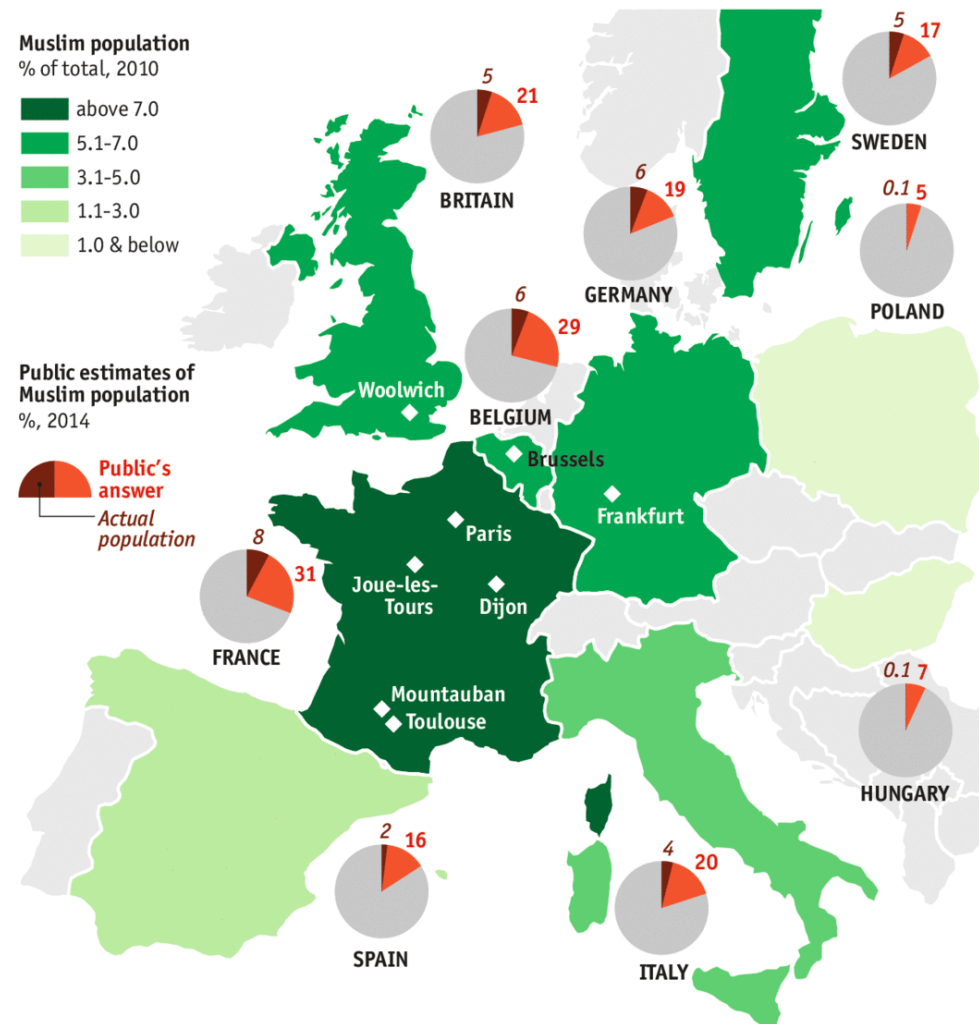
Claudia Wagner, Philipp Singer, Fariba Karimi, Jürgen Pfeffer and Markus Strohmaier, Sampling from Social Networks with Attributes, 26th International World Wide Web Conference (WWW 2017), 2017.

Part II: Perception of minorities in social networks

Does homophily influence perception of minorities?

Lee, E., Karimi, F., Wagner, C., Jo, H.H., Strohmaier, M., Galesic, M., 2017.
Homophily and minority-group size explain perception biases in social networks. *Accepted for publication in Nature Human Behavior*

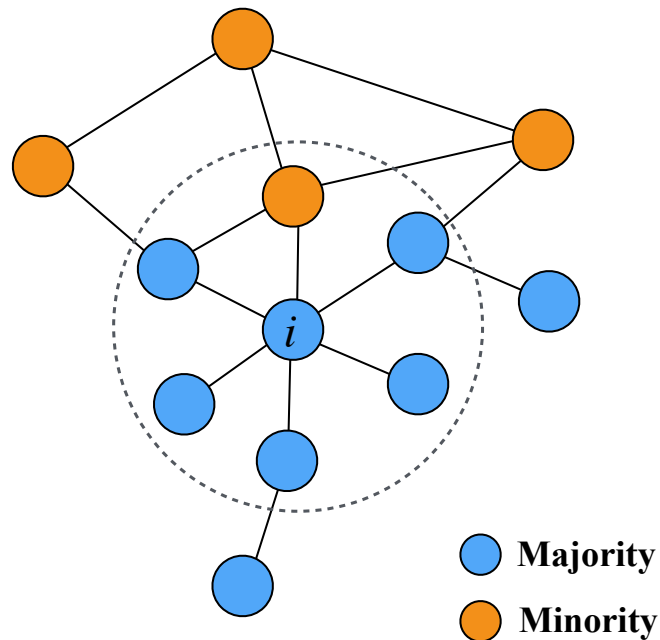
Perception of minorities



Perception of minorities in social networks

Individual and group-level perception

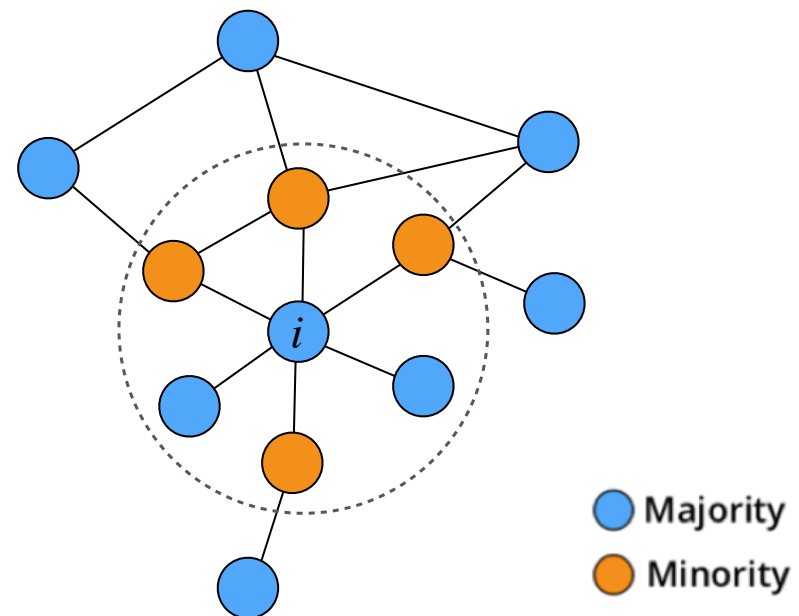
(a) Homophilic network
(False Consensus)



$$P_{\text{indiv}}(i) = 1/6 \approx 16\%$$

(0.5 fold underestimation)

(b) Heterophilic network
(False Uniqueness)



$$P_{\text{indiv}}(i) = 4/6 \approx 67\%$$

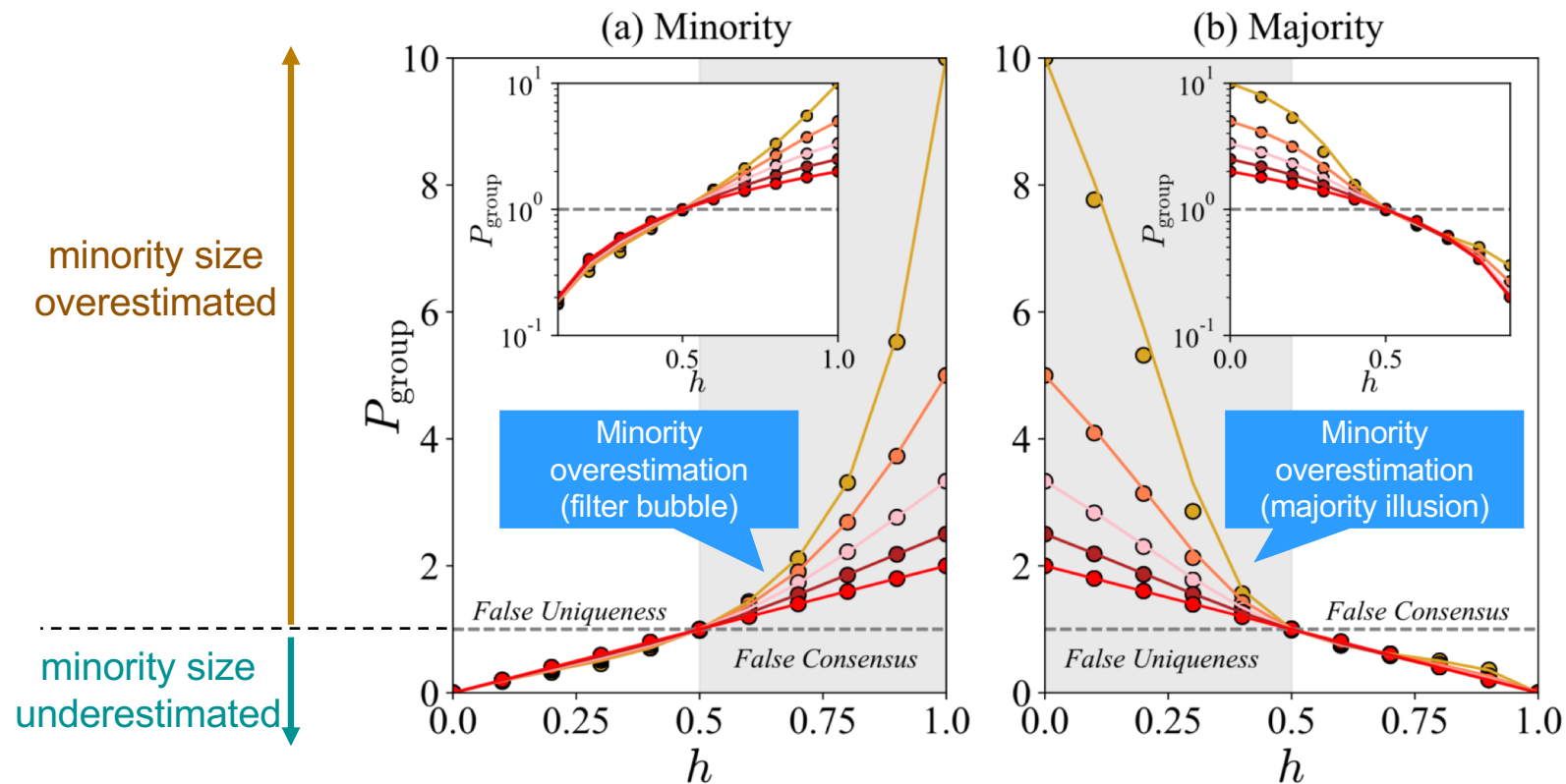
(2 fold overestimation)

Perception of minorities in social networks

Perception bias vs. homophily and minority size

Estimates of the size of the minority

● $f_a = 0.1$ ● $f_a = 0.2$ ○ $f_a = 0.3$ ● $f_a = 0.4$ ● $f_a = 0.5$



Perception of minorities in social networks

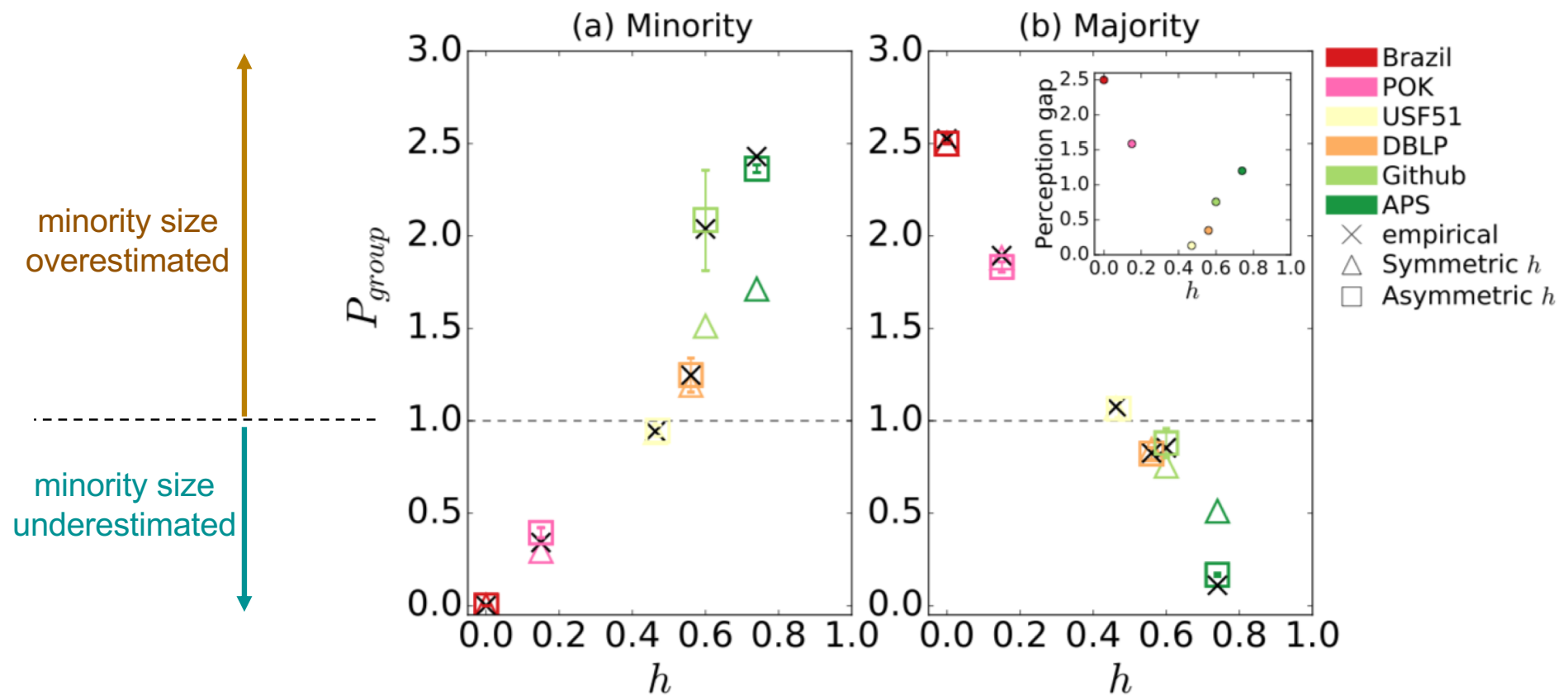
Empirical datasets

Data	Nodes	Minority	Majority	Symmetric h	Asymmetric h (minority, majority)
Brazil	16,730	sex-workers 6,624 (40%)	sex-buyers 10,106	0	0, 0
POK	29,341	minority 12,868 (44%)	majority 16,473	0.15	0.2, 0.17
USF51	6,253	male 2626(42%)	female 3,627	0.47	0.48, 0.47
DBLP	280,200	female 63,356(22%)	male 216,844	0.56	0.57, 0.57
Github	127,668	female 7,330 (6%)	male 120,338	0.6	0.69, 0.54
APS	1,853	CSM 695(37%)	QSM 1,158	0.74	0.88, 1.0

Perception of minorities in social networks

Perception bias vs. homophily in empirical datasets

Estimates of the size of the minority

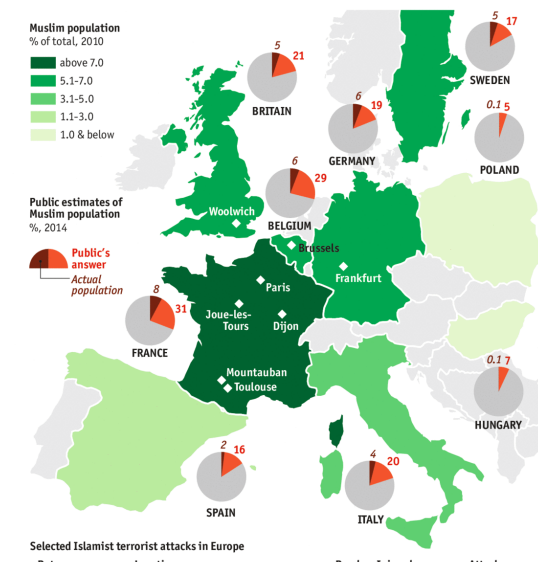


Perception of minorities on a population level

Can we observe similar perception biases on a national level?

International survey programs including the **US**, **Germany** and **South Korea**:

Characteristic	Question text	Original source of the question text the data for the general population		
		US	Germany	S.Korea
1. Not having money for food	Have there been times in the past 12 months when you did not have enough money to buy food you or your family needed? Yes–No	Gallup World Poll (2010)	Gallup World Poll (2010)	Social Integration Status Survey (2011)
2. Donating to charity	In the past month, have you donated money to a charity? Yes–No	Gallup World Poll (2010)	Gallup World Poll (2010)	Social Survey of Welfare (2017)
3. Experiencing theft	Within the past 12 months, have you had money or property stolen from you or another household member? Yes–No	Gallup World Poll (2010)	Gallup World Poll (2010)	-
4. Religion importance	Is religion an important part of your daily life? Yes–No	Gallup World Poll (2010)	Gallup World Poll (2010)	Religion of Koreans by Gallup (1984-2014)
5. Worship attendance	Have you attended a place of worship or a religious service within the past seven days? Yes–No	Gallup World Poll (2010)	Gallup World Poll (2010)	Religion of Koreans by Gallup (1984-2014)



Perception of minorities on a population level

Can we observe similar perception biases on a national level?

Examples of different minority / majority issues:

Characteristics	US(%)		Germany(%)		Korea(%)	
	Yes	No	Yes	No	Yes	No
1. Not having money for food	19	81	5	95	3	97
2. Donating to charity	57	43	43	57	26.7	73.7
3. Experiencing theft	12	88	9	91	-	-
4. Religion importance	70	30	27	73	52	48
5. Worship attendance	53	47	33	67	44	56
6. God and morality	47	53	33	67	-	-
7. Belief in a god	64	36	38	62	39	61
8. Smoking	15.2	85	21.9	78	23.9	76.1
9. Military force	76.5	24	50	50	-	-
10. Homosexuality	35.5	64	12.1	87.9	34	58

Table S2. The object ratio of population for US, Germany, and Korea with the survey questions.

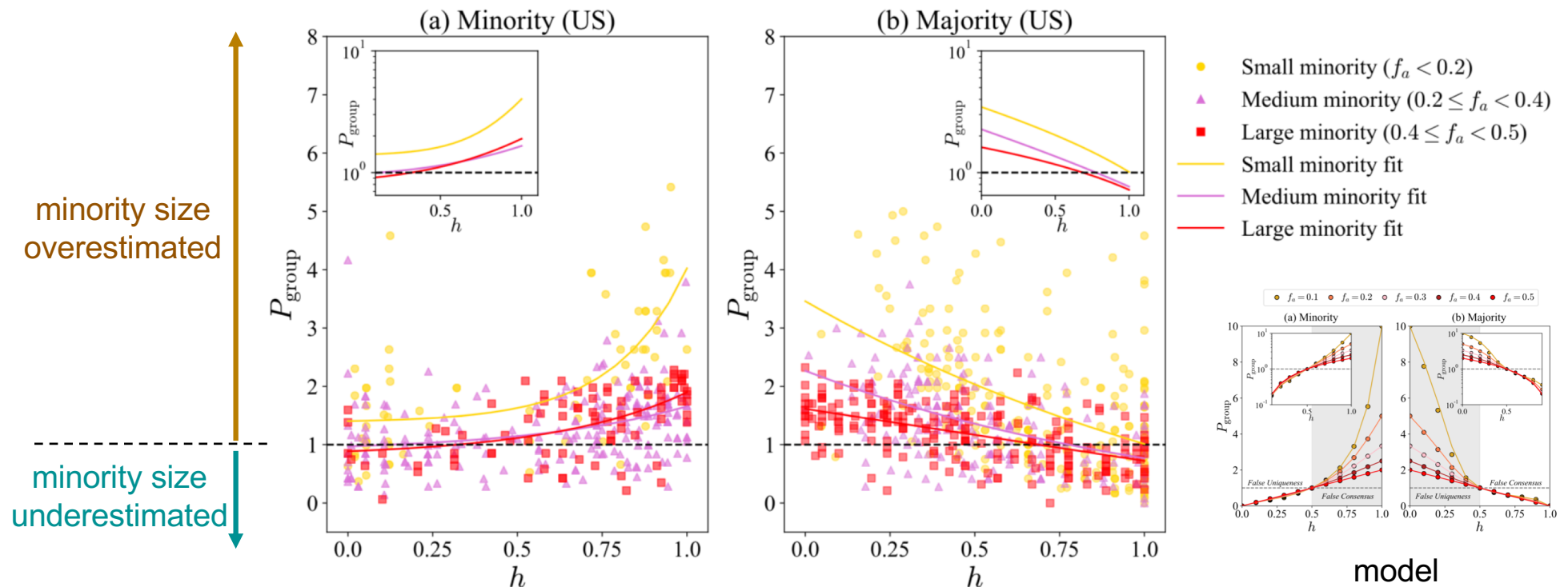
+ a crowdworker survey (n=300) asking:

1. Do you have characteristic x?
2. How frequent is characteristic x in your personal network?
3. How frequent is characteristic x in the population of your country?

Perception of minorities on a population level

Can we observe similar perception biases on a national level?

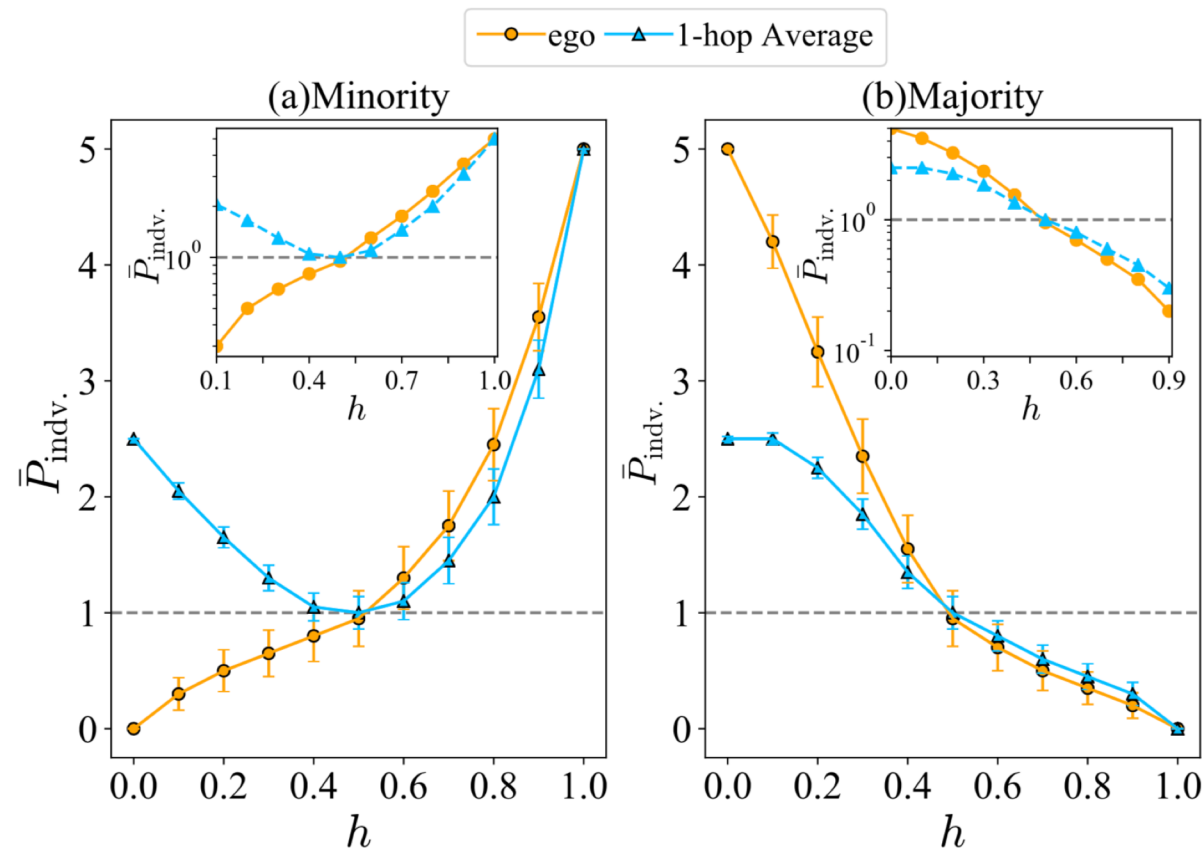
Results for minority/majority estimates from the US (results similar for Germany):



Perception of minorities in social networks

Can we mitigate perception biases in social networks?

Asking friends:



Part III: Conclusions

Conclusions

1.) Homophily influences ranking of minorities

Minorities are more affected by homophilic interactions and their group size than majorities

Karimi, F., Génois, M., Wagner, C., Singer, P. and Strohmaier, M., 2018. Homophily influences ranking of minorities in social networks. *Scientific Reports*, 8.

2.) Homophily can impact perception of groups

Evidence for perception biases on social network and population levels, can be (partially) mitigated

Lee, E., Karimi, F., Wagner, C., Jo, H.H., Strohmaier, M., Galesic, M., 2017. Homophily and minority-group size explain perception biases in social networks. *Accepted for publication in Nature Human Behavior*

Implications for Computational Social Science

- 1.) Confluence of separate streams of research**
integrating models, theory, behavioral data and survey data
- 2.) Attention shifts from theory to models and data (for now)**
new opportunities to evaluate the rich historic body of theories and hypotheses
- 3.) Emergence of entirely new computational social systems**
where social interactions are influenced and/or shaped by algorithmic systems, requiring **new theories and models**

talk info + papers



References:

Karimi, F., Génois, M., Wagner, C., Singer, P. and Strohmaier, M., 2018. **Homophily influences ranking of minorities in social networks.** *Scientific Reports*, 8.

Wagner, C., Singer, P., Karimi, F., Pfeffer, J. and Strohmaier, M., 2017, April. **Sampling from Social Networks with Attributes.** In *Proceedings of the 26th International Conference on World Wide Web* (pp. 1181-1190).

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Thank you!

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