

# Minority group size moderates inequity-reducing strategies in homophilic networks

*Keywords: social networks, network models, minority groups, inequality, complex systems*

## Extended Abstract

Members of minority groups often occupy less central positions in networks, which translates into a lack of access to essential information, social capital, and financial resources [1]. This marginalization in relation to the majority group can arise from simple structural features of social networks: the tendency of individuals to connect to own in-group (homophily) and the preference for connecting to popular individuals in the network (preferential attachment) [2], [3]. The literature has proposed tackling minority marginalization in networks by increasing the size of the minority group and changing homophily in majority and minority groups to boost the position of minority groups members [4].

Yet in real life, groups of actors exist at the boundaries of minority and majority group memberships whose presence affects the visibility of the minority group. Such individuals can play brokerage roles in social networks and facilitate communication and contact between otherwise disconnected minority and majority groups. We explore how introducing two types of such individuals into the network affects the outcomes of minority groups. By modeling a social system with these boundary groups, we illuminate the hidden role of the minority group size in moderating (even non-linearly) the benefit of these intermediating groups. First, we introduce *allied majority group members* who support the minority group by forming ties to it. Second, we introduce *incorporated minority members* whose minority characteristics are mostly invisible or unreadable and thus face no discrimination by the majority group.

To evaluate how the presence of such allied majority and incorporated minority members affects the visibility of minority groups in networks, we build on the directed network model with preferential attachment and homophily (DPAH) introduced by Espin-Noboa et al. [2]. To capture marginalization, we measure inequity in the generated network as the proportion of the minority in the top-k ranked nodes using the PageRank algorithm [2]. Guided by the social-scientific literature, we design three scenarios capturing different homophily preferences of majority and minority groups towards allied and incorporated members.

In *Scenario 1*, allied majority and incorporated minority members prefer to attach to minority members, but are in turn penalized by themselves and the minority group. In *Scenario 2*, allied majority and incorporated minority members can recognize themselves, but are still penalized by the minority group members. Finally, in *Scenario 3*, integrated minority members are visible to their minority group while still being accepted by the majority group. We investigate how these homophily parameters interact with the share of allied majority and incorporated minority group members and the overall share of the minority group in the population.

Our results suggest that interventions on structural inequities on networks can depend sensitively on the relative sizes of the groups involved. We observe the increasing difficulty of a minority group to achieve parity as the group shrinks: both external strategies (increasing allies) and internal strategies (increasing incorporation) require a higher relative threshold of participation before equity is reached. Allied majority members are equally successful in helping minority overcome inequity regardless of whether minority members associate with them

or not (Fig. 1). Yet, the efforts of incorporated minority members are facilitated if other incorporated and minority members affiliate with them (Fig. 2). Policymakers attempting to adopt policies that have been successful in improving representation for one group may need to account for the relative group sizes, as well as the nuances in relationships between different groups and allied and incorporated members as a basic variables.

## References

- [1] P. DiMaggio and F. Garip, “Network Effects and Social Inequality,” en, *Annual Review of Sociology*, vol. 38, no. 1, pp. 93–118, 2012. DOI: 10.1146/annurev.soc.012809.102545.
- [2] L. Espín-Noboa, C. Wagner, M. Strohmaier, and F. Karimi, “Inequality and inequity in network-based ranking and recommendation algorithms,” *Scientific Reports*, vol. 12, no. 1, p. 2012, 2022. DOI: 10.1038/s41598-022-05434-1.
- [3] F. Karimi, M. Génois, C. Wagner, P. Singer, and M. Strohmaier, “Homophily influences ranking of minorities in social networks,” *Scientific Reports*, vol. 8, no. 1, p. 11 077, 2018. DOI: 10.1038/s41598-018-29405-7.
- [4] L. Neuhäuser, F. Karimi, J. Bachmann, M. Strohmaier, and M. T. Schaub, “Improving the visibility of minorities through network growth interventions,” 2022. [Online]. Available: <http://arxiv.org/abs/2208.03263>.

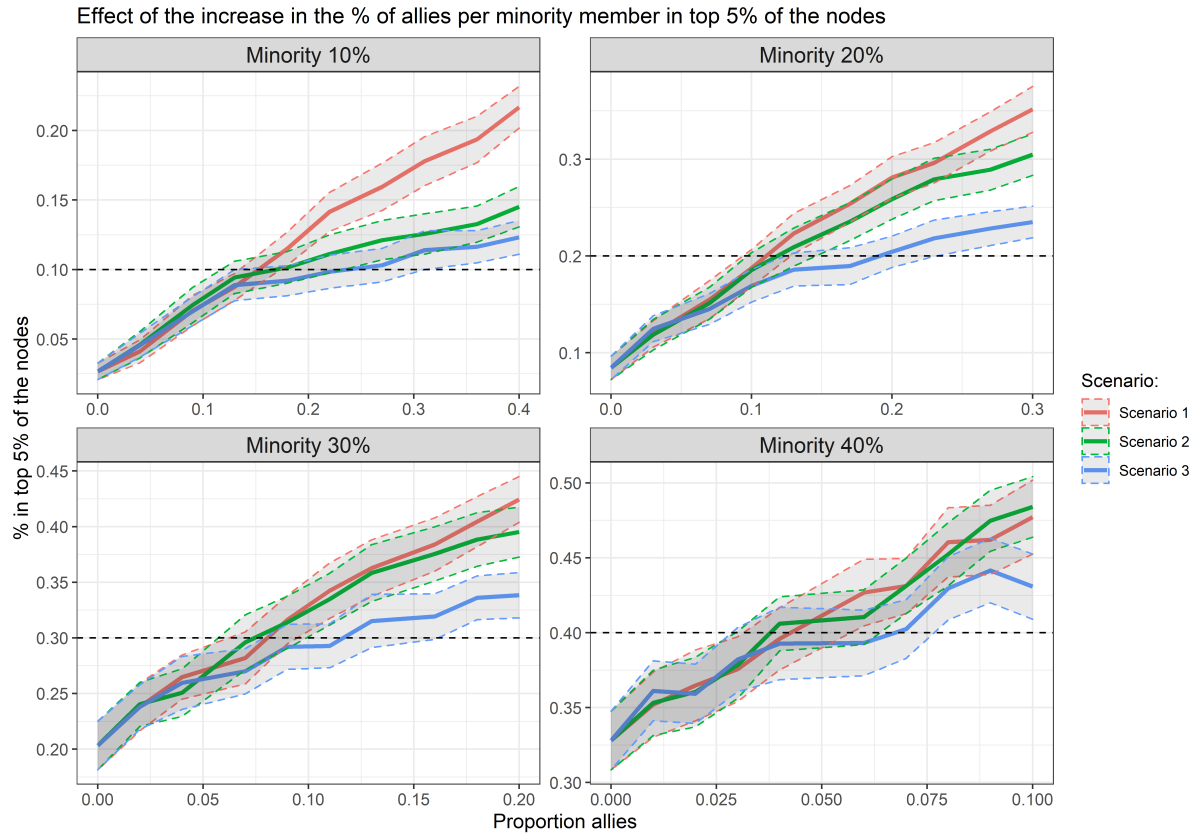


Figure 1: **Three scenarios: Proportion of allies necessary for equity.** Regardless of the scenario, the proportion of allies necessary for equity decreases in proportion to the size of the minority group. Shown are means and 95% CIs over 50 simulations at each data point.

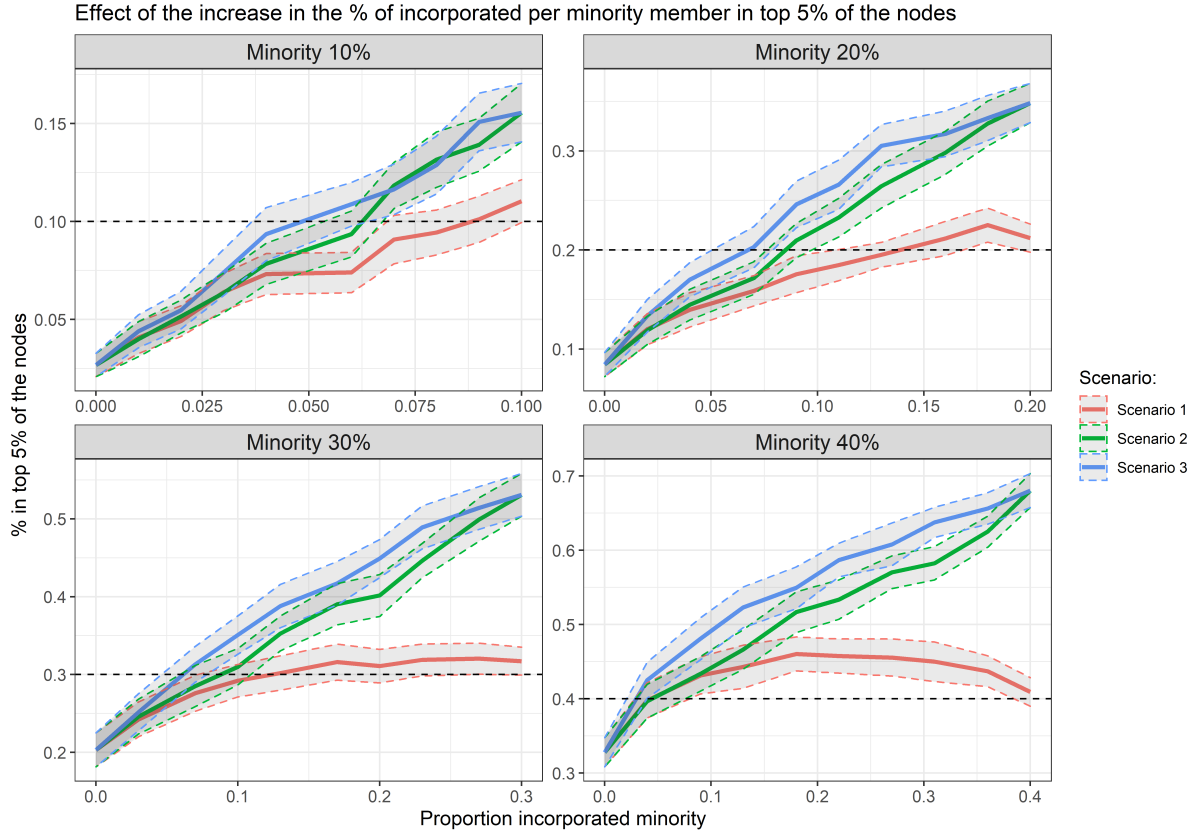


Figure 2: **Three scenarios: Proportion of incorporated minority members necessary for equity.** The benefit of incorporating into the majority group is moderated by the size of the minority group in the population. Larger minority groups reach equity with a smaller proportion of incorporated members, and experience diminishing returns to subsequent incorporation. If other incorporated minority members (Scenario 2) and the minority members (Scenario 3) also prefer to affiliate with the incorporated minority, the relationship becomes monotonic. Shown are means and 95% CIs over 50 simulations at each data point.