# Invisible Gatekeeping: Intersectional Bias in Maintainer Promotion Pathways in Open Source Software

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## Introduction

In open-source software (OSS), formal titles often emerge organically through contribution rather than appointment. Maintainers—contributors who merge pull requests, review code, and oversee releases—occupy critical positions of power. Yet, the pathway to maintainership remains opaque and unevenly distributed. Research in organizational behavior and diversity in tech has long demonstrated that promotion systems, even when informal, can reproduce structural inequalities. However, intersectional disparities in OSS promotion—where gender, race, and geography interact—remain largely unexamined.

This study investigates **intersectional bias in the pathways to OSS maintainership**, asking: *Who gets promoted to positions of authority, and how do intersecting identities influence this trajectory?* Drawing on theories of cumulative advantage and intersectionality, we conceptualize maintainership as a social mobility process within digital organizations. We hypothesize that women and contributors from the Global South—and especially those at the intersection of multiple marginalized identities—face systemic barriers to upward mobility, even when contribution metrics are equivalent.

By combining longitudinal behavioral data, organizational modeling, and intersectional analysis, this research empirically examines how power reproduces itself in supposedly meritocratic environments.

## Methods

We adopt a **longitudinal, mixed-methods design** combining OSS data analytics, survival modeling, and qualitative inquiry to trace career trajectories from newcomer to maintainer.

**Phase 1: Repository Sampling and Contributor Histories**

We select 800 OSS projects with transparent governance structures and publicly recorded maintainership events (e.g., additions to CODEOWNERS, MAINTAINERS, or core team documentation). Using the GitHub GraphQL API and GHTorrent datasets, we reconstruct the contribution histories of approximately 60,000 contributors spanning a five-year period. We extract fine-grained data on commits, reviews, issue responses, and mentorship interactions, generating a temporal dataset of contributor activity over time.

**Phase 2: Operationalizing Promotion Events**

A "promotion event" is defined as the point at which a contributor is first granted merge privileges or added to the maintainer list. To model promotion likelihood, we create a binary outcome variable (promoted = 1/0) and compute explanatory variables such as contribution volume, review acceptance rate, response time to issues, and centrality in communication networks.

Intersectional demographic categories are inferred using probabilistic gender, race, and geographic inference pipelines (as in Abstract #1), resulting in multi-dimensional identity groups (e.g., "Latina woman, Global South"). We compute both additive and interaction terms to test intersectional effects rather than single-axis disparities.

**Phase 3: Statistical Modeling**

We use **Cox proportional hazards models** to estimate the time-to-promotion for each contributor, with intersectional identity and behavioral metrics as covariates. Hazard ratios represent the relative rate at which contributors are promoted to maintainers. Project-level random effects control for differences in size, activity, and culture. Robustness checks include logistic regression models of promotion within fixed time windows and sensitivity analyses excluding inactive contributors.

We also test for **cumulative advantage effects** by examining whether early recognition (e.g., being thanked in release notes, having code merged by maintainers) amplifies promotion likelihood—testing whether such advantage accrues unevenly across intersectional lines.

**Phase 4: Qualitative and Contextual Analysis**

To interpret the statistical findings, we conduct 20 semi-structured interviews with contributors at different stages of their OSS careers. Questions probe perceptions of fairness, mentorship, and gatekeeping in promotion processes. Interview transcripts are coded using grounded theory to identify structural and interpersonal forms of exclusion, including differential access to informal mentorship networks.

## Potential Impact

This research exposes the hidden inequalities underlying leadership advancement in open-source communities. By quantifying how intersectional identities affect promotion rates, it provides empirical grounding for interventions in mentorship, sponsorship, and governance. OSS foundations and corporate open-source programs can use these insights to design transparent promotion criteria, implement equitable nomination practices, and ensure that leadership diversity reflects contributor diversity.

Theoretically, the study bridges **intersectionality theory**, **organizational behavior**, and **computational data science**, offering a novel model of digital social mobility. Methodologically, it advances reproducible frameworks for measuring equity in decentralized organizations. Beyond OSS, these methods can inform broader analyses of career progression and bias in remote, volunteer-driven knowledge work. Ultimately, the work demonstrates that meritocracy in open collaboration is not self-correcting—and that structural reform requires both visibility and accountability.