Selected Papers of #AoIR2025:
The 26th Annual Conference of the
Association of Internet Researchers
Niterói, Brazil / 15 – 18 Oct 2025

INTERACT AND REACT: GENDER, OPEN-SOURCE SOFTWARE, AND THE GOVERNANCE OF USER INTERFACE TECHNOLOGIES

Dr. Siân Brooke
Digital Interactions Lab, Informatics Institute, University of Amsterdam

Introduction

The governance of digital infrastructures, how they are designed, maintained, and expanded, shapes who has agency in technological development (Davis, 2020; Schwartz & Neff, 2019). The tools used to build the internet, including UI frameworks, libraries, and open-source platforms, are rarely neutral; they reflect their contributors' values, priorities, and labor structures (Brooke, 2021; Gray, 2019; Nafus, 2012). However, much of the research on digital exclusion and platform governance has focused on the end-user experience rather than the structural conditions of software development itself (Brooke, 2021; Burnett et al., 2016).

This paper examines gendered participation in open-source software (OSS) development through a case study of React, one of the most widely used JavaScript libraries for UI design. React underpins major web platforms and interactive systems, making it a critical site for analyzing how gender shapes software robustness and innovation (Sakhniuk & Boduch, 2024). By conducting a longitudinal computational analysis of 11 years of React development, this study explores the exclusionary dynamics of OSS governance, asking:

> *RQ1.* How does gender influence the robustness in the development of UI tools?
> *RQ2.* How does gender impact innovation in UI tools design?

Despite increased discourse around inclusivity in OSS (Frluckaj et al., 2022), women and non-binary developers remain underrepresented and marginalized in the governance of UI frameworks. This study demonstrates how gendered labor divisions in OSS impact software development and the broader structure of internet technologies, reinforcing power imbalances in who defines the future of digital infrastructures.

Suggested Citation (APA): Brooke, S. (2025, October). *Interact And React: Gender, Open-Source Software, And The Governance Of User Interface Technologies.* Paper presented at AoIR2025: The 26th Annual Conference of the Association of Internet Researchers. Niterói, Brazil: AoIR. Retrieved from http://spir.aoir.org.

Theoretical Framing

Gender in Software Design

Software development has long been shaped by gendered biases that define technical expertise as masculine and reinforce the perception that programmers are "*male by default*" (MacKenzie & Wajcman, 2011; Vasilescu et al., 2015). This dominance influences who codes and how software interfaces are designed, used, and valued (Brooke, 2022; Vorvoreanu et al., 2019).

Research in Human-Computer Interaction (HCI) has demonstrated that software often favors male-oriented usage patterns, as seen in online education platforms, home automation, and intelligent agents (Vorvoreanu et al., 2019). Williams (2014) shows that gender bias can be embedded at any stage of the software development cycle, while GenderMag, a method for detecting gender bias in interface design, highlights how software workflows reinforce exclusionary cognitive patterns (Burnett et al., 2016). Additionally, interface aesthetics and interaction styles impact who feels a sense of belonging in software environments (Metaxa-Kakavouli et al., 2018).

Understanding how women's participation influences the development of OSS projects over time is crucial for moving beyond bias mitigation and toward equitable design processes.

Defining Quality in OSS Contributions

The way "*quality*" and "*success*" are defined in computing is deeply gendered, reflecting biases in whose contributions are valued (May et al., 2019; Nafus, 2012). Riley (2017) argues that, when used to refer to quality, terms like "*rigor*" and "*hardness*" reinforce masculine ideals of technical expertise, marginalizing more collaborative and iterative forms of knowledge production.

These biases extend to code reviews and contribution assessments, where women's work is more likely to be described as "*elegant*" or "*neat*" rather than "*strong*" or "*rigorous*" (Marino, 2020). Brooke (2023) found that men and women write Python code with similar quality, yet men's contributions are more likely to be perceived as technically superior. Non-code contributions—such as documentation, bug tracking, and community management—are devalued, even though they are critical to OSS success (Nafus, 2012).

In this study, I move beyond narrow, masculine-coded measures of software success, emphasizing collaboration, maintenance, and iterative improvement through *robustness* and *innovation.*

Defining Robustness and Innovation

Two key dimensions of OSS success are *robustness*, a software system's capacity to handle errors, maintain adaptability, and support long-term functionality, and *innovation,* introducing new features and improvements over time (Burnett et al., 2011). Yet, OSS research often fails to account for how gender influences these dimensions. This study operationalizes robustness and innovation by considering robustness as bug fixing, dependency management, and code documentation. In comparison, innovation is defined as feature development, contribution diversity, and activity around major software releases.

These indicators provide a structured way to examine how gendered participation impacts the development of digital infrastructures and what this means for the governance of internet technologies.

GitHub and React

GitHub is the world's OSS collaboration platform, where developers contribute, review, and manage code. Despite its global reach, GitHub remains male-dominated, reinforcing exclusionary norms in OSS governance (Padala et al., 2022). Women's contributions face longer review times, lower acceptance rates, and limited visibility in leadership roles (Sultana et al., 2023; Terrell et al., 2017).

React, a widely used JavaScript library for building web interfaces, exemplifies this imbalance, with 92% of React developers identifying as men. As AI-driven coding tools increasingly learn from and automate development using repositories like GitHub, these biases risk being encoded into the next generation of software (Seaborn et al., 2023).

Methodology

This study examines React's development history (*2013 – 2024*) using GitHub Archive and the GitHub REST API, analyzing 1,246,593 recorded events from 433,187 unique contributors. To explore how gender dynamics evolve over time, I also assess key software version releases (*React 15 – 18*), identifying potential shifts in participation patterns around major updates.

Gender Inference and Participation Metrics

To infer gender, I used name-based classification (*genderComputer*) and explicit gender declarations in GitHub profiles and biographical sections (e.g., *explicitly stated pronouns or emojis indicating gender*). Contributors were categorized as women, men, non-binary, or anonymous. To examine how this shapes OSS, this study quantifies two key dimensions:

> *Robustness*: A project's ability to handle errors, maintain clear documentation, and ensure long-term stability. Contributions like bug fixes and dependency management reflect this.

Innovation: Introducing new features, major updates, and enhancements that define a project's evolution. Version releases serve as key milestones, shaping future development.

These indicators allow for a structured analysis of who contributes, how contributions are valued, and whose work is retained in OSS projects. The following section presents findings on how gender influences these patterns, using bootstrapped statistical tests to ensure reliability.

Findings

Gender and Robustness in UI Tools

- Women's contributions are closed faster (*10.76 days earlier than men's*) but have lower merge rates (*20.38% vs. 24.62% for men*), indicating that women's contributions are scrutinized but not fully integrated (Terrell et al., 2017).
- Women raise more issues (64.69%) but resolve fewer (33.04%), suggesting a labor division in which they identify problems rather than lead fixes.
- Retention disparities are clear: Women's participation drops off significantly after 20 months, aligning with prior research on OSS gender exclusion (Frluckaj et al., 2022).

Gender and Innovation in UI Tools

- Women's contributions are disproportionately concentrated in feature enhancements and dependency management, which are crucial for sustaining OSS ecosystems.
- Men dominate high-impact release events (*88.8% vs. 6.31% for women*), suggesting gendered power asymmetries in OSS governance.
- As React approaches release milestones, women's contributions to feature enhancements and documentation spike, while men's contributions to testing increase, revealing gendered adjustment costs (Pecis, 2016).

Conclusion

The briefly outlined findings highlight how gendered labor hierarchies in OSS development shape the governance of UI technologies. The exclusion of women from key governance and innovation roles in OSS risks perpetuating exclusionary participation structures, reinforcing biases that extend beyond software into broader internet governance frameworks.

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