

Diversity, Equity, and Inclusion in Open Source

Exploring the challenges and opportunities to create equity and agency across open source ecosystems

December 2021

Hilary Carter, *VP Research, The Linux Foundation*

Jessica Groopman, *Industry Analyst and Founder, Kaleido Insights*

With a foreword by Jim Zemlin, *Executive Director, The Linux Foundation*

In partnership with:



and



Contents

- Foreword.....3**
- Infographic5**
- Executive Summary7**
- Introduction8**
- Part 1: The State of Diversity, Equity, and Inclusion in Open Source..... 10**
 - Open source diversity reflects growing global adoption 11
 - Time: The #1 determinant for open source participation..... 15
 - Overcoming reputational hurdles toward inclusion and belonging 15
 - Then versus now: Changes in diversity, equity, and inclusion over time 18
- Part 2: Obstacles and Challenges to DEI in Open Source.....20**
 - Exclusionary behaviors influence community cultures 21
 - How backgrounds impact equitable access to open source participation.....26
 - Barriers to representation in leadership32
- Part 3 Opportunities to Foster Greater Inclusion35**
 - The Efficacy of Current Open Source DEI initiatives36
 - Emerging Solutions and Opportunities46
- Conclusion58**
 - Methodology59
 - Demographics60
 - Qualitative Interviews.....61
 - Acknowledgments62
 - About the Authors63
 - Disclaimer 64

Foreword

Diversity, equity, and inclusion (DEI) in the technology industry—and within open source specifically—is an opportunity we need to continuously leverage for the benefits it brings. Given that people of vastly different backgrounds, nationalities, orientations, and identities create open source software, hardware, and standards, their participation and well-being is important. Study after study reveals that diversity in participation produces better outcomes and more robust technologies—that diverse communities are simply stronger communities. For communities to continue evolving for the better, we need to improve our collective understanding in DEI, studying the current state, and what types of collective efforts lead to better outcomes.

At the Linux Foundation, we've taken several steps to improve diversity in open source communities by supporting new projects such as the Inclusive Naming Initiative, which seeks to remove non-inclusive language from project repositories. We've also helped advocates in the community launch the Software Developer Diversity and Inclusion Project (SDDI), which will explore, evaluate, and promote best practices from research and industry to increase diversity across all dimensions—such as race and ethnicity, gender identity, age, and cognitive ability—to ensure an environment and culture of inclusion in software engineering.

In addition, we created the LFX Mentorship Program to help developers from diverse backgrounds (most of whom are first-time open source contributors) gain the necessary skills to effectively contribute to open source communities. We grant almost \$1 million a year in travel funding and registration scholarships to those from diverse backgrounds to join events and nurture relationship building and learning through face-to-face collaboration via the Linux Foundation Travel Fund. We also have DEI programs and outreach at each of our events designed to create open and welcoming spaces that reflect the diversity we aim to see across the ecosystem.

While these are important steps to creating inclusive communities, it is incumbent upon us all to do more. And through new DEI research, we have an opportunity to double down or redirect our efforts to improve open source environments with quantifiable data.

The report you are about to read is the culmination of many months of primary research by research professionals and leaders across our communities. This work was made possible by the responses of thousands of open source participants who completed the survey and those who engaged in qualitative interviews to provide a richer perspective on the issues at hand. In particular, we thank those who, through the research



process, came forward to express that they felt marginalized or excluded from the communities in which they participate. In addition, we are grateful to our project partners Amazon Web Services (AWS), CHAOSS Community, Comcast, Fujitsu, GitHub, GitLab, Hitachi, Huawei, Intel, NEC, Panasonic, Red Hat, Renesas, and VMware. Their financial support enabled survey translation and deep analysis of this important subject matter.

We hope you find this report a valuable resource as you seek to foster diversity in your own communities. We encourage you to take this report's findings into current and future discussions you're involved in to support changes that deliver better outcomes for open source communities.

Jim

Jim Zemlin

Executive Director, *The Linux Foundation*

Encouragingly, **82% feel welcome in open source**, but demographic segmentations show varied sentiments.



DEI IN 2021

Of survey respondents, when asked about their ability to reach their goals when contributing to open source, **30% report that some aspect of their identity was a factor.**



DEI CHALLENGES

Of respondents, **22% disagreed that equal opportunity exists** for people with different backgrounds to be part of the decision-making process in open source.



DEI CHALLENGES

People who do not feel welcome in open source are from **disproportionately underrepresented groups.**



DEI IN 2021

Women, non-binary, LGBTQ+, and people with disabilities were **2X as likely to have experienced threats of violence** in the context of an open source project. **Transgender respondents were 3X as likely.**



DEI CHALLENGES

While 81% of people surveyed can read and write English well, there are others for whom **language presents a barrier to participation or belonging** in open source communities.



DEI CHALLENGES

Of survey respondents, **37% agree that there are clear processes to becoming a leader** or maintainer in an open source project.



DEI IN 2021

Language that makes people feel unwelcome includes profanity, racist jokes, sexual imagery, hostility, rudeness, name calling, etc.



DEI CHALLENGES

When respondents participate in a project, **30% are unsure that codes of conduct will be enforced** or somewhat disagree with that assertion.



DEI CHALLENGES

55% of respondents feel their opinion is valued by leadership in open source projects where they participate, while 10% disagree.



DEI CHALLENGES

Of survey respondents, **17% experienced exclusionary behaviors** occasionally or frequently.



DEI CHALLENGES

Of survey respondents, **36% have experienced some sort of stereotyping behavior** based on perceived demographic characteristics.



DEI CHALLENGES



Of survey respondents, **only 14% get paid** for their open source contributions.

DEI IN 2021

Evolve education.
Extend DEI training programs into areas unique to open source.



DEI OPPORTUNITIES



Localize efforts.
Deliberately drive global inclusion across underrepresented regions.

DEI OPPORTUNITIES

Time is the #1 determinant for participation in open source. Things like time zones, unpaid time, and onboarding time factor into when or how people can participate.



DEI IN 2021



Enact structural change.
Embrace more than code as open source evolves into a tool for a more inclusive digital economy.

DEI OPPORTUNITIES

Resources matter.
Prioritize funding to build inclusive designs into open source programs.



DEI OPPORTUNITIES



When surveyed about their curriculum, **only 16% of students report that open source is taught.**

DEI IN 2021

Measurement matters.
Take (and share) a data-driven approach to learning and improving.



DEI OPPORTUNITIES



Embrace Ecosystems.
Distribute agency and responsibilities to drive adoption across overlooked stakeholders.

DEI OPPORTUNITIES

Of respondents, **89% feel they can have a positive impact on the world** by participating in open source.



DEI IN 2021



Be proactive with inclusion.
Improve equity with active steps and dedicated efforts.

DEI OPPORTUNITIES

Offer open source hospitality.
Cultivate newcomers' experience to increase the number of new open source contributors.



DEI OPPORTUNITIES

Executive Summary

Linux Foundation Research and its partners have put diversity, equity, and inclusion (DEI) at the top of their 2021 inaugural research agenda, and for good reason. It is the social imperative of our time. This research aims to identify the state of DEI in open source communities, identify challenges and opportunities within them, and draw conclusions around creating improvements in much-needed areas.

Open source diversity reflects growing global adoption. As open source accelerates in both its supply and demand, barriers to inclusion vary widely, far beyond common categorizations like gender and race.

Time is a top determinant for open source participation. Time-related barriers to access and exposure in open source include discretionary and unpaid time, time for onboarding, networking, and professional development, as well as time zones.

Encouragingly, 82% feel welcome in open source, but demographic segmentations show varied sentiments. The 18% of those that do not feel welcome are from disproportionately underrepresented groups: people with dis/abilities, transgender people, and racial and ethnic minorities in North America.

Exclusionary behaviors can have a cascading effect on contributors' experience and retention. Exclusionary behavior has cascading effects on feelings of belonging, opportunities to participate, achieve leadership, and retention. While toxic experiences are generally infrequent, rejection of contributions, inter-personal tensions,

stereotyping, and aggressive language are far more frequently experienced by certain groups. (2-3 times higher frequency than the study average).

People's backgrounds can impact equitable access to open source participation early in their careers, compounding representation in leadership later on. Just 16% of students' universities offer open source as part of their curricula. This, along with unreliable connectivity, geographic, economic, and professional disparities, narrow an individual's opportunity to contribute.

"We've come a long way..." Societal trends have accelerated steps toward inclusivity in open source. A common refrain among those interviewed recognizes that initiatives unheard of a decade ago have become commonplace for new projects created every day.

"... But we still have a long way to go." Opportunities abound to improve DEI throughout the open source ecosystem. This report evaluates the efficacy of five common DEI initiatives in open source and identifies several recommendations for the entire open source ecosystem.

Introduction

Open source technologies, and the broad ecosystem of people that build and use them, stand to benefit from greater levels of diversity. There remains a school of thought in open source in which identity does not matter, code is supreme, and efforts to promote otherwise are divisive, or at best, a diversion. Research has repeatedly shown that diversity drives innovation and better products. Therefore, improving DEI in open source is about maximizing the potential for open source projects worldwide to better reflect global communities.

We define diversity within open source communities as a pluralism of any number of the following possibilities: gender identity and expression, race, ethnicity, sexual orientation, age, social class, caste, language, physical and neurological ability or attributes, religious beliefs, value systems, national origin, and political affiliation.

According to the Equal Employment Opportunity Commission, the technology sector consistently has a lower representation of women, people of color,

people with dis/abilities, and older people than other industries.¹ Many organizations in the industry are prioritizing ways to change minority representation. Our research revealed that “diversity, equity, and inclusion” is often considered a Western concept, and that the lens through which DEI is viewed focuses primarily on gender and racial representation. However, the global nature of open source demands a broader assessment of what constitutes representation and the need to address the barriers and enablers for inclusion at all levels. In this report, we take a quantitative and qualitative approach to evaluate both.

This research has two core objectives. The first objective is to gain a clearer picture of the current state of representation, belonging, and inclusion of various demographics and dynamics within open source communities. Understanding the extent of exclusion and lack of parity is important because we cannot change what we don’t understand. It is in this context that new data becomes a valuable and transformative resource.

The second objective is to identify critical solutions, both current initiatives and emerging opportunity areas, needed to overcome obstacles and foster healthy, productive, and pluralistic open source environments.

¹ Diversity in High Tech, Equal Employment Opportunity Commission, accessed September 27, 2021, www.eeoc.gov/special-report/diversity-high-tech.



To support leadership teams across the ecosystem, who bear responsibility for both technologies produced and the health of the environments in which they are created, this report surfaces tactical recommendations to act.

In July 2021, the Linux Foundation conducted a global survey of the open source community fielded in ten different languages beyond English. The survey received more than 2,000 complete responses from participants around the world. We also interviewed more than two dozen open source leaders across projects, DEI programs, corporate [Open Source Program Offices](#) (OSPOs), and researchers worldwide. Through the findings in this report, we hope to influence the design

of new and more effective practices and policies to increase access and lower barriers to entry for people from marginalized communities. In addition, we seek to create a more inclusive environment that benefits everyone who uses and develops open source technologies and standards. Finally, we hope to inspire further research into the various elements at a more granular level to drive outcomes that directly impact those whose needs are not presently being met.

Using the data from our 2021 survey, we present a high-level view of the open source ecosystem that matters to so many people.

Part 1

The State of Diversity, Equity, and Inclusion in Open Source

“The whole notion that our differences don’t matter is backwards, our differences are what maximize the potential of tech to do good in the world. If we involve people from the cultures and communities affected by abuse of tech in the process, that’s how to anticipate and understand impact that can lead to better outcomes.”

—**Coraline Ada Ehmke, Founder of the Organization for Ethical Source**

“The meritocracy model typically assumes that people have a ton of time to invest to prove their ‘worth’. People who need to work two jobs to make ends meet don’t have this time.”

—**Survey respondent**

“We have to stop and ask why DEI? Because it’s important to have. If you’re trying to include everyone with the products you’re building, how can you do that without representation?”

—**Michelle Mannering, Developer Advocate at GitHub**

“It can’t be all about bootstraps when not everyone has boots. There is a luxury for people who have been successful in open source to assume everyone has the same access and opportunities—meritocracy mindset, that if you just show up and demonstrate what you can do, you will be successful, but it’s just not how it works. People are coming from very different backgrounds and entry points.”

—**Neisha Fredericks, Allyship Consultant and Operations Manager of the Open Source Program Office at Red Hat**

“Most software is discussed and written in English, a lot of open source emanates from US based sources and US culture; there are some implicit hurdles one has to jump through if you’re from other backgrounds. They can be jumped, people are welcomed to jump them, but they’re certainly there.”

—**Survey respondent**

Open source diversity reflects growing global adoption

Around the world, 2021 has seen a 73% year-over-year growth in open source component downloads.² As the global adoption of open source technologies grows rapidly, so, too, is diversity within open source communities. The global adoption and impact of open source beyond North America and Europe brings a wider array of backgrounds, skills, and perspectives to the open source ecosystem.

Yet, while diversity exists on a macro level in open source, digging deeper, we find that our communities are not representative of the realities of the world at large—the same world that uses the very technologies created through open methodologies.

We analyze demographic diversity within the open source community through several lenses to capture the state of diversity and its many intersections. Using survey data, the following table depicts demographic, geographic, accessibility, and other categories of representation in the open source ecosystem.

As more countries, localities, and communities embrace open source, standard (Western) classifications of diversity (like race, and gender) can become abstractions, and local realities (like time zone) begin to determine equity in contribution.

People from marginalized communities are not a monolith and can be disenfranchised based on more than one identity. Intersectionality refers to ways in which a person's overlapping identities (social, gender identity, race, ethnicity, and economic) can combine to exacerbate discrimination or privilege. "Intersectional inclusion" aims to understand the complexities of a particular group. This is an opportunity to accelerate inclusion in open source as participation grows globally because seemingly unrelated identities often share common barriers to inclusion.

² "2021 State of the Software Supply Chain," Sonatype, Sonatype Inc., 2021, accessed September 17, 2021, www.sonatype.com/resources/state-of-the-software-supply-chain-2021.

TABLE 1

A Snapshot of Demographics from the 2021 DEI in Open Source Survey

Language: The predominant language of open source is English—in code, content, and community interactions—and English proficiency is a metric by which performance and personality can be judged. While 81% surveyed can read and write English well, there are many others for whom language presents barriers to participation or belonging.

Employment: A majority (66%) of open source community members surveyed are employed full time. 15% are part-time employees or self-employed. Yet, those without employment stability struggle to see the economic value of participating in open source for no compensation outside of working hours or without a direct path to employment. This is a particular barrier in industries where employers do not use or value open source tools. Nonetheless, open source participation can lead to recruitment and employment. Only 14% of survey respondents get paid for their open source contributions.

Gender: The vast majority of people in open source are men: some 82% of respondents, compared to 14% women, with 4% identifying as non-binary or third gender. Gender bias exists in open source environments. Our study finds gender is a primary determinant for a wide range of differences in feelings of welcomeness in open source, community experiences, and leadership representation. Women and transgender people of any gender are far more likely to experience exclusionary behaviors like stereotyping, aggressive language, lack of response or rejection of contribution, and unwanted sexual comments.

Age: Age distribution in open source communities surveyed tracks with general distribution of adults in the workforce. 71% are between ages 25 and 54, and an additional 19% are 55 or older. The plurality (29%) are between 35 and 44 years old. While those older or younger have less representation, both are important voices of generational experiences, expertise, and preferences.

Sexuality: Some 74% surveyed are heterosexual, with 17% self-identifying as lesbian, gay, bisexual, pansexual, asexual, or queer, with the balance preferring not to answer. While sexuality may seem irrelevant to building software, open source cultures can be exclusionary to nonheterosexual people. Our survey finds a disproportionate impact on lesbian, gay, bisexual, pansexual, asexual, queer, and questioning people in the frequency in which they experience exclusionary behaviors.

Race: Racial divisions and discriminations are present in open source community interactions and impact opportunities too. Surveying racial groups in North America, we find that Latinx, Black, and Indigenous groups are less likely to agree that people from different backgrounds have equal opportunities to participate and make decisions in open source. They are far more likely than White/Caucasian people to experience exclusionary behaviors in open source communities.

[\(continues on following page\)](#)

Dis/ability: 17% of contributors reported having a long-term physical, mental, intellectual, or sensory impairment, slightly higher than the 12% US government benchmark for disability representation in employment.³ Accessibility of tools and interfaces is a critical upstream enabler to widen participation and adoption of open source for anyone with a dis/ability and to benefit many others.

Education level: Open source participation strongly correlates with university-level education, with 73% having a college degree or higher. Secondary schools, vocational programs, and colleges also play a crucial role in developing the next generation of open source participants and leaders. Early exposure to open source can have educational value for students as well.

Geography: Our survey and qualitative research showed that differences in where people are located in the world causes inequity and results in practical barriers to open source contribution. Examples include access to reliable connectivity, time zones, employment opportunities, and more social barriers like language, cultural stereotyping, geopolitical tensions, or socioeconomic backgrounds. North America and Europe accounted for 36% of survey respondents each, 15% from Asia-Pacific, 8% from Central and South America, and 5% from the Middle East and Africa.

Caregivers: 53% surveyed have caregiving responsibilities, whether for children, elderly or loved ones with dis/abilities. This can significantly impact the time one has to contribute to open source and the feasibility of synchronous collaboration, such as attending meetings.

Rural, Suburban, Urban: A vast majority (>85%) of open source participants live and work in urban and suburban environments. Where a person lives can exacerbate several barriers to inclusion in open source, such as the “digital divide” and broader socioeconomic disparities in technology access.

Internet Access and Connectivity: While 94% surveyed report access to reliable Internet connectivity at home, this is not universally true. Poor access to connectivity by default hampers the ability to participate, let alone the opportunity to maintain leadership roles in open source communities.

Source: Linux Foundation DEI in Open Source Survey, July 2021. MoE is +/- 3.1% with 90% confidence and +/- 2.6% with 95% confidence

³ Deepa Sheevaram, “Across Federal Workforce, People with Disabilities See Need for More Representation,” NPR. July 31, 2021, accessed September 15, 2021, www.npr.org/2021/07/31/1020746037/disability-access-representation-ada.

TABLE 2

The Dynamics of “Time” in Open Source

“Unpaid” time, defined as the time available to spend on open source work with no compensation, outside of employment. This can be compounded by other aspects of identity (e.g., caregivers).

“Networking” time, being the time it takes to establish oneself in open source communities through meet-ups, interest groups, or events.

Time zones, the scheduled hour of meetings, recognition, or proposals, may not be designed for asynchronous engagement (but accrue to one’s visibility in open source).

“Professional development” time, defined as the time invested in contributions with no prospect of employment or professional reward.

“Onboarding” time, defined as the process for newcomers to overcome learning curves, determine roles and standards, and overcome hurdles to becoming an established open source contributor.

“Discretionary” time, defined as the percentage of “employer-approved” work time devoted to open source or other personally-directed pursuits, is culturally variant and not condoned in some countries.

Pandemic-driven impacts on time, such as fatigue, burnout, and capacity of both mentors and mentees to focus on long-term goals.

Source: Linux Foundation Research, Qualitative Interviews, July, August, and September, 2021

Time: The #1 determinant for open source participation

Qualitative interviews and open-ended survey responses showed that time is the most commonly mentioned determinant for participation and inclusion in open source. Often people lack time to contribute. The privilege of having the time to participate has many manifestations, all of which require proactive steps to change the status quo. “Providing flexibility contributes to a welcoming environment for contributors,” explains Katia Rojas, VP of Diversity and Inclusion at the Apache Software Foundation.⁴

Overcoming reputational hurdles toward inclusion and belonging

Is the culture of open source inclusive? Do people feel a sense of purpose and belonging? Cultures of inclusion vary from community to community in open source. Several open source leaders we spoke with acknowledge that “open source has had a reputation in the past,” pointing to various events and experiences that have impacted perceptions of open source community culture. Many allude to the culture being associated with bigotry, toxicity, and abusive language. Others cite perceived misconceptions that all contributors must be developers. Some point to underrepresentation in decision-making power, while

⁴ Katia Rojas (VP of Diversity and Inclusion at the Apache Foundation), interview with the author, August 26, 2021.

others recount changes in high-profile leadership and internal reckoning. How accurate are these perceptions?

With thousands of open source communities spanning the globe, there is no single culture of inclusion. Each community sets its own standards and expectations, many of which have adopted codes of conduct and other best practices to promote community health. Leadership and funding from larger open source organizations and corporations have instituted outreach, mentorship, and other programs designed to foster access and exposure. But “top-down” approaches don’t always translate to culture; “Inclusion happens at the community level,” says Demetris Cheatham, Senior Director of Diversity Inclusion Strategy at GitHub.⁵

On the surface, the vast majority of respondents in our study (82%) feel welcome in open source. However, the segmentation of respondents into various demographic categories reveals variation, particularly evident along gender and sexual identity lines. People with dis/abilities and those who must leave their homes to access the Internet are also less likely (than average) to feel welcome. Notably, just 55% of Black respondents in North America feel welcome in open source, significantly lower than all other segmentations and racial backgrounds analyzed. To prevent reidentification of survey respondents, racial categorizations were only asked of people in North America, hence the specification of “North America” throughout the chart responses on the next page.

⁵ Demetris Cheatham (Senior Director of Diversity Inclusion Strategy at GitHub), interview with the author, September 15, 2021.

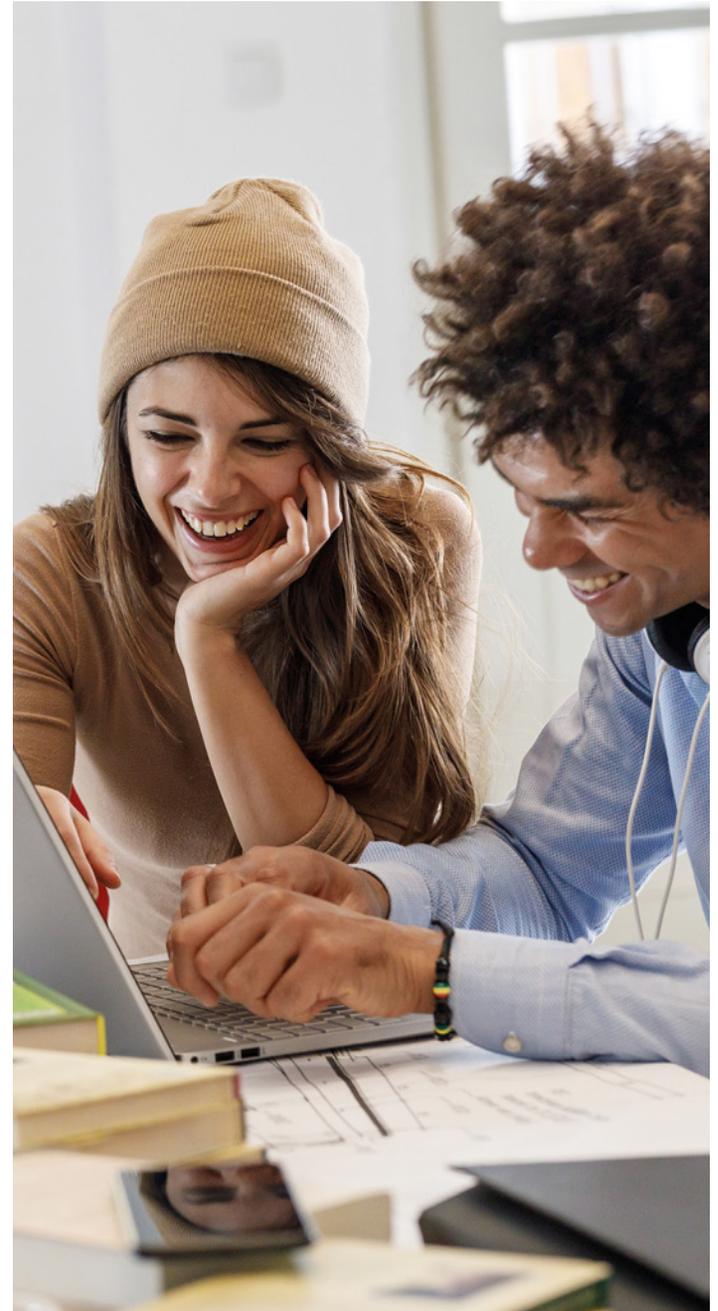
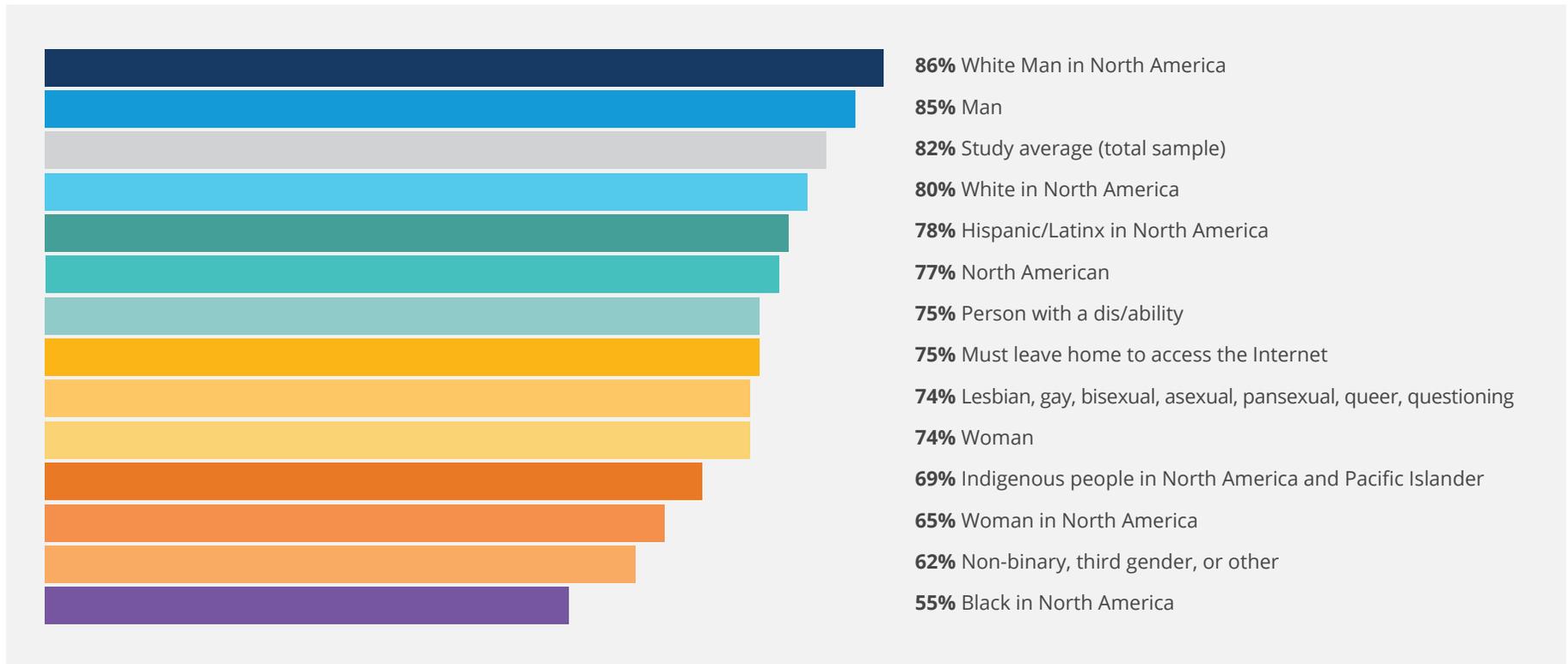


FIGURE 1

**To what extent do you agree or disagree with the following statement?
“I feel welcome in open source.”**



Note that race categorizations were only asked of North American respondents | Sample Size = 2,346. White Man in North America (n=641), Man (n=1,625), White in North America (n=587), Hispanic/Latinx in North America (n=82), North America (n=651), Person with a dis/ability (n=387), Must leave home to access Internet (n=68), Lesbian, gay, bisexual, asexual, pansexual, queer, questioning (n=390), Woman in North America (n=147), Indigenous people in North America and Pacific islander (n=51), Non-binary, third gender or other (n=116), Black in North America (n=84)

Source: Linux Foundation DEI in Open Source Survey, July 2021.

Further segmentation of the 18% of respondents that do not feel welcome reinforces the distinctly different experiences of particular groups. People with dis/abilities account for 38% of those who do not feel welcome, nor do 16% who are transgender people. Despite their dominance in the open source industry, North Americans were 53% of those who did not feel welcome (though they represented just 36% of the study's sample).

“The term dis/ability is used intentionally to counter the emphasis on having a whole person be represented by what [a person] cannot do, rather than what [a person] can.”

—Annamma, Connor, & Ferri. *DisCrit: Disability Studies and Critical Race Theory in Education*. 2016, p.1.

Then versus now: Changes in diversity, equity, and inclusion over time

“Openness” has always been a core principle in open source; the whole model is designed to grant anyone the ability to use, update, and distribute source code for any purpose. “But open doesn’t always equal fair,”

as Director of Tech for Social Good at GitHub, Mala Kumar explains.⁶ Existing structures, from typical contributor backgrounds and hierarchies to financing and success metrics, are entrenched. Recent societal trends have influenced several such structural dynamics within communities, several of which we list here:

Enterprise Digital Transformation: As Big Tech and other industry corporations pursue, and compete on, the digitization of everything, “IT” is no longer considered the only tech-related job. Open source tools and communities have become a strategic element in recruiting, talent retention, product, partner, and competitive initiatives. Therefore what happens in open source is relevant to entities beyond open source.

Techlash: Countless revelations of tech-enabled harms prompt backlash, regulation, research, and debunking of old narratives like “Tech is Neutral.” Renewed calls for governance extend the scope of responsibility far beyond writing code.

Political polarization: Unfortunately, social and racial justice movements have been politicized. Divergent camps are either on the defensive or seizing the moment(um) to fix systemic issues, including issues in open source. “Those who were wavering before are embracing the new normal; those with preexisting misogynistic and racist tendencies are really digging in now,” said one respondent.⁷ This polarization can

⁶ Mala Kumar (Director of Tech for Social Good at GitHub), interview with the author, August 25, 2021.

⁷ 2021 DEI Survey, open text response.

sometimes obscure any progress made and detract from the work that still needs to be done.

Social media ecosystem: Whereas disagreements in open source communities have always existed, the current social media tools enable harassment at an unprecedented scale, speed, and reach. “If you were harassed in a chat forum back in the day, it could have been from someone at another university; now it could be from a troll farm anywhere in the world, a swarm of bots, and a deluge of false reports against you publicly... at the same time,” summarized an open source maintainer interviewed.⁸ This dynamic also impacts how open source contributors, particularly women, evaluate risk in establishing themselves and gaining recognition across digital forums.

Content moderation: The business models, scale, and speed of digital networks have injected novel tensions

to content moderation questions and what merits censorship. While open source communities have long had mechanisms for content moderation, fragmentation of communities across different channels and inconsistent terms of moderation in these areas has exacerbated “standards” of behavior. Josh Berkus coins it as “the prisoner’s dilemma exercise in optimism,” where trusting in the goodwill and long-term interests of others can be at odds with toxic personalities.⁹

Collectively, these forces have exposed and amplified exclusionary narratives and designs, mandating increased awareness, and recalibrating individual and organizational attention. “We’ve come a long way” was a common refrain among many long-time open source contributors, often paired with the addendum that much work remains to address the toxic and exclusionary attitudes that have found fertile ground in digital environments.

⁸ Open source maintainer at a large technology company, interview with author, August 27, 2021.

⁹ Josh Berkus (Kubernetes Community Architect at Red Hat), interview with the author, August 26, 2021.

Part 2

Obstacles and Challenges to DEI in Open Source

“The dominant paradigm is not thinking about the contributor funnel, instead thinking of users as merely customers which is rooted in a world of geographic distribution. If I’m selling you a can of corn, why would my business think of you, the customer, as valuable for improving farming, packaging, supply chain? The digital world is disrupting this, and open source is a conduit for giving back. Anyone should be able to dive back in, contribute ideas, time, references, energy resources, and facilitate change. If we don’t make that opportunity obvious, we’re missing out on the promise of the Internet.”

—Rev. Remy DeCausemaker, Hackademic, and TODO Group Steering Committee Member ‘19-’20

“Today the notion of trust is transactional—you’re trusted if you reliably produce—but this actually alienates a lot of people. Those with power must earn trust through what they do, and those who have less power, people who are traditionally underrepresented and undervalued, must have trust extended to them by default.”

—Coraline Ada Ehmke, Founder of the Organization for Ethical Source

“There is a common misconception that you need to be a developer to participate in open source. That’s a barrier in itself, and an opportunity to expand how we bring people in by targeting a wider range of roles.”

—Neisha Fredericks, Allyship Consultant and Operations Manager of the Open Source Program Office at Red Hat.

“There’s a strong culture of sneering in open source spaces that makes it difficult to feel safe making contributions; if I have to wonder if the work I put in offering feedback is going to get an immediate dismissal, it makes me really not want to do anything at all.”

—Survey respondent

“There are a ton of projects where it’s hard to make an impact unless you’re in the group of ‘core maintainers’, and oftentimes ‘core maintainers’ fit one demographic.”

—Survey respondent

“There is a certain exclusion for newbies (n00bs) by the experienced community members.”

—Survey respondent



Exclusionary behaviors influence community cultures

Although cultures of inclusion vary from community to community, some of the most public incidents have influenced open source's reputational issues and compounded barriers to inclusion for prospective and current contributors. Toxic behavior, which involves aggressive language and insinuation towards particular groups or individuals, is not unique to open source. Indeed it is prevalent in many Internet communities, from social media to gaming to crypto.

Our research surveyed more than 2,000 respondents about the frequency in which they experience particular exclusionary behaviors.

Across all respondents, we see that the more overt, potentially criminal behaviors like violent threats, unsolicited sexual advances, and doxxing are extremely rare. Far more common are the somewhat more ambiguous flavors of avoidance and antilocution. When it comes to experiences with written or spoken language that made respondents feel unwelcome, compare the study average of 18% reporting occasional or frequent experiences with other respondent populations from figure 3 below, and it becomes clear that sentiments of belonging differ significantly.

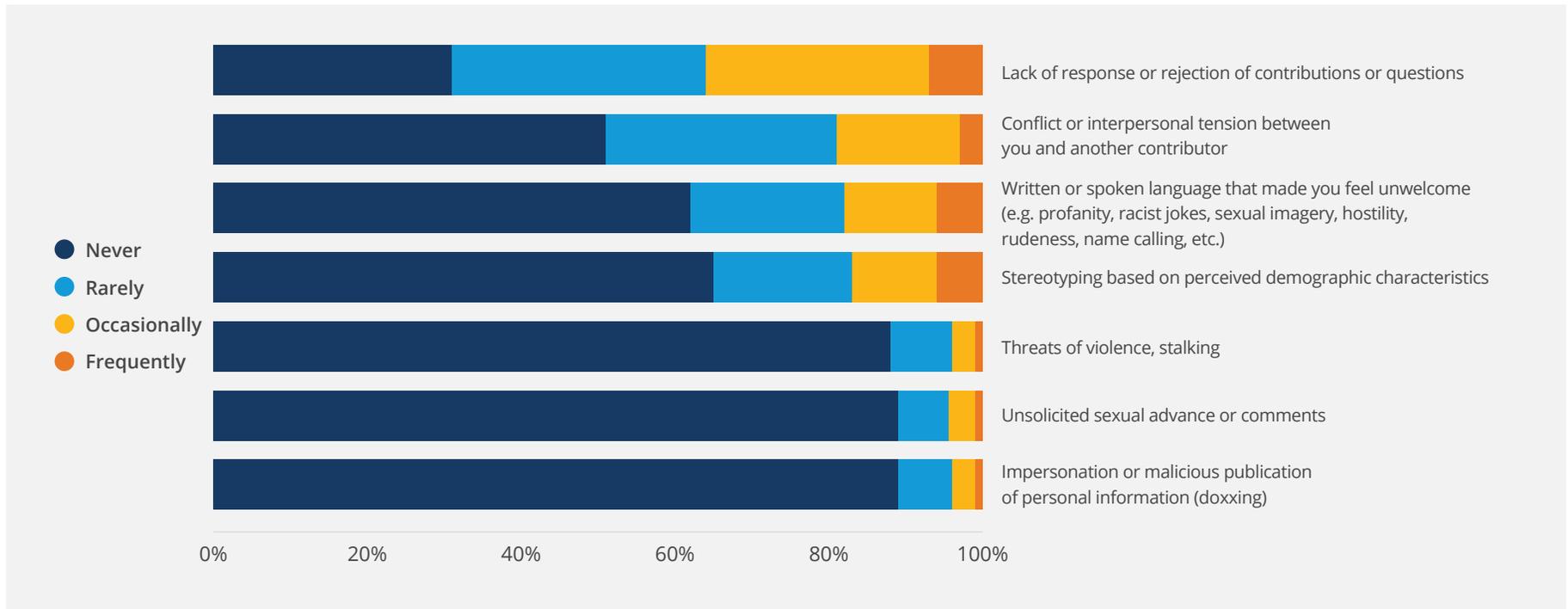
“It’s hard to decouple many of the Internet’s issues from open source issues when it comes to safety.”

—Emma Irwin, Project Manager, Microsoft OSPO.¹⁰

¹⁰ Emma Irwin (Project Manager, Open Source Program Office at Microsoft), interview with the author, September 10, 2021.

FIGURE 2

Have you ever EXPERIENCED any of the following behaviors directed at you in the context of an open source project?

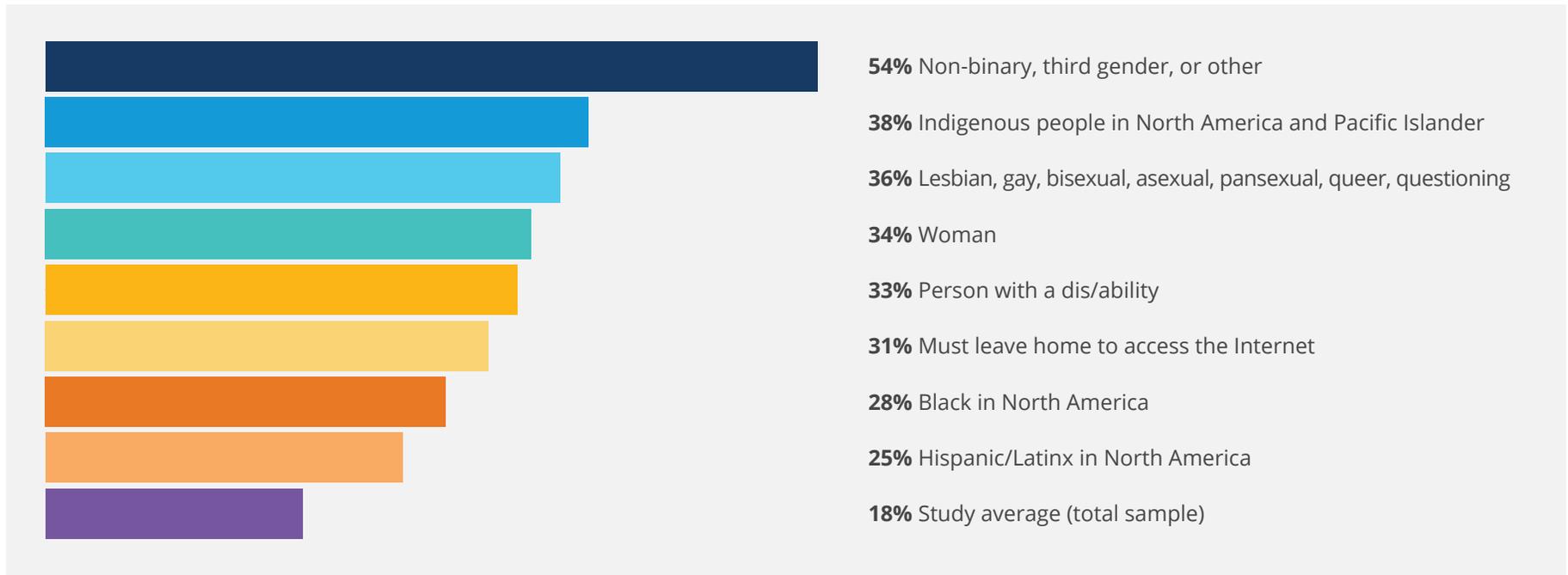


Sample Size = 2,291. Impersonation or malicious publication of personal information (doxxing) (n=2,281), Unsolicited sexual advances or comments (n=2,278), Threats violence, stalking (n=2,277), Stereotyping based on perceived demographic characteristics (n=2,276), Written or spoken language that made you feel unwelcome (e.g., profanity, racist jokes, sexual imagery, hostility, rudeness, name-calling etc.) (n=2,286), Conflict or interpersonal tension between you and another contributor (n=2,277), Lack of response to or rejection of contributions or questions (n=2,282)

Source: Linux Foundation DEI in Open Source Survey, July 2021.

FIGURE 3

Frequent or occasional experiences with written or spoken language that made respondents feel unwelcome, by demographic.

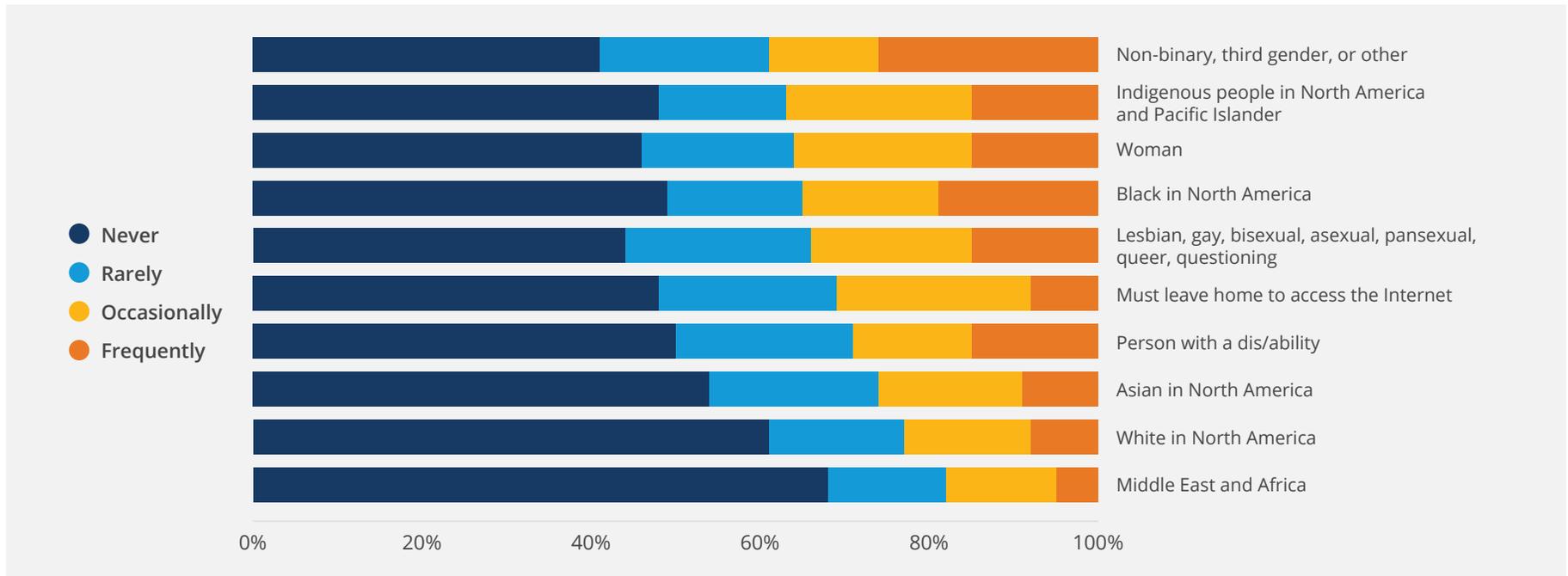


Note race categorizations were only asked of North American respondents | Sample Size = 2,286. Black in North America (n=83), Indigenous People and Pacific Islander in North America (n=47), Must leave home to access the Internet (n=67), Non-binary, third gender or other (n=113), Lesbian, gay, bisexual, asexual, pansexual, queer, questioning (n=379), Women (n=323), Person with a dis/ability (n=379).

Source: Linux Foundation DEI in Open Source Survey, July 2021.

FIGURE 4

Have you ever EXPERIENCED stereotyping based on perceived demographic characteristics directed at you in the context of an open source project?



Note race categorizations were only asked of North American respondents | Categories not included above were in line with the study average of 17.4%. Sample Size = 2,276. Asian in North America (n=66), Black in North America (n=80), Hispanic/Latinx in North America (n=82), Indigenous People in North America and Pacific Islander, Middle East and Africa (n=124), Must leave home to access Internet (n=66), Non-binary, third gender or other (n=112), North America (n=814), Lesbian, gay, bisexual, asexual, pansexual, queer, questioning (n=377), White in North America (n=566), Woman (n=325), Person with a dis/ability (n=379).

Source: Linux Foundation DEI in Open Source Survey, July 2021.

When analyzing which demographics experience stereotyping based on perceived demographic characteristics, we see significant differences in how underrepresented groups compare to the study average, with 17% reporting occasionally or frequently.

From hostile language to sexual advances, these kinds of behaviors worsen the experience for everyone—those who experience them directly and those who witness them—and can impact retention for everyone, experienced contributors and newcomers alike. Further, they threaten the long-term integrity of the code (and software) itself by diminishing the diversity of perspectives from people who are willing to contribute.

Given the frequency of interactions, such behaviors can also be difficult to identify, not to mention moderate and manage, especially across multiple platforms. “Grass-roots” efforts *by the community itself* help to extend Codes of Conduct from policy into practice (e.g., by community members standing up for others, reporting toxic or predatory behaviors, and pressuring leaders to act). Interestingly, among those who don’t feel welcome in open source, 46% do not trust that the Codes of Conduct are being enforced. By contrast, 76% of those who do feel welcome trust in the enforcement of Codes of Conduct.

Demographics most impacted by toxic behavior in open source communities tend to be those generally underrepresented in tech. People with marginalized genders (women and non-binary people) and people with a dis/

ability are the two most common demographics reporting a higher frequency of toxic behaviors experienced. Indeed, according to many of those interviewed, the tech industry has an outsized influence on DEI in open source. It is not only about workforce and leadership representation but also about how the industry has allowed “and continues to foster” bad behaviors and unethical decisions in culture and product development. “Open source communities can only do so much if those trying to go about their daily life are working at companies that allow these pervasive inequities to continue,” says James Governor, Co-Founder of RedMonk.¹¹

Our quantitative survey and qualitative interviews found a uniquely North American dynamic to the influence of toxic behaviors and stereotyping on open source culture. North America was more likely (25%) to report the occasional or frequent experience of stereotyping based on perceived demographic characteristics, versus the 14.5% average across the other geographic regions, which had almost no variation among them. Anecdotally, those interviewed from North America more commonly raised the issues of trolling and toxicity in open source than those from other global regions.

Globally, the primary barriers to equity and inclusion in open source are less limited to toxic behaviors in community forums and more systemic. From education to employment opportunities, access to open source depends on several factors early on and across contributors’ lives.

¹¹ James Governor (Co-Founder of RedMonk), interview with the author, September 2, 2021.

How backgrounds impact equitable access to open source participation

When it comes to global barriers to inclusion, access and exposure to open source often hinge on very practical and contextual—if altogether overlooked—realities, creating new challenges. While one’s “background” constitutes many different parameters, the common theme is that primary (i.e., early on in professional

development) barriers to access can have a bottleneck effect later on when it comes to open source contribution and leadership. Educational and environmental obstacles set the context in which young developers become aware of open source, and conceptualize its value in their professional development. For example:

TABLE 3
Environmental Barriers to Equity in Open Source

Environmental Barriers	Such as...
“Digital Divide” access to technologies	<ul style="list-style-type: none"> • Reliable Internet access, at home vs. elsewhere • Personal laptops vs. shared or mobile-only • Rural vs. urban disparities, ability to work remotely
Educational access	<ul style="list-style-type: none"> • Whether open source is taught in schools and universities • Level of education achieved • Educational opportunities (hackathons, internships, courses)
Language access	<ul style="list-style-type: none"> • Languages learned (English is dominant in open source) • Fluency, for communications, networking, trust-building
Geographic access	<ul style="list-style-type: none"> • Time zones, ability to attend meetings and network • Disparities in infrastructure • Geopolitical and sociopolitical tensions exacerbated by COVID-19, local challenges
Economic and professional access	<ul style="list-style-type: none"> • Compensation for open source contributions • Employers’ approval of open source technologies and employee time spent • Job opportunities, grants, funding, sponsorships, mentorships

Source: Linux Foundation Research, Qualitative Interviews, July, August, and September, 2021

Our research canvassed several aspects of these barriers and found the following:

Digital Divide

While some 94% of respondents have access to reliable Internet, just 80% of respondents from the Middle East report the same. People in rural areas globally tend to have less reliable Internet access than those in urban areas. Younger respondents (18-24) are also more likely to have to go outside the home (to school, or a library) to access reliable Internet.

“I live in Latin America. Here exclusion takes a very physical form. Access to technology is not easy in any form.”

—Survey respondent

“In our country, not all have the capacity to pay for their Internet connection monthly. Based on my observation, having an Internet connection is a barrier to entry in participating in open source projects.”

—Survey respondent

Educational Access

Only 16% of the 234 full-time students in the study said open source is taught as part of their curriculum. Across respondents, 73% had obtained a bachelor's degree or higher.

“Developing countries like mine have a lot of barriers to open source because of their education problems.”

—Survey respondent

Economic/Professional Access

Just 14% of all respondents get paid for their contributions. Non-Westerners represent 43% of all the paid contributors that are employed part-time or are self-employed. In comparison, 80% of the full-time employed contributors that get paid live in either North America or Europe.

“There is a default expectation that participants will have a steady income which can support computer ownership (beyond mobile phone), high-speed reliable Internet, reliable electricity, and a steady supply of hours per day to be active and visible and interactive. This biases strongly to people who are already in the industry or at least second generation middle- or upper-class.”

—Survey respondent

“Having more companies support open source contributions would bring even more diversity into the ecosystem from people who don’t have the time to contribute in their free time. This would also make it easier to bring more people into our projects from various abilities, genders, ages, sexual orientations, etc.”

—Dawn Foster, Director of Open Source Community Strategy at VMware¹²

Language Access

While just 8% say the general preference for English in open source has negatively affected their ability to participate, a sense of belonging involves more than the ability to contribute code in English. Those who prefer languages other than English, particularly French and Portuguese, were less likely to feel welcome or believe that different backgrounds have equal opportunities to participate in open source projects.

“I have seen code reviewers who are very picky on grammatical mistakes inside code comments. Even like a missing period, they are nitpicking on those kinds of things.”

So these types of issues often frustrate people who are non-native speakers who may not be experts grammatically, but have the programming expertise.”

—Amiangshu Bosu, Ph.D., Assistant Professor, Department of Computer Science, Wayne State University¹³

“I am not taken seriously when I use my real name in Spanish. There is a huge difference when I use an alias.”

—Survey respondent

Geographic Access

Western, urban culture dominates open source. North America and Europe best describe the location for 72% of survey participants (36% each respectively), while Asia-Pacific, Central, and South America, and the Middle East and Africa account for 15%; 8%; and 5%, respectively. About half of all respondents live in city environments, with 63% working in urban areas.

“A stable, affordable Internet connection was something for which I had to move from a rural to a suburban area.”

—Survey respondent

¹² Dawn Foster (Director of Open Source Community Strategy at VMware), email interview with the author, October 4, 2021.

¹³ Amiangshu Bosu, PhD, (Assistant Professor, Department of Computer Science, Wayne State University), interview with author, August 20, 2021.



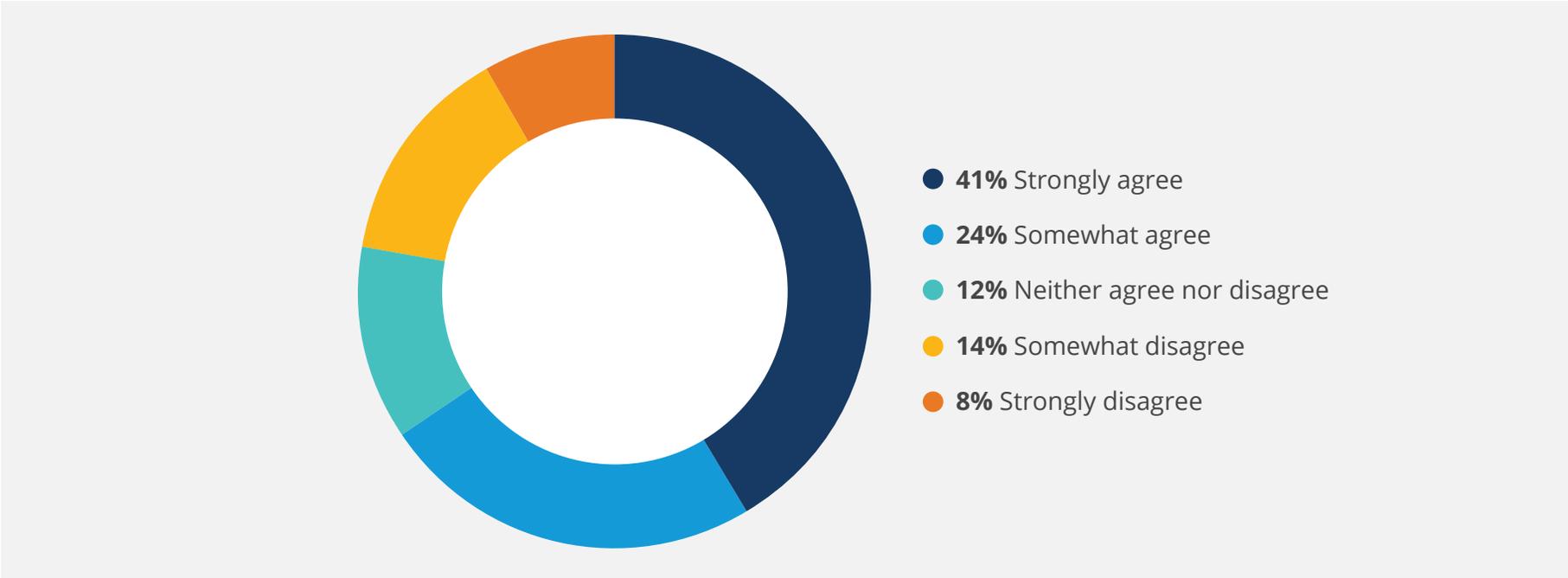
Accessibility itself has surfaced as one of the most impactful enablers for inclusion. While accessibility in the West is often associated with ensuring features suited for people with dis/abilities, DEI leaders we interviewed encourage expanding the aperture to advance intersectional inclusion the world over.

“It starts with considering a global audience, both developers and end users,” says Rev. Remy DeCausemaker, Hackademic, and TODO Group Steering Committee Member ‘19-’20. “Everything mechanical about how code flows is a whole other side of equity and inclusion often overlooked.” For example, does the project have developers in every time zone? How do we make sure everyone can actually use the software? Are there teams for localization and translation, and are we unnecessarily hard coding information that can’t be machine-translated later on? Are we ensuring backward compatibility, standards, interoperability? Will this work with 2G (low) bandwidth, on legacy hardware, for those with sensory differences, or for a mobile user interface? “Start from there, and more contributors can contribute in more ways.”¹⁴

¹⁴ Rev. Remy DeCausemaker (Hackademic, and TODO Group Steering Committee Member ‘19-’20), interview with the author, August 24, 2021.

FIGURE 5

**To what extent do you agree or disagree with the following statement?
“People from different backgrounds have equal opportunities
to participate in open source projects.”**



Sample Size = 2,341

Source: Linux Foundation DEI in Open Source Survey, July 2021.

Just as people from different geographies have different constraints, so too do people with diverse backgrounds. While 65% of all respondents surveyed feel people from different backgrounds have equal opportunities to participate in open source projects, 22% disagree. The other 12% were neutral. Segmentation reveals more complexity: women, lesbian, gay, bisexual, asexual, pansexual, queer, questioning, and Black North American respondents were more likely to disagree with this statement, while those from the Asia-Pacific region and those who don't read English very well were more likely to agree.

Further analysis suggests participation barriers may be linked with identity. About half (49%) of those who disagree that people with different backgrounds have equal opportunities to participate think their identity

had an impact on their ability to achieve their open source goals. That compares to just 23% of those that agree with the statement. Overall, one out of three respondents feel that their identity has affected their ability to achieve their open source goals.

Whether through broader environmental and accessibility barriers or more overt intimidation within community forums, the experience of newcomers becomes a principal focus for advancing DEI in open source. Historically, new participants are often ignored, as communities favor experienced contributors. The difficulty of an overwhelming learning curve or unwelcoming onboarding experience is only compounded by other barriers outlined above. *(Reference recommendations on more inclusive onboarding in Part 3.)*

“For any kind of underrepresented person, the barriers often surround how you present yourself to the community. It is very daunting getting into open source for the first time, especially if you don't feel like you have the skills—and not just developer skills, but community management, project management, documentation, design. Addressing this is so important for getting more backgrounds and skill sets into open source.”

—Michelle Mannering, Developer Advocate at GitHub

Barriers to representation in leadership

Many of the barriers that impact participation can cascade into representation in decision-making and leadership in open source. After all, the overrepresentation of certain demographics influences who becomes most experienced contributors, which affects who becomes maintainers and leaders. This can have a compounding effect, known as familiarity bias or homophily, whereby like-minded and similar-looking groups of maintainers may be more likely to engage with, respond to, and mentor those that resemble themselves.

As noted in the Linux Foundation's Inclusive Speaker Training course created in collaboration with the National Center for Women in Information Technology, according to a study of GitHub activity, a woman making anonymous contributions has a better chance of having a pull request accepted than when her gender is known. Similarly, men who switched to gender-neutral contributor profiles experienced decreases in the acceptance of their pull requests.¹⁵

When other (dissimilar) participants experience low responses or rejections of contributions, or worse, interpersonal tensions, stereotyping, name-calling, or other aggressions, they are far less likely to feel welcome and may devote their time and efforts elsewhere.

This difference was evident in our survey results when comparing the experiences of those who “feel welcome” in open source versus those who “do not feel welcome.” Some 80% of those who feel unwelcome occasionally or frequently experience rejection of contribution, relative to just 36% of those who feel welcome.

Improving diversity among leadership can also have a compounding effect, as Dawn Foster, Director of Open Source Community Strategy at VMware explains: “It becomes way easier for people to feel included when they can see people in leadership positions who are like them.”¹⁶ Existing leaders, regardless of their background, play an important role in fostering belonging and allyship. Our study finds that 55% of all respondents feel their opinion is valued by leadership. Segmentation shows that among the 55%, 66% say that people from different backgrounds have an equal opportunity to be a part of decision-making. In contrast, among those 10% that don't feel included, only 26% agree that those from different backgrounds have an equal opportunity to be part of decision making.

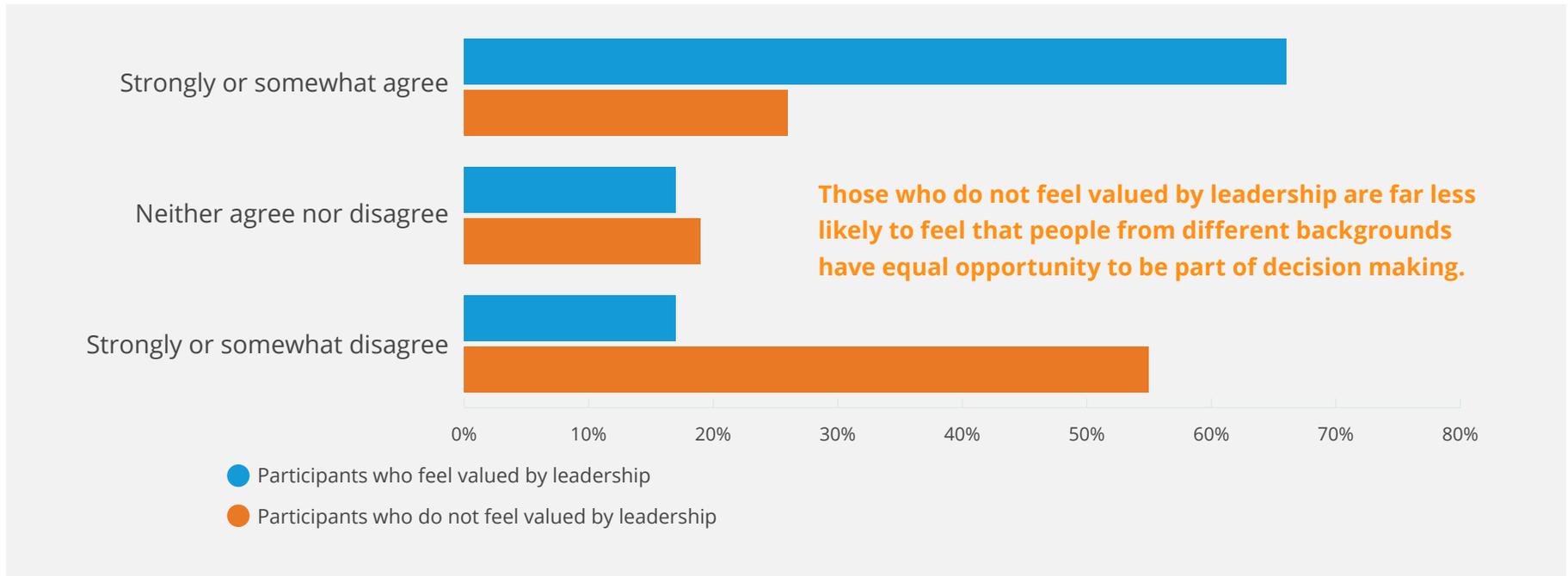
The 10% in disagreement are also twice as likely to be a transgender person (8% compared to 4%), be a Black person in North America (15% as compared to 7%), or to believe that the general preference for the use of English in open source negatively affected their ability to participate (16% compared to 8%).

¹⁵ Josh Terrell et al., “Gender Differences and Bias in Open Source: Pull Request Acceptance of Women Versus Men,” *PeerJ Computer Science*, PeerJ, Inc. 3:e111 (May 1, 2017), <https://doi.org/10.7717/peerj-cs.111>, accessed November 21, 2021.

¹⁶ Dawn Foster (Director of Open Source Community Strategy at VMware), email interview with the author, October 4, 2021.

FIGURE 6

**To what extent do you agree or disagree with the following statement?
“I feel that people from different backgrounds have an equal opportunity to be a part of the decision-making process within open source projects.”**



Sample Size = 1,490. Strongly or somewhat agree that “I feel included and my opinion is valued by leadership in open source projects where I participate” (n=1,269), Strongly or somewhat disagree that “I feel included and my opinion is valued by leadership in open source projects where I participate” (n=221)

Source: Linux Foundation DEI in Open Source Survey, July 2021.

Leadership roles are critical to expanding inclusion in open source, given their influence. Maintainers have technical influence and social influence in their communities; corporate and OSPO leaders have immense financial and commercial influence, as do investors. Across the ecosystem, the growing embrace of DEI by people in decision-making roles has been a force for change in recent years.

When asked whether people from different backgrounds have an equal opportunity to be part of the decision-making process in open source, 55% of respondents agreed; 22% disagreed, with the balance being neutral. While those from the Asia-Pacific region were more likely to agree (65%), segmentation finds people with dis/abilities, women, and virtually all racial groups (including whites) were less likely to agree.

Transparent processes for becoming a decision-maker in open source help foster trust. Today, just 37% of all respondents surveyed agree that there are clear processes to become a leader or maintainer in an open

source project. Language barriers may exacerbate clarity, as those preferring German, Spanish, Portuguese, and French were all more likely to disagree. Meanwhile, respondents from the Asia-Pacific region, Middle East, and Africa were more likely to see clarity in the path to leadership than the study average.

These trends were reiterated when asked whether respondents felt they had a visible leadership role in open source. Unfortunately (though not surprisingly), those with no reliable Internet access are less likely to hold visible leadership positions.

Survey findings underscore there are undoubtedly barriers to DEI in open source communities. Compounding the challenge is the fact there is no single solution. Barriers themselves vary widely, as do dynamics and impacts within different groups and communities. The initiatives born of these realizations have therefore focused on instilling values of inclusion into open source culture—the mindset behind how we build, measure, collaborate, and grow open source.

Part 3

Opportunities to Foster Greater Inclusion

“The industry has had a lot of scrutiny lately on just how much has gone wrong. Industry corporations can push things from the top and set the stage for expected values. One recent shift has been more companies paying their employees to contribute to open source, and they can leverage their positions and push that farther by targeting more diverse people with compensation to contribute to open source.”

—**Kelly Blincoe, Senior Lecturer in the Department of Engineering at the University of Auckland New Zealand**

“The move for structural change in open source is not just about focusing on DEI, but incorporating mutual respect, trust, accountability and equity as core values.”

—**Coraline Ada Ehmke, Founder of the Organization for Ethical Source**

“We need a culture of responsibility and recognition of plurality and that there will never be just one answer. When we’re talking about community platforms, we need a plurality of voices, rules, and ways of giving back.”

—**Rev. Remy DeCausemaker, Hackademic, and TODO Group Steering Committee Member '19-'20**

The whole ethos of open source is the contribution, giving back, meeting and learning from others. One of the reasons people contribute to open source is because of what they get back from the community. You’re developing projects alongside the best devs in the world from massive companies, and you can learn from them. It’s very powerful.”

—**Michelle Mannerling, Developer Advocate at GitHub**

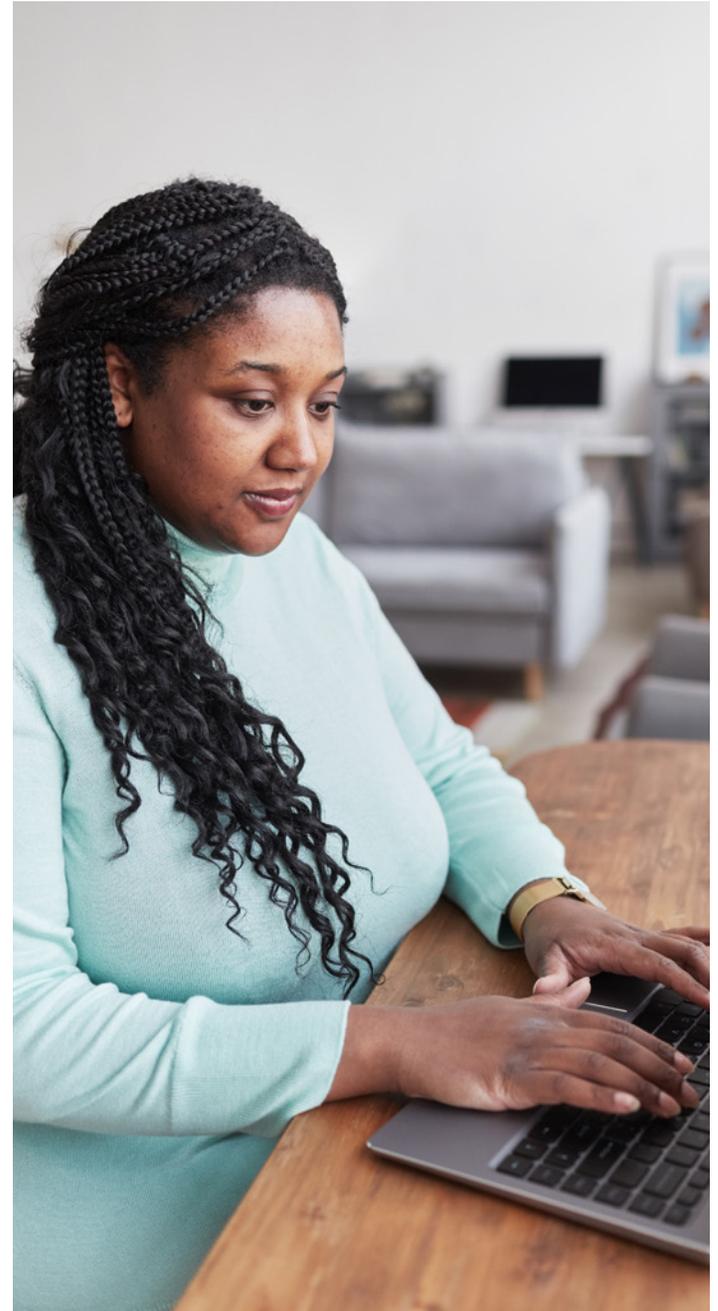
The Efficacy of Current Open Source DEI initiatives

Significant efforts toward improving inclusion in open source communities are already well underway. What began as incremental changes have evolved and spread across communities. Initiatives that were unheard of a decade ago have become commonplace, serving as templates for new projects created every day.

Current efforts to foster greater inclusion in open source exist primarily within open source foundations, hosting platforms, events, and in communities themselves. While many “grassroots” efforts have emerged, and have been championed and normalized by community participants, others are the product of dedicated resources and specific policy and program initiatives.

Below we surface key DEI initiatives in open source communities today and analyze their effectiveness.

- Codes of Conduct
- Inclusive Naming
- Mentorship and Sponsorship Programs
- CHAOSS Community and Tools
- Governance



Codes of Conduct

More open source communities are using Codes of Conduct, which are sets of rules, standards, and enforcement guidelines to be followed to maintain a respectful, welcoming, and professional environment for all participants. They safeguard the rights of community members from experiencing misbehavior and ill treatment.

[Contributor Covenant](#), developed by Coraline Ada Ehmke, is an example of this trend in open source. What was proposed by Ehmke as an open source document in 2014 has since been adopted by more than 100,000 open source projects, including ones maintained by Apple, Google, Microsoft, Salesforce, and other large corporations.

“It’s a minimum social contract, says Ehmke. “Anytime people come together, especially in multi-cultural and dynamic global environments, a shared understanding of conduct, constraints, and responsibilities helps foster collaboration.”¹⁷

Efficacy: Codes of Conduct have gained significant traction in the last decade, and their presence can signal to marginalized people that the open source community cares. They provide guidance for newcomers and a reference for core values and norms for existing community members to observe. Some 70% of respondents surveyed trust that codes of conduct will be enforced. Another 22% say their open source participation occa-

sionally or frequently is related to Code of Conduct enforcement, accessibility, and diversity inclusion.

Larger organizations have helped normalize the existence and uptake of Codes of Conduct, extending their reach into new projects. Adoption by open source hubs like GitHub and Ruby has extended Codes of Conduct from pledge into platform, adding in features to enable them natively in the software projects their users develop.

Limitations: Codes of Conduct do not enforce themselves, nor does having them mean that members abide by them. They are as powerful as the community’s will to manifest them consistently. Many lament that uptake by large organizations has eroded their influence, transforming them to be more like “cookie-cutter” licensing or read-me agreements. Similarly, because open source projects have enabled simple Code of Conduct creation does not mean that their adherence is reliable. Projects that rely on the signaling alone (requiring only a few clicks to add) and fail to implement an inclusive mindset may continue to alienate minority developers.

Next steps: To extend what is effectively a statement of values requires deeper integration with project governance across the actual and proverbial “stack.” Greater accountability, transparency, and consensual governance for behaviors, decision-making, licenses, access, and downstream outcomes are all part of extending Codes of Conduct. (Reference Governance section below for more.)

¹⁷ Coraline Ada Ehmke (Founder of the Organization for Ethical Source), interview with the author, August 5, 2021.

Inclusive Naming

To address exclusionary, unclear, and harmful language used in technology coding and development environments, a group of organizations created the [Inclusive Naming Initiative](#) (INI). Through collaboration across IT professionals and companies, the INI is focused on addressing language issues end-to-end: Identifying and developing suggested alternatives to problematic terms (i.e., master-slave hierarchies); defining processes for eliminating such language from software, standards, documentation, application programming interfaces (APIs); and creating resources like language evaluation frameworks, implementation paths and measurement, and other best practices to prevent code breakage.

Efficacy: *“Words matter,”* says DeCausemaker.¹⁸ Source code is the commonality across all software development communities, so addressing language in code is a tangible way to implement change “at the source.” A collaborative approach and widespread uptake has helped mitigate backward compatibility and ensure that essential linkages don’t break. In addition, the highly focused nature of the INI is in part responsible for its efficacy. “For as wide-ranging as DEI issues are, taking a laser-focused approach has been very successful,” says Priyanka Sharma, Executive Director at Cloud Native Computing Foundation and a co-founder of the INI.¹⁹ This highly focused model of the INI is one from which the community can draw lessons for other issues.

What’s more, leadership and resourcing from CNCF and the Linux Foundation has cemented INI’s role as a kind of hub for inclusive language across the broader open source ecosystem: in packaging, repositories, and documentation; in governance, standards, and for specific use cases; in events, speaker training, branding, and marketing; in curriculum development for educators, and in supportive tooling like code scanning.

In 2021, the INI received an [Honorable Mention by Fast Company’s 2021 World Changing Idea Awards](#).

Limitations: While language is critical to numerous technical and social aspects of open source, it is but one aspect of DEI solutions. Even with its relatively narrow focus, limited resources and bandwidth remain a challenge to meeting demand and growth for the program.

Next steps: The INI has established a tiered approach to priorities for inclusive naming and is seeking more resources to accelerate efforts through a more dedicated project management function and processing multiple sub-initiatives across collaborators.

¹⁸ Rev. Remy DeCausemaker (Hackademic and TODO Group Steering Committee Member ‘19-’20), interview with the author, August 24, 2021.

¹⁹ Priyanka Sharma (Executive Director at CNCF, Co-Founder, Inclusive Naming Initiative), interview with the author, August 25, 2021.



TABLE 4
Inclusive Speaking and Presenting Language Tips

Replace	With
Master/Slave	Primary/Secondary
Blacklist	Denylist
Man Hours	Engineer Hours
Dummy Value	Placeholder Value
“So simple your mother can do it”	User-Friendly

Source: Linux Foundation Inclusive Speaker Training Course, 2021.

Mentorship Programs

Mentorship and related intern and sponsorship programs offer early-stage contributors resources, skills, and guidance to contribute more effectively to open source communities. The programs can operate remotely or be part of physical events and meet-ups. Many DEI mentorship programs focus on specific open source communities or needs like accessibility projects. In contrast, others are geared toward coding more generally, such as Google's [Summer of Code](#) and [Major League Hacking](#), designed to bring more new contributors into open source.²⁰ Programs like Kubernetes Contributor Experience SIG and the [Node.js Mentorship Program](#) offer shadowing and mentorship to diversify potential leadership roles, while [Outreachy](#) invites anyone who faces under-representation and systemic bias or discrimination in the tech industry in their country to apply. The [Linux Foundation](#) also offers several mentorship programs specifically for newcomers and contributors from diverse backgrounds.²¹

Efficacy: According to mentorship program leaders at the Linux Foundation, these programs are invaluable to improving diversity and inclusion in open source communities, not only because they often boost technical skills and confidence but because they bolster social, economic, and geographic equity. Mentorship enables:

- Lower barriers to entry, onboarding
- Networking, introductions to others
- Direct stipends to help ease financial constraints
- Travel stipends to support networking and speaking at events
- Junior contributors being able to establish their résumés, participate in hackathons, and demonstrate their skills
- Career development and exposure to job opportunities

"A lot of how you achieve status in open source is based on your social connections, but if you're coming from a disadvantaged background, regardless of what that is—time zone, gender, country of origin—part of the handicap is that you have fewer social connections," says Josh Berkus, Kubernetes Community Architect at Red Hat.²²

Limitations: While those interviewed mentioned the importance of DEI-related mentor and sponsorship programs repeatedly, many also cited the need for more programs, resources, mentors, and reach. For example, targeting outreach to specific underserved localities around the world to solve their local problems via secondary schools or community vocation programs could expand the program in a meaningful way. Similarly, increasing the number of mentors is import-

²⁰ "Open Source Diversity," n.d., accessed September 17, 2021, <https://opensourcediversity.org/#programs>.

²¹ "Virtual Mentorship Series," The Linux Foundation Mentorships via LFLive, The Linux Foundation, n.d., accessed November 21, 2021, <https://events.linuxfoundation.org/lf-live-mentorship-series> and "LF Mentorship Programs," The Linux Foundation, n.d., accessed November 21, 2021, <https://linuxfoundation.org/diversity-inclusion>.

²² Josh Berkus (Kubernetes Community Architect at Red Hat), interview with author, August 26, 2021.

ant, as many programs can only accept a small percentage of applicants. In addition, once funding runs out for mentees, their participation in open source projects wanes, if not ceases altogether.²³ Keeping participants engaged remains a challenge of the program.

Next Steps: The pandemic has shifted formats to remote internships, and many organizations are still adapting to the challenges and opportunities therein. Flexibility in program format has also helped to mitigate mentor and maintainer burnout. With the support of its Events team, the Linux Foundation launched the [LF Live: Mentorship Series](#), a suite of on-demand webinars where mentees can learn from experts on their own time. With additional funding, these and similar mentorship programs that provide maximum flexibility can serve as a template for extending open source contributors' skills development across more than coding, including content, design, project management, and more.

²³ Shuah Khan (Linux Foundation Fellow), interview with the author, August 20, 2021.



CHAOSS Project Initiatives

Launched in 2017, the Linux Foundation sponsored [CHAOSS Project](#) (Community Health Analytics Open Source Software) has developed several initiatives encouraging healthy and more sustainable open source community engagement. Recognizing that metrics can help manage large communities and prioritize resources, CHAOSS serves as a collaborative hub for creating implementation-agnostic metrics, supporting software, and best practices from which countless communities can draw. The CHAOSS Project is rooted in academic and industry research. It uses the goal-question-metric approach to gathering data, in which the community's strategic objectives inform questions that help determine whether the goal is achieved. The project is divided into working groups, including Common Metrics, Risk Metrics, and Value Metrics. Additionally, CHAOSS includes a working group focused on DEI metrics and programs.

Efficacy: CHAOSS's DEI efforts have been applied across numerous organizations and programs, mentorship program development, and the CHAOSS DEI Event Badging Program, launched in September 2020.²⁴ The Diversity & Inclusion Event Badging Program awards badges to open source events based on their adherence to DEI metrics and best practices. While displaying the badge on event materials signals to participants that the organizers are prioritizing DEI, the program's open design has cascading benefits.

"The DEI Badging Initiative aims to implement our DEI metrics in real-world scenarios," explains CHAOSS Community Manager Elizabeth Barron. "Designed to be a cooperative effort, when event organizers complete the badging application process, our team helps them identify new ways they can improve attendees' and speakers' experiences, based on CHAOSS's DEI metrics. Because the process is transparent, other event organizers can also get ideas on how they might center DEI in their own events, even if they don't apply. The DEI Badging Initiative is barely a year old and has already awarded badges to 42 events. We expect that number to grow significantly in 2022."²⁵

With growing participation and interest in CHAOSS, the project continues to develop and evolve DEI metrics across the following areas:

- **Event Diversity:** identify how effectively events are set up to include diverse people.
- **Contributions:** identify the diversity of the contributions within a community and how these different contributions are valued.
- **Communication Inclusivity:** identify how communication channels and styles impact diversity and inclusivity among existing and potential contributors.

²⁴ Georg J.P. Link and Sarah Conway, "How CHAOSS D&I Can Help Diversity in the Open Source Community," *The New Stack*, April 30, 2019, accessed September 15, 2021, <https://thenewstack.io/how-chaoss-di-can-help-diversity-in-the-open-source-community/>.

²⁵ Elizabeth Barron (Community Manager at CHAOSS), in collaboration with the author, September 20, 2021.

- **Recognition of Good Work:** identify how ‘good work’ is recognized and rewarded in a way that is inclusive.
- **Leadership:** identify if leadership is appropriately designed for inclusion and how well the group is functioning.
- **Governance:** identify how well components of governance are set up to enforce standards for inclusion.
- **Project and Community:** identify how diverse and inclusive project places are and where community engagement occurs.

The broader lens of “community health” helps align DEI with long-term open source growth strategies by centering DEI principles on how communities (online and in-person) are considered.

Limitations: While several interviewed leaders celebrate CHAOSS’s influence, gaps remain in ecosystem adoption and how individual communities apply metrics to their specific contexts. “What holds us back as an ecosystem is that it is hard to figure out how to apply metrics to our work, how to embed inclusion instead of treating it separately. Today the application of metrics is largely piecemeal,” explains Emma Irwin, Project Manager on Microsoft’s Open Source Programs Office, who collaborated with CHAOSS in developing metrics based on her research at Mozilla.²⁶ Barriers to “integrating” metrics exist at both levels: how the ecosystem leverages and shares existing resources (be they

sources of new contributors from underrepresented groups like “[Black Girls Code](#)” or best practices), as well as how *specific open source communities* incorporate DEI metrics into their existing workflows. Irwin elaborates that what requires being proactive today should simply be embedded into how communities are run.

Next Steps: The CHAOSS project is focused on bringing their work into existing DEI programs, virtual and in-person open source events, student initiatives, and maintainer mentorship efforts, so as to better center DEI within all sorts of open source projects. In addition, CHAOSS is applying this lens internally through periodic reviews of its own policies, procedures, and community members’ experiences, as well as integrating across all CHAOSS working groups by considering every new metric’s impact on DEI.

²⁶ Emma Irwin (Project Manager, Open Source Program Office at Microsoft), interview with author, September 10, 2021.

Governance

Governance—the need for more, the need for standards, and the need for its adherence and integration—was a resounding theme in analyzing the efficacy of DEI solutions in open source. While the initiatives listed above are powerful tools, many point to their limitations without broader governance or a centralized foundation for their deployment. Transparency of governance itself is also important, especially as for-profit corporations adopt open source for their products and make decisions about user experiences and tooling therein.

Governance in open source includes the following areas, each of which are instrumental for maintaining community health and enforcing standards for inclusion.

Codes of Conduct: As mentioned previously, these are the baseline social contract for standards of behaviors in open source communities, but without enforcement and accountability mechanisms, their power is limited. (See the above Codes of Conduct section for more).

Decision-Making Frameworks: Transparency and accountability around how decisions are made is critical for establishing trust and maintaining contributors' sense of safety. Such frameworks are useful for establishing clarity and consistency in how decisions are made, by whom, as well for "proactive governance" in which forethought is given to scenarios before they arise. "Our worst biases creep in when things are messy and people don't know what to do," says Berkus.²⁸

Process Documentation: Documentation is important for open source software and hardware utilization and for how open source communities run. How are leaders determined? How are contributors onboarded, managed, and supported? How is feedback incorporated into workflows? From community outreach to multiple languages, from release schedules to policy creation, open source governance includes various processes for which documentation substantiates accountability and enforcement. Despite its importance, just half of the respondents report the open source projects in which they have involved capture process documentation, in addition to technical documentation.

"Often what is missing today is explicit, transparent, representative, and accountable governance."

—Coraline Ada Ehmke, Founder of the Organization for Ethical Source²⁷

Governance Boards: Boards of people often support strategic, contentious, and high-impact decisions in open source communities. Leadership has a distinct role in encouraging diverse perspectives and incorporating inclusive principles into these decisions. Boards themselves should be representative of different demographics.

²⁷ Coralina Ada Ehmke (Founder of the Organization for Ethical Source), interview with author, August 5, 2021.

²⁸ Josh Berkus (Kubernetes Community Architect at Red Hat), interview with author, August 26, 2021.

Enforcement: Policies are only as powerful as the consistency with which they are enacted. Enforcement in open source governance refers to the manual and automated execution of carrying out the rules, standards, and norms outlined in policies and codes of conduct.

Training: Several open source leaders stress the importance of training on general governance, policies, and how to think through both with a lens for inclusion. This includes leadership training, managing contributors, bias awareness, writing documentation for community outreach, and more. Training is critical for developing and exemplifying an “inclusive mindset.” For example, incorporating inclusive language into speaker and event programming training as the INI has supported or evaluating how requirements for leadership (e.g., attending meetings at noon PST) may exclude certain participants.

Metrics: DEI and other metrics put forth by CHAOSS (referenced above) offer a strong foundation for incorporating and evolving DEI metrics into governance program designs. Applying metrics to the above areas (e.g., clear criteria for leadership promotion, fairness in decision-making processes) is not just about promoting transparency and accountability but advancing broader validation for digital inclusion metrics. For example, the United Nations is developing global guidance on digital inclusion metrics, for which open source communities provide an important, geographically, and industry-diverse proxy.²⁹

While these initiatives are crucial steps, broader systemic changes require greater ecosystem adoption and integration. The next section offers eight actionable solutions to help bridge the current gaps in DEI across the open source ecosystem.

²⁹ UNU-EGOV researchers for the Digital Future Society, “Measuring the Margins: A Global Framework for Digital Inclusion, United Nations University. February 7, 2020, accessed Sept. 15, 2021, <https://egov.unu.edu/news/news/measuring-margins-digital-inclusion-report.html>.

Emerging Solutions and Opportunities

In addition to capturing the current state of DEI dynamics and initiatives in open source, this research sought to identify the most critical solutions and opportunities to address unmet needs across the open source ecosystem. The Linux Foundation recommends all open source constituents embrace these eight opportunity areas.

- **Proactive Inclusion:** improve equity with active steps and dedicated efforts
- **Resources Matter:** prioritize funding to build inclusive designs into open source programs
- **Open Source Hospitality:** cultivate newcomers' experience to increase the number of new open source contributors
- **Evolving Education:** extend DEI training programs into areas unique to open source
- **Localize Efforts:** deliberately drive global inclusion across underrepresented regions
- **Measurement Matters:** take (and share) a data-driven approach to learning and improving
- **Ecosystem Embrace:** distribute agency and responsibilities to drive adoption across overlooked open source stakeholders
- **Structural Change:** embrace more than code as open source evolves into a tool for a more inclusive digital economy



Proactive Inclusion: Improve equity with active steps and dedicated efforts

Fostering inclusion is not merely an afterthought or passive experience; it takes effort, resources, and active measures. We heard this resounding theme from multiple parties interviewed, from DEI leaders to OSPO leaders, from contributors to conference organizers. “Frankly, it takes more time and resources to expand access,” as an interviewee who sits on open source conference committees summarized.³⁰ Whether engaging new developers, promoting maintainers, building an inclusive design working group, or, at the board level, where heterosexual white men are in the majority, engaging people from underrepresented groups requires resources, mindful consideration, and time. This clarion call also extends to the ecosystem to develop shared resources for bringing in contributors and speakers with more diverse perspectives, rather than “reinventing the wheel” with every initiative. This is also an area for “top-down” influence, where formal support and enforcement set a precedent, and help to procure funding.

Tactical Steps towards Proactive Inclusion:

- Engage with underrepresented groups where teams lack diversity.
- Develop central, shared resources for bringing in contributors from underrepresented backgrounds.
- Leverage DEI metrics for representation in leadership.
- Extend timelines, as inclusive efforts can be thwarted by short notice.
- Educate teams on inclusive design within workflow scenarios (e.g., plan events outside of local holidays, create promotion criteria).

“I want to see a room that looks like being on the subway in a major city. But we won’t don’t get there by accident.”

—James Governor, Cofounder of RedMonk³¹

³⁰ Open Source Maintainer at a large technology company, August 27, 2021.

Resources Matter: Prioritize funding to build inclusive designs into open source programs

In addition to establishing a culture of proactive inclusion, money talks. “Funding allows us to do more,” says Katia Rojas, VP of Diversity and Inclusion at the Apache Foundation.³² Many DEI programs have to date focused on training and education, but the distributed nature of open source requires educational efforts to be both more accessible (i.e., free, 24/7), and applied to specific workflows, such as documentation or code reviews. Our research scanned for other resource needs across the open source ecosystem.



Tactical Steps toward DEI Resourcing:

- Sponsorship of DEI programs and initiatives in open source (i.e., dedicated people, related testing and implementation for DEI metrics, new initiatives)
- Scholarships to events, meet-ups, including in regions of low representation; mentorships, paid internships
- Free training, funding for DEI expertise, mentorship programs
- Sponsorship of open source programs in communities, schools, universities, start-up ecosystems
- Funding for related research (i.e., surveys, reporting, data analysis)
- Funding for DEI programs in corporations (i.e., parental leave, daycare, reskilling)
- Funding for DEI-related messaging (i.e., marketing, communications)

³¹ James Governor (Co-Founder of RedMonk), interview with author, September 2, 2021.

³² Katia Rojas (VP of Diversity and Inclusion at the Apache Foundation), interview with author, August 26, 2021.

Open Source Hospitality: Cultivate newcomers' experience to increase the number of new open source contributors

The experience of newcomers is a major barrier to expanding contributor demographics in open source communities. This is both a cultural issue, where new developers feel unwelcome, intimidated, “not technical enough,” or incapable of producing something that will meet maintainers’ standards, as well as a logistical issue, where onboarding resources, documentation, and accessible tools for beginners are lacking. These only compound other barriers newcomers from different backgrounds face, like language, economic, and time-related dynamics (described in Part 1). This obstacle also influences potential career opportunities, as open source contributions serve as easily accessible demonstrations of skill during job interviews.

The open source ecosystem must address this issue to expand diversity and inclusion. “We need Open Source Hospitality” as Brian Douglas, Director of Developer Advocacy at GitHub and maintainer of the Open Sauce community, coined it, “a kind of standard for welcome-ness, like we have basic expectations for a hotel experience. Offering clarity, guidance, central resources, and best practices for contributing to projects would save newcomers so much time and help them feel at home more quickly.”³³

³³ Brian Douglas (Director of Developer Advocacy at Open Sauce), interview with the author, August 26, 2021.

Tactical Steps toward Open Source Hospitality:

- ❑ Funding for DEI-related messaging (i.e., marketing, communications)
- ❑ Offer clear governance and Code of Conduct documentation, including practical tips for pull requests, communications, suggested participation
- ❑ Create “Good First Issue” labels to clearly indicate ideal practice exercises for beginners, and include practices for non-developers (e.g., documentation, design, community management)
- ❑ Ensure outside social/communications tools are accessible to welcome and support beginners and make learning paths easy-to-find in these communities
- ❑ Align onboarding efforts with resourcing strategies (e.g., paid internships, mentorships, shadowing, community outreach programs, events, community research)
- ❑ Incorporate maintainers into support, mentorship, and criteria for leadership

“We should do more to help beginners join the community. They have little experience, and would benefit from having access to easy demos, or having more tools that they could practice with. Also, not all technology projects have WeChat or WhatsApp groups set up especially for beginners, and these are really helpful to build a sense of support in the community right at the outset.”

—Xiaoman Hu, Community Operations Manager and Code Contributor at Huawei



Mindspore, an AI-focused project, has social media groups specifically for beginner, senior, and expert-level coders.

Supabase is an open source community where maintainers themselves are dedicated to supporting newcomers through clear messaging like “We’re maintainers, we’re here to help you and welcome contributions from everyone!”; maintainer-selected “first issues” for practice; and a GitHub discussion board to support learning and involvement.

Kubernetes put forth a dedicated effort to broaden their maintainer program for mentoring and bringing in newcomers to the community.

Evolving Education: Extend DEI training programs into areas unique to open source

Education is crucial for advancing inclusion because building awareness and substantiating it with research and scenarios helps to integrate best practices into communities. Thematic DEI training (i.e., in unconscious bias, leadership, allyship, events, and decision-making) are universally useful for general knowledge-building and “overcoming the challenge of learning what we don’t know,” as one interviewee put it.

However, DEI training in open source has unique needs and nuances from other domains. For example, what does a “good” code review or “accessible” documentation look like? What constitutes “safe spaces” in open source (virtual and in-person) environments? What is the role of maintainers versus other “explicit vs. implicit” mentors or community managers? What are the constraints of subsystems when it comes to newcomers’ experience or contributor retention? The above questions are the research focus of several researchers and institutions to deepen open source communities’ grasp of dynamics and impacts on specific groups.

The Inclusive Naming Initiative and the Linux Foundation’s Inclusive Speaker Training program are two areas where communities have banded together to focus squarely on open source language, communications, and events—and while highly specific in their focus, these initiatives are instrumental for improving inclusion in open source.

Tactical Steps toward DEI Training for Open Source:

- Resource for training tailored across roles (leaders, maintainer, contributors, community managers, event organizers)
- Incorporate best practices into governance training, onboarding support, and sharing across communities, OSPOs
- Incorporate best practices into sponsorship programs (mentorships, internships, schools, funding for projects reporting and improving DEI metrics)
- Provide scenarios and real-world examples rather than recommendations only (particularly to counter pushback that “it’s not a problem” or “I don’t see exclusion happening”)
- Support deeper investigation “asking the next question” through continued resourcing (e.g., The INI has identified new opportunities, such as “how to write inclusive code” resource development)

Localize Efforts: Deliberately drive global inclusion across underrepresented regions³⁴

Open source DEI efforts may originate from “hubs,” community DEI leaders, or even corporate sponsorships, but they must resonate with people’s interests and lived experiences. “We can’t push people to work on things they just don’t care about,” says Maneesh Sharma, General Manager of GitHub India. “It must accrue to the economic value of the individual partici-

“We need more mentorship and targeted outreach in communities with low awareness of open source. This helps bring in people with different identities across different dimensions of diversity. Sharing open source expertise with humanitarian and social good projects to address issues they are working on helps involve marginalized groups in open source use and development.”

—Marina Zhurakhinskaya, Senior Program Manager, Diversity, Equity, and Inclusion at Red Hat and Co-Organizer at Outreachy³⁴

³⁴ Marina Zhurakhinskaya (Senior Program Manager, Diversity, Equity, and Inclusion at Red Hat and Co-Organizer at Outreachy), interview with author, August 27, 2021.

³⁵ Maneesh Sharma (General Manager of GitHub India), interview with author, August 27, 2021.

pating.”³⁵ Sharma explains how open source software development is a key driver for India’s vibrant innovation ecosystem. “Open source has prompted a proliferation in start-ups, many of which are using open source technologies to cater to local consumer trends in retail, multilingual chat, fintech, and more. Now, as the government continues to embrace open source and digitisation, the future looks even brighter for India’s rich community of start-ups and developers.”

Tactical Steps toward Local Alignment:

- Understand and seek feedback on prospective contributors’ pressing local issues (e.g., women’s rights, job opportunities, government corruption, digital skills)
- Tailor program or event design to local benefit (e.g., programs to promote how open source can be used to advance local causes)
- Target regions (demographic, market, geographic) where teams are not representative
- Incorporate time zones and linguistic needs into collaboration: in-person, virtual, asynchronous work
- Leverage humanitarian organizations, like the United Nations, to bolster presence, and use insights into local needs to improve open source accessibility programs

Aligning with local dynamics is as important (if distinct) in India as in any other community, whether it be classrooms in New Orleans, or citizens in Nigeria. “It’s not just about underrepresented groups, but underrepresented needs in underrepresented countries,” says Mala Kumar, Director of Tech for Social Good at GitHub.³⁶

Measurement Matters: Take (and share) a data-driven approach to learning and improving

We cannot manage what we do not measure, and so it goes for open source DEI programs. Metrics outlined in the CHAOSS section above are instrumental for incorporating DEI into open source communities and projects. Still, measuring specific initiatives, reporting, and ongoing research is key for evolving broader inclusion objectives across the ecosystem. Katia Rojas, VP of Diversity and Inclusion at the Apache Foundation, uses surveys to capture trends and feedback on program effectiveness, community satisfaction, additional skills needed, and more. This informs how Apache can improve its program, update other tools like its community health checklist, and better direct resources.

Another opportunity to apply metrics supporting inclusion in open source is in broader ecosystem adoption. For example, some venture capital and investment

firms are incorporating both DEI metrics and incentivizing open source development into their portfolio strategies.³⁷

Tactical Steps toward Applied Measurement:

- Use metrics to inform DEI program and related resource improvements
- Use metrics to elevate open source efficacy (e.g., superior accessibility features)
- Bolster best practice sharing (across communities, OSPOs, foundations, universities) with metrics
- Invest in research to better understand and apply metrics for specific regions and communities, as well as in government sponsorship and policy design

³⁶ Mala Kumar (Director of Tech for Social Good at GitHub), interview with author, August 25, 2021.

³⁷ “Major Philanthropies Tackle Inequality By Strengthening How Open Source Code Is Developed and Maintained,” Omidyar Network, The Omidyar Group. March 3, 2021, accessed September 22, 2021, <https://omidyar.com/major-philanthropies-tackle-inequality-by-strengthening-how-open-source-code-is-developed-and-maintained/>.

Ecosystem Embrace: Distribute agency and responsibilities to drive adoption across overlooked stakeholders

No single organization can achieve greater DEI on its own. It takes a village; DEI requires shared commitment, responsibilities, and governance across the broader open source ecosystem. In addition to open source community platforms, foundations, and participants, our analysis identified additional stakeholder constituencies that play a role in proactively advancing inclusion and normalizing equity as a core value in open source. Below we surface key roles these constituents can play.

TABLE 5
Inclusive Speaking and Presenting Language Tips

Open Source Stakeholder	Roles and Recommended Steps
<p>Corporations</p>	<p>Large enterprise technology adopters have immense influence in workforce culture, open source and developer relations strategies, technology design and implementation, and global reach. Industry resources can help:</p> <ul style="list-style-type: none"> • Align DEI objectives and funding with open source strategy (e.g., paid time allocation for open source contribution) as well as related talent, product, Corporate Social Responsibility (CSR)/Social Impact, and outreach efforts • Contribute inclusive tooling to the ecosystem. For example, gaming giant Electronic Arts (EA) is open sourcing code from five of its accessibility patents to enable developers and competitors to encode features supporting people with dis/abilities more easily.³⁸ • Exercise leadership in transparency and accountability in technology and data governance, both in OSPO decisions and proprietary platforms. <p style="text-align: right;">(Continues on following page)</p>

³⁸ “Electronic Arts Grants Competitors Free Use of Accessibility Patents,” TrendWatching, TrendWatching BV, September 10, 2021, accessed September 12, 2021, <https://info.trendwatching.com/innovation-of-the-day/electronic-arts-patent-pledge>.

TABLE 5 (CONTINUED)

Inclusive Speaking and Presenting Language Tips

Open Source Stakeholder	Roles and Recommended Steps
<p>Open Source Program Offices (OSPOs)</p>	<p>OSPOs help promote open source projects and tooling within organizations and liaise with open source communities and other constituents. OSPOs can support DEI integration:</p> <ul style="list-style-type: none"> • Leverage TODO to facilitate cross-industry/technology best practice sharing • Share best practices internally (with the organization) for inclusive design, DEI metrics, talent sourcing, mentoring • Promote partnerships across organizations
<p>Conferences and Events</p>	<p>Events are integral to building community, networking, and establishing profiles of newcomers in open source. Organizers can use events as platforms to improve DEI in the following ways:</p> <ul style="list-style-type: none"> • Leverage CHAOSS Badges and DEI criteria into event design (sponsorship criteria; speaker representation; board representation; accessible venues, closed captioning, childcare) • Promote diverse representation across programming (content, showcases, keynotes, networking) • Prioritize time-considerations, such as supporting asynchronous access, budgeting time to recruit underrepresented voices
<p>Universities, Schools, and Local Communities</p>	<p>Educational institutions and community programs are great partners for increasing the diversity of open source contributors, aligning tools and skills with what kids, students, and citizens are interested in.</p> <ul style="list-style-type: none"> • Introduce open source earlier in life as platforms for school-age children and youth to build and collaborate • Further embed open source into funding for educational tooling (shared code and data repositories, communities, hackathons) and curricula (STEM, inclusive design, governance, ethical use) • Share research and best practices on retention to better understand those that drop out vs. continue with open source • Apply these across both university and non-university settings (e.g., coding bootcamps, Massive Open Online Courses) <p style="text-align: right;">(Continues on following page)</p>

TABLE 5 (CONTINUED)

Inclusive Speaking and Presenting Language Tips

Open Source Stakeholder	Roles and Recommended Steps
<p>Start-Ups</p>	<p>The next generations of businesses are increasingly building on open source platforms. Start-up ecosystems can contribute to diversity:</p> <ul style="list-style-type: none"> • Use global open source tools to address local problems and engage local workforce • Prioritize diversity in hiring leadership and in building company culture • Accommodate start-ups across backgrounds through grants, selections, mentorships
<p>Investors and Venture Capitalists</p>	<p>Investors play a critical role in improving equity because they can determine which projects and technologies merit funding and how expectations for returns impact product design. This can help:</p> <ul style="list-style-type: none"> • Incentivize open source development in funding criteria • Prioritize diversity in perspectives and backgrounds in leadership teams (both investors and start-ups) • Develop partnerships with other open source constituents (foundations, universities) to contribute funding and advisory services
<p>Government and International Bodies</p>	<p>Governments are beginning to embrace open source tools in their own development, in areas such as policy, education and industrial strategy, and grants. These efforts align with broadening access and inclusion:</p> <ul style="list-style-type: none"> • Align with funding and initiatives in STEM and industry. For example, the Government of India has policies prioritizing free and open source software (FOSS), open APIs, and open source stacks to promote fintech innovations.³⁹ • Leverage open source communities for government-backed standards for technology and security • Explore projects across bodies like the United Nations, Organization for Economic Cooperation, or World Economic Forum to help coordinate government and industry groups around relevant frameworks, such as digital inclusion, inclusive employment, and open government.

³⁹ Maneesh Sharma, “Free and Open Source Software,” Ministry of Electronics and Information Technology, September 3, 2021, accessed September 20, 2021, www.meity.gov.in/content/free-and-open-source-software.

TABLE 6
Shifting Mindsets Offer a Vision for the Future of Open Source

FROM Systemic Exclusion	TO Proactive Inclusion
Meritocracy-based	Inclusive by design
Code-centric valuation of roles	Holistic open source, valuing roles in content, governance, design, project management, community management, and coding
Reactive governance	Proactive governance
Codes of conduct optional, “encouraged”	Codes of conduct integrated, expected, and enforced
Policies on paper, low standardization for governance and process	Standardized templates, “across the stack” governance
Coder as adopter (business, developer)	Human as adopter (end-user, person, citizen)
Low awareness of inclusion across open source projects	Broad understanding around criteria for inclusion, tied to strategy
“Benevolent Dictator for Life”	Accountability for leadership’s behaviors, regardless of stature
“Tech is neutral”	Tech has governance; values are encoded

Source: Linux Foundation Research, Qualitative Interviews, July, August, September, 2021

Structural Change: Embrace more than code as open source evolves into a tool for a more inclusive digital economy

To improve DEI in open source is to address the structures that have enabled the exclusionary, meritocratic culture that has co-evolved alongside the tech industry itself. This uncomfortable reality underlies many assumptions, like tech is neutral, or contributors’ worth is based solely on their code. Part of the scaffolding of this structure is based on the dominant orientation of power (wealthy White men) which has resulted in systemic marginalization of countless groups outside of that orientation. The efficiency of technological design has come at the cost of inclusive perspectives and deemphasis of “non-technical” roles. Inclusive design is not just about products but systems themselves, and this is where ecosystem adoption, with particular accountability by those with decision-making power, catalyzes change.

“There is a slow shift taking place in open source, from actively exclusive to proactively inclusive,” summarizes Kelly Blincoe, Senior Lecturer in the Department of Engineering at the University of Auckland, New Zealand, who studies human dynamics and team collaboration in open source communities.

Both survey respondents and individuals interviewed reiterate the view that DEI is a catalyst for, and a byproduct of, structural change.

Conclusion

The “free and open” philosophy at the heart of open source has surely brought about revolutionary advancements in technology, software, and standards. But as open source permeates global industries, markets, power structures, and beyond, code is no longer enough. Shifting from systemic (if passive) exclusion of non-coders toward a more proactive and inclusive open source ecosystem manifests the very ethos on which open source was founded. Many perspectives lead to better technologies, better products, and more inclusive digital economies.

“Diversity: the art of thinking independently together.”

—Malcolm Forbes



Methodology

From July 15 to July 29, 2021, Linux Foundation Research fielded a worldwide survey of Linux Foundation subscribers and community members on a range of questions about their sense of inclusion and belonging in open source communities.

The survey was promoted via social media, the Linux Foundation and Linux.com websites, the Linux Foundation newsletter, and was created with the support of the following partners:

- Amazon Web Services (AWS)
- CHAOSS Community
- Comcast
- Fujitsu
- GitHub
- GitLab
- Hitachi
- Huawei
- Intel
- NEC
- Panasonic
- Red Hat
- Renesas
- VMware

Several thousand responded to the survey, and a total of 2,350 completed the survey with sufficient demographic data to qualify for the final sample size used to conduct analysis. Respondents under 18 years of age did not qualify to complete the survey.

The survey was offered in English as well as Arabic, Chinese (simplified), French, German, Hindi, Japanese, Korean, Portuguese, Russian, and Spanish.

Demographics

Below is a summary of demographic data from the survey:

Respondents report that their command of reading and writing English is: Very Fluent (81%), Moderately Fluent (16%), Not Very Fluent (3%), and Not Fluent (less than 1%).

Worldwide, participants originate from North America (36%), Europe (36%), Central America/South America/Caribbean (8%), South Asia (8%), East Asia/Pacific Islands (3%), Oceania (3%), Middle East and North Africa (2%), Eastern and Southern Africa (2%), Central Asia (1%), and West and Central Africa (1%).

Participant ages are: 35 to 44 years (29%), 25 to 34 years (22%), 45 to 54 years (21%), 55 to 64 years (13%), 18 to 24 years (8%); 65 to 74 years (4%), 75 or older (2%), and 1% prefer not to answer.

Bachelor's degree (36%) is the highest level of formal education of respondents, followed by Master's degree (28%), Some college/no-degree vocational/trade program or scholarship (18%), Doctoral degree or other advanced (9%), Secondary/High school or equivalent (6%), less than Secondary/High school or equivalent (1%), and 1% prefer not to answer.

Gender is reported as follows: Man (82%), Woman (14%), Non-binary or third gender (4%), with 1% of respondents specifying something other than the above, and less than 1% who prefer not to answer. Additionally, 10% are gender diverse, gender variant, or gender expansive. In response to a different question, 4% indicate they are transgender, with 1% questioning their gender status and 2% preferring not to answer.

The sexual orientation of respondents is as follows: Heterosexual (74%), Bisexual (8%), Asexual (6%), Queer (4%), Pansexual (3%), Gay (3%), Questioning (2%), Lesbian (2%), specifying something other than the previous (2%), and preferring not to answer (10%).

The racial background demographics for North American respondents is reported as White (70%), Black (10%), Hispanic/Latinx (10%), Asian (8%), Native or Indigenous (5%), Pacific Islander (1%), something other than the previous responses (6%), and 6% prefer not to answer.

Seventeen percent of respondents identify as a person with a dis/ability, and 46% of respondents have a caregiver responsibility.

Qualitative Interviews

The authors express their sincerest thanks to the following people who participated in the interview process, sharing thoughtful and candid perspectives and insights:

- Elizabeth Barron, Community Manager at CHAOSS
- Josh Berkus, Kubernetes Community Architect at Red Hat
- Kelly Blincoe, Senior Lecturer in the Department of Engineering at the University of Auckland, New Zealand
- Amiangshu Bosu, PhD, Assistant Professor, Department of Computer Science, Wayne State University
- Rev. Remy DeCausemaker, Hackademic, and TODO Group Steering Committee Member '19-'20
- Demetris Cheatham, Senior Director of Diversity Inclusion Strategy at GitHub
- Brian Douglas, Director of Developer Advocacy at GitHub and maintainer of the Open Sauce community
- Coraline Ada Ehmke, Founder of the Organization for Ethical Source
- Dawn Foster, Director of Open Source Community Strategy at VMware
- Neisha Fredericks, Allyship Consultant and Operations Manager of the Open Source Program Office at Red Hat
- James Governor, Co-Founder of RedMonk
- Xiaoman Hu, Community Operations Manager and Code Contributor at Huawei
- Emma Irwin, Project Manager, Open Source Program Office at Microsoft
- Shuah Khan, Linux Fellow and Kernel Maintainer at the Linux Foundation
- Mala Kumar, Director of Tech for Social Good at GitHub
- Michelle Mannering, Developer Advocate at GitHub
- Katia Rojas, Vice President of Diversity and Inclusion at Apache Foundation
- Priyanka Sharma, Executive Director at CNCF and Co-Founder of the Inclusive Naming Initiative
- Maneesh Sharma, General Manager of GitHub India
- Marina Zhurakhinskaya, Senior Program Manager, Diversity, Equity, and Inclusion at Red Hat and Co-Organizer at Outreachy

Acknowledgments

This report would not have been possible without the support of Amazon Web Services (AWS), CHAOSS Community, Comcast, Fujitsu, GitHub, GitLab, Hitachi, Huawei, Intel, NEC, Panasonic, Red Hat, Renesas, and VMware.

In addition to the research project partners and interviewees, the authors wish to thank the following individuals for their involvement in the various stages of the research process:

Suzanne Ambiel, VMware • Dominik Bamberger, IAC • Elizabeth Barron, CHAOSS • Angela Brown, The Linux Foundation • Rachel Bueker, Kaleido Insights • Candace Byrdsong Williams, GitLab • Demetris Cheatham, GitHub • Michael Dolan, The Linux Foundation • Sobie Don, University of Nebraska at Omaha • Justin Flory, UNICEF Office of Innovation • Neisha Fredericks, National MS Society • Daniel German, University of Victoria • Matt Germonprez, University of Nebraska at Omaha/CHAOSS • Robin Ginn, OpenJS Foundation • Sean Goggins, University of Missouri-Columbia • Lawrence Hecht • Stephen Hendrick, The Linux Foundation • Emma Irwin, Microsoft Open Source Programs Office • Catherine Jeppsen, GitHub • Shuah Khan, The Linux Foundation • Max Lemoine • Inayaili Leon, GitHub • Amy Marrich, Red Hat/Open Infrastructure Foundation/CHAOSS • Jennie Ohyoung, GitHub • Sarah Oyetubo, GitHub • Jason Perlow, The Linux Foundation • Kristi Proгри, GNOME Foundation • Darryl Robinson, GitHub • Alison Rowan • Nuritzi Sanchez, GitLab • Anita Sarma, Oregon State University • Alexander Serebrenik, Eindhoven University of Technology, The Netherlands • Kate Stewart, The Linux Foundation • Alexandra Stratigos, FINOS • Kate Travers, Senior Software Engineer, GitHub • Brittany Vincent • Stephen Winslow • Selene Yang, Geochicas • Frances Zlotnick, GitHub • Marina Zhurakhinskaya, Red Hat

We thank all of the people who participated in the survey, as well as those who dedicate time and effort toward building inclusive communities in open source.



About the Authors

Hilary Carter is VP Research at the Linux Foundation where she leads the creation of decision-useful insights into the open source technologies and standards underpinning much of the digital infrastructure on which the global economy depends. She is the author of multiple research projects exploring blockchain industry and ecosystem dynamics. She has contributed to books and reports on the subject of blockchain technology in government, enterprise, and society, as well as research on the state of open source in the financial services sector. She speaks publicly on the subjects of innovation, gender diversity, leadership, and digital transformation. Hilary is a management graduate of the London School of Economics.

Jessica Groopman is an industry analyst and founding partner of Kaleido Insights. She leads research on human and societal impacts of emerging technologies, specializing in AI, blockchain, IoT, renewables and more. Her recent research covers digital inclusion and DEI, Web3 and digital governance, and regenerative business and sustainable designs. Based in the San Francisco Bay Area, Jessica works with organizations internationally, supporting strategic advisory, digital transformation, and research across several industry verticals. She is a regular keynote speaker and media contributor, co-host of the Hype Hazard Podcast, advises start-ups and has served as a contributing member of the International IoT Council, the IEEE's IoT Group, and named among Analytica's 100 Most Influential IoT Thought Leaders. Groopman led research practices at Tractica, Harbor Research, Altimeter Group and more, having authored over 40 reports and contributed to several books.

Disclaimer

This report is provided “as is.” The Linux Foundation and its authors, contributors, and sponsors expressly disclaim any warranties (express, implied, or otherwise), including implied warranties of merchantability, non-infringement, fitness for a particular purpose, or title, related to this report. In no event will the Linux Foundation and its authors, contributors, and sponsors be liable to any other party for lost profits or any form of indirect, special, incidental, or consequential damages of any character from any causes of action of any kind with respect to this report, whether based on breach of contract, tort (including negligence), or otherwise, and whether or not they have been advised of the possibility of such damage. Sponsorship of the creation of this report does not constitute an endorsement of its findings by any of its sponsors.

 twitter.com/linuxfoundation

 facebook.com/TheLinuxFoundation

 linkedin.com/company/the-linux-foundation

 youtube.com/user/TheLinuxFoundation

In partnership with:



Linux Foundation Research explores the growing scale of open source collaboration, providing insight into emerging technology trends, best practices, and the global impact of open source projects.



Copyright © 2021 [The Linux Foundation](https://www.linuxfoundation.org)

This report is licensed under the [Creative Commons Attribution-NoDerivatives 4.0 International Public License](https://creativecommons.org/licenses/by-nc/4.0/).

To reference the work, please cite as follows: Hilary Carter and Jessica Groopman, "Diversity, Equity, and Inclusion in Open Source: Exploring the Challenges and Opportunities to Create Equity and Agency Across Open Source Ecosystems," foreword by Jim Zemlin, The Linux Foundation, December, 2021.