Embracing Diversity, Equity, and Inclusion in BSOE Open-Source Communities

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I.   Introduction

The main goal of this research is to propose a model to improve diversity, equity, and inclusion (DEI) within the Baskin School of Engineering (BSOE) and the Center for Research in Open Source Software (CROSS) open-source (OS) projects and communities. We start by exploring the current research findings on the state of diversity and inclusion in the OS communities and the perception of their members. Based on this research, we will present our conclusions and insights about the barriers to creating a more diverse, inclusive, and equitable research environment within the OS communities supported by BSOE and CROSS. To design a strategy to overcome the identified challenges, we analyze the methods and techniques that DEI professionals have developed over the years to help organizations promote DEI cultures and create dynamic, innovative, and productive work environments. Finally, we detail our proposal to implement concrete activities that help the Baskin Engineering OS projects to adopt and promote a DEI culture and potentially lessen the issues identified by the student experience report.

II.   Diversity and inclusion in open-source communities

Even though diversity is a defining characteristic of collective online communities facilitated by the internet, research data shows that this does not apply to the OS developer community. The 2017 GitHub OS survey [7] collected demographic information from 5,500 OS users and developers worldwide, and the results showed that the development community remains startlingly white and male. Of that randomly selected cohort, 95% of responders are men; just 3% are women, and 1% are non-binary. Only 1% identify as transgender, and 7% identify as lesbian, gay, bisexual, or another minority sexual orientation. 26% are immigrants, and 16% are members of an ethnic minority in the country they currently live.

OS communities have a reputation for being aggressive and fostering "toxic cultures" that cultivate behaviors like name-calling, stereotyping, gender biases, and incivility [2, 3, 4, 13, 16, 17]. Negative interactions are infrequent; only 18% of the OS survey respondents declared to have personally experienced negative interactions; however, they are highly visible and have real consequences for the project's health. The OS survey shows that 21% percent of people who witnessed or experienced a negative behavior stopped contributing to a project because of a negative experience.

Beyond the consequences for OS projects themselves, the OS community's diversity problems also have deeper negative social repercussions. The OS movement has changed drastically over the last decade. OS projects are producing a large ecosystem of popular products and involve more industry participation; today, companies like Exxon Mobil, Wal-Mart, and Wells Fargo work with open source communities and are releasing their own OS tools [5]. Consequently, OS contributions are becoming an important part of a programmer's career development. We can find a clear example in the Github survey results, as half of the responders said their OS contributions were a significant part of landing in their current jobs. Therefore, the under-represented groups are at a professional disadvantage, and lack of access to open source communities can be a barrier to the high-tech job market.

This challenge is particularly problematic for women. According to the US Bureau of Labor Statistics, the

number of female computer scientists dropped from 37% in 1995 to 24% in 2017; and as the OS diversity research has found, the statistics for women participation in the OS community are dramatically lower (2% to 5%). Results from [2] also reveal a gender bias vicious circle that systematically discourages women from getting involved in OS projects. The problem starts with technical biases against female developers that create lower acceptance rates as well as delayed and poor feedback during code reviews. As pointed out by Kim Tran [13], "feedback for women in technology often criticizes character instead of skill". This situation is a significant factor in preventing women from reaching higher positions within core development teams of OS projects and thus negatively impacting their ability to gain leadership positions, which arguably can have the most impact on fostering gender diversity.

A.   Motivations for participating in open-source projects

Before we propose actions to tackle the diversity problem in the OS communities, we should look at what motivates people to participate in OS projects in the first place. Developers and software engineers are influenced by their "motivational state", which often determines the success or failure of OS projects. Motivational states are physiological internal states in individuals that play an important role in initiating behavior. Motivation refers to the individual's psychological needs that require satisfaction. These motivational needs can either be acquired through the influence of the environment or be innate to the individual. While there is extensive literature on motivational theories, intrinsic and extrinsic motivation constructs are frequently used to analyze the OS community. A number of studies [6, 8] aim to understand the intrinsic and extrinsic motivations of the developers contributing to the OS community.

The results show that intrinsic and internalized motivations explain what drives most of the contributors today. Responders in these studies agreed that their motivations to contribute to OS projects include learning, fun, altruism, and kinship, with average percentages of 93%, 91%, 85%, and 80% respectively. In contrast, extrinsic factors like career and payment only received 67% and 28% agreement respectively. Finally, ideology is another factor to consider, as 80% of the responders identify with the philosophy that source code should be open. It is particularly notable that motivations shift when segmenting the data by the individual's characteristics and demographics. For example, data shows that experienced developers with more than 15 years of experience give more importance to social and philosophical factors such as ideology and altruism, while novices usually decide to join and continue in OS projects pursuing career development and professional opportunities.

B.   Students in open-source communities

So far, we have a general picture of the OS community, its demographic characteristics, and the main motivations of its members. However, it is crucial to keep in mind our goal when investigating OS communities. Therefore, we have to focus on the relevant data that helps create a model to improve DEI specifically within the BSOE-originating projects. First, we need to consider the characteristics of the BSOE-based OS contributors and developers, who will be predominantly students–particularly undergraduate UC Santa Cruz students–and, maybe over time, alumni, depending on the project's success in building a community that stays active.

Research revealed that students have an interesting mix of internal and external motivations to engage in OS projects. The results presented by [8] show that 96.9% of the students identify career building as the main factor to participate in OS projects and 33.3% highlight self-marketing. For internal motivations, 36.4% of the student responders consider that community identification is essential for them to continue contributing to a project, and for 24.2% altruism is also part of their engagement in OS. Another study focusing on the Google Summer of Code (GSoC) participants [10] discovered that 44% of the students considered adding GSoC to their resumes essential, preferring not to participate otherwise. Around 30% of the students regard the stipend received as crucial for participating in GSoC, although it should be noted that this question regarding stipends also had the largest number of neutral responses.

C.   Codes of Conduct in open-source projects

Collaboration is an essential part of OS projects. In order to assure collaboration that allows promoting inclusion, equity, and sustainable growth in the community, contributors must avoid toxic or exclusion-

ary behaviors that may include but are not limited to online or offline verbal comments, sexual jokes or insults, sexual images in public spaces, intimidation, stalking, inappropriate physical contact, and bullying. Therefore, it seems crucial for OS communities to protect their members from these unacceptable behaviors and provide a welcoming, safe, friendly, and inclusive environment where people can collaborate effectively. Codes of conduct establish ground rules for communications between participants, outline enforcement mechanisms for violations, and try to codify the spirit of a community. A code of conduct outlines the expectations and values of an OS community against its members' behaviors to create a friendly and inclusive community while assuring that violations have consequences. These codes of conduct target all collaboration spaces of the community, either online or offline, but the scope can be broader as well.

The study carried out by Tourani et al., in 2017 [12] identified eleven codes of conduct commonly used in OS projects, with seven of them ranging from 500 up to several thousand adopting projects. The seven principal codes of conduct identified by the study were: *Contributor Covenant*, *Open Code of Conduct*, *Python*, *Citizen*, *Ubuntu*, *Django*, and *Geek Feminism*. Although the seven codes are independent, the study found considerable overlap in terms of their major components. This was even highlighted by some of the leaders and creators of the codes of conduct interviewed. One interviewee said that communities already copy text from one another and believed that codes of conduct will converge to some extent as communities have similarities that lead to the reuse of codes of conduct. The following are the common components identified by the study:

- **Purpose:** All codes stress the desire to foster diverse and welcoming communities, some go even further and explicitly list the desired diversity attributes.

- **Honorable behavior:** Codes of conduct tend to pinpoint general positive behaviors like being respectful, patient, kind, focusing on the best for the community, being considerate, and collaborative.

- **Unacceptable Behaviour:** Most codes of conduct denounce sexist/racist language, contempt, and jokes that harass marginalized people, as well as violence and threats.

- **Enforcement:** In communities with a code of conduct, unacceptable behaviors typically are reported to a specific group of team members with the power to decide about the appropriate actions to take.

- **Scope:** Codes of conduct apply to all community members, i.e. both paid and volunteering contributors, in all community spaces, either online or offline, however, a broader scope is possible.

The seven codes of conduct promote an inclusive and safe environment for everyone. For example, the *Contributor Covenant* refers specifically to personal characteristics like gender, age, body size, religion, ethnicity, and sexual orientation. *Python* and *Ubuntu* just generally refer to diverse groups, without explicitly naming them. Citizen also mentions socioeconomic status and *Django* adds political belief and family status, while the *Open Code of Conduct* has a separate diversity statement that explicitly encourages members towards expected behaviors. We think that codes of conduct should trigger discussion and generate some pushback to work properly and have a chance to change people's minds. The authors of *Geek Feminism* stress the importance of reporting and enforcement policies as well as a clear demarcation between community guidelines and unacceptable behavior to accomplish the effective implementation of a code of conduct. Additionally, communities that grow around their codes of conduct have the opportunity to attract like-minded people and repel those who disagree, naturally reinforcing the norms embedded within the code.

III.   The importance of belonging

Cultivating a diversity, equity, and inclusion culture within an organization has gained significant importance over the last decade. Today most of the Fortune 500 companies have diversity and inclusion programs focused on the needs of a diverse workforce [11]. While there are differences between a workplace ecosystem and the OS communities, people are the essential asset for both. Consequently, OS communities can benefit from some of the ideas and techniques companies use to create a dynamic, innovative, and productive organization.

A question that may arise from the stated above is why corporations embrace and promote an internal DEI culture? Historically, one of the first motivations for the companies was avoiding legal liability [1] that can be highly costly, like the famous $156 million settlement that the Coca-Cola company had to pay for a racial bias case filed in 1999 [19]. This risk for companies promoted the emergence of a new consulting industry, focusing on promoting DEI cultures within organizations. As the DEI professionals developed strategies, systems, and programs that effectively cultivated inclusive cultures, an interesting side effect occurred as key performance indicators in productivity and innovation improved [9]. The bottom line is that the workplace has the power to connect people in an authentic and meaningful way. Relationships with colleagues and other stakeholders in the workplace ground a powerful connection. Everything from formal team meetings to brainstorming sessions or even passing conversations in the hallways can stimulate creativity and the ability to polish ideas through relationships. When the workplace is intentionally designed to foster a greater sense of team morale and camaraderie, it is possible to disrupt the hazards of isolation and segregation to unleash the organization's potential.

The core value for many DEI promotion frameworks is the idea of belonging. The definition for belonging in this context is a sense of fitting in or feeling like an important member of a group. A feeling of belonging is a sense of authentically feeling in solidarity with others. Belonging is considered a human need, ranking third among Maslow's pyramid of needs, just above the physiological need for food, water, shelter, and safety needs of personal security and well-being. Maslow's work, complemented by emerging neuroscience research [20], indicates that when the brain determines that we do not belong or process feelings of rejection from a particular person or group of people, their threat response activates in the limbic system. When this occurs, the brain processes these feelings the same way as it processes physical pain, thirst, and hunger, starting its alarm system and sending the fight or flight response into high gear. This unconscious negative response leads to protection mechanisms like covering. Covering occurs when someone downplays or intentionally hides a known stigmatized identity to fit in with the dominant culture.

According to [9], 61% of employees in the United States cover some aspect of who they are at work. When employees downplay their authentic selves, they negatively impact a workplace's overall productivity, innovation, and ability to build solid and meaningful relationships with fellow colleagues. Conversely, when we know that we belong and experience feelings of acceptance from a particular person or group of people, the reward response activates in the prefrontal cortex. Having a sense of belonging at work increases psychological safety, a feeling of acceptance and respect. It empowers people to be more authentic and become more likely to engage with their colleagues, improving employee relationships, team morale, and innovation.

A. Cultivating a sense of belonging

Embracing the vision alone is not enough to shift the organization's culture. Vision in isolation is simply a dream. Reaching the organization's DEI vision requires significant effort and intentional action. A lack of vision, and the absence of a clearly articulated strategy with defined steps to help an organization reach its vision, set those leading the charge up for failure. Without these elements, an organization is simply resting its DEI commitments on hope alone to transform the culture into one that fosters a sense of belonging. To avoid the command-and-control approach that forces culture change upon the contributors, we can instead incorporate feedback from the contributors throughout the organization's ecosystem on ideas that can help others feel a sense of belonging. Such feedback has the potential to foster cooperation, strengthen team camaraderie, and inform the DEI vision along with the work required to activate it. While the vision and strategic plan make up only a small part of the equation, they are essential for informing the leader's actions. Actions lacking vision simply pass the time and help only to "check off the box" to communicate that the organization is doing something.

1. The social-belonging intervention

The framework developed by the social psychologist Greg Walton has proven to successfully transform the perceptions of belonging [18]. The framework consists of two broad messages:

1. If you feel like you don't belong, you are not alone. No matter how isolated you feel, those feelings are common and are no evidence that you don't belong.

2. If you feel like you don't belong, your experience will improve, and over time, you're likely to feel a greater sense of belonging.

While seemingly simple, when these messages are communicated effectively to the community, the social-belonging intervention framework positively impacts overcoming gender and racial achievement gaps for women and students of color in overwhelmingly white and male-dominated environments.

2. Intentional culture

The values of an organization consist of a set of explicitly defined principles that are informed by the key contributors throughout the community. An organization's values guide critical decision-making and the overall strategy. The values offer a framework to determine the socially responsible or "right" action to take, even when faced with tough choices. However, even when an organization communicates the importance of its values, if they do not align with its existing culture, its community members may still feel pressured to conform to its culture. This pressure to assimilate occurs when the DEI values fail to translate into measurable, daily practices. The consequences leave both dominant and underrepresented groups feeling the existence of an implicit culture that only obscures the members' unconscious biases, i.e., attitudes toward and stereotypes of other social groups that negatively affect our understanding, actions, and decisions in an unconscious way. Unconscious biases create an empathy gap; this inhibits people from truly empathizing with another person who differs from their own identity, background, beliefs, or experiences.

3. Inclusive leadership

An inclusive leader communicates the feeling of belonging by offering their contributors a sense of purpose [9]. They can connect their organization's mission and values to those they lead, and they ignite a sense of meaning for every stakeholder. Inclusive leaders lead from the center and move away from the paradigm of one leader having all of the answers, leveraging the group's collective wisdom. Inclusive leaders should study and understand the difference between equity and equality. Equity recognizes that while we should all have access to fair treatment on the team because we are not the same, we will need different things to advance within the organization. When inclusive leaders notice structural differences that make it difficult for other team members to advance, they will shine a light on them without making team members feel tokenized or singled out.

Inclusive leaders also embrace the value of self-awareness. They understand where their own unconscious biases may show up in their actions through continuous self-education and the feedback of others. They remain open-minded and curious to enhance their cultural intelligence, i.e., their ability to relate and work effectively with others across cultural differences, whether those differences are related to working styles, experiences, identities, or beliefs. Inclusive leaders work to recognize their privileges by considering how their race, gender identity or expression, sexual orientation, immigration status, ability, and religious practices, among other aspects of their identity, offer different levels of privilege and access. Consequently, they are empowered to intervene when witnessing microaggressions or discriminatory behaviors that run counter the organization's commitment to inclusion, respect, and belonging.

The value of on-boarding or training culturally intelligent leaders has a tremendous return on investment. When considering how multicultural teams work together, an inclusive leader with a high level of cultural intelligence can yield positive outcomes ranging from productive cross-cultural negotiations to improved job performance, especially for teams with members working remotely.

IV. Building inclusive open-source communities within BSOE

With all the information presented above, we are now ready to propose a model that helps CROSS to reach their DEI goals within their sponsored OS projects, and at the same time, advance BSOE towards a more equitable, inclusive, and diverse student community.

A. BSOE Diversity Equity and Inclusion challenges

First, let's start by exploring the specific DEI challenges that BSOE has to overcome. According to the 2020 Student Experience Report, BSOE has grown exponentially between 2007 and 2017, going from 700 to over 4,500 students. This rapid growth has caused a deficit of resources, including strategic planning, staff, and faculty. Consequently, the study's results revealed DEI issues affecting the underrepresented groups within BSOE.

The student experience report [14] found that while the relative percentages of African American and Asian students have remained stable, the Latinx students have consistently become less represented in the school, going from -0.8 to -10.7 relative percent in the past ten years. Additionally, Latinx students reported significantly lower levels of parental academic support and engineering identification. Women remain markedly underrepresented. However, the analyses revealed that women earn better grades than men, and the relative percentage of women has gradually increased, from -40% in 2007 to -28.4% in 2017.

In terms of equity, the report shows significant disparities in pre-college academic support. Twenty-five percent of returning-generation students reported higher levels of parental and high school support for college, in contrast with a negligible number of underrepresented students who reported having this support. Twenty-three percent of returning-generation students reported attending summer coding camp (paid by their parents), whereas only 4% of first-generation students reported this opportunity. This tendency of disparities between first- and returning-generation students extends to other forms of academic preparation for engineering, like private STEM-related tutoring, AP computer science, programming language classes, and computer science or robotic clubs. These disparities impact how the students feel about their preparation and capacities when comparing themselves with other students that had access to this privileged education. When these better-prepared students eventually outperform them, the feeling of unfitness grows to the point it tears down their "engineering identification" i.e. they do not identify themselves as engineers.

The sense of belonging and engineering identification in BSOE varies primarily across socioeconomic and ethnic groups, affecting especially African American and Latinx students as well as first-generation students. The study identified two interesting patterns. The first one is that the same demographic groups that don't have faculty representation are the ones striving to identify themselves as engineers. The second one is that the students of color do not find the school or campus welcoming, some students even think that the university and its stakeholders are unconcerned about their academic success or socioemotional state.

B. Open-source Projects as a DEI tool

As described in the previous section, BSOE faces several DEI issues that negatively impact the underrepresented student groups. The OS projects sponsored by BSOE and CROSS could contribute to not only lessening these issues but also to help students to improve their resumes and boost the start of their careers as OS contributions are gaining importance in the job market. Following, we will describe the actions BSOE and CROSS could take to tackle the issues identified by the student experience report.

1. Open-source project leaders at Baskin Engineering

Creating a training program to educate the students and researchers at Baskin Engineering who are developers working on open source projects on the importance of DEI and how best to achieve diverse communities. Training these potential mentors to seek out and be effective supporters to contributors from underrepresented groups would be the first step to helping their communities embrace a DEI culture. As described in section III-A-4, inclusive leaders are crucial to communicating a sense of belonging and purpose to the contributors by being self-aware of their unconscious biases, knowledgeable about the differences between equity and equality, and willing to increase their cultural intelligence by continuous self-education.

There is a high potential on the positive impact that inclusive leaders could have on the issues reported by the student experience report, as these students potentially become mentors for novice students that are struggling to feel part of the BSOE dominant culture or that have had uneven access to pre-college engineering education. Therefore, awareness of the DEI issues that BSOE faces and their impact on

the underrepresented and first-generation students must be an essential part of the inclusive leadership training. It is important to consider that the creation of inclusive leaders would require an active effort and resources. The figure below shows how we envision the impact of inclusive leaders in the OS projects.
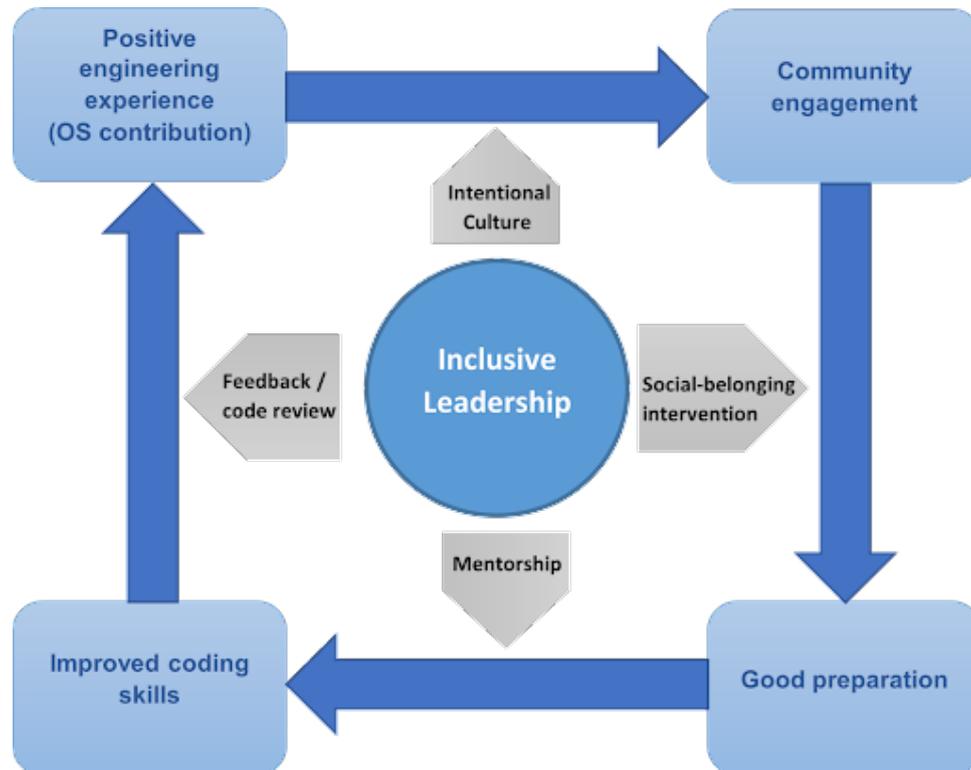

Figure 1: Inclusive leadership in BSOE open-source projects

Engineers often focus only on the technical details of a project and overlook the impact that the social aspect can have on the health, productivity, and life of their OS projects which partially explains all the DEI problems that the OS community in general presents, as described in section II. Finding effective ways to motivate experienced and talented students to become inclusive leaders and dedicate time and effort to mentor novice students of underrepresented groups should be the primary goal of the BSOE and CROSS DEI vision.

2. Intentional culture for the Baskin Engineering OS projects

To create an intentional culture within their communities, the UCSC Principles of Community [15] could be explicitly adopted by UC Santa Cruz originating OS projects. However, the "purposeful" principle may not translate effectively for specific projects. Then the project owners could define their project purpose instead. These principles would guide decision-making when conflicts or dilemmas occur and guide the project's overall planning. Following, we list a proposal for the adapted UCSC Principles of Community for the OS projects to adopt:

- **We embrace diversity:** This community embraces diversity in all its forms and strives to foster an open, enlightened and productive environment.

- **We are open:** This community believes that the free exchange of ideas requires mutual respect and consideration for our members' differences.

- **We are caring:** This community promotes mutual respect, trust and support to foster bonds that strengthen our community.

- **We are just:** This community is committed to due process, respect for individual dignity and equitable access to mentoring, recognition and rewards.

- **We value discipline:** This community seeks to advance common goals through reasonable and realistic practices, procedures, and expectations.

- **We are celebrative:** This community celebrates the heritage, achievements and diversity of the community and the uniqueness and contributions of our members.

It is essential to remark that, as exposed in section III-A-2, the values alone are not enough to prevent the surge of implicit cultures. It takes every member of the community to grow a sense of belonging. Conversely, it only takes one person to "toxify" the community. Therefore adopting a code of conduct as exposed in section II-C is vital, as well as its enforcement and zero-tolerance policies.

3. Implementing the social-belonging intervention framework

The implementation of the framework exposed in section III-A-1 can help to cultivate a sense of belonging within the developers' community as well as promote contributors' engagement. This framework was initially developed for first-year college students who felt that they didn't fit in on campus. The first time it was put in practice, the school trained juniors and seniors on campus to connect with first-year students by sharing quotations, statistics, and stories of similar times when they felt they didn't belong, but eventually overcame these feelings. The approach helped first-year students understand that those feelings were common and were no evidence that they didn't belong. Rather, they were encouraged to recognize the opportunity to grow and to realize that over time, they were likely to develop a greater sense of belonging. A similar approach could be made to implement this framework in the context of the BSOE OS projects. Instead of junior and senior students, it would be the more experienced community developers sharing quotations and stories of how they started to contribute to open source projects and experiences about personal growth in their engineering studies.

The student experience report shows that students from historically marginalized groups struggle to identify themselves as engineers due to several socioeconomic factors. Implementing the social-belonging intervention framework could potentially reduce this problem by encouraging students to contribute to the projects, engage in the community, and learn new skills. Consequently, contributing to the OS projects would give them a feeling of accomplishment that helps them boost their self-confidence as engineers.

V.   Conclusions

We presented our research on the current state of diversity and inclusion in the OS community, with an emphasis on information relevant to the Baskin Engineering demographics. We then considered the diversity, equity, and inclusion issues that exist within the University based on the results from the student experience report 2020. Finally, we presented a proposal for the implementation of specific actions to improve diversity, equity, and inclusion within Baskin Engineering using open-source projects as a tool to cultivate the students' sense of belonging. We identify inclusive leadership as the main factor to address the DEI challenges in BSOE. These actions can become the driving force for change by promoting an understanding of the benefits of a diverse community in OS projects and addressing the DEI challenges in BSOE, and providing concrete ways of overcoming them.

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