

Are We Welcome Here? A Preliminary Study of Newcomer Onboarding in the ROS Ecosystem

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Abstract

Open-source software (OSS) development is a fundamental component of modern software systems. The long-term sustainability of OSS projects depends on the continuous onboarding of newcomers to support community work, maintain and develop the codebase, and contribute to the project's evolution [1]. While prior studies have explored the participation of newcomers in traditional software ecosystems (e.g., web development [2]), little is known about the advantages and challenges of newcomers in robotics. In this paper, we present a preliminary investigation of how new contributors onboard and how they engage in contribution activities within the Robot Operating System (ROS) package ecosystem. Using data extracted from 461 ROS repositories hosted on GitHub, we analyze the life of new software contributors in robotics under three dimensions: onboarding activity, type of contribution, and community reception. Our preliminary findings suggest that newcomer onboarding in ROS packages does occur, but it remains limited and concentrated in a relatively small subset of repositories, many of which do not adopt common OSS practices to support the onboarding of new contributors.

Keywords

Newcomers, Onboarding, ROS, Packages, OSS

1. Introduction

Software development ecosystems often rely on open-source solutions to support the implementation of projects [3]. In web development, for example, widely used tools such as React, Angular, and MySQL are distributed for developers and organizations under open-source licenses like the MIT and the GNU General Public License. In the robotics domain, life is no different. The Robot Operating System (ROS), considered by many one of the most popular software solutions in the field, provides open-source packages and libraries for a variety of robots, ranging from educational platforms to industrial systems. Different from proprietary projects, where software engineers are usually hired to implement software, open-source projects like those associated to ROS often depend on the onboarding of external contributors (many of whom are *volunteers*) to keep software repositories active. According to literature, the success of OSS projects is usually influenced by their ability to continuously onboard and retain new contributors [4]. Projects that fail to attract new contributors over time tend to become inactive, creating maintenance gaps in software-dependent ecosystems like robotics [5]. While many OSS projects succeed in retaining developers, onboarding barriers created by both communities and newcomers themselves often prevent potential contributors from joining OSS projects [3]. These barriers include both technical challenges (e.g., a newcomer's ability to understand the code) and community-related challenges (e.g., the community's ability to welcome a newcomer) [6]. The proper onboarding of new contributors has become such a relevant issue for the sustainability of OSS projects that GitHub, one of the most popular code hosting platforms in the world, created its own portal to provide guidance for newcomers and maintainers, the <https://opensource.guide/>. Among their guidelines, key aspects adopted by successful OSS projects are highlighted, including the use of CONTRIBUTING files, the labeling of tasks that are good for new contributors, and the enforcement of a welcoming code of conduct. While prior studies have already explored these onboarding factors in other OSS-related ecosystems (e.g., web development [2], database management [7]), little is known about the life of newcomers and the receptivity of OSS communities in the robotics domain. To the best of our knowledge, our work is the

RoSE'26: 8th International Workshop on Robotics Software Engineering, June 1st, 2026, Vienna, Austria.

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first empirical evaluation focusing on newcomer onboarding in OSS projects for robotics, specifically in the ROS package ecosystem. In this preliminary study, we seek to extend the prior research work by evaluating repositories in the ROS package ecosystem using equivalent onboarding metrics discussed in the literature. Our end goal is to develop strategies that support the continued evolution of the ROS ecosystem through the analysis of software repositories and the design of tools that improve the onboarding of newcomers. This preliminary investigation is concentrated on four primary research questions:

RQ₁ *How many newcomers join ROS package repositories over time?*

RQ₂ *Which ROS package repositories do newcomers most frequently target for their first contributions?*

RQ₃ *What types of initial contributions do newcomers make to ROS package repositories?*

RQ₄ *To what extent do these repositories implement practices that support newcomer onboarding?*

2. Related Work

Newcomer Onboarding in OSS: Prior research has extensively investigated the onboarding and contribution patterns of newcomers within the general open-source software (OSS) landscape [1]. Existing literature suggests that repositories exhibit diverse newcomer growth patterns, usually driven by a variety of organizational and technical factors [8]. For instance, studies indicate that early contribution behavior is a significant predictor of a newcomer’s long-term retention and success [1], while the quality of onboarding resources, such as documentation and mentorship, directly influences onboarding barriers [4]. Furthermore, scholars have conducted analysis of newcomer contributions [9] and characterized the specific repository environments that tend to attract novice developers [10]. They found that developers receiving onboarding support through mentoring were more active at an earlier stage of the contribution process than developers entering projects through other means. Our work extends prior contributions by exploring newcomer onboarding in the robotics domain, a field where the required skill sets differ from those typically found in traditional software engineering environments.

Software Engineering in the ROS Ecosystem: While little is known about the life of newcomers in ROS, researchers have already explored software engineering practices in its ecosystem. For instance, Kolak et al. [11] examined how the need for robotics-specific knowledge influences collaboration among OSS contributors in ROS-based repositories. They found that ROS development is centralized among a small cluster of domain-specific working groups spanning research, industry, and competition teams. Their findings suggest that OSS development in ROS is centralized and dependent on a small number of highly influential groups, an organizational structure that is not commonly seen in other OSS ecosystems. Other related studies around ROS have also explored other dimensions of software engineering, such as the reproducibility of robotics repositories [12] and the inter-dependency of ROS packages [13]. Our investigation provides an initial evaluation of the activity and reception of newcomers in ROS packages, extending prior work on software engineering in ROS.

3. Method

3.1. Repository Selection

To define a clear scope of ROS-related repositories to analyze in our study, we limited our data extraction process to active ROS2 packages hosted on GitHub. By *active*, we refer to packages developed for ROS2 distributions that have not yet reached their end-of-life (EOL), which at the time of data extraction included the Kilted, Jazzy, and Humble distributions (Extraction date: March 2026). Packages are the fundamental unit of organization, build, and release for software in the ROS ecosystem. They can be developed by anyone, from ROS maintainers to external organizations, and therefore provide an appropriate setting for analyzing newcomer-related activities in the ROS ecosystem. Of the 6,253 active packages published on active ROS2 distributions, 5,607 (89.7%) are maintained on GitHub. To identify

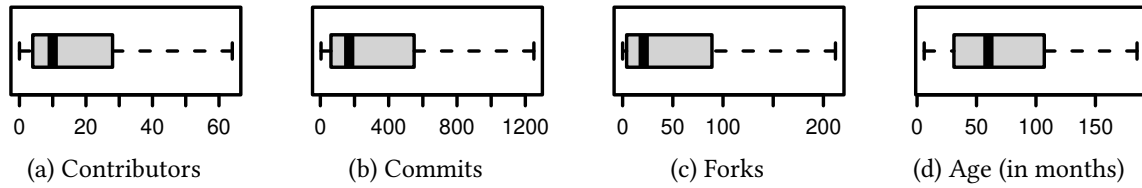


Figure 1: Distribution of repository characteristics in the dataset.

packages currently active in ROS2 distributions and hosted on GitHub, we used ROS Index¹, the official search engine for ROS resources. In total, 875 repositories were extracted from the engine. To ensure a minimum observation period of contributor activity, and to exclude inactive or non-code repositories, we removed from our list package repositories that were: (a) archived, (b) inactive for more than six months, (c) lacking source code, or (e) less than six months old. We also excluded forks of other package repositories, as they may duplicate information already present in the original ones. Among our final list of repositories, 67 (14.9%) belong to the Humble distribution, 10 (2.2%) to Jazzy, and 4 (0.9%) to Kilted. In addition, 380 (82%) repositories appeared in more than one distribution and were included in our final dataset as *multi-distribution* to avoid duplicates. We also observed that 1,382 (85.6%) of the packages in our dataset were hosted in repositories that also contained other packages, resulting in a final set of 461 package repositories for analysis.

3.2. Newcomer and Community Metrics

In this preliminary investigation, we explore onboarding metrics in package repositories from two perspectives: that of the *newcomers* and that of the *community*. From the *newcomer* perspective, our preliminary goal was to analyze (a) the inflow of newcomers per package over time, (b) to identify which types of repository they most frequently target (e.g., core, industrial, or research packages), and (c) to describe the types of first contributions newcomers typically make (e.g., code, configuration, or documentation). To ensure a fair comparison across repositories, we examined the last 28 weeks of newcomer activity for each one, a range corresponding to the age of the youngest repository in our dataset. We identified a newcomer as a developer who made their *first commit* to a repository during a given week. Thus, any developer who contributed at least one commit to a repository in our final set was considered a newcomer in the week of their first contribution. This is a common approach to identify newcomers in OSS ecosystems, adapted from related work [9]. The three newcomer-related investigations (inflow, target repository, and type of contribution) were then conducted by inspecting the first commit of each newcomer, with the type of contribution inferred from the files modified in that commit. In terms of *community* metrics, we examined the presence of newcomer-oriented files in the package repositories, including the existence of README, CONTRIBUTING, PULL_REQUEST_TEMPLATE, ISSUE_TEMPLATE, and CODE_OF_CONDUCT files. We also verified whether repositories used issue labels indicating tasks ideal for newcomers (e.g., good-first-issue). These indicators are commonly present in OSS communities that are more welcoming to newcomers [14], and are strongly encouraged by GitHub’s Open Source Guide.

3.3. Data Extraction and Analysis

The metrics described above were extracted using the GitHub API. From each package repository, we collected commits (for newcomer analysis), issues (for label analysis), repository contents (for file analysis), and metadata (for descriptive analysis). Scripts were implemented in Python and R using standard libraries, including requests for API access, pandas for data analysis, and matplotlib for visualization. Our code and dataset are publicly available in our replication package². In Figure 1, we

¹<https://index.ros.org/>

²<https://github.com/riseatlsu/rose-2026-newcomers>

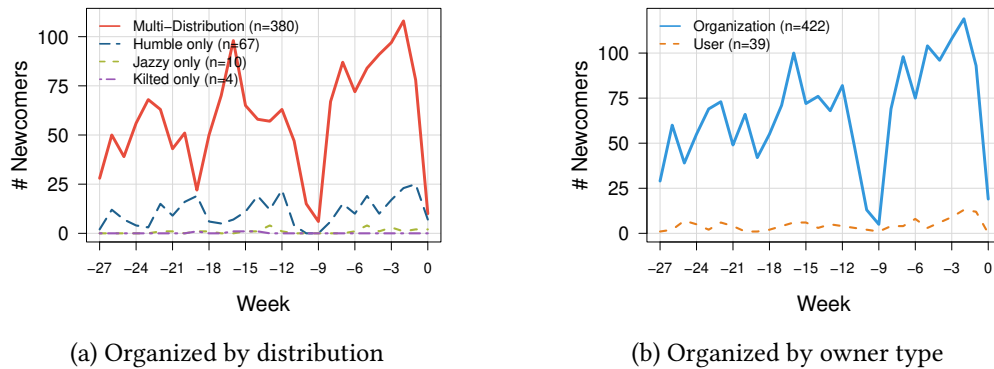
provide a visual overview of our dataset, highlighting the diversity of analyzed repositories in terms of contributors, commits, forks and age.

4. Preliminary Results

(RQ1, RQ2) How many newcomers join ROS package repositories over time, and which repositories do they typically target?

In our preliminary investigation on newcomer onboarding, we analyzed the last 28 weeks (≈ 6.5 months) of activity for each repository, a range that corresponds to the age of the youngest package repository in our dataset. In total, 2,013 newcomers joined package repositories during this period, averaging 70 new contributors per week onboarding the ROS ecosystem. This corresponds to less than one newcomer joining each repository per week, a number substantially lower than what has been reported in other OSS ecosystems [15]. However, additional insights emerge when package repositories are grouped into different clusters. Figure 2 presents the onboarding of newcomers per week across the 461 repositories organized by supported distributions and owner type.

Figure 2: Onboarding of newcomers in the last 28 weeks of activity.



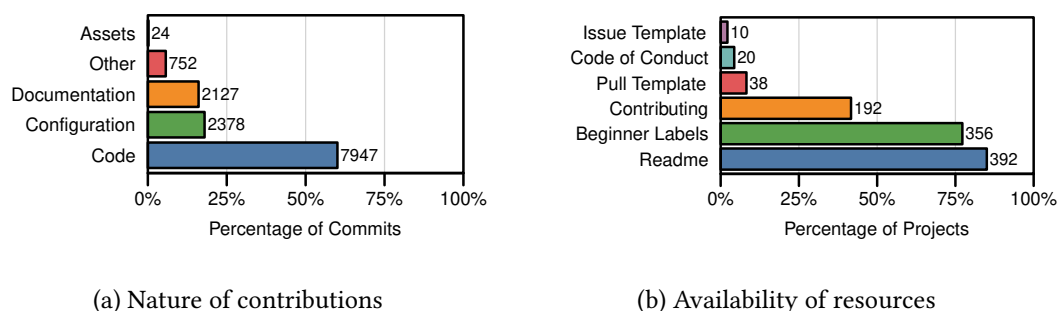
From these charts, we can observe that package repositories supporting multiple distributions and hosted under organizational accounts are more likely to attract newcomers. Of the 2,013 newcomers identified in the last 28 weeks of repository activity, 1,550 submitted their first contributions to packages hosted by well-established organizations supporting multiple ROS distributions. Among the 20 repositories that attracted the highest number of newcomers during this period, 10 (50%) are hosted by the ROS organization itself (e.g., `ros2/rviz`), 3 (15%) by research labs specialized in robotics (e.g., `borglab/gtsam`), 4 (20%) by companies (e.g., `realsenseai/librealsense`), 1 (5%) by a non-profit organization (`autowarefoundation/autoware_core`), and 2 (10%) by an individual user (`facontidavide/PlotJuggler`). These results highlight the prominent role of the ROS organization (Open Source Robotics Foundation) in the ROS ecosystem. They also bring light to the importance of very specialized knowledge in the field, with many of these contributors being experts in robotics. While a variety of non-profit foundations often play a substantial role in attracting new contributors for other open-source ecosystems (e.g., Apache, Mozilla), the ROS ecosystem seems to be more centralized. Instead, research labs and the ROS organization itself account for the most considerable share of the repositories attracting newcomers. Industry-hosted repositories also seem to play a pivotal role in the development of ROS packages, consistent with patterns observed in other OSS environments. These findings are also consistent with previous studies [11], indicating that ROS development is often centralized among relatively small groups of domain experts.

(RQ3, RQ4) What is the nature of first contributions, and how receptive are ROS package repositories to newcomers?

While Figures 1a and 2 show that the number of contributors and newcomers onboarding ROS package repositories is relatively small, Figure 3 highlights findings that may help explain these values. The first

chart presents the types of first contributions made by newcomers in the repositories analyzed. Code contributions account for the majority of initial contributions (60%), followed by changes to configuration settings (18%) and documentation (16%). Other types of contributions, including modifications to assets, are rarely observed as first contributions (6%). While it may seem natural to assume that code contributions are the most suitable starting point for newcomers, the literature suggests otherwise [16]. Prior studies indicate that newcomers are generally expected to first familiarize themselves with the codebase and the basic practices of a project before making more substantial contributions. Starting with smaller tasks, such as improving documentation, may increase the likelihood of having a contribution accepted and can help encourage newcomers to remain engaged with the project. This tendency among new contributors in ROS to submit code changes as their first contribution, possibly driven by limited familiarity with OSS practices, may partially explain the low inflow of newcomers to ROS repositories. This potential lack of familiarity with common OSS practices becomes even more apparent when we

Figure 3: Nature of contributions made by newcomers and the availability of onboarding-related documents.



look at the onboarding resources provided by project maintainers. While 356 package repositories (77%) highlight tasks that are friendly for newcomers, only 192 (41%) explain how they can start contributing to the project. From our set of 461 repositories, only 38 (8%) provide a pull-request template for newcomers to organize their first contribution. These findings suggest two important points: neither newcomers nor project maintainers appear to be fully aware of OSS practices that encourage a higher inflow of contributions. While developers from other ecosystems could potentially help ROS bridge this gap, the specialized expertise required in the robotics domain, combined with development being concentrated within small groups of domain experts, appears to keep ROS within a relatively small contributor base that is not fully aware of foundational OSS practices. Although this dependency may not seem problematic at the moment, it could lead the ROS ecosystem to bigger software development issues as the robotics domain continues to grow.

5. Conclusion and Future Steps

If the central question of this paper is “*Are newcomers welcome here?*”, the answer is yes. Our preliminary findings suggest that, although limited and concentrated in a subset of repositories, the onboarding of newcomers regularly occurs across ROS package repositories. However, further investigation is necessary to better understand the factors that influence the inflow of newcomers, both positively and negatively. Limitations include the time window chosen to study newcomer activity, which may not fully capture contribution patterns across the ROS ecosystem, as well as our definition of a newcomer, which currently does not distinguish between contributors who are new to a specific repository versus new to ROS itself. For future work, we plan to expand the scope of our analysis by examining aspects such as the effectiveness of newcomer-oriented labels, the acceptance and rejection rates of pull requests, and the interactions between newcomers and maintainers within the ROS community.

Declaration on Generative AI

During the preparation of this work, the authors used Gemini 3 and Claude Sonnet 4.6 in order to: Grammar and spell check, Rephrase. After using these tools/services, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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