



# Forges in research software development: evaluating Bitbucket, GitHub, and GitLab for Amsterdam UMC

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<https://doi.org/10.5281/zenodo.11065899>

Version 1, 29 April 2024

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## Introduction

Forges are toolkits for collaboratively developing and distributing software, extending the functionality of distributed version control systems such as git. We seek to integrate forges into research software development at Amsterdam University Medical Center (UMC) in alignment with our data-driven strategy (Daemen et al., 2021). To determine which forge(s) would be most suitable, we evaluated the three forges that are most popular in 2024: [Bitbucket](#), [GitHub](#), and [GitLab](#) (Le Berre et al., 2023). The forge evaluation is covered in the next section. Having selected GitHub, we next evaluated three academic subscription scenarios for GitHub, which are covered in the succeeding section.

The particularities of research software engineering at Amsterdam UMC have similarities with other UMCs, as well as with biomedical and general research software engineering. Hence, we believe this evaluation can be of wider use, so we released it publicly. However, we would like to emphasize that this evaluation is solely the assessment by the authors and is not intended to be absolute. Nor is the evaluation definitive, given that the functionality and offerings of each forge can change over time. We advise the reader to form their own assessment based on their own considerations and research. In support of this, we took some care to reference sources for our statements.

## Forge evaluation

Bitbucket, GitHub, and GitLab are similar in being mature systems that can support relatively sophisticated development workflows, including the use cases listed in [Appendix A](#). For our goals, some specific demands come into play. For example, the dynamic and collaborative nature of research software puts demands on interoperability and user acceptance, while the criticality of medical research puts demands on data security and audit trails.

Informed by a range of stakeholders (see [Acknowledgments](#)), we listed six licensing features ([Table 1](#)), and eight technical and social features ([Table 2](#)). We ranked Bitbucket, GitHub, and GitLab on each of these features as *above average*, *average*, *below average*, or *unknown*. For a general impression of the suitability of each forge, we also calculated a simple unweighted score based on our rankings.

With regard to licensing conditions, GitHub scored highest, tied with or followed by Bitbucket depending on the availability of existing agreements, then GitLab. Regarding technical and social features, GitHub also scored highest, followed by GitLab, then Bitbucket. Hence, we conclude that overall, GitHub may be most suitable for research software development at Amsterdam UMC.

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Table 1. Ratings of Bitbucket (BB), GitHub (GH), and GitLab (GL) on a range of licensing features. Per feature, “+” means that a forge scores above average, “\*” means average, “-” means below average, and “?” that we are unsure how to rate that forge. Counting “+” as +1, “-” as -1, and “\*/?” as 0, Bitbucket’s sum score is 1, GitHub 2 (flat-fee) or 1 (per-seat), and GitLab 0.

Feature	BB	GH	GL	Explanation
Institutions qualifying for academic license	?	*	?	Atlassian is not explicit on which institutions qualify for their <i>Academic license</i> but does refer to non-profit organizations in reference materials (Atlassian, n.d.-a; Percent, 2023). GitHub offers academic licenses via its <i>Campus Program</i> , for which an institution qualifies if it is “a teaching-focused institution that grants degrees or certificates” (GitHub, n.d.-e). GitLab is not explicit on which institutions qualify for their <i>GitLab for Education Program</i> but mentions examples in which research institutes directly owned by a university do qualify and medical research centers do not (GitLab, 2023a).
Free use cases under academic license	-	+	?	Bitbucket does not offer free use cases on their academic license (Atlassian, n.d.-a). GitHub does but restricts use to “non-commercial academic” (GitHub, n.d.-a). GitLab is not explicit, but we assume, based on their reference to a “free license” in their handbook (GitLab, 2023a), that they offer free licenses for “instructional use and non-commercial academic research” (GitLab, 2022).
Pricing	+	+	-	Outside of free use cases, per seat per year, Bitbucket would cost roughly \$69/€63, GitHub \$189/€172, and GitLab \$278/€253. GitHub offers a flat-fee option of \$50,000/€45,500 per year, which is cost-effective at 265 GitHub users (or 1515 Bitbucket users). In these estimations, we assume a relatively high subscription tier for offering a higher level of security instruments, 100 to 1000 seats, no guest seats, Single-Sign-On (SSO) enabled, an exchange rate of \$1 to €0.91, and academic discounts. Given these assumptions, Bitbucket Cloud charges around \$5.5 per seat/month for their Premium tier (Atlassian, n.d.-c), offering a 50% discount on Bitbucket Cloud for qualified institutions (Atlassian, n.d.-d), adding a surcharge of around \$36 per seat/year for SSO. GitHub charges \$21 per seat/month for their Enterprise tier (GitHub, n.d.-d), offering a 25% discount or a flat fee of \$50,000 (GitHub, n.d.-b). GitLab charges \$29 per seat for their Ultimate tier (GitLab, n.d.-b), offering a 20% discount to educational institutions (GitLab, n.d.-a).
Additional conditions of academic license	+	-	+	The free version of the GitHub Campus Program requires (a) that it is made available to all departments of a participating institution (GitHub, 2023c), (b) the right to use the participating organization’s logo (GitHub, n.d.-a), and (c) an opt-out communication channel to reach out to students and staff (GitHub, n.d.-a). We could not find such additional conditions for GitLab (GitLab, 2022) nor Bitbucket (Atlassian, n.d.-d).
Piggybacking on existing agreements	+	-	-	Amsterdam UMC is already purchasing services from the company behind Bitbucket (Atlassian) and could use existing agreements made by SURF <sup>3</sup> with GitHub for the flat-fee version of the GitHub Campus Program (University Unlimited).
Products on academic license	-	+	+	The academic license of GitLab and GitHub covers Software-as-a-Service (SaaS) and self-managed hosting (GitHub, 2023c), while the campus license of Bitbucket only covers SaaS (Atlassian, n.d.-d).

<sup>3</sup> The Dutch National Research and Education Network

Table 2. Ratings of Bitbucket (BB), GitHub (GH), and GitLab (GL) on technical and social features. Per feature, “+” means that a forge scores above average, “\*” means average, “-” means below average, and “?” that we are unsure how to rate that forge. Counting “+” as +1, “-” as -1, and “\*/?” as 0, Bitbucket’s sum score is -4, GitHub 5, and GitLab 2.

Feature	BB	GH	GL	Explanation
Popularity in science	-	+	*	In the science community, GitHub is the most popular forge, followed by GitLab and Bitbucket (Le Berre et al., 2023). Strategy documents on open science tend not to mention Bitbucket, mentioning only GitHub (Akhmerov et al., 2021) or GitHub more often than GitLab (NPOS, 2022; Sufi et al., 2023; Vermaas, 2023). We encountered two research software reports with references to Bitbucket (Bakker et al., 2021; Le Berre et al., 2023). Much existing research software is already on GitHub and training materials focus on GitHub (Carpentries, 2023). Currently, 6 of the 15 Universities of the Netherlands (n.d.) and none of the 7 UMCs are listed under the free GitHub Campus Program (GitHub, n.d.-e).
Purging sensitive data	*	*	+	When sensitive data is accidentally added to a repo hosted by a forge, purging that data requires triggering “garbage collection” at the forge. Bitbucket and GitHub can perform such garbage collection by reaching out to them (Atlassian, 2020; GitHub, 2023f), while GitLab offers a button for it in a control panel (GitLab, 2023d).
Migrating	-	+	*	Because all three forges are based on git, all repository data based on git can be migrated relatively easily. Beyond that, each forge maintains additional metadata such as issues and pull/merge requests that can be migrated to varying extents. We only found documentation on what data is migrated per source forge for GitHub and GitLab (GitHub, 2023d; GitLab, 2023b). Because of GitHub’s popularity in science, adopting GitHub likely requires the least migrations of existing personal repos.
Deployment models	*	-	+	Both self-managed Bitbucket, GitHub, and GitLab support installing to a range of cloud/cluster platforms, such as AWS, and virtual containers, such as Docker for Bitbucket and GitLab or VMware for GitHub (Atlassian, n.d.-e, n.d.-g; GitHub, n.d.-c; GitLab, 2023c). In addition, Bitbucket and GitLab offer support materials for installing flavors of Linux (Atlassian, n.d.-e; GitLab, 2023c), while GitHub only does so for virtual containers. GitLab has been described as the easiest to install, and is therefore the most popular option for self-managed forges (Le Berre et al., 2023).
Web-service integration	-	+	*	Science-oriented web services tend to have the best support for GitHub, medium support for GitLab, and little support for Bitbucket. For illustration, we report on three such services: Zenodo, Research Software Directory (RSD), and SOMEF (Kelley & Garijo, 2021). Zenodo’s automated archiving is only supported for GitHub (Zenodo, n.d.), with GitLab having been discussed (Rampin, 2017). We found no mention of Bitbucket. Both the Research Software Directory and SOMEF can extract metadata from repos on GitHub and GitLab, but not Bitbucket (Garijo, 2024; Maassen, 2022).
Single Sign-On (SSO)	-	+	+	All three forges offer SSO based on SAML, which enables us to set up a connection with SurfConext. For GitHub (GitHub, 2023a) and GitLab (GitLab, 2023e), SSO is offered without any surcharge, while Bitbucket charges per seat for it via their Atlassian Access subscription (Atlassian, n.d.-b).
Roles and permissions	-	+	*	Bitbucket supports a set of four predefined roles (Atlassian, n.d.-f), while both GitHub (GitHub, 2023b) and GitLab (GitLab, 2024) allow custom user roles with custom authorizations, with GitHub having the largest variety of authorizations available.
Client-side GUIs	+	+	-	Bitbucket and GitHub offer dedicated client-side GUIs (Atlassian, 2023; GitHub, 2023e), but GitLab does not.

## GitHub Campus subscription scenarios

Based on the evaluation, the GitHub Campus Program was selected for further examination. We selected GitHub Cloud, preferring SaaS to the efforts required to maintain a self-managed solution and adequately respond to incidents (e.g., Toulas, 2024). We compared the three SaaS subscription types offered under the Campus Program. Their distinguishing characteristics are listed in Table 3 and summarized in a brief evaluation below. We recommend starting with a paid-per-seat for early adoption in research software. We could later switch to a flat-fee subscription if the range of use cases or number of seats would warrant doing so.

- **Free license.** *Free, but perhaps more effort than it's worth.* The free license is naturally very cheap but sets some challenging terms of use, which can pose a risk to availability if violated. Likely, we would also need to facilitate use cases that are not “non-commercial academic”, requiring a paid-per-seat or flat-fee subscription in addition to the free license and an administration to track which repo falls under which subscription.
- **Paid-per-seat.** *Balanced efforts and pricing; especially attractive for early adoption in research software.* No challenging terms nor usage restrictions and cheaper than a flat-fee subscription for up to 265 seats. Some governance is required to track department-level use, which can be difficult when allowing unrestricted GitHub use. This difficulty does not apply to research software, since research software will be governed relatively carefully already.
- **Flat-fee.** *Least effort but a high price; attractive when scaling up seats and use cases.* The flat-fee subscription is cheaper with 265 seats onwards and lends itself to looser governance models. Hence, it might become attractive at a later stage. A benefit of starting with the flat-fee subscription is the option to piggyback on existing agreements on a national level.

Table 3. Three types of GitHub Cloud subscriptions (free license, paid per seat, and flat-fee), with distinguishing characteristics per subscription.

Characteristic	Free license	Paid-per-seat	Flat-fee
Challenging terms of use	(1) Offer organization-wide, (2) Share logo, (3) provide a communication channel.	No distinct efforts.	No distinct efforts.
Legal effort	Test GitHub against our privacy, security, and reliability policies.	Test GitHub against our privacy, security, and reliability policies.	Use existing agreements made by SURF with GitHub.
Governance effort	Provide a mechanism for supporting GitHub outside of the free use cases (i.e., “non-commercial academic”).	Offer for free to individuals. Charge a department when their number of seats exceeds a threshold.	No distinct efforts.
Price	Free.	€172 per seat per year. Flat-fee is cheaper starting at 265 seats. We expect 50 seats in the first year.	€45,500 per year.
Risks	If we breach the terms of the free license, GitHub can terminate the agreement after an optional grace period of unspecified length.	No distinct risks.	No distinct risks.

## Appendix A. Forge use cases

Below is a list of forge use cases supported by Bitbucket, GitHub, and GitLab.

- **Cloning and synchronizing changes between remote repos**, which is known in git parlance as “tracking branches” and on GitHub as “forking”.
- **Adjusting the visibility of repos**, distinguishing between repos that are accessible from the outside (public) or only to a select set of users (private).
- **Setting up repo governance**, by distinguishing between roles such as administrators (who can set up permissions for other users), developers (who can change the source code), and other users (who can only view the source code and/or post new issues/discussions).
- **Setting up access control**, such as enforcing 2-factor authentication or limiting access to a specific IP range.
- **Setting up organization structures**, by organizing users into teams and sub-teams
- **Proving access to external users** on a case-by-case basis.
- **Advertising and archiving a software release**. Note that it is becoming increasingly common to advertise software releases via registries such as the [Research Software Directory \(RSD\)](#), while services such as [Zenodo](#) can offer a guaranteed long-term archive.
- **Managing discussions**, which can concern code reviews in the form of Pull Requests (PRs) or Merge Requests (MRs), issues and bugs, or more general discussions, such as Q&A.
- **Maintaining documentation**, such as a knowledge base in the form of a wiki.
- **Continuous Integration and Continuous Delivery/Deployment**, which concerns automating parts of the development, such as testing, building, and sometimes deploying.
- **Forge-hosted websites**, generally known as “Pages” functionality, i.e., “GitHub Pages”

## Acknowledgments

This evaluation was informed by earlier research performed by Jacob Rousseau and Ronald van Schijndel from Amsterdam UMC and an internal forge evaluation shared by Meron Vermaas from Vrije Universiteit Amsterdam. We also consulted, from Amsterdam UMC, Arno Sinjewel, Daoud Sie, Floris Wiesman, Hans van den Berg, Mar Barrantes Cepas, Michel Paardekooper, Roxane Boyer, Rudy Scholte, and Tom Fuchs. From SURF, we consulted Giacomo Cannizzaro, Natascha van Lieshout, and Rogier de Jong. Assisted by Meron Vermaas, we consulted, from Vrije Universiteit Amsterdam, Kees Verstoep, Max Paulus, Rob Limburg, and Sophie Arnoult. The participants of the NFDI4DataScience Hackathon ([Castro et al., 2023](#)), organized by Leyla Jael Castro at ZB MED, provided insights into the wider tooling ecosystems that forges are part of. Finally, Sam Langton from Amsterdam UMC reviewed and edited the penultimate version of this document. We would like to thank the people above for all their valuable input.

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