

Version control with Git, Github and Gitlab



Team project workshop

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- 1) Git
 - 1) Basics
 - 2) Internals
 - 3) Remote repos
 - 4) Merge, rebase, conflicts
- 2) Forges (Github, Gitlab, Gitea, SourceHut)
- 3) Github
 - 1) Issues
 - 2) Pull Requests
 - 3) CI/CD
 - 4) External services (codecov)
 - 5) Github Pages

- Version control system
- Started by Linux Torvalds for version control of the Linux kernel
- Distributed – no need for a central repository (peer-to-peer)
- Fast, efficient
- Command line tool + many GUIs
 - `git <subcommand> ...`



The screenshot shows the Git website homepage. At the top, the Git logo is followed by the tagline "--local-branching-on-the-cheap". Below this is a search bar. The main content area features a paragraph describing Git as a free and open source distributed version control system, followed by another paragraph highlighting its ease of learning and performance. To the right of the text is a diagram illustrating a branching model with stacks of code and arrows showing the flow between branches. Below the text are five icons with corresponding links: About, Documentation, Downloads, and Community. On the right side, there is a section for the latest source release (2.35.1) with a download button for Linux. At the bottom right, there are links for Linux GUIs, Tarballs, Mac Build, and Source Code.

git --local-branching-on-the-cheap

Search entire site...

Git is a **free and open source** distributed version control system designed to handle everything from small to very large projects with speed and efficiency.

Git is **easy to learn** and has a **tiny footprint with lightning fast performance**. It outclasses SCM tools like Subversion, CVS, Perforce, and ClearCase with features like **cheap local branching**, convenient **staging areas**, and **multiple workflows**.

About
The advantages of Git compared to other source control systems.

Documentation
Command reference pages, Pro Git book content, videos and other material.

Downloads
GUI clients and binary releases for all major platforms.

Community
Get involved! Bug reporting, mailing list, chat, development and more.

Pro Git by Scott Chacon and Ben Straub is available to **read online for free**. Dead tree versions are available on **Amazon.com**.

Latest source Release
2.35.1
[Release Notes \(2022-01-29\)](#)
[Download for Linux](#)

 **Linux GUIs**

 **Tarballs**

 **Mac Build**

 **Source Code**

Git use cases

- Source code version management
- Documentation (e.g. Markdown)
- Wiki
- Website
- Configuration management
- File comparison (advanced diff)
 - observing changes in program output
 - ...
- Storage of virtual machine images...
 - extensions like *git lfs* and *git annex*

Basics commands (local repo)

- Basic commands
 - git init – create an empty repository
 - git add – add files to index (staging area)
 - git add -p
 - git commit
 - git log
 - git diff
 - git diff –color-words
 - git help, git <command> --help
 - git stash
- “Built-in” GUI
 - git gui – for creating commits
 - gitk – history viewer
- Branches, tags
 - Branch = “pointer” to a commit
 - typically the last commit in development history
 - creating a commit updates the pointer
 - Tag = “fixed pointer” to a commit
 - versions, releases
 - Merging, rebasing – see later
 - git branch
 - git checkout/switch
- HEAD – points to the currently active commit
 - usually same as current branch
 - can be detached from a branch (risky)

Working with remote repositories

- git clone – create a local copy of a remote repo
- git fetch – download updates from remote repo, but don't modify any local files, commits etc.
- git push – push local changes to the remote repo
 - diverging branches
 - force pushing (--force, --force-with-lease)
- git pull – pull remote changes to the local repo
 - fetch + merge
- git remote – working with multiple remote repos
 - upstream (typically read-only)
 - personal fork (read-write)
 - local CI server
 - multiple personal computers
- Remote branches
 - Each remote has its own branch namespace
 - Easy to compare state of repositories
 - local branch can be set up to track a remote branch
 - git push/pull works automatically
 - visible in `git branch -vv`

Investigating git history

- `git log` \cong `gitk` – show history, accepts similar arguments
- Specifying revisions and ranges:
 - `<commit>` = hash, branch, tag, ...
 - `git rev-parse -help`
- Revisions:
 - `gitk` = `gitk HEAD`
 - `gitk HEAD^`, `gitk HEAD^^` – parent commits
 - `gitk mybranch~5` – five commits back from `mybranch`
 - `gitk main mybranch` – show two branches
- Ranges
 - `gitk HEAD~5..HEAD` = `HEAD~5..` - five last commits
 - `gitk main..myfeature` = `gitk myfeature ^main`
Commits in `myfeature` but not in `main`.
 - Symetrical difference:
`gitk main...myfeature`
- Filter by file, directory
 - `gitk ... [--] subdirectory`
 - Follow file renames:
`gitk --follow dir/file`

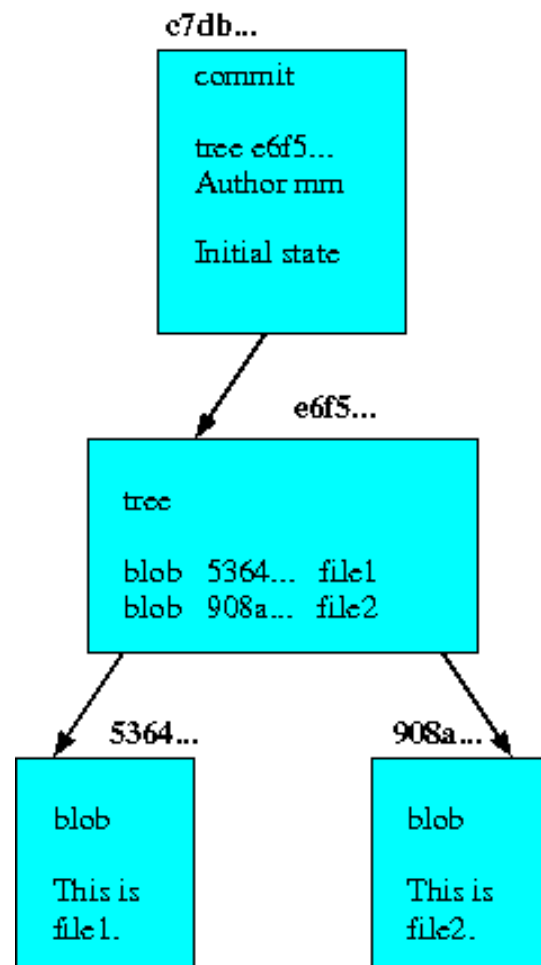
- Very efficient storage of history:
 - Unpacked Linux 5.16 sources:
 - `du -sh --exclude=.git: 1.2 GiB`
 - 17 years of Linux development history = 1.06 million commits = 170 commits every day (in average)
 - `du -sh .git: 2.6 GiB`

Git internals – components

- **Object Database**
 - collects objects of four types:
 - blob,
 - tree,
 - commit,
 - tag
 - objects are addressed by SHA1 hash of their content
 - individual objects can shown by `git cat-file -p <hash-or-similar>`
- **Index (staging area)**
 - current tree **cache**
 - stores the next revision to be committed

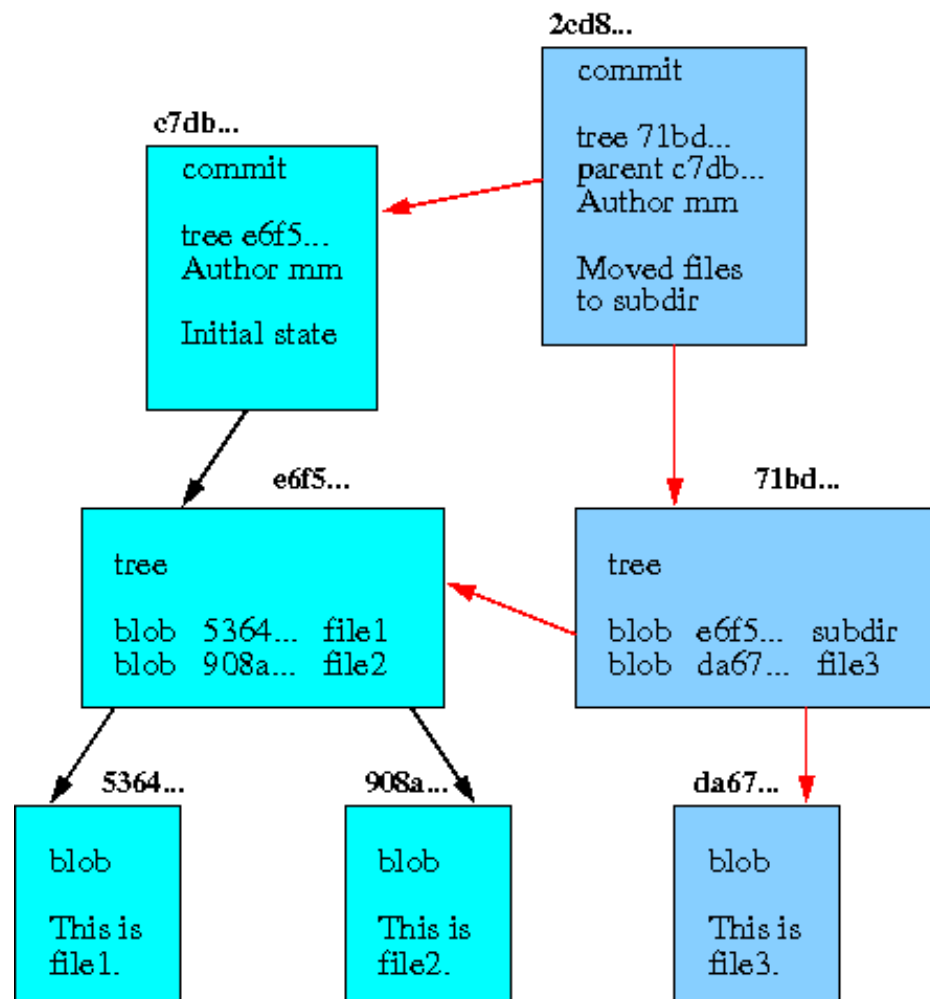
Example: Object Database I.

- 1. Start with a new repository
- 2. Create file1 with the content: "This is file1."
- 3. Create file2 with the content: "This is file2."
- 4. Update the index
- 5. Make an initial commit



Example: Object Database II.

- 1. Move file1 and file2 into subdirectory
- 2. At top level, create file3 with the content: "This is file3."
- 3. Update the index
- 4. Make a commit



- **blob object**
 - represents **contents** = one version of a file
 - if two files in a directory tree (or in multiple different versions of the repository) have the same contents, they will share the same blob object
- **tree object**
 - represents one directory
 - contains sorted list of text lines with the following information: *mode, object type, SHA1, path name*
 - information about blobs and tree objects lying in the directory
 - several tree objects forms hierarchical directory **structure**

- **commit object**

- contains by the reference to related tree object, the parent commits, commentary
- sequence of commit objects provides the history
- commit objects tie the directory structures together into a acyclic graph (DAG)

- **tag object**

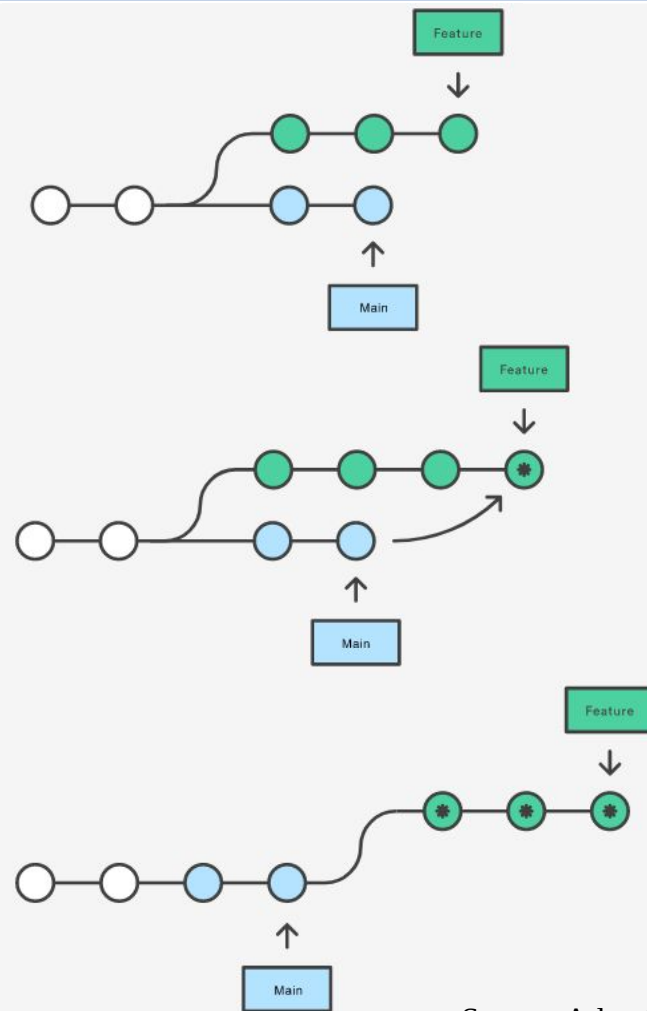
- assigns symbolic name to particular object reference e.g. commit object associated with a named release
- contains SHA1, object type, symbolic name of referenced object and optionally a signature

Objects are not compressed individually, but together – multiple (similar) versions of the same blob are compressed together ⇒ efficient.

- simple binary file, which contains an efficient representation of a virtual directory content
- it is implemented by a simple array that associates a set of names, dates, permissions and content (blob) objects together
- serves as staging area to prepare commits
- helps with merge conflict resolution
- improves performance (speed of operations)

Merging, rebasing, conflicts

- `git checkout feature`
- `git merge main`
 - Creates a commit with two parents and merged content
- `git rebase main`
 - Moves all commits from feature on top of main
 - Don't use on public branches!!!
- `git rebase -i`
 - interactive rebase = editing history (commits, commit messages, ...)



Source: Atlassian

Handling of merge/rebase conflicts

- Why conflicts emerge? Two people edit the same piece of code.
- Must be resolved manually
- Tools can help (e.g. gitk -merge, git mergetool)
- git merge branch
Auto-merging src/boardproxy.cpp
CONFLICT (content): Merge conflict in src/boardproxy.cpp
Recorded preimage for 'src/boardproxy.cpp'
Automatic merge failed; fix conflicts and then **commit** the result.

```
static struct argp argp = {
    options, parse_opt, "[SOCK_DIR]",
    <<<<<< HEAD
    "Great tool to access a pool of remote boards (or other resources) with "
    "Access a pool of remote boards (or other resources) with "
    "Poor tool to access a pool of remote boards (or other resources) with "
    >>>>>> conflict
    "connection proxying via SSH port forwarding."
};

int main(int argc, char *argv[])
{
    argp_parse(&argp, argc, argv, 0, 0, NULL);
}
```

- After merge conflict:
 - git merge --abort
 - Fix conflict and then:
git merge - -continue
- After rebase conflict:
 - git rebase --abort
 - git rebase --skip
 - Fix conflict and then:
git rebase --continue

- Github.com

- proprietary (Microsoft)
- most popular
- single point of failure for open source movement
- Used mostly in the following slides



- Gitea

- open source (<https://gitea.io/>)
- very good for self-hosting (easy to install)
- codeberg.org



- Gitlab

- open source
- gitlab.com, gitlab.fel.cvut.cz
- feature-wise comparable to github



- sourcehut

- open source
- hacker friendly
- <http://sr.ht>

Typical forge features

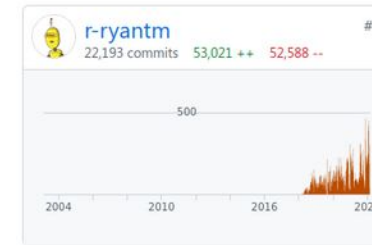
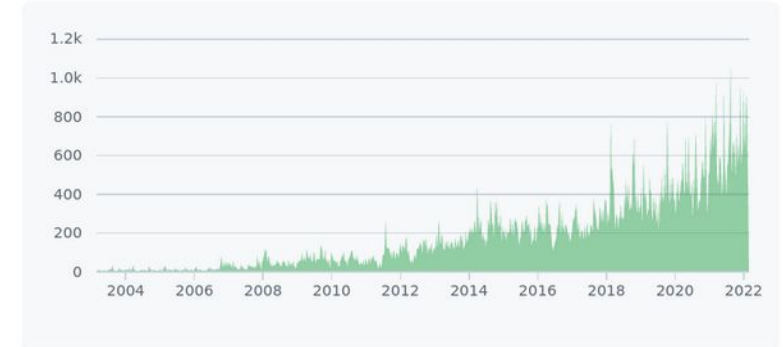
- Organizations/Teams/Repos
- Issues/Tickets
- Pull requests (Merge requests)
- Continuous integration (CI/CD)
- Integration with 3rd party tools (webhooks, ...)
- Websites (pages), Wiki
- Release management
- Project management
- Development statistics



Mar 9, 2003 – Mar 8, 2022

Contributions: Commits ▾

Contributions to master, excluding merge commits and bot accounts






 **CTU-IIG / demos-sched** Public

 Pin

 Unwatch 7 ▾

 Fork 1

 Star 0 ▾

 Code  Issues 13  Pull requests 1  Actions  Projects  Wiki  Security  Insights ...

Repositories

- Creating a new repository (few clicks)
 - Specify the license for public repos (otherwise, nobody can use your project legally)
- Forking existing repositories
 - Mostly for proposing changes to the original (upstream) repo

Types of repositories on Github

- Personal repos: username/reponame
 - simple permission management (write or nothing)
- Organizations: orgname/reponame
 - Team member management
 - Role management (admin, maintain, write, triage, read)

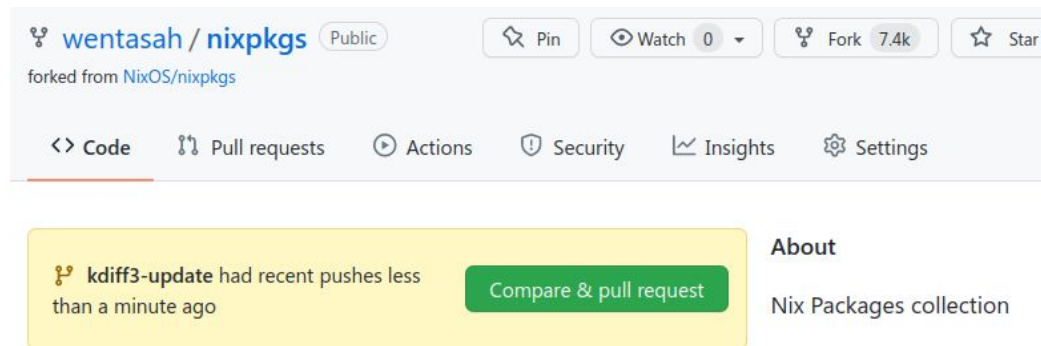
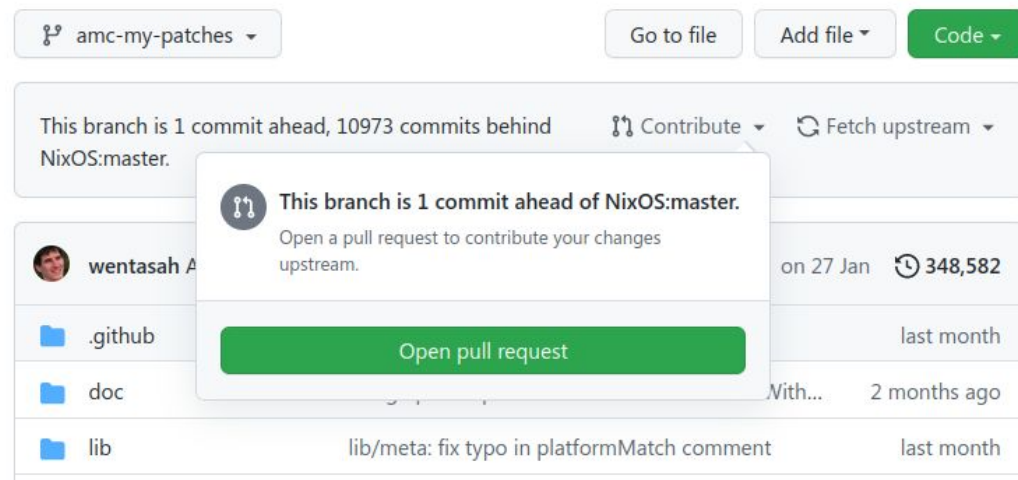
Issues

- Communication between users
- Templates ([documentation](#))
`.github/ISSUE_TEMPLATES/...`
- Labels (bug, question, ...)
- References ([documentation](#))
 - to other issues: #NN
 - to issues in other projects: owner/repo#NN
- Automatic closing of issues with keywords in commits/PRs ([documentation](#)):
Closes #13, Fixes #34, ...

• Scarab Hollow Knight mod installer	0.kind: packaging request	1
#162865 opened 3 days ago by l0b0		
• Gitea service's option mailerPasswordFile does not work.	0.kind: bug	
6.topic: nixos		
#162853 opened 3 days ago by dit7ya		
• comixcursors: longDescription renders wrong	6.topic: documentation source	
9.needs: documentation		
#162844 opened 3 days ago by DerickEddington		
• nginx no index for virtualhost	6.topic: nixos	2
#162840 opened 3 days ago by blobcode		
• Frequent Killed: 9 with rust on M1 Mac	0.kind: bug	3
6.topic: rust		
#162795 opened 4 days ago by n8henrie		
• element-{web,}: 1.10.6	9.needs: package (update)	1
#162733 opened 4 days ago by genofire		
2 tasks done		
• surf: Functionality reliant on WebKitWebExtension broken	0.kind: bug	1
#162727 opened 4 days ago by ninjin		
• Packaging Request: cfn-nag (Gem)	0.kind: packaging request	
6.topic: ruby		
#162708 opened 4 days ago by WolfgangAukang		
• boost: needsUserConfig setting not compatible with enableStatic on Darwin	0.kind: bug	
6.topic: darwin		
#162699 opened 4 days ago by kfiz		
• Invalid bubblewrap config in lutris	0.kind: bug	1
#162693 opened 5 days ago by jclangst		
• perlPackages.AppSqitch: 1.2.1	9.needs: package (update)	
#162687 opened 5 days ago by sekunho		
2 tasks done		
• Declarative containers ignore networking.nameservers, even with privateNetwork=true	0.kind: bug	2
6.topic: nixos-container		
#162686 opened 5 days ago by delroth		







Pull requests (PR, Github), Merge requests (MR, Gitlab)

- For proposing changes and discussing about them
- Opened via “contribute” link or offered after push:
- source branch, destination branch
 - same repo
 - from fork to upstream repo
- Protected branches
 - restriction of direct pushes to the branch
 - configurable rules:
 - Require PR before merging
 - Required number of approvals
 - CI status



Continuous integration/deployment

- Run test suite, checks, ... on every push, PR, time, ...
- Github Actions ([quickstart docs](#))
 - Configured with a YAML file ([doc](#)) in `.github/workflows` directory in the repo.
 - When to run, what to run
 - Test matrix (test your code with multiple versions of a dependency)
 - Github Actions run in the cloud (2 CPUs, 7 GB RAM) or on self-hosted runners ([doc](#))
 - You can execute plain (Linux) commands (*run* keyword) or whole actions (*uses* keyword)
- Secret management
- problem-matchers
- Example with a simple (1D) matrix and 3rd-party actions:
<https://github.com/wentasah/meson-mode/blob/master/.github/workflows/run-tests.yml>
- Example with combination of 3rd-party actions and “run” commands:
<https://github.com/wentasah/boardproxy/blob/main/.github/workflows/test.yml>

 Complie Complie #37: Scheduled	4 months ago 2m 2s	...
 Complie Complie #36: Scheduled	4 months ago 1m 57s	...
 github: Also test with meson --wrap-mode=forc... Complie #35: Commit 41c5fa7 pushed by wentasah	4 months ago 2m 21s	... main
 github: Also test with meson --wrap-mode=forc... Complie #34: Commit 369acde pushed by wentasah	4 months ago 1m 36s	... main
 Test build with different versions of dependencies Complie #33: Commit d2d0064 pushed by wentasah	4 months ago 1m 33s	... main
 README: board -> board's Complie #32: Commit c1ba27f pushed by wentasah	4 months ago 47s	... main

Integration of 3rd-party services

- Example: <https://codecov.io>
- Generate test coverage report as a part of your CI
- Upload the report to codecov.io:
- [Example workflow](#)

steps:

- ...
- **name:** Generate coverage report
run: `ninja -C build coverage-xml`
- **name:** Upload coverage to Codecov
uses: `codecov/codecov-action@v2`
with:
 - directory:** `./build/meson-logs`
 - fail_ci_if_error:** `true`
 - verbose:** `true`

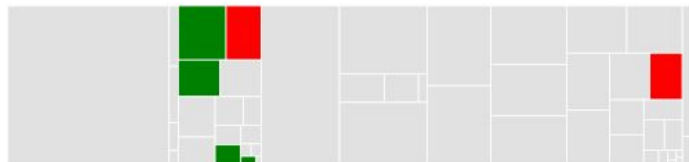


codecov-commenter commented on 14 Dec 2021



Codecov Report

Merging #74 (073f056) into master (51086b7) will decrease coverage by 1.60% .
The diff coverage is 2.47% .



Coverage Diff				
##	master	#74	+/-	##
=====				
- Coverage	36.39%	34.79%	-1.61%	
=====				
Files	46	50	+4	
Lines	2459	2578	+119	
Branches	1117	1172	+55	
=====				
+ Hits	895	897	+2	
- Misses	1094	1209	+115	
- Partial	470	472	+2	

Impacted Files	Coverage Δ	
src/power_policy/_power_policy.cpp	22.22% <0.00%> (-1.59%)	

Gitlab webhook examples

- Run a script on every push:
<https://gitlab.fel.cvut.cz/sojkam1/brute-async/-/blob/master/gitlab-webhook-receiver.py>
- Manage issues for osy.pages.fel.cvut.cz
(uses Gitlab HTTP API):

```
#!/usr/bin/env python3
import gitlab

cviceni = { ... }
teachers = { .... }

def application(env, start_response):

    def handle_event(env, event):
        if \
            not "HTTP_X_GITLAB_TOKEN" in env \
            or env['HTTP_X_GITLAB_TOKEN'] != \
                HTTP_X_GITLAB_TOKEN:
            return False

        if event['object_kind'] == 'issue' and \
            event['object_attributes']['action'] == 'open':
            return handle_open_issue(env, event)

    return True
```

```
def handle_open_issue(env, event):
    gl = gitlab.Gitlab('https://gitlab.fel.cvut.cz', env['GITLAB_API_TOKEN'])
    p = gl.projects.get(event['project']['id'])
    student = event['user']['username']
    teacher = teachers[cviceni[student]]
    users = p.users.list(search=teacher)
    for u in users:      # Find exact username
        if u.username == teacher:
            user = u
    issue = p.issues.get(event['object_attributes']['iid'])
    if re.search('přednáška.*slide', event['object_attributes']['title'],
        re.IGNORECASE) is not None:
        # Přednáška
        issue.labels.append('Přednášky')
    else:
        # Cvičení - přiřad' cvičícího
        if not event['object_attributes']['assignee_ids']:
            issue.assignee_ids = [user.id]
    issue.save()

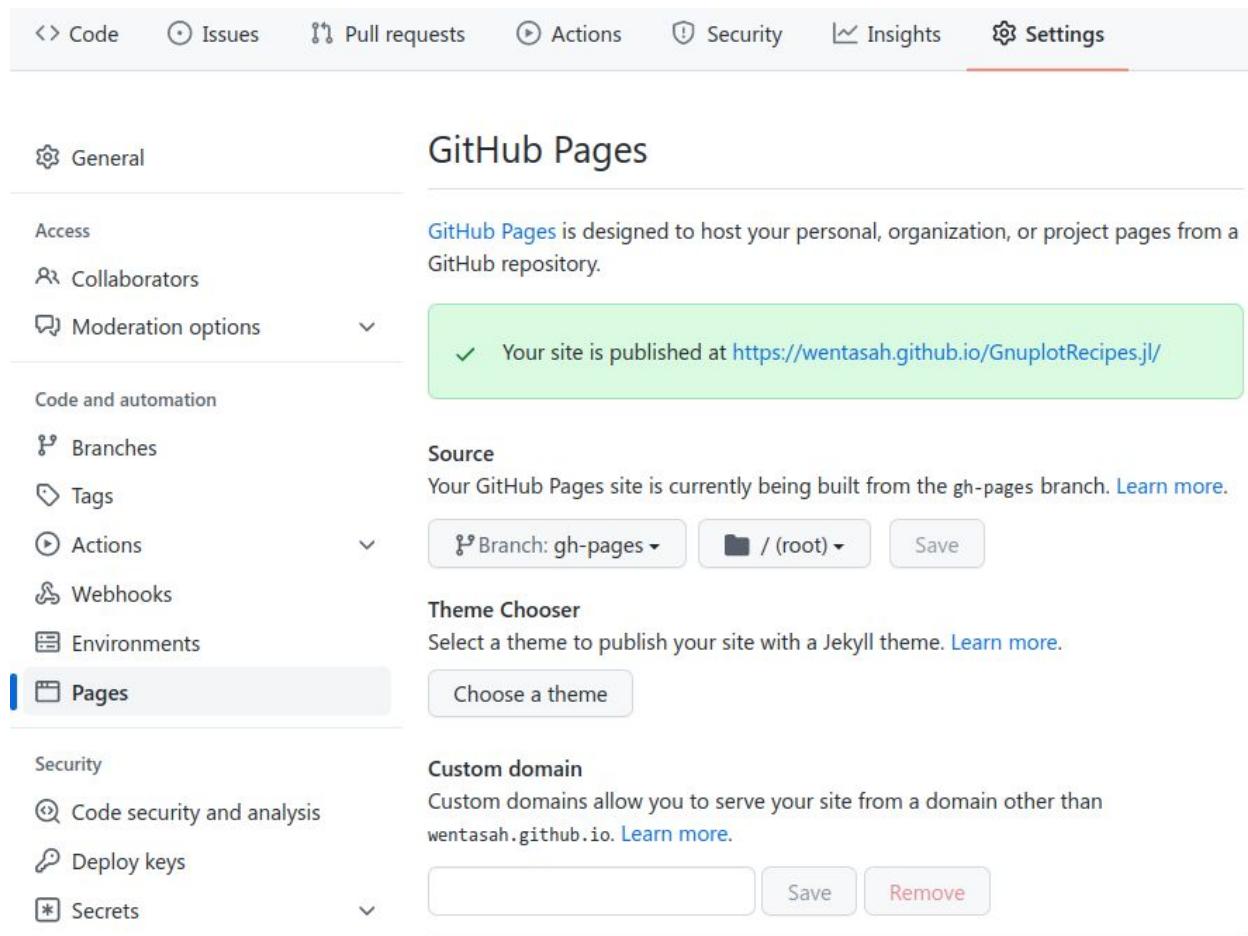
    if event['object_attributes']['confidential']:
        issue.notes.create({'body': textwrap.dedent("""
            Je opravdu nutné utajovat toto issue? Sdělujete nám
            zde svá hesla, čísla platebních karet apod.? Pokud ne,
            změňte prosím toto issue na veřejné, aby odpovědi
            učitelů byly dostupné i ostatním.

            """))})

    return True
```


Github/Gitlab pages

- Maintain a website in a git repo
 - Documentation to a project
 - Plain web sites, ...
- Content in Markdown (or similar) formats
- Every push triggeres CI/CD and updates the web site
- Github – [Jekyll static site generator](#)
- Other SSG: [Hugo](#)
- Gitlab example:
<http://osy.pages.fel.cvut.cz/>
 - CI config with Hugo



The screenshot shows the GitHub repository settings page for a repository named 'GnuplotRecipes.jl'. The 'Settings' tab is selected in the top navigation bar. On the left sidebar, the 'Pages' section is highlighted. The main content area is titled 'GitHub Pages' and contains the following information:

- Access:** General, Collaborators, Moderation options.
- Code and automation:** Branches, Tags, Actions, Webhooks, Environments.
- Pages:** This section is active and shows:
 - Source:** Your GitHub Pages site is currently being built from the gh-pages branch. A green box indicates the site is published at <https://wentasah.github.io/GnuplotRecipes.jl/>. Below this, there are dropdowns for 'Branch: gh-pages' and '/ (root)', and a 'Save' button.
 - Theme Chooser:** Select a theme to publish your site with a Jekyll theme. A 'Choose a theme' button is present.
 - Custom domain:** Custom domains allow you to serve your site from a domain other than wentasah.github.io. A text input field is empty, with 'Save' and 'Remove' buttons.
- Security:** Code security and analysis, Deploy keys, Secrets.