

Git & GitHub

Introdução Engenharia Informática

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Exercises

Practical Lab: Git & GitHub

From Local Repository to Open-Source Collaboration

Objective: This lab will guide you through the complete lifecycle of a Git repository. You will learn to create a local repository, manage versions, work with branches, and finally, collaborate on a remote project using GitHub.

Prerequisites:

- **Git Installed:** You must have Git installed on your machine.
 - **A GitHub Account:** You will need a free GitHub account for the collaboration exercises.
 - **A Text Editor:** Any text editor (like VS Code, Sublime Text, or Nano) will work.
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Part 0: Setup & Authentication

Before we can work with remote repositories, we need to install Git and tell GitHub who we are.

Step 1: Install Git

On Debian-based systems (like debian trixieOS or Ubuntu), you can install Git using apt.

1. First, update your package list:

```
$ sudo apt update
```

2. Then, install Git:

```
$ sudo apt install git
```

Step 2: Configure Your Identity

You must tell Git your name and email. This information will be baked into every commit you make.

```
$ git config --global user.name "Your Name"
$ git config --global user.email "your.email@ua.pt"
```

(Use your UA email.)

Step 3: Authenticate to GitHub

To push your code to GitHub, you must prove who you are. You have two main options: SSH (recommended) or a Personal Access Token (PAT).

Method 1: Using an SSH Key (Recommended)

This method is more secure and convenient. You add a “key” to your GitHub account, and your computer uses it to authenticate automatically.

1. Generate a new ed25519 SSH key. This command creates a key pair without asking for a password (-N "").

```
$ ssh-keygen -t ed25519 -C "your.email@example.com" -f ~/.ssh/id_ed25519 -N ""
```
2. Display your new **public** key in the terminal so you can copy it.

```
$ cat ~/.ssh/id_ed25519.pub
```
3. Copy the entire output (starting with ssh-ed25519 ... and ending with your email).
4. Add the key to GitHub:
 - Go to **GitHub.com** and click your profile icon in the top-right.
 - Go to **Settings** -> **SSH and GPG keys** (in the "Access" sidebar).
 - Click **New SSH key**.
 - Give it a **Title** (e.g., "My TrixieOS Laptop").
 - Paste your copied key into the **Key** box.
 - Click **Add SSH key**.

Method 2: Using a Fine-Grained Personal Access Token (PAT)

A PAT is like a password that you can use for Git operations.

1. Go to **GitHub.com** -> **Settings** -> **Developer settings** (at the bottom of the sidebar).
2. Go to **Personal access tokens** -> **Fine-grained tokens**.
3. Click **Generate new token**.
4. Set the following options:
 - **Token name:** Give it a descriptive name (e.g., "IEI Class Token").
 - **Expiration:** Select **No expiration**.
 - **Repository access:** Select **All repositories**.
 - **Permissions:** Scroll down to "Repository permissions" and find **Contents**. Change its access to **Read and write**.
5. Click **Generate token**.
6. **IMPORTANT:** Copy the token (it starts with github_pat_ ...) *immediately*. You will **never** see it again after you leave this page.
7. When you need to connect to GitHub (in Part 2 and 3), you will use this token in the URL:

```
https://<YOUR_USERNAME>:<YOUR_TOKEN>@github.com/<YOUR_USERNAME>/<REPOSITORY>.git
```

Part 1: Your Local Repository

Exercise 1: git init (Creating a Repository) Our first step is to tell Git to start tracking a new project.

1. Create a new folder for your project and navigate into it.

```
$ mkdir my-git-project  
$ cd my-git-project
```
2. Now, initialize it as a Git repository.

```
$ git init
```
3. This creates a hidden .git folder. You've officially created a repository!

Exercise 2: The Core Loop (add, commit, status, log) Let's create a file, "stage" it, and "commit" it to our history.

1. Create a file named index.html inside your my-git-project folder and add the following content:

```
<h1>Welcome to My Project</h1>
```
2. Check the "status" of your repository.

```
$ git status
```

Git will show you index.html as an "untracked file."
3. Tell Git you want to track this file by adding it to the **Staging Area**.

```
$ git add index.html
```

4. Check the status again. The file is now “staged” and ready to be committed.

```
$ git status
```

5. Now, save this “snapshot” to your history with a **commit**.

```
$ git commit -m "Initial commit: Add homepage"
```

6. Finally, look at the history log.

```
$ git log
```

Exercise 3: Fixing a Bad Commit (--amend) Good commit messages are vital. Let’s fix a bad one.

1. Make a small change to `index.html`. For example, add a paragraph:

```
<h1>Welcome to My Project</h1>
<p>This is a project for my IEI class.</p>
```

2. Commit this change with a **bad** message. The `-a` flag is a shortcut for `git add` (for tracked files) and `git commit`.

```
$ git commit -a -m "fix stuff"
```

3. Check your log: `git log --oneline`. You’ll see your “fix stuff” message. Let’s fix it.

4. Run the **amend** command. This will replace your *previous* commit with a new one.

```
$ git commit --amend -m "Doc: Update homepage text"
```

5. Check your log again: `git log --oneline`. The “fix stuff” commit is gone, replaced by your better message.

Exercise 4: Ignoring Files (.gitignore) We never want to commit secret keys or temporary files.

1. Create a file named `.env` and add a “secret” to it.

```
$ echo "DATABASE_PASSWORD=12345" > .env
```

2. Run `git status`. You’ll see Git wants to add `.env`. We don’t want this.

3. Create a file named `.gitignore` (yes, it starts with a dot).

4. Add the following line inside `.gitignore`:

```
.env
```

5. Run `git status` again. The `.env` file has vanished from the list, but Git now wants to track the `.gitignore` file, which is exactly what we want.

6. Add and commit the `.gitignore` file.

```
$ git add .gitignore
```

```
$ git commit -m "Feat: Add .gitignore to ignore environment files"
```

Exercise 5: Branching (branch, checkout) Let’s work on a new feature in isolation without breaking our main code.

1. Create a new branch for a new “about” page.

```
$ git branch feature/about-page
```

2. Switch to your new branch.

```
$ git checkout feature/about-page
```

(Shortcut: `git checkout -b <branch-name>` creates and switches in one command.)

3. Create an `about.html` file with this content:

```
<h1>About Us</h1>
<p>This is the about page.</p>
```

4. Add and commit this new file *on your feature branch*.

```
$ git add about.html
$ git commit -m "Feat: Add new about page"
```

5. Now, switch back to your main branch and look at your files.

```
$ git checkout main
$ ls
```

The `about.html` file is gone! This is because it only exists on the feature branch.

Exercise 6: Merging (merge) Your “about page” feature is complete. Let’s merge it into the main branch.

1. Make sure you are on the branch you want to receive the changes (i.e., main).

```
$ git checkout main
```

2. Run the merge command to pull in the changes from your feature branch.

```
$ git merge feature/about-page
```

3. Check your files with `ls`. The `about.html` file is now present on main.

4. Look at your history to see the merge commit.

```
$ git log --online --graph
```

Exercise 7: Resolving Merge Conflicts What happens when two branches edit the same line?

1. From your main branch, create a new branch.

```
$ git checkout -b change-title-A
```

2. On this `change-title-A` branch, edit `index.html` to say:

```
<h1>Welcome to the IEI Project</h1>
```

3. Commit this change.

```
$ git commit -a -m "Update title on branch A"
```

4. Now, go back to main and create a *conflicting* change.

```
$ git checkout main
$ git checkout -b change-title-B
```

5. On this `change-title-B` branch, edit the *same line* in `index.html` to say:

```
<h1>Welcome to the TIA Project</h1>
```

6. Commit this change: `git commit -a -m "Update title on branch B"`

7. Now, let’s try to merge `change-title-B` into `change-title-A`.

```
$ git checkout change-title-A
$ git merge change-title-B
```

CONFLICT! Git will stop and tell you there is a conflict in `index.html`.

8. **Fix it:** Open `index.html`. You will see the conflict markers (`<<<<<`, `=====`, `>>>>>`). Edit the file to be correct (e.g., delete the markers and choose one title, or write a new one).

9. **Finalize:** Once fixed, add the file and commit.

```
$ git add index.html
$ git commit -m "Merge: Resolve title conflict"
```

Part 2: GitHub - Collaboration

Exercise 8: clone, remote, & origin Let's connect our local repository to a remote one on GitHub.

1. Go to **GitHub.com**. Create a **new, empty, public repository**. Name it `git-practice-repo`.
2. **Do NOT** initialize it with a README. We want it to be empty.
3. GitHub will show you URLs. Find the **Code** button.
 - **If you set up an SSH Key:** Select the **SSH** tab and copy the URL (e.g., `git@github.com:<YOUR_USERNAME>/practice-repo.git`).
 - **If you created a PAT:** Select the **HTTPS** tab and copy the URL (e.g., `https://github.com/<YOUR_USERNAME>/practice-repo.git`).
4. In your local terminal, go back to your `my-git-project` folder.
5. Add this new GitHub repository as your "remote" named "origin", using the URL that matches your authentication method.
 - **If using SSH:**
`$ git remote add origin <PASTE_YOUR_SSH_URL_HERE>`
 - **If using PAT:** Use the special URL format from Part 0, replacing the placeholders.
`$ git remote add origin https://<YOUR_USERNAME>:<YOUR_TOKEN>@github.com/<YOUR_USERNAME>/practice-repo.git`
6. Verify that the remote was added. `"bash $ git remote -v`

Exercise 9: push (Pushing Your Work) Your local repository has history, but the remote one is empty. Let's push your work.

1. First, let's rename our local master branch to main to match GitHub's standard.
`$ git branch -M main`
2. Now, **push** your local main branch to the remote origin. The `-u` flag sets it as the default, so you can just use `git push` in the future.
`$ git push -u origin main`
3. Refresh your GitHub repository page. All your files (`index.html`, `about.html`, `.gitignore`) and your commit history are now online!

Exercise 10: tag & release (Marking a Version) Your project is at a stable point. Let's tag it as version 1.0.

1. Create a "tag" that points to your latest commit.
`$ git tag -a v1.0.0 -m "First stable release"`
2. Push your new tag to GitHub (tags don't push automatically).
`$ git push origin v1.0.0`
3. **On GitHub:** Go to your repository's main page. Find "Releases" on the right side. Click "Create a new release" (or "Draft a new release").
4. Select your `v1.0.0` tag, give it a title like "Version 1.0.0", and write a short description. Click "Publish release". You now have an official release!

Part 3: The Full Open-Source Workflow

Exercise 11: fork (Contributing to a Project) You will now contribute to a project that you do not own.

1. Go to this repository on GitHub (the tictactoe repository from last class): <https://github.com/mariolpantunes/tictactoe>
2. In the top-right corner, click the **"Fork"** button. This will create a copy of the repository under your own GitHub account.
3. Now, on **your** fork's GitHub page, click the green **"<> Code"** button.
 - **If you set up an SSH Key:** Select the **SSH** tab and copy the URL (e.g., `git@github.com:<YOUR_USERNAME>/tictactoe.git`).
 - **If you created a PAT:** Select the **HTTPS** tab and copy the URL (e.g., `https://github.com/<YOUR_USERNAME>/tictactoe.git`).
4. In your terminal (outside your old project folder), **clone your fork** using the correct command for your auth method.

- **If using SSH:**

```
$ git clone <PASTE_YOUR_SSH_URL_HERE>
$ cd tictactoe
```

- **If using PAT:**

```
$ git clone https://<YOUR_USERNAME>:<YOUR_TOKEN>@github.com/<YOUR_USERNAME>/ticta
$ cd tictactoe
```

Exercise 12: The Pull Request (pull request) Let's make a change and propose it to the original project.

1. Create a new branch for your change.

```
$ git checkout -b add-my-name
```

2. Edit the CONTRIBUTORS.md file and add your name to the list.

3. Add and commit your change.

```
$ git add CONTRIBUTORS.md
$ git commit -m "Add [Your Name] to contributors list"
```

4. Push this new branch *to your fork* (origin).

```
$ git push origin add-my-name
```

5. **Go to GitHub:** Go to your fork's repository page. You should see a green banner that says "This branch is 1 commit ahead..." Click the **"Contribute"** button and then **"Open a pull request"**.

6. Review the changes, add a nice message, and click **"Create pull request"**.

7. **Congratulations!** You have just made a pull request, the heart of open-source collaboration.
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Bonus Challenge: rebase (Cleaning History)

Let's re-do Exercise 6, but with rebase for a cleaner history.

1. Get back to a state before the merge. A good way is to reset main.

```
$ cd ~/my-git-project # Go back to your first project
$ git checkout main
$ git reset --hard HEAD~1 # This rewinds 'main' one commit (deletes the merge)
```

2. You still have your feature/about-page branch. Let's make another commit on main to create a divergence.

```
$ echo "" >> index.html
$ git commit -a -m "Add a comment to homepage"
```

3. Now, main has a commit that feature/about-page does not.

4. Switch to your feature branch and use rebase to replay your branch's commits *on top of* the new main.

```
$ git checkout feature/about-page
$ git rebase main
```

5. Now, switch back to main and merge.

```
$ git checkout main
$ git merge feature/about-page
```

6. It will say "Fast-forward". Look at your log (`git log --oneline --graph`). The history is perfectly linear and clean!