Git & GitHub tutorial

Content of the following tutorial is taken from the books Pro Git by Chacon & Straub and Git Community Book.

Please submit any ambiguities in this document as Comments, or mail me directly, or reach me via WhatsApp.

Ignore your default branch name, it can either be `main` or `master` or `devel`, git doesn't give a shit.

Please download this Google Document as a PDF if you find some of the text and images too small. You can zoom-in the downloaded PDF and see clearly. To download, click on top left **`File -> Download -> PDF Document (.pdf)`**

Download Git

If already installed, the command `git --version` will print out the installed git version. Download Git for Windows here: https://git-scm.com/download/win. MacOS has Git preinstalled. If not, follow this page.

First time Git setup

1. `git config --global user.name "Your Name"`
2. `git config --global user.email "yourname.1234@yahoo.com"`
3. (optional) `git config --global core.editor "code -w" (for Windows and Ubuntu users)`
4. (optional) `git config --global init.defaultBranch main`

Tip

If you want to override the default global values for a specific project (for example, to use a work email address), you can run the git config command **without** the `--global` option while being inside that project

For example `git config user.email "yourname@pilani.bits-pilani.ac.in"`

Let's get started!

Go into a folder (a new/existing), right click and select `Open with Git Bash`. Alternatively, open command prompt/powershell/terminal and navigate to your desired folder.

1. Initialize the folder as a git repository using
   `git init`
2. Check the status of the folder using
   `git status`
3. Do something inside this git folder (except deleting the folder itself lol). You can make new files, copy some of your existing files to this folder, or edit any existing files. You can even make a new folder and put files inside that new folder.
4. Check status again
   `git status`
5. Stage the changes using
   `git add .`
6. Check the status using
   `git status`
7. Commit your staged changes using
   `git commit`

   Write your commit message and exit out of the commit screen. Don't close the window, just close the editor opened by the command `git commit`.

Tip

The 'dot' in the end of the "`git add .`" command signifies "'all contents at the current folder". If you want to stage only a specific file/folder, use

```
git add myPythonFile.py myNewFile.cpp myBITSFile.txt myFolder
```

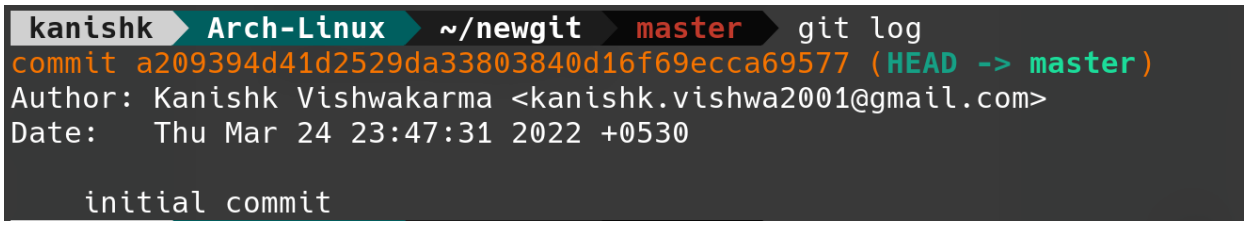
where you specify the file/folder names you want to add.

That's it!

You have made your very first commit. If you change something inside this folder, you can always revert to the first commit you made, which is the state of your folder currently (right after the commit).

To see this in action change the folder contents like adding/editing a file/folder, stage the changes using `git add .` and committing the changes using `git commit`.

Check the commit hash of your first commit using the command `git log` (it will be something like

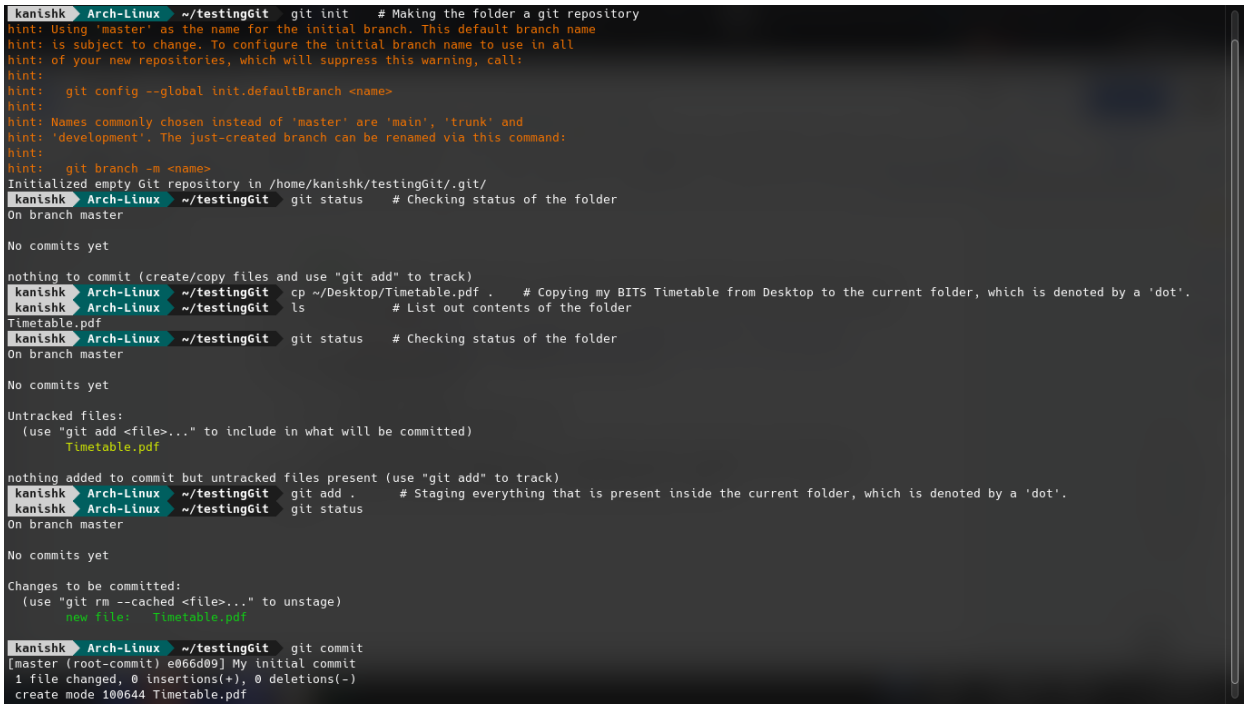


Copy the commit hash number (the one having time and date of your first commit) and do

```
git checkout a209394d41d2529da33803840d16f69ecca69577
```

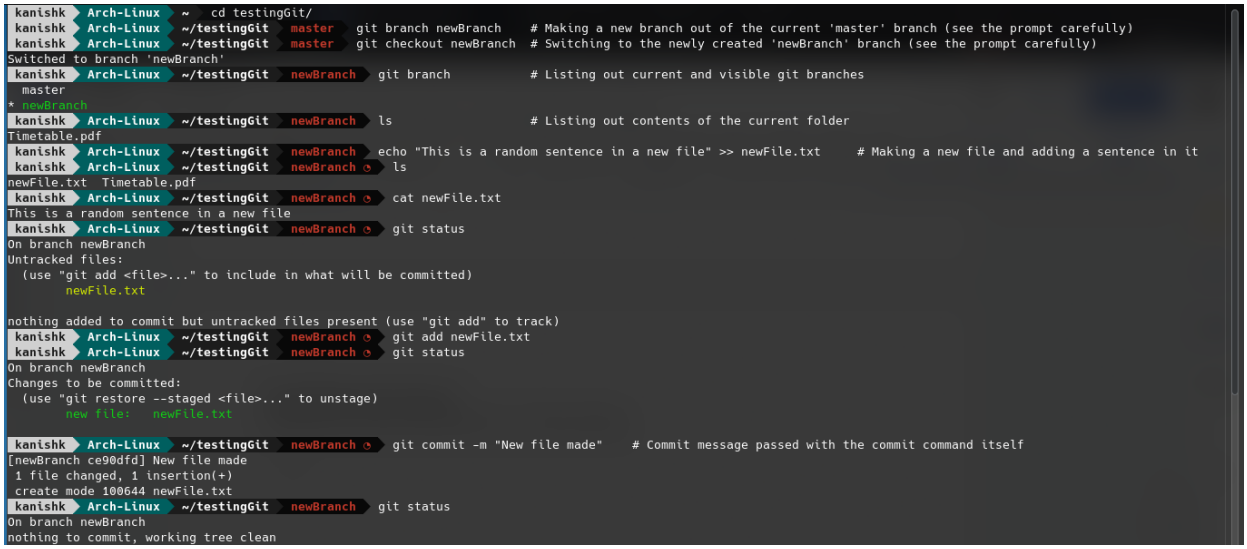
Now your folder is back to the state it was at that date and time. You can switch between commits just like that :)

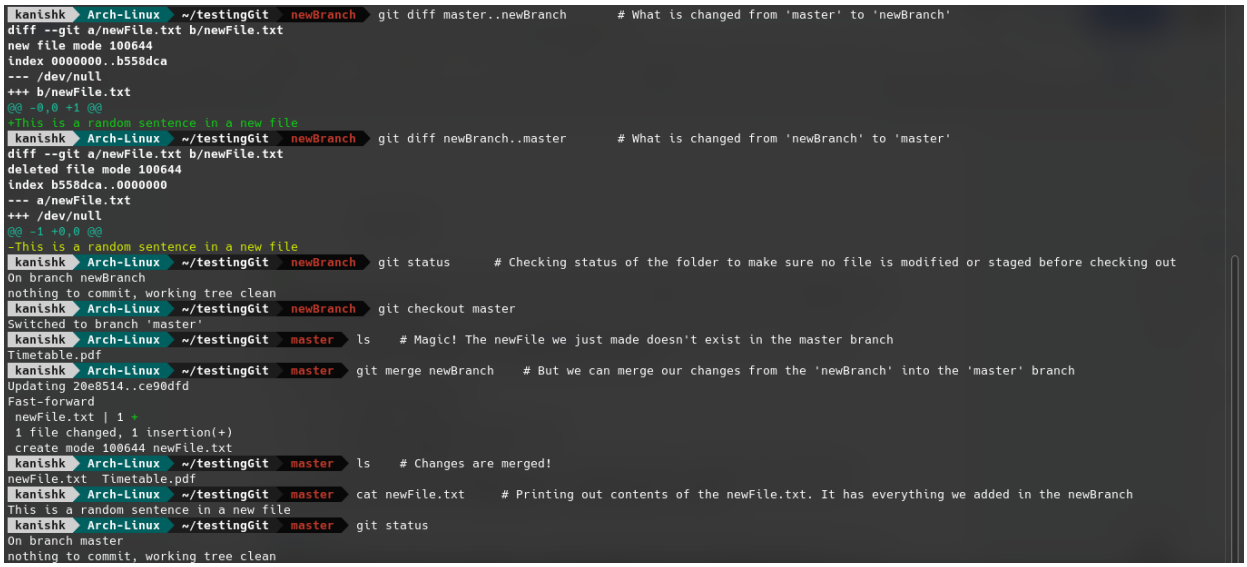
Below is a demo of everything done till now:



Branching and merging

Magic lies in git branching. Wanna see? Follow along with the demo.



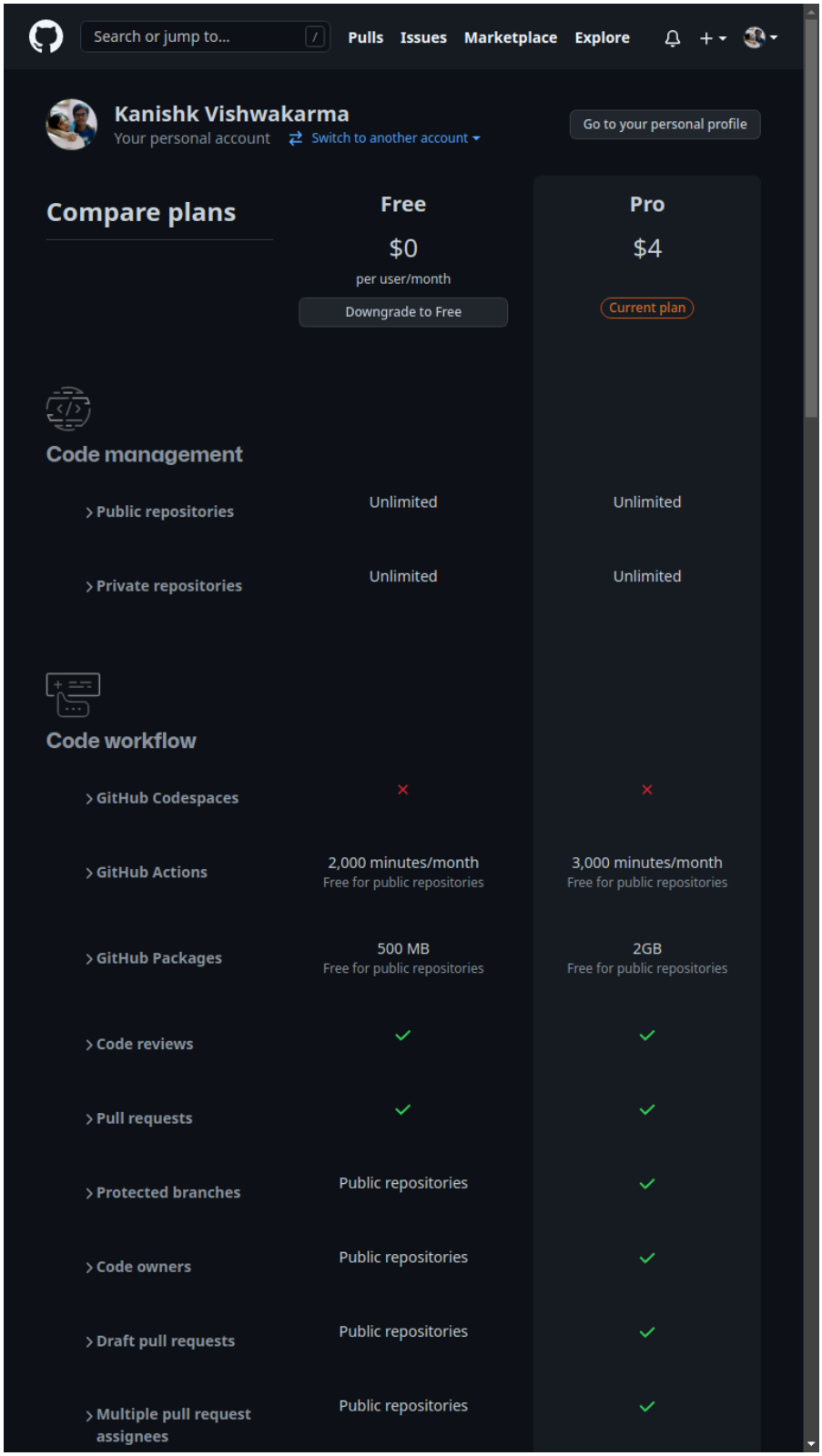


Finally moving online on GitHub

Make a new GitHub account and a new repository in your account. Make sure to have basic knowledge about **intellectual property** licences and add a relevant licence to every repo you make. Read more about the legal side of Open Source software here.

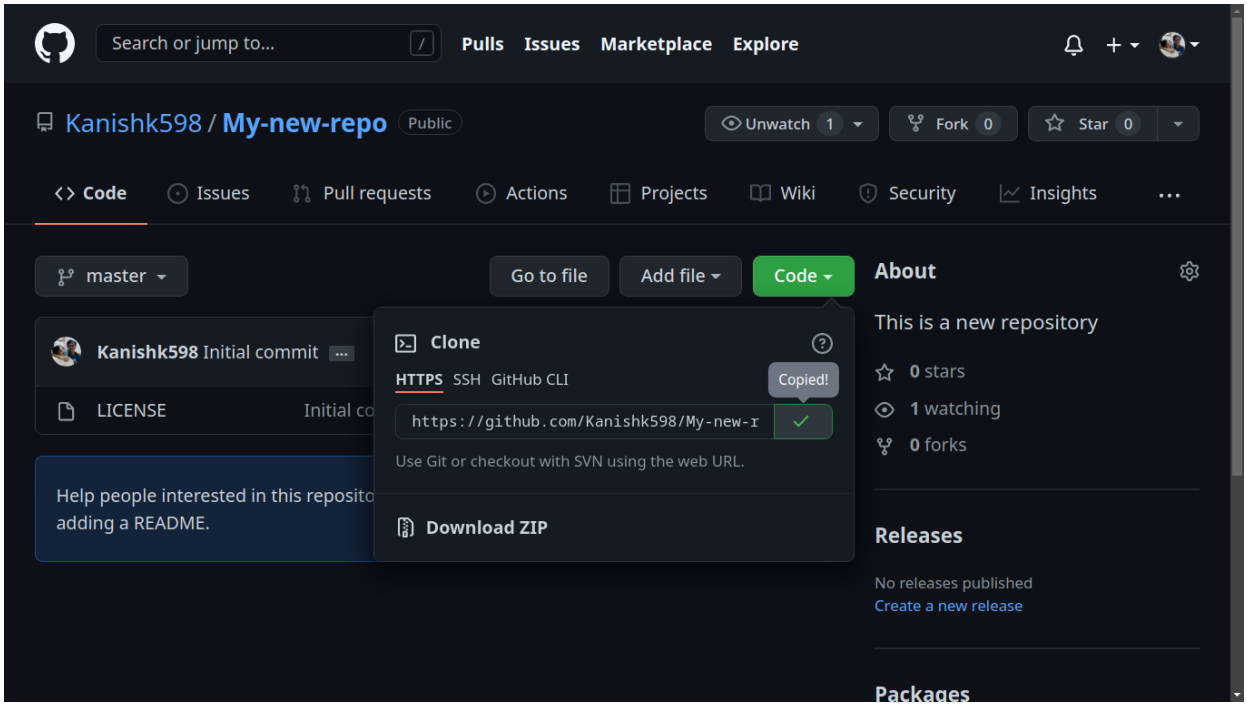
Tip

With BITS Pilani email students can avail the GitHub PRO service **Absolutely FREE**. It is very useful if you want to make a private team. Below is a small snap of a very large list of available services with a PRO account.


Search or jump to...
Pulls
Issues
Marketplace
Explore
Kanishk Vishwakarma
Your personal account
Switch to another account
Go to your personal profile
Compare plans
Free
$0
per user/month
Downgrade to Free
Pro
$4
Current plan
Code management
Public repositories
Unlimited
Unlimited
Private repositories
Unlimited
Unlimited
Code workflow
GitHub Codespaces
GitHub Actions
2,000 minutes/month
Free for public repositories
3,000 minutes/month
Free for public repositories
GitHub Packages
500 MB
Free for public repositories
2GB
Free for public repositories
Code reviews
Pull requests
Protected branches
Public repositories
Code owners
Public repositories
Draft pull requests
Public repositories
Multiple pull request assignees
Public repositories

Working on GitHub repo

Download the GitHub repository either using the command in Step 1 below, or directly extracting the ZIP format of the repo.



1. If you downloaded the ZIP format, unzip the folder and skip this step. Otherwise open the Git Bash/terminal/powershell and type
   ```
   git clone https://github.com/yourUserName/yourRepoName.git
   ```
2. A new folder is made which is your GitHub repository. You can go inside this repository and see everything that is up there online on GitHub.
3. Make some changes in this repository, like adding/editing file(s)/folder(s), or making new branches. The repository (set of files and folders on your computer) is called local, because it exists as a copy of the files on GitHub. Any changes made here are not directly reflected in the repository on Github. To reflect these changes in the repository on Github (which is called a remote repository), you need to push the changes.
4. Push these changes online so that they reflect on GitHub
   a. `git push origin branchName`
   origin is the alias of your remote GitHub repository.
   branchName can be '`master`' or any new branch that you made. You will have to repeat this command for every branch in which you made changes.

Ideally, we commit changes more frequently in a local repository, but don't push every commit every single time. You tend to push commits so that changes are reflected online. This means that if you're collaborating with someone else, they can receive your changes, which in fact is

one of the most powerful features of git and GitHub. Before you push, you typically fetch changes, but you can skip this step since you're working alone.

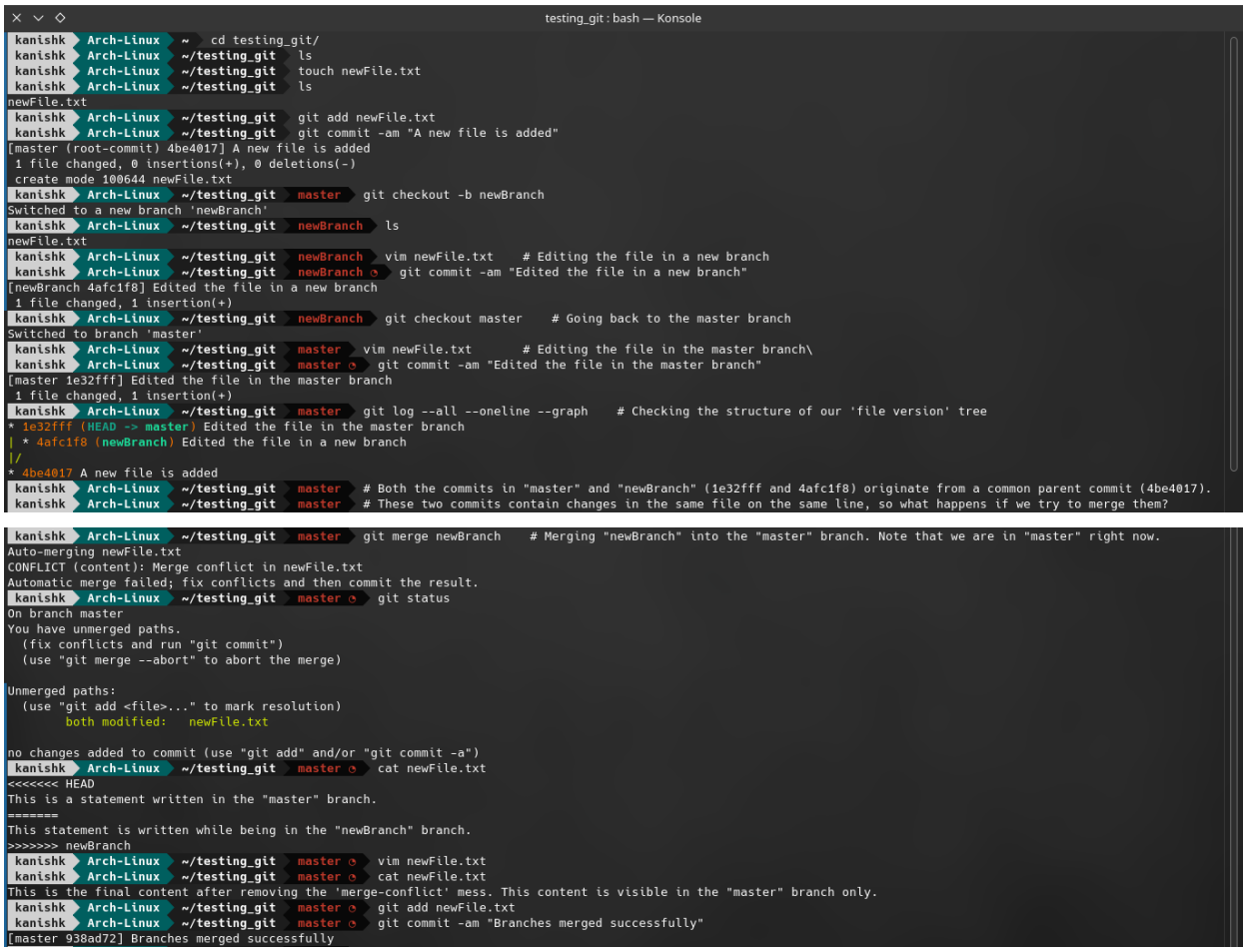
Tip

You can have many upstream repositories with different aliases. Default alias for a single local-remote repo pair is **origin**. You can add another remote repository using
`git remote add` **`remoteName`** `https://github.com/userName/repoName.git`
Now you can push and pull from both remote repositories.

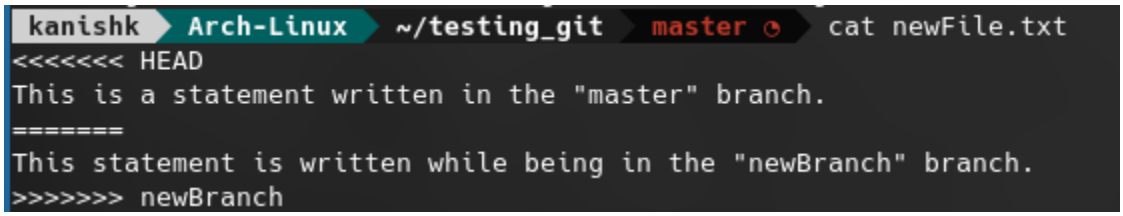
Merge conflicts

Merge conflicts happen whenever two branches have 'line-level' content conflict. It means if a file has been changed at the same line in two branches after a common commit, then there will be a merge conflict if one tries to merge the two branches. Git cannot decide which branch has correct code, so it leaves marks inside the conflicting regions for the programmer to solve.

To see a merge conflict yourself, make a new branch and commit something in an existing file. Now go back to the master branch, edit the same line in that file and commit it. At this point the master branch commit and the other branch commit are a divergence of the same previous commit, basically two different histories of the same file. Now merging the other branch into master will result in a merge conflict.



Merge conflict marks in a file look like the following (the `cat` command just lets us view the file):



1. Line 1 says the **current location** which is **HEAD** (trying to merge another branch (newBranch) into the current branch (master), which is also the location of the HEAD pointer).
2. Line 2 lists the contents present inside **HEAD**.
3. Line 5 mentions the location (**newBranch**) that you're trying to merge into the current location (here I am trying to merge newBranch into the master branch using `git merge newBranch` while being present in the master branch).
4. Line 4 lists the contents present in the **newBranch** branch.
5. Line 3 is a separator between the two conflicting contents in both the branches.

Programmers have to manually solve this conflict by editing the messy file itself.
After removing the merge conflict disarrangement, my file looks like this:

Now staging the clean file using `git add myFile.txt` and committing it using `git commit --message "Merge conflicts resolved"`, the merge conflict has been resolved.

Where can you get merge conflicts?

Merge conflicts can be found during conflicting combinations, either branch-branch combinations, branch-remote combinations, rebasing different branches, or any new weird experiment you pull out yourself.
The most common of these conflicting combinations is branch-remote combination, which happens when your local computer's changes are different from remote GitHub's changes (in the same file at the same line of course) and vice versa.

Follow along to see merge conflicts in action

1. Push your local repository on GitHub.
2. Edit a line in a file in your local repository.
3. Edit the same file on the same line on GitHub.
4. Run `git pull origin master` locally to merge your GitHub repository into your local repository.

Here you have a new merge conflict right in front of you. Solve this as a fun exercise and push it to your remote GitHub repository.

Tip

The command `git pull origin master` does two things in the background:

1. `git fetch origin master`
2. `git merge`

It is always suggested to manually run the `git fetch origin master` command first, then `git diff master..origin/master`, followed by the `git merge` command.

1. The `git fetch origin master` command downloads the new changes from GitHub but doesn't merge it locally yet.
2. The `git diff master..origin/master` command lists the new changes on the remote that is fetched above from the GitHub repository. This `diff` tool is used to diagnose any potential merge conflicts.
3. Finally the `git merge` command actually merges the newly downloaded remote master branch into the local master branch.

Submodules

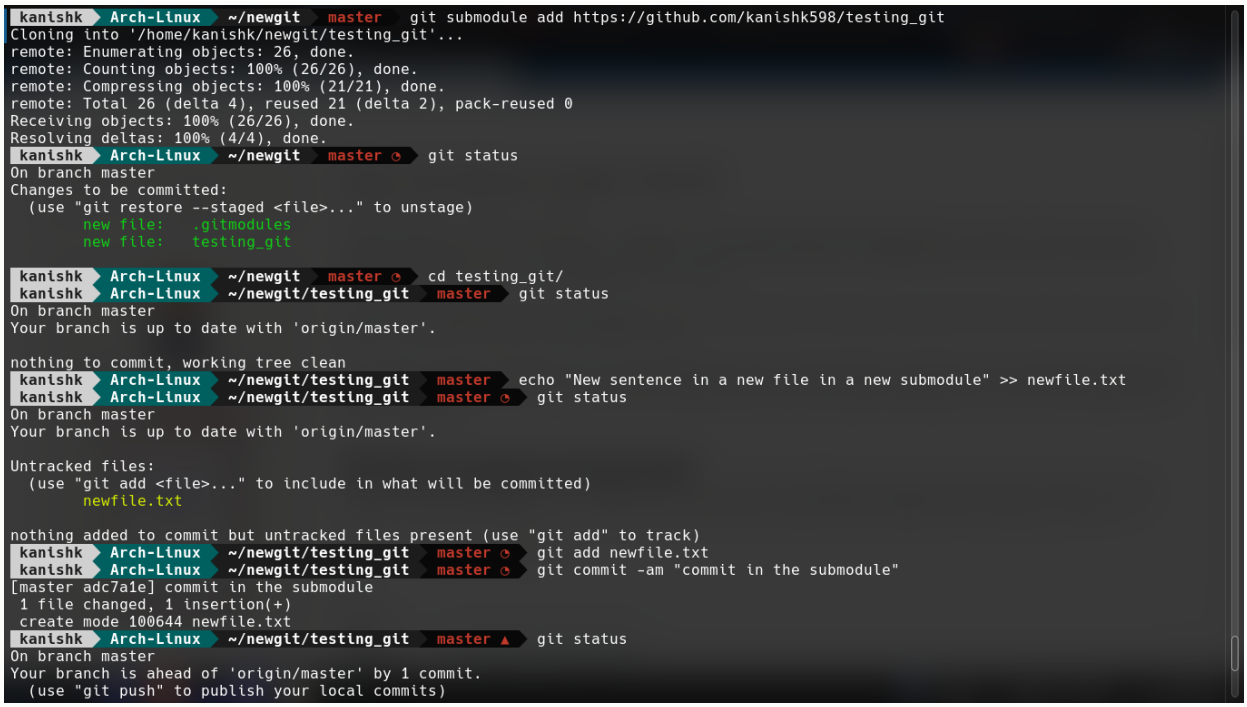
Oftentimes one needs to use someone else's work from within their own repository. A common issue arises in these scenarios: you want to be able to treat the two projects as separate yet still be able to use one from within the other.
The way you add another repository into your repository is by doing

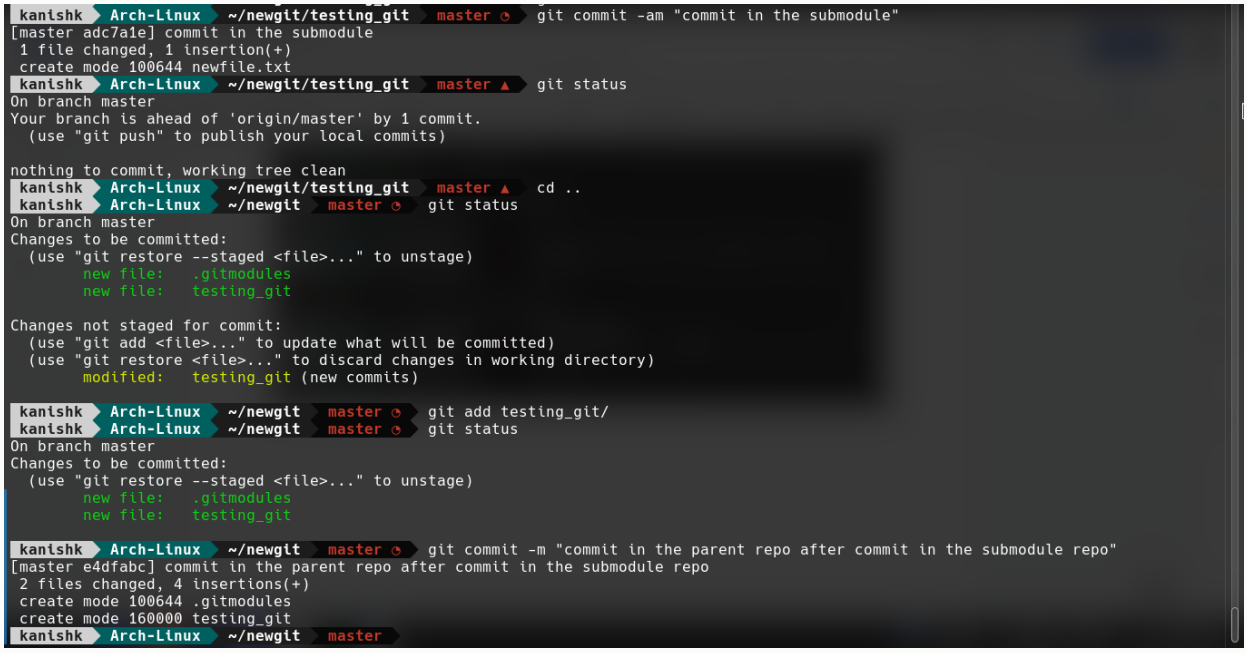
```
git submodule add https://github.com/userName/repoName.git
```

Anything you do outside of the submodule folder doesn't affect the submodule folder, but every time you do anything in your submodule, you need to

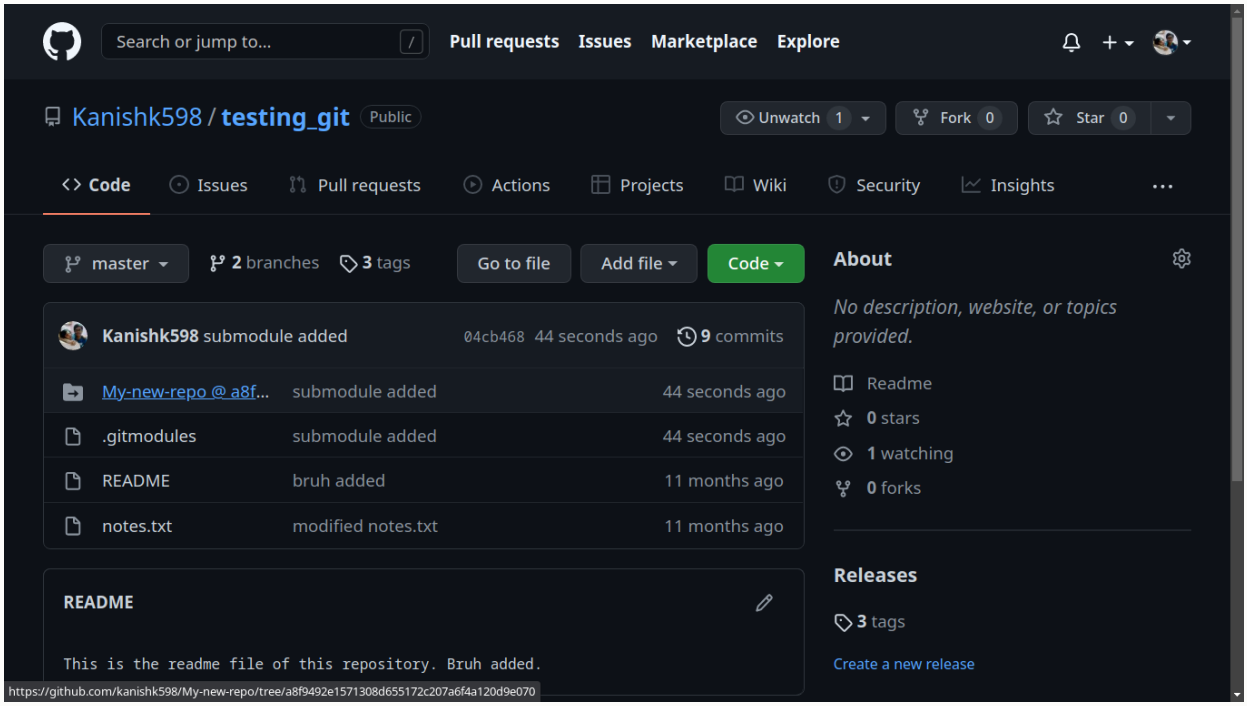
1. Commit the submodule repository,
2. Go out of the submodule repository while being inside the parent repository, and
3. Commit in the parent repository.

See carefully the following demo




kanishk Arch-Linux ~/newgit/testing_git master ◔ git commit -am "commit in the submodule"
[master adc7a1e] commit in the submodule
1 file changed, 1 insertion(+)
create mode 100644 newfile.txt
kanishk Arch-Linux ~/newgit/testing_git master ▲ git status
On branch master
Your branch is ahead of 'origin/master' by 1 commit.
(use "git push" to publish your local commits)
nothing to commit, working tree clean
kanishk Arch-Linux ~/newgit/testing_git master ▲ cd ..
kanishk Arch-Linux ~/newgit master ◔ git status
On branch master
Changes to be committed:
(use "git restore --staged <file>..." to unstage)
new file: .gitmodules
new file: testing_git
Changes not staged for commit:
(use "git add <file>..." to update what will be committed)
(use "git restore <file>..." to discard changes in working directory)
modified: testing_git (new commits)
kanishk Arch-Linux ~/newgit master ◔ git add testing_git/
kanishk Arch-Linux ~/newgit master ◔ git status
On branch master
Changes to be committed:
(use "git restore --staged <file>..." to unstage)
new file: .gitmodules
new file: testing_git
kanishk Arch-Linux ~/newgit master ◔ git commit -m "commit in the parent repo after commit in the submodule repo"
[master e4dfabc] commit in the parent repo after commit in the submodule repo
2 files changed, 4 insertions(+)
create mode 100644 .gitmodules
create mode 160000 testing_git
kanishk Arch-Linux ~/newgit master

Whenever a repository having a submodule is pushed on GitHub, it shows the submodule not as a regular folder but as a link to the submodule repository.



Sometimes one needs to delete the submodule. Deleting a submodule involves 3 steps

1. Deleting the submodule folder itself
2. Deleting the folder `.git/modules/submoduleName` (mind the 'dot')
3. Editing the `.gitmodules` file and removing the lines for the submodule

Now staging and committing the repository again will have the submodule removed completely. If you push the repo, the link to the submodule is gone.

Task

This is to see if you have understood using git from **git bash (terminal)**, in conjunction with GitHub. Create a repository, and try out as many of these commands as you can - create multiple branches, commits; try to merge them.

Surf online (Pro Git book is the second best resource after StackOverflow lol) how you can undo a commit (for those oopsies and spelling mistakes, go back to a different commit to view older files, perhaps even create a branch from an old point in history and merge it ;)

You **must** be able to use the commands **add, commit, push, pull and branch** as these are used very frequently. However, use this opportunity to try out the rest as well, because they can get challenging when you actually have to use them. To view how much you've understood, we'd like you to share the history of your repo.

For this type the commands:

1. `git log --graph --pretty="%C(bold blue)%h" --decorate --all`
2. `git log --graph --pretty="%C(yellow) Hash: %h %C(blue)Date: %ad %C(red) Message: %s " --date=human`
3. `git log --all --decorate --oneline --graph`

You can submit the outputs of these commands to us, preferably as text file (.txt). Screenshots are also welcome.

Tip

To put output of any command into a text file, use the following trick:

```
your command >> myNewFile.txt
```

This will put the entire output of the command in the newly generated `myNewFile.txt`. Moreover, if you try to put content of a new command in this file while this file is non-empty, it inserts the new output at the end of the file without removing the old output already present.

Example:

```
dir >> myNewFile.txt
dir | wc >> myNewFile.txt
any third command of your wish >> myNewFile.txt
```

Above chain of commands will insert the command outputs into the `myNewFile.txt` file in order.