

Version control using Git & GitHub

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Version Control Systems (VCS)

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Allows to:

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- See who last modified something that is causing a problem
- Who introduced an issue and when
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If you screw things up or lose files, you can easily recover

Version Control Systems (VCS)

Local Version Control Systems

Filesystem-based

- Duplicate files/directories
 - Hopefully time-stamped
 - Usually with prefix/suffix such as 'v1', ..

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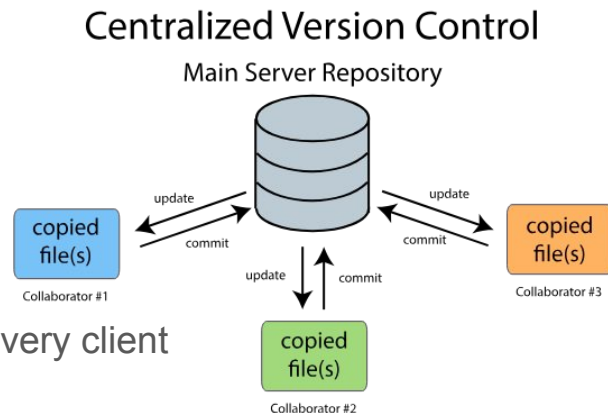
Database-based

- First approach to a real VCS
- Each new version is stored in the DB as a patch set (only diffs)
- Able to re-create any file by adding up the appropriate patches

Version Control Systems (VCS)

Centralized Version Control Systems (*aka CVCS*)

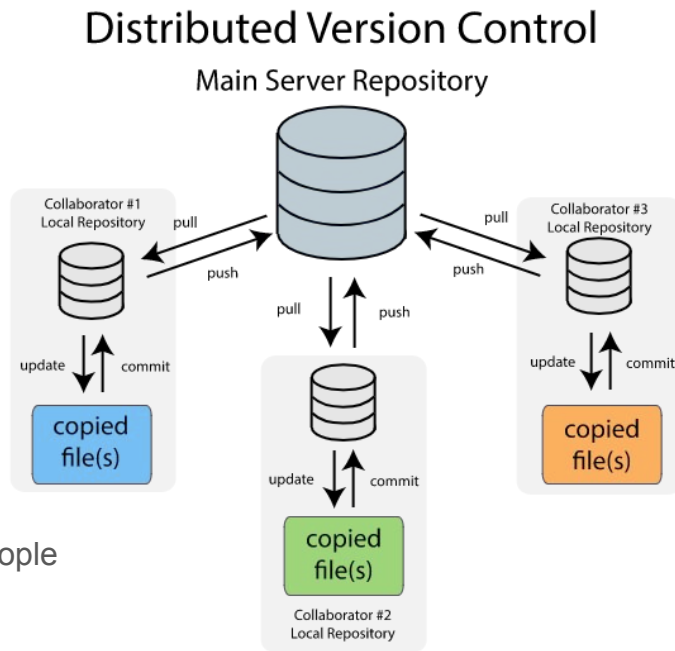
- Problem: Collaboration was needed (geographically distributed)
- Centralized solution:
 - **1 server** with all the versioned files
 - N clients that check out files from the server
- Pros:
 - Allows collaboration
 - Everyone knows what the others do (to a certain degree)
 - Facilitates administration when compared with local DBs on every client
- Cons:
 - **Single point of failure**
 - Network outage (temporary loss), disk failure/corrupted (~permanent loss)
- Examples: CVS, Subversion



Version Control Systems (VCS)

Distributed Version Control Systems (*aka DVCS*)

- Problem: Availability & reliability
- Distributed solution:
 - Each client **mirrors/clones the entire repository**
 - Full backup
 - Speed
- Pros:
 - High Availability
 - If *Main Server Repository* dies, it can be restored
 - From any client repository
 - Multiple collaborations
 - Through multiple remotes
 - Simultaneously collaborate with different groups of people
- Cons:
 - None, they are perfect! (almost)
- Examples: Git, Mercurial



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 - High availability: they do not depend on a central server
 - Improve collaboration: handling multiple remotes
 - Speed: common operations are done faster as metadata is stored locally

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- *DVCS are the most mature VCS solutions*
 - High availability: they do not depend on a central server
 - Improve collaboration: handling multiple remotes
 - Speed: common operations are done faster as metadata is stored locally
- *Git is most widely-used DVCS tool*

Git and GitHub

GitHub

Git-repository hosting service

<https://github.com>



Social code: account-based

- Individual, e.g. <https://github.com/orviz>
- Organizations, e.g. <https://github.com/masterdatascience-UIMP-UC>

Extra functionality (on top of Git):

- Collaboration (social coding)
 - Forks
 - Pull requests
- Private/public repositories
- Integrations with other services (CI, monitoring, ..)
- Tools (wiki, issue tracking)
- Project webpage: GitHub Pages
- Reporting: graphs/stats
- ..

Alternatives: <https://bitbucket.org>, <https://sourceforge.net>

GitHub.com (<https://octoverse.github.com/>)

- 24 millions of users from 200 countries
- 1.5 millions of organizations
- 67 millions of repositories



GitHub

Social coding

Science in GitHub.com: democratic databases

1. Ebola outbreak in West Africa, July 2014
2. PhD student wanted to model the outbreak spread
3. Every day
 - Downloaded PDF updates from the ministries of health of the affected countries
 - Converted the numbers into computer readable tables
 - Uploaded the files to a GitHub.com repository, thought may be useful for someone
4. Other researchers started to contribute in the project:
 - On some days, files were uploaded before hers
 - Created programming scripts for error-checks on the data

<https://www.nature.com/news/democratic-databases-science-on-github-1.20719>



Git basics

- Uses **snapshots**, not differences
 - Every change (commit, save state, ..) triggers a snapshot of all the data and adds a reference to it
 - Different from the *delta-based*: stores the files changed and the changes themselves
- Most operations are **local**
 - Operations are *instant*
 - Checks local database, no network needed
 - Unlike CVCS, which adds network latency overhead
- The Three States
 - Committed: data safely stored in your local database
 - Modified: the file is changed but not committed
 - Staged: mark a modified file to go into your next commit snapshot

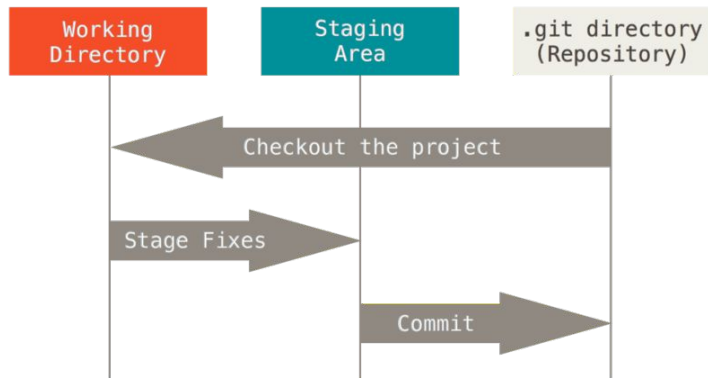
Git basics

The Three Sections of a Git project

- *Git directory* (.git), metadata and DB.
- *Working directory*: single checkout of one version of the project.
- *Staging area*: file that stores information about what will go into the next commit.

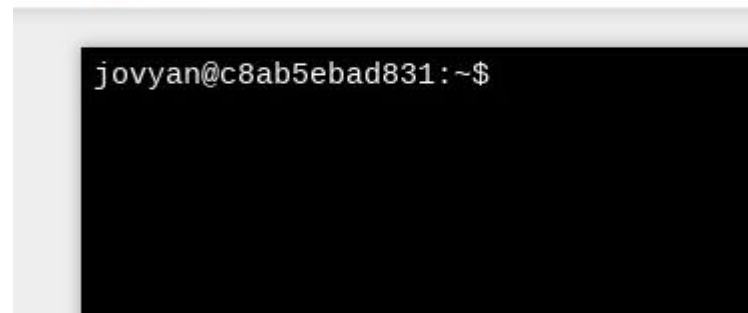
Workflow:

1. You modify files in your *working dir*.
2. You stage changes to go into the next commit.
 - Adds only these changes to the *staging area*.
3. You do a commit
 - Does a snapshot of the files as they are in the staging area to place them in the *Git directory*.



Getting started with Git

Command-line vs GUI



- *We will be using Git on the command line*
 - GUIs implement only a partial subset, e.g. <https://desktop.github.com/>
 - Hard way: if you master the command-line, GUI won't be any secret.
 - The opposite is not necessarily true.
- *Command line is available through <https://datasciencehub.ifca.es>*
 - Through the web browser, no need to install the Git client locally
 - Log in using your GitHub account.
 - If not already, create one in <https://github.com>
 - Sake of completeness: [how to install Git](#)

Getting started with Git

First-time Git Setup

- 3 Git configuration files on your system (from lowest to highest priority):
 1. `/etc/gitconfig` (system-wide)
 2. `$HOME/.gitconfig` or `$HOME/.config/git/config` (user space)
 3. `.git/config` in your Git directory (single repository)
- **`git config`** command line will modify the values in the files above for you
 - With **`--system`** option, reads/writes from `/etc/gitconfig`
 - With **`--global`** option, reads/writes from user space, aka `$HOME/.gitconfig`
 - With **`--local`** option, reads/writes from current repository, aka `.git/config`

Getting started with Git

First-time Git Setup

- Set your Git identity (globally)
 - **Important!** Name & Email will be used in each commit

```
$ git config --global user.name "John Doe"
```

```
$ git config --global user.email johndoe@example.com
```

- Additional configurations..
 - Set your preferred editor (**vim is not available by default in JupyterHub btw**)

```
$ git config --global core.editor vim
```

Getting started with Git

Check your Settings

- List all of them:

```
$ git config --list
user.name=John Doe
user.email=johndoe@example.com
color.status=auto
color.branch=auto
...
```

- Print specific configuration parameter:

```
$ git config user.name
John Doe
```

Ask Git for Help

- Quick reference of a command

```
# git <verb> -h
$ git config -h
```

- Manpage (full documentation)

```
# git help <verb>
$ git help config

# git <verb> --help
$ git config --help

# man git-<verb>
$ man git-config
```


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 - *Not a VCS solution*, it hosts repositories that are managed with Git
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 - Collaboration (Forks, Pull Requests)
 - Project Management (Issue tracking, Wiki, Project web page, ..)

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 - States: Only cares about *tracked* files (modified, staged, committed)

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 - Project Management (Issue tracking, Wiki, Project web page, ..)

- Git

- States: Only cares about *tracked* files (modified, staged, committed)
- 3 Sections:
 - *Working directory*: current version, where you are working
 - *Staging area*: contains the file/s that will go in the next commit
 - *Git directory*: contains the data (local DB) for Git usage

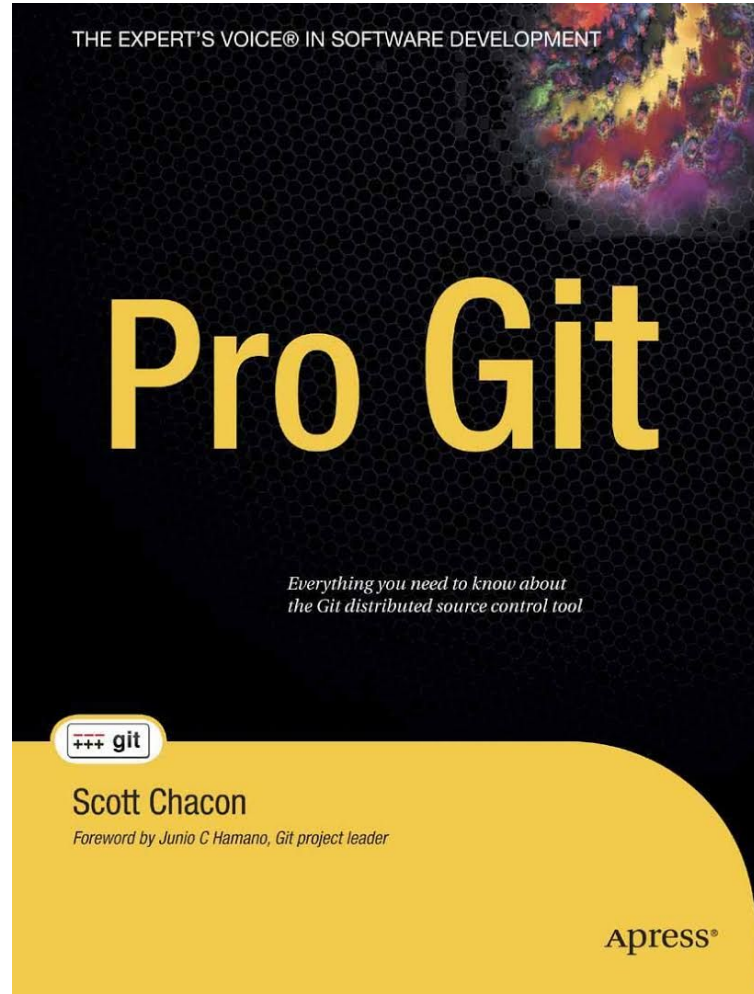
Hands-on

Git Basics

*This tutorial is based on **Pro Git** by Scott Chacon*

Free ebook:

<https://git-scm.com/book/en/v2>



Getting a Git repository in your system

1. Clone a remote (existing) repository

With **git clone** == Full copy from remote

```
# Full copy (files, Git directory, ..) to 'hellogitworld' dir in current path  
$ git clone https://github.com/masterdatascience-UIMP-UC/hellogitworld
```

```
# Full copy (files, Git directory, ..) to a different 'myhellogitworld' dir in current path  
$ git clone https://github.com/masterdatascience-UIMP-UC/hellogitworld myhellogitworld
```

Getting a Git repository in your system

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# Full copy (files, Git directory, ..) to a different 'myhellogitworld' dir in current path
$ git clone https://github.com/masterdatascience-UIMP-UC/hellogitworld myhellogitworld
```

- This command results in a copy of this repository in our system
 - Nothing yet in our Github account
- We will work locally on our copy
 - We may not have permissions for updating the remote repository

Getting a Git repository in your system

2. Initiate our Git repository from a directory in our system

With `git init` == Creates the `.git` directory

```
# Move to the directory meant to be the repository
$ cd /home/user/my_project

# Convert directory to Git repository (creates .git directory)
$ git init
```

Getting a Git repository in your system

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$ cd /home/user/my_project

# Convert directory to Git repository (creates .git directory)
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```

- Git does not track any file by default
 - Have to tell Git about the files we want to start tracking
- There is no remote repository in GitHub
 - We need to create one!

Creating a Git repository in GitHub

1. Create an empty repository

- Go to `Repositories > New` and fill in the relevant information
- Once done, we can either clone it (1) or push changes of an initialized one (2)

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2. Fork a repository

- A fork is a copy of a repository
- Freely experiment with changes without affecting the original project
- Go to the URL of the project to fork from and click on [Fork](#)

The screenshot shows the GitHub interface for the repository 'masterdatascience-UIMP-UC / hellogitworld', which is forked from 'githubtraining/hellogitworld'. At the top, there are buttons for 'Unwatch' (8), 'Star' (0), and 'Fork' (372), with the 'Fork' button highlighted by a black rectangle. Below these are tabs for 'Code', 'Pull requests' (0), 'Wiki', 'Insights', and 'Settings'. The repository name is 'Hello Git World sample training repository', with an 'Edit' button. A 'Manage topics' link is also present. A progress bar shows 26 commits, 10 branches, 2 releases, and 3 contributors. Below the progress bar are buttons for 'Branch: master', 'New pull request', 'Create new file', 'Upload files', 'Find file', and 'Clone or download'. The main content area shows a commit by 'jordanmccullough' with the message 'Fix groupid after package refactor', the latest commit hash 'ef7bebf' from Nov 7, 2014, and a resource titled 'Addition of the README and basic Groovy source samples.' from 8 years ago.

Example: Fork & Clone from GitHub

- Usual workflow for the exercises in the master..
 1. You will be given a GitHub repository URL with the exercises
 2. You will fork it to your GitHub personal account
 3. You will clone your fork to your system
 4. You will work on them, committing & pushing changes
 5. You will provide the fork URL to your teacher

Example: Fork & Clone from GitHub

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- Let's do an example:
 1. (Web) Login to <https://github.com>
 2. (Web) Fork this repository: <https://github.com/masterdatascience-UIMP-UC/hellogitworld>
 - i. Use your personal account as the target space
 3. (Terminal) Clone your fork:

```
# Full copy (files, Git directory, ..) to 'hellogitworld' dir in current path
$ git clone https://github.com/<your-account-name>/hellogitworld

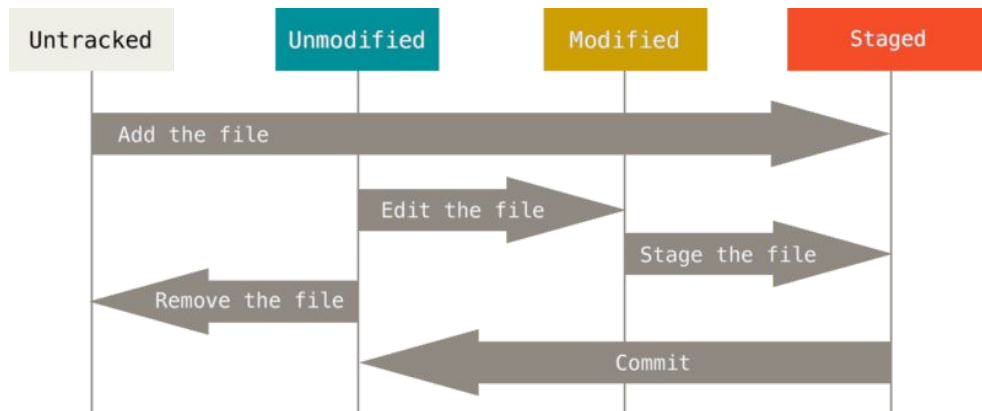
# Enter in the 'hellogitworld' directory just created and list the files included
$ cd hellogitworld
$ ls -l
```

Checking the status of your files

- Status of files
 - a. *Untracked*: Git does not know about these files
 - b. *Tracked*: Git knows about
 - i. *Unmodified*
 - ii. *Modified*
 - iii. *Staged*

- Workflow

- a. Edit files -> *Modified*
- b. Stage the required files -> *Staged*
- c. Commit them -> *Unmodified*



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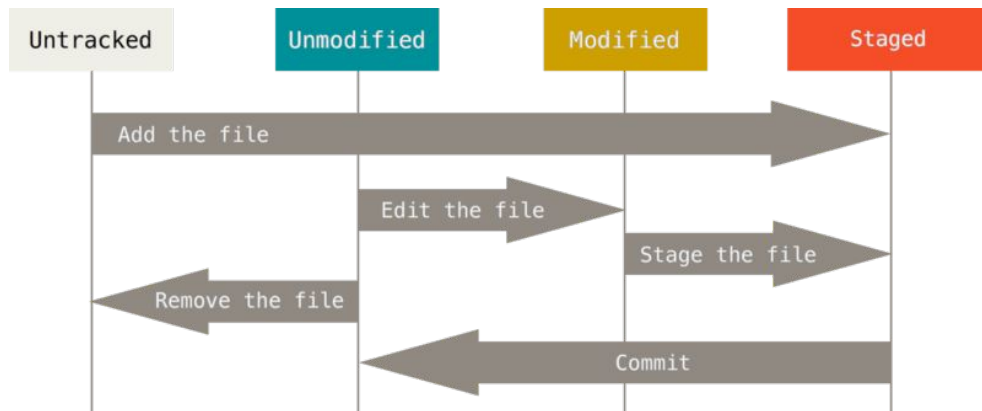
- **`git status`** command

```
# Inside 'hellogitworld' directory ==  
$ git status
```

```
On branch master
```

```
Your branch is up-to-date with 'origin/master'.
```

```
nothing to commit, working directory clean
```



A note on branches..

```
$ git status
```

```
On branch master
```

```
Your branch is up-to-date with 'origin/master'.
```

```
nothing to commit, working directory clean
```

Branching is more advanced topic that we will cover in a dedicated section of this tutorial

- For this introductory part, we will consider the default branch `master`

Tracking new files

```
# Create a new file called README  
$ echo "My own README file" > README
```

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```
# Check the repository status
```

```
$ git status
```

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```

```
Your branch is up-to-date with 'origin/master'.
```

```
Untracked files:
```

```
  (use "git add <file>..." to include in what will be committed)
```

```
    README
```

```
nothing added to commit but untracked files present (use "git add" to track)
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  (use "git add <file>..." to include in what will be committed)

    README

nothing added to commit but untracked files present (use "git add" to track)
```

- README is **untracked** (under *Untracked files*)
 - README was not in the previous snapshot (commit)
- Git just warns us, it won't do anything until we explicitly request so
 - Let's track the README file

Tracking new files

To track a new file we use `git add`

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Changes to be committed:
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    new file:   README
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$ git status
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    new file:   README
```

README is now **staged** (under *Changes to be committed*)

- Achieved by `git add` command
- At this point we could commit this change, resulting in the README file to be added to the repository content

Staging modified files (I)

Understanding **staging**..

```
# Same situation as before: README file was added  
# We now modify an already tracked file --> fix.txt  
$ echo "Fix #1 added -- You can safely remove this line --" >> fix.txt
```


Staging modified files (I)

Understanding **staging**..

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$ echo "Fix #1 added -- You can safely remove this line --" >> fix.txt
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On branch master
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Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    new file:   README

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working directory)

    modified:   fix.txt
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  (use "git add <file>..." to update what will be committed)
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    modified:   fix.txt
```

`fix.txt` is **unstaged** (under *Changes not staged for commit*)

- == modified in the working directory but not staged
- Use **git add** command to stage it

Staging modified files (II)

Understanding **staging**..

```
# Stage fix.txt file  
$ git add fix.txt
```

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  (use "git reset HEAD <file>..." to unstage)

    new file:   README
    modified:   fix.txt
```

Staging modified files (II)

Understanding **staging**..

```
# Stage fix.txt file
$ git add fix.txt
# Check the status
$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
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  (use "git reset HEAD <file>..." to unstage)
```

```
new file:   README
modified:   fix.txt
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Both `README` and `fix.txt` are ***staged*** and will go into the next commit

Staging modified files (II)

Understanding **staging**..

```
# Stage fix.txt file
$ git add fix.txt
# Check the status
$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)
```

```
new file:   README
modified:   fix.txt
```

Both `README` and `fix.txt` are ***staged*** and will go into the next commit

..but you remember one little change that you want to make to `fix.txt` before you commit it..

Staging modified files (III)

Understanding **staging**..

```
# Add the last minute change to fix.txt
```

```
$ echo "Fix #2: Very important fix added -- You can safely remove this line --" >> fix.txt
```

Staging modified files (III)

Understanding **staging**..

```
# Add the last minute change to fix.txt
$ echo "Fix #2: Very important fix added -- You can safely remove this line --" >> fix.txt
# Check the status
$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    new file:   README
    modified:   fix.txt

Changes not staged for commit:
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    modified:   fix.txt
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Changes not staged for commit:
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  (use "git checkout -- <file>..." to discard changes in working directory)
```

```
modified:   fix.txt
```

`fix.txt` is **unstaged** and **staged** at the same time ?;

- If you commit now, only the first version of `fix.txt` ("Fix #1.." as it was when we ran `git add`) will be considered
- You have to `git add fix.txt` to stage it, so it goes in the next commit

Staging modified files (IV)

Understanding **staging**..

```
# Stage the last change of fix.txt == 'Fix #2..'
$ git add fix.txt
```

Staging modified files (IV)

Understanding **staging**..

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Changes to be committed:
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```

```
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Committing your changes (I)

To commit a new change we use `git commit`

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To commit a new change we use `git commit`:

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 - A commit may involve multiple changes (although atomic ones are preferred)
 - Anything not staged won't be part of the next

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```
# Our changes are all staged, so we commit..  
$ git commit
```

With no options, git commit opens the default editor (core.editor from git config), with the content:

```
# Please enter the commit message for your changes. Lines starting  
# with '#' will be ignored, and an empty message aborts the commit.  
# On branch master  
# Your branch is up-to-date with 'origin/master'.  
#  
# Changes to be committed:  
#   new file:   README  
#   modified:   fix.txt
```

Committing your changes (I)

To commit a new change we use `git commit`:

- A commit makes a snapshot of your project you can later on compare/revert to
 - A commit may involve multiple changes (although atomic ones are preferred)
 - Anything not staged won't be part of the next

```
# Our changes are all staged, so we commit..  
$ git commit
```

With no options, git commit opens the default editor (core.editor from git config), with the content:

```
# Please enter the commit message for your changes. Lines starting  
# with '#' will be ignored, and an empty message aborts the commit.  
# On branch master  
# Your branch is up-to-date with 'origin/master'.  
#  
# Changes to be committed:  
#   new file:   README  
#   modified:   fix.txt
```

- A **descriptive commit message** must be added to the blank line above the default text
- The default content can be left, just to remind in the future what files you have changed

Committing your changes (II)

A one-liner approach to git commit

```
# Our changes are all staged, so we commit..  
$ git commit -m "New README and the two first fixes documented"  
[master 1a90007] New README and the two first fixes documented  
2 files changed, 3 insertions(+)  
create mode 100644 README
```

Committing your changes (II)

A one-liner approach to git commit

```
# Our changes are all staged, so we commit..  
$ git commit -m "New README and the two first fixes documented"  
[master 1a90007] New README and the two first fixes documented  
2 files changed, 3 insertions(+)  
create mode 100644 README
```

Your first commit is done!

- To branch `master`
- With ID `1a90007`

Moving/renaming files

To move or rename tracked files we use ***git mv***:

```
# Let's rename the README file..  
$ git mv README README.to_delete
```

Moving/renaming files

To move or rename tracked files we use `git mv`:

```
# Let's rename the README file..
$ git mv README README.to_delete

$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    renamed:    README -> README.to_delete
```

Removing files

To remove a tracked file we use `git rm`:

```
# Let's remove README.to_delete file
$ git rm README.to_delete
error: the following file has changes staged in the index:
  README.to_delete
(use --cached to keep the file, or -f to force removal)
```

Removing files

To remove a tracked file we use `git rm`:

```
# Let's remove README.to_delete file
$ git rm README.to_delete
error: the following file has changes staged in the index:
    README.to_delete
(use --cached to keep the file, or -f to force removal)

$ git rm -f README.to_delete
rm 'README.to_delete'

$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    deleted:    README
```

The next commit will eliminate the file and will be no longer tracked

Removing files

To remove a tracked file we use `git rm`:

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$ git rm README.to_delete
error: the following file has changes staged in the index:
    README.to_delete
(use --cached to keep the file, or -f to force removal)

$ git rm -f README.to_delete
rm 'README.to_delete'

$ git status
On branch master
Your branch is up-to-date with 'origin/master'.
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    deleted:    README
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Viewing Commit History

To view the commit history of our project we use `git log`:

Viewing Commit History

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```
$ git log
commit 1a900077fdeffd73e0c7412a731949c540c78250 (HEAD -> master)
Author: Pablo Orviz <orviz@ifca.unican.es>
Date:   Mon Oct 1 15:33:36 2018 +0000
```

New README and the two first fixes documented.

```
commit ef7bebf8bdb1919d947afe46ab4b2fb4278039b3 (origin/master, origin/HEAD)
Author: Jordan McCullough <jordan@github.com>
Date:   Fri Nov 7 11:27:19 2014 -0700
```

Fix groupId after package refactor

```
commit ebbbf773431ba07510251bb03f9525c7bab2b13a
Author: Jordan McCullough <jordan@github.com>
Date:   Wed Nov 5 13:00:35 2014 -0700
```

Update package name, directory

```
commit 45a30ea9afa413e226ca8614179c011d545ca883
Author: Jordan McCullough <jordan@github.com>
Date:   Wed Nov 5 12:59:55 2014 -0700
```

Update package name, directory

```
commit 9805760644754c38d10a9f1522a54a4bdc00fa8a
Author: Jordan McCullough <jordan@github.com>
Date:   Wed Nov 5 12:19:02 2014 -0700
```

Fix YAML name-value pair missing space

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commit ebbbf773431ba07510251bb03f9525c7bab2b13a
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Author: Jordan McCullough <jordan@github.com>
Date:   Wed Nov 5 12:19:02 2014 -0700

    Fix YAML name-value pair missing space
```

- Most recent commits show up first
- Info per commit:
 - commit ID
 - Author's name & email
 - Date
 - Author's commit message

Viewing Commit History

`git log` command has several interesting options:

Viewing Commit History

git log command has several interesting options:

- **-p** or **--patch**

```
$ git log -p -1
commit 1a900077fdeffd73e0c7412a731949c540c78250 (HEAD -> master)
Author: Pablo Orviz <orviz@ifca.unican.es>
Date:   Mon Oct 1 15:33:36 2018 +0000

    New README and the two first fixes documented.

diff --git a/README b/README
new file mode 100644
index 0000000..29afdfa
--- /dev/null
+++ b/README
@@ -0,0 +1 @@
+My own README file
diff --git a/fix.txt b/fix.txt
index e69de29..3e6b239 100644
--- a/fix.txt
+++ b/fix.txt
@@ -0,0 +1,2 @@
+Fix #1 added -- You can safely remove this line --
+Fix #2: Very important fix added -- You can safely remove this line --
```

Viewing Commit History

git log command has several interesting options:

- **-p** or **--patch**

```
$ git log -p -1
commit 1a900077fdef73e0c7412a731949c540c78250 (HEAD -> master)
Author: Pablo Orviz <orviz@ifca.unican.es>
Date:   Mon Oct 1 15:33:36 2018 +0000

    New README and the two first fixes documented.

diff --git a/README b/README
new file mode 100644
index 0000000..29afdfa
--- /dev/null
+++ b/README
@@ -0,0 +1 @@
+My own README file
diff --git a/fix.txt b/fix.txt
index e69de29..3e6b239 100644
--- a/fix.txt
+++ b/fix.txt
@@ -0,0 +1,2 @@
+Fix #1 added -- You can safely remove this line --
+Fix #2: Very important fix added -- You can safely remove this line --
```

- **--pretty**

```
$ git log --pretty=oneline
1a900077fdef73e0c7412a731949c540c78250 (HEAD -> master) New README and the two first fixes documented.
ef7bebf8bdb1919d947afe46ab4b2fb4278039b3 (origin/master, origin/HEAD) Fix groupId after package refactor
ebbbf773431ba07510251bb03f9525c7bab2b13a Update package name, directory
```

Options for **--pretty**:

- oneline
- short
- full
- Format (customizable)

Working with remotes

So far we have been working locally on our computer..

Working with remotes

So far we have been working locally on our computer..

- Remote repositories are versions of your project that are hosted on the Internet (e.g. GitHub)
- Remote repositories could be either controlled by you, such as forks (write permissions), or collaborative (owned by others, read permissions)
- Collaboration == Manage remote repositories
 1. Add & Remove remotes: with `git remote`
 2. Push & Pull changes to remote repositories, with `git push` and `git pull`

Showing your remotes

```
# Lists shortnames of each remote  
$ git remote  
origin
```


Showing your remotes

```
# Lists shortnames of each remote
$ git remote
origin

# Lists shortnames of each remote together with their URLs
$ git remote -v
origin https://github.com/orviz/hellogitworld (fetch)
origin https://github.com/orviz/hellogitworld (push)
```

- `origin` is the default name Git gives to the remote repository you have cloned from
- **`git clone`** adds the `origin` remote for us

Adding remote repositories

Let's add the repository we forked from

`https://github.com/masterdatascience-UIMP-UC/hellogitworld`
as a remote repository

```
# Adds a remote repository named 'upstream'
```

```
$ git remote add upstream https://github.com/masterdatascience-UIMP-UC/hellogitworld
```

Adding remote repositories

Let's add the repository we forked from

`https://github.com/masterdatascience-UIMP-UC/hellogitworld`
as a remote repository

```
# Adds a remote repository named 'upstream'
$ git remote add upstream https://github.com/masterdatascience-UIMP-UC/hellogitworld

# List remotes
$ git remote -v
origin https://github.com/orviz/hellogitworld (fetch)
origin https://github.com/orviz/hellogitworld (push)
upstream https://github.com/masterdatascience-UIMP-UC/hellogitworld (fetch)
upstream https://github.com/masterdatascience-UIMP-UC/hellogitworld (push)
```

Now we can refer to `upstream` for any operation we may need to do with this remote repository

Fetch and pull from your remotes

git fetch allows us to retrieve data from remote repositories

- Format: **git fetch <remote>**
- In collaborative scenarios, your local repository might be behind the last version of the remote repository
 - By fetching, Git gets any new work from the previous time you ran the command
- Only downloads the data to your local repository, **git fetch** does not merge it with your current version
 - You would need to merge it manually with **git merge** command

Fetch and pull from your remotes

git fetch allows us to retrieve data from remote repositories

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- Only downloads the data to your local repository, **git fetch** does not merge it with your current version
 - You would need to merge it manually with **git merge** command

git pull can be seen as a combination of **git fetch** + **git merge**

- Format: **git pull <remote> <branch>**
- Will try to automatically fetch and merge the remote version into the current version you are currently working on (locally)
- More convenient, although may not work in all the scenarios

```
# Pulls from remote repository labelled as 'origin'
$ git pull origin master
From https://github.com/orviz/hellogitworld
 * branch          master      -> FETCH_HEAD
Already up to date.
```

Push to your remotes

`git push` allows us to send our committed changes to a remote repository

- Format: `git push <remote> <branch>`

Push to your remotes

`git push` allows us to send our committed changes to a remote repository

- Format: **`git push <remote> <branch>`**

```
# Pushes changes to the remote labelled as 'master'  
$ git push origin master
```

This command will only work if we have write permissions to the remote repository, otherwise it will fail with a permission denied error.

Push to your remotes

git push allows us to send our committed changes to a remote repository

- Format: **git push <remote> <branch>**

```
# Pushes changes to the remote labelled as 'master'  
$ git push origin master
```

This command will only work if we have write permissions to the remote repository, otherwise it will fail with a permission denied error.

Exercise (understand permissions):

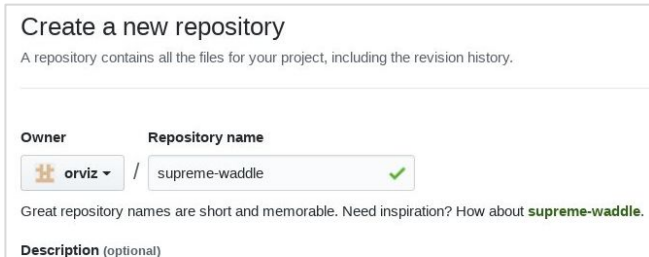
- Compare the output between pushing to the **origin** and **upstream** remote repositories

Setting up a GitHub repository from a local directory (I)

Exercise with remotes

1. (GitHub) Create a new repository in your personal account

■ Repositories > New



The screenshot shows the GitHub 'Create a new repository' interface. At the top, it says 'Create a new repository' and 'A repository contains all the files for your project, including the revision history.' Below this is a form with two main sections: 'Owner' and 'Repository name'. The 'Owner' section has a dropdown menu showing 'orviz' with a user icon. The 'Repository name' section has a text input field containing 'supreme-waddle' with a green checkmark to its right. Below these fields, there is a note: 'Great repository names are short and memorable. Need inspiration? How about **supreme-waddle**.' At the bottom, there is a 'Description (optional)' label.

2. (Terminal) Create a Git repository from a directory in your system, with git init

```
# Directory name does not need to match the GitHub repository name
$ mkdir mygithubrepo
$ cd mygithubrepo
$ git init
Initialized empty Git repository in /home/jovyan/mygithubrepo/.git/
```

3. (Terminal) Create a file

```
# Create README.md file (or with `nano README.md`)
$ echo "Welcome to my GitHub repository! It was created from a local directory" > README.md
```

Setting up a GitHub repository from a local directory (II)

Exercise with remotes

4. (Terminal) Add it to be part of the commit (add to the staging area) and commit

```
# One-liner would be `git commit -a -m "The first commit in my GitHub repo"`  
$ git add README.md  
$ git commit -m "The first commit in my GitHub repo"
```

5. (Terminal) Add your GitHub repository as remote

```
# Copy the URL from GitHub (web browser)  
$ git remote add origin https://github.com/orviz/supreme-waddle  
$ git remote -v  
origin https://github.com/orviz/supreme-waddle (fetch)  
origin https://github.com/orviz/supreme-waddle (push)
```

6. (Terminal) Push the changes to GitHub

```
# Push the commit to the recently added 'origin' remote  
$ git push origin master
```

7. (GitHub) Check in the repo that you actually have a new README.md file!

If all you remember is..

- A **fork** is a GitHub feature that copies a remote repository in your local account
 - Forks will be the most common way to deliver work to teachers
- **git clone** creates a local copy of a remote repository
 - Sets the remote repository as **origin**
 - Sets the current branch as **master**
- **git add** is a multipurpose command:
 - Begin tracking new files
 - Stage files
- **git commit** gathers all the staged changes and creates a snapshot of the project
 - **git commit -a** is shortcut to **git add** + **git commit**
 - Warning: **All modified files will be added** to the commit
- **git pull** gets last updates from a remote repository and merges them with the current version in the local working directory
- **git push** sends committed changes to a remote repository

Hands-on

Undoing things

Basic Undoing

Undoing a commit message

- Example scenario:
 - You commit too early and forget to add some files or you want to modify the commit message

Basic Undoing

Undoing a commit message

- Example scenario:
 - You commit too early and forget to add some files or you want to modify the commit message
- Solution:
 - Use **`git commit --amend`**
 - Right after having committed something it will allow you to change the commit message
 - Otherwise if you make some changes afterwards and stage them, they will take part of the last commit:

```
$ git commit -m "Initial commit"
$ echo "line added for the amendment" >> README.md
$ git add README.md
$ git commit --amend
```

Basic Undoing

Unstaging a Staged file

- Example scenario:
 - You added some file to the staged area that you later feel you don't want it there

Basic Undoing

Unstaging a Staged file

- Example scenario:
 - You added some file to the staged area that you later feel you don't want it there
- Solution:
 - Use **`git reset HEAD <file>`**
 - The command is suggested by **`git status`** command after adding a file

```
$ echo "line added that was not for this commit" >> README.md
$ git add README.md
$ git status
On branch master
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        modified:   README.md
# Let's unstage README.md file
$ git reset HEAD README.md
# The commit won't consider this change (BEWARE of using the 'handy' -a option when
committing)
$ git commit -m "Unstaging test"
```


Basic Undoing

Unmodifying a Modified file

- Example scenario:
 - You want to discard the changes done to a file

Basic Undoing

Unmodifying a Modified file

- Example scenario:
 - You want to discard the changes done to a file
- Solution:
 - Use `git checkout -- <file>`
 - The command is (once again) suggested by `git status` command after modifying a file

```
$ echo "line added to test unmodifying" >> README.md
$ git status
On branch master
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working directory)

        modified:   README.md
# Let's unmodify README.md file
$ git checkout -- README.md
# Check with `git status` that the file is not longer listed in "Changes not staged for commit"
$ git status
```

Basic Undoing

Reverting a file to a previous version

- Example scenario:
 - You want a file to get back to a previous version, N commits ago

Basic Undoing

Reverting a file to a previous version

- Example scenario:
 - You want a file to get back to a previous version, N commits ago
- Solution
 - Use `git checkout <commit-ID> -- <file1> <file2>`

```
# Check your commit history
$ git log --patch --pretty=oneline
# Find the commit ID you want to revert to
$ git checkout 94d0778 -- README.md
# (or `nano README.md`) Check that the file has been reverted to the specific version
$ cat README.md
```

If all you remember is..

- Anything that is committed in Git can almost always be recovered
 - Commits overwritten with --amend, commits in deleted branches, etc.

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If all you remember is..

- Anything that is committed in Git can almost always be recovered
 - Commits overwritten with --amend, commits in deleted branches, etc.
- Last commit (file/s included, message) can be modified with `git commit --amend`
- `git checkout` and `git reset` are powerful commands to revert things

Hands-on

Collaborative work

GitHub Pull requests

GitHub feature that allows you to propose changes to others

- Primary source of collaboration

GitHub Pull requests

GitHub feature that allows you to propose changes to others

- Primary source of collaboration
- *“Once a PR is opened, you can discuss and review the potential changes with collaborators and add follow-up commits before your changes are merged into the base branch” (github.com)*

GitHub Pull requests

GitHub feature that allows you to propose changes to others

- Primary source of collaboration
- *“Once a PR is opened, you can discuss and review the potential changes with collaborators and add follow-up commits before your changes are merged into the base branch” (github.com)*
- Owner/s of the repository are the one/s that eventually accept/reject the change
 - If accepted, the change will be typically merged into the owner's `master` branch

GitHub Pull requests

The importance of review..

- GitHub offers, through PRs, a nice **place for discussion** => code review

GitHub Pull requests

The importance of review..

- GitHub offers, through PRs, a nice **place for discussion** => code review
- Owner/s, collaborator/s and (if public) any external user/expert can comment and suggest further modifications, e.g.:
 - Goal/scope of the change
 - If source code, any suggestion to optimize the execution (efficiency, efficacy) of the code
 - Commit/s message/s description

GitHub Pull requests

The importance of review..

- GitHub offers, through PRs, a nice **place for discussion** => code review
- Owner/s, collaborator/s and (if public) any external user/expert can comment and suggest further modifications, e.g.:
 - Goal/scope of the change
 - If source code, any suggestion to optimize the execution (efficiency, efficacy) of the code
 - Commit/s message/s description
- Code review process may result in the change being merged into the production version (master branch) => extra careful!
 - Usually is complemented with the execution of a set of automatic tests => GitHub Integrations

Git Branching

*“Diverge from the main line of development (**master branch**) and continue to do the work without messing with that main line” (Pro Git)*

- Default branch name in Git is **master**
 - *Not a special branch*, just like any other
- Check what branch we currently are
 - Format: **git branch**

Git Branching

“Diverge from the main line of development (master branch) and continue to do the work without messing with that main line” (Pro Git)

- Default branch name in Git is master
 - *Not a special branch*, just like any other
- Check what branch we currently are
 - Format: **git branch**
- Create a branch
 - Format: **git branch <branch-name>**
 - New branch (~environment) *pointing to the same commit ID you are currently on*
 - Git knows what branch is currently on by the special pointer HEAD → Can be checked with **git log**

Git Branching

“Diverge from the main line of development (master branch) and continue to do the work without messing with that main line” (Pro Git)

- Default branch name in Git is `master`
 - *Not a special branch*, just like any other
- Check what branch we currently are
 - Format: `git branch`
- Create a branch
 - Format: `git branch <branch-name>`
 - New branch (~environment) *pointing to the same commit ID you are currently on*
 - Git knows what branch is currently on by the special pointer `HEAD` → Can be checked with `git log`
- Switching branches
 - Format: `git checkout <branch-name>`
- One-liner: with `-b` option

```
# Shorthand for “git branch testing + git checkout testing”  
$ git branch -b testing
```



Git Branches + GitHub Pull Requests

When you have write access to the remote repository

- Workflow

1. (Terminal) For each new change, create an individual branch `new-fix`
2. (Terminal) Make all the needed changes within the branch
3. (Terminal) Once done, push the branch to the remote repository
4. (GitHub) Head to the remote repository webpage
5. (GitHub) Create a Pull Request from `new-fix` to be merged in `master` branch
6. (GitHub) Review the Pull Request and merge it if ok

Git Branches + GitHub Pull Requests

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- Workflow
 1. (Terminal) For each new change, create an individual branch `new-fix`
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 5. (GitHub) Create a Pull Request from `new-fix` to be merged in `master` branch
 6. (GitHub) Review the Pull Request and merge it if ok
- Outcome
 - `master` branch is protected from direct pushes
 - Via feature branches we isolate new additions/fixes from production/working version in `master`

Git Branches + GitHub Pull Requests

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- Workflow

1. (Terminal) For each new change, create an individual branch `new-fix`
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6. (GitHub) Review the Pull Request and merge it if ok

- Outcome

- `master` branch is protected from direct pushes
 - Via feature branches we isolate new additions/fixes from production/working version in `master`

- Exercise

- Based on the workflow above, merge a new change in master with a Pull Request
- Choose one of your test repositories in your personal account
 - `hellogitworld` fork repository
 - Repository created from local directory

GitHub Forks + Git Branches + GitHub Pull Requests

When you **do not** have write access to the remote repository

- Workflow

1. (GitHub) Create a Fork of the repository you want to contribute to
2. (Terminal) Clone the Fork
3. (Terminal) For each new change, create an individual branch `new-fix`
4. (Terminal) Make all the needed changes within the branch
5. (Terminal) Once done, push the branch to the remote forked repository
6. (GitHub) Head to the Fork repository webpage
7. (GitHub) Create a Pull Request from `new-fix@fork` to be merged in `master@remote` branch
8. (GitHub) The owner/s of the remote repository will review the Pull Request and merge it if approved

GitHub Forks + Git Branches + GitHub Pull Requests

When you **do not** have write access to the remote repository

- Workflow

1. (GitHub) Create a Fork of the repository you want to contribute to
2. (Terminal) Clone the Fork
3. (Terminal) For each new change, create an individual branch `new-fix`
4. (Terminal) Make all the needed changes within the branch
5. (Terminal) Once done, push the branch to the remote forked repository
6. (GitHub) Head to the Fork repository webpage
7. (GitHub) Create a Pull Request from `new-fix@fork` to be merged in `master@remote` branch
8. (GitHub) The owner/s of the remote repository will review the Pull Request and merge it if approved

- Outcome

- Contribute changes to repositories not managed by you (no write permissions)

GitHub Forks + Git Branches + GitHub Pull Requests

When you **do not** have write access to the remote repository

- Workflow

1. (GitHub) Create a Fork of the repository you want to contribute to
2. (Terminal) Clone the Fork
3. (Terminal) For each new change, create an individual branch `new-fix`
4. (Terminal) Make all the needed changes within the branch
5. (Terminal) Once done, push the branch to the remote forked repository
6. (GitHub) Head to the Fork repository webpage
7. (GitHub) Create a Pull Request from `new-fix@fork` to be merged in `master@remote` branch
8. (GitHub) The owner/s of the remote repository will review the Pull Request and merge it if approved

- Outcome

- Contribute changes to repositories not managed by you (no write permissions)

- Exercise

- Create a contribution using a Pull Request to the repository:

<https://github.com/masterdatascience-UIMP-UC/gittutorial-teacher-repo>

Git Branching - Merging

- When we click on Merge Pull Request button in GitHub, it runs `git merge` for us

```
# Create and switch to a new branch 'generate-conflict'
$ git checkout -b feature-to-merge

# Do whatever change (e.g. remove README file) and commit
$ git rm README
$ git commit -m "Remove unused README file"

# Checkout to master and merge
$ git checkout master
$ git merge feature-to-merge
Updating c858518..4b41eff
Fast-forward
 README | 1 -
 1 file changed, 1 deletion(-)
 delete mode 100644 README
```


Git Branching - Merge conflicts

- Occasionally, merging two branches (such as a feature branch into `master`) does not go smoothly
 - E.g. if we changed the same part of the same file differently on both branches

```
# Create and switch to a new branch 'generate-conflict'
$ git checkout -b generate-conflict

# Add a new line (3rd line) in fix.txt and commit
$ echo "line added in generate-conflict branch" >> fix.txt
$ git add fix.txt
$ git commit -a -m "Added important line"

# Switch to master branch
$ git checkout master

# Add a new line (3rd line) in fix.txt and commit
$ echo "line added in master branch" >> fix.txt
$ git add fix.txt
$ git commit -m "Added very important line"

# Merge branch 'generate-conflict' into 'master'
$ git merge generate-conflict
Auto-merging fix.txt
CONFLICT (content): Merge conflict in fix.txt
Automatic merge failed; fix conflicts and then commit the result.
```

Git Branching - Merge conflicts

- We have to edit the affected file/s to select the right content and commit

```
$ git status
On branch master
Your branch is ahead of 'origin/master' by 1 commit.
  (use "git push" to publish your local commits)

You have unmerged paths.
  (fix conflicts and run "git commit")
  (use "git merge --abort" to abort the merge)

Unmerged paths:
  (use "git add <file>..." to mark resolution)

        both modified:   fix.txt

$ cat fix.txt
otra cosa
otra cosa 2
<<<<<< HEAD
line added in master branch
=====
line added in generate-conflict branch
>>>>>> generate-conflict
```

- Conflict markers:
 - <<<<< (start conflict)
 - >>>>> (ends conflict)
 - ===== (conflict separation)

```
# Edit fix.txt with 'nano' editor and leave just the
# right content
$ cat fix.txt
otra cosa
otra cosa 2
line added in generate-conflict branch

# Mark resolution and commit
$ git add fix.txt
$ git commit -m "Merge branch 'generate-conflict'"
```

A last note on Fork maintenance.. (I)

- Since a fork is a copy, it needs to be up-to-date
 - You only have the versions of the files at the time the fork was created
 - If there are changes in the original repo, you may find that your fork is out of sync
- Recommended workflow
 - Having master branch updated with the original master repository
 - Fork master branch is **protected**
 - Not directly modified by us
 - Should always contain the last version of master@upstream
 - Whenever you want to contribute a change to upstream (remote repository)
 - Create a separate branch from your updated master (in the fork)
 - Create a pull request to master@upstream from

A last note on Fork maintenance.. (II)

- How to update your forked master branch?

```
# Be sure you are in master branch
$ git checkout master
# 'upstream' remote has to be previously added
$ git fetch upstream
# Find the commit ID you want to revert to
$ git pull upstream master
# Push the updated master to GitHub
$ git push origin master
```

Exercise: after updating a master@upstream branch, try to update your forked master