Git for developers

Source code management with *git*

git Smile

OPEN SOURCE SOLUTIONS

Agenda

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Git presentation and history

- Git is a *distributed revision control* and *source code management* system
- Git is a free software created by *Linus Torvalds*
- Git is available under the *GNU GPL V2* license
- Git was initialy created to host the *Linux* kernel sources after the hosting on BitKeeper was abandonned
- Key dates:
  - 3 April 2005: Linus starts development
  - 16 June 2005: release 2.6.12 of the linux kernel managed by git
  - 26 July 2005: handover of maintenance to a major contributor (Junio Hamano)
  - 21 December 2005: release of v1.0 of git
  - 28 May 2014: release of v2.0 of git

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Git design criteria

- Strong support for non-linear development:
  - rapid branching and merging
  - *core* assumption: a change will be merged more often than it is written
- *Distributed* development and workflow
- Strong safeguard against corruption (accidental or malicious)
- Compatibility with existing systems/protocols (http, ftp, rsync, ssh)
- Efficient handling of large projects
- *Object Oriented* model
- *Plumbing* vs. *Porcelain*

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Other SCMs

- Centralized (client/server):
  - Concurrent Version System (CVS)
  - Subversion (svn)

  Distributed:
  - Mercurial
  - GNU Bazaar
  - BitKeeper

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Distributed system benefits and drawbacks

- Benefits:
  - Full history available locally
  - No need for network connection for usual operations
  - No need for manager approval for day to day usage (branch, tag, merge ...)
  - There is still a reference repository
  - You can clone the reference repository or any existing clone
  - Merge system (vs. lock one)
- Drawbacks:
  - Initial cloning can be long (full history)
  - No lock system (can be a problem for binaries)

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Differences with Subversion

- Distributed (vs. centralised)
- Use of meta data (vs. files)
  - only one `.git` folder at root level (this point has changed with last versions of svn)
- Better data integrity (usage of *SHA-1* hash to identify each object)
- No global revision in git
- Better branch management
- "Real" tags which can be signed with *GPG* keys if needed
- The system stores full contents as opposed to delta (diff)

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Data integrity control

- Usage of *SHA-1* hashes (same result on any machine/system for the same content)
- 160 bits footprint (40 chars.)
- All files are stored in `.git/objects`
- Files are identified by an ID: fast and efficient

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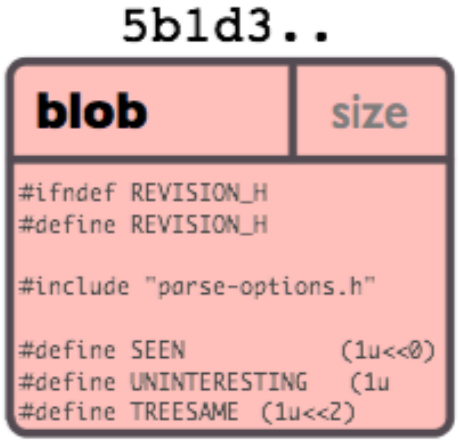
Git Object Model

There are 4 types of objects in Git:

- Blob
- Tree
- Commit
- Tag

Git Object Model: Blob

A blob object stores the content of a file. It's a piece of binary data which does not reference anything, not even a file name.

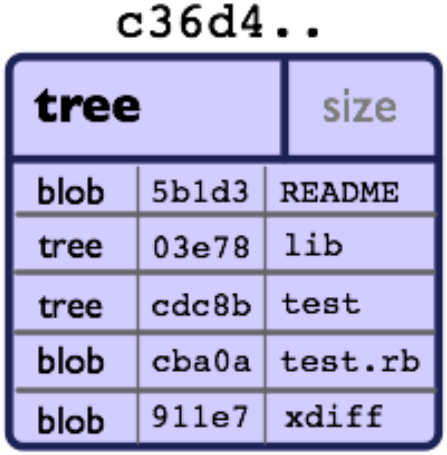


You can
inspect the content of a blob if you know its hash with the command:

```
git show <hash> / git cat-file -p <hash>
```

Git Object Model: Tree

A tree object contains a list of pointers to *blobs* and other *trees*. It represents the content of a directory or sub-directory.



You
can use **git show** to inspect a tree but **git ls-tree** will give more info:

```
git ls-tree <hash> / git show <hash>
```

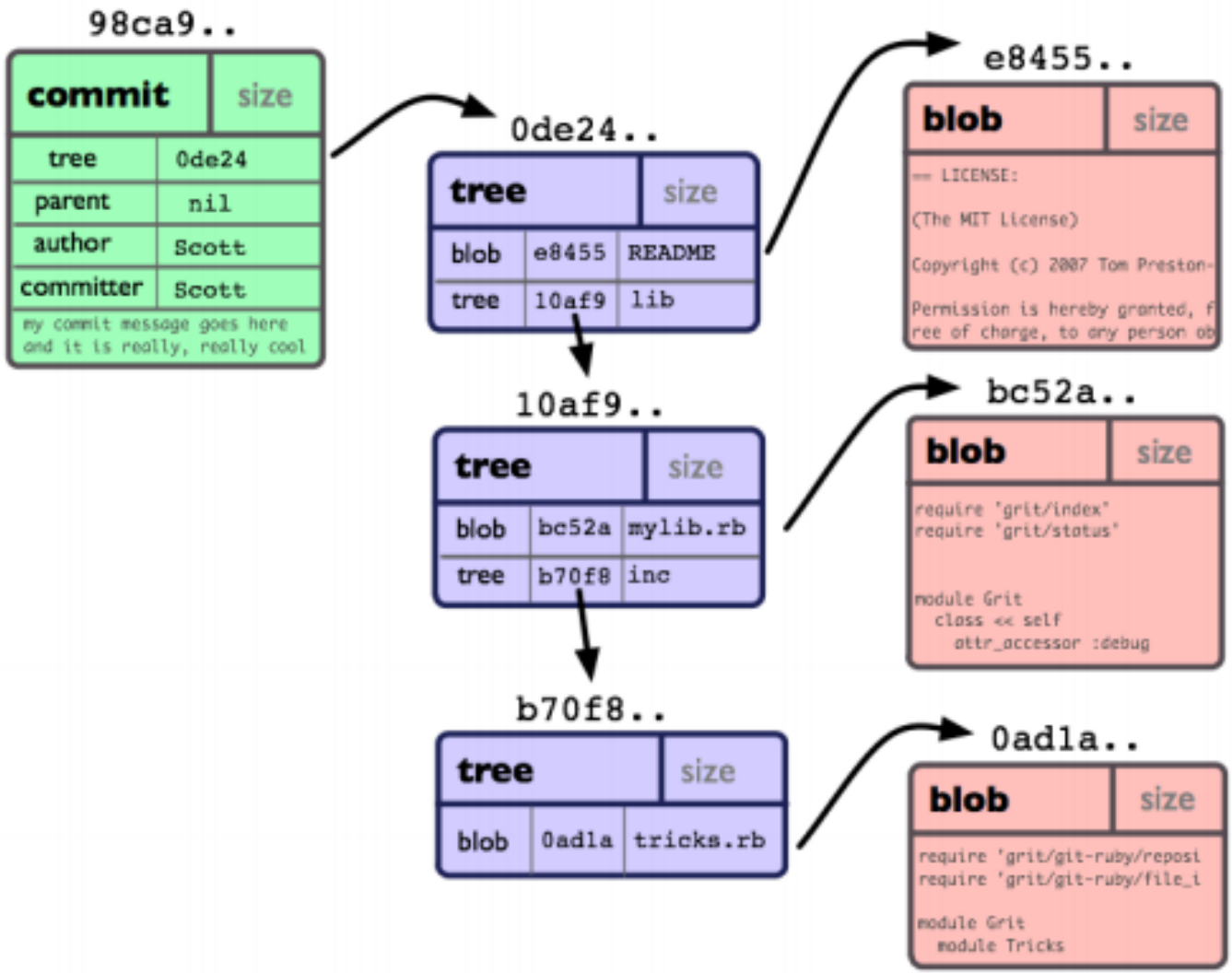
Git Object Model: Commit

A commit links the physical state of a *tree* with a comment explaining why it came to that state. It is defined by a tree, one or several parents, an author, a committer and a comment.

You can use **git show** or **git log** with the **–pretty=raw** option to inspect a commit:

```
git show --pretty=raw <hash> / git cat-file -p <hash>
```

Git Object Model: Commit/Tree/Blob relations



Git Object Model: Tag

A tag object points to a specific state of the code. It contains an object id, an object type, the name of the tagger and a message with an eventual signature.

You can use **git cat-file** to view the content of a tag:

```
git cat-file tag <TAG_NAME>
```

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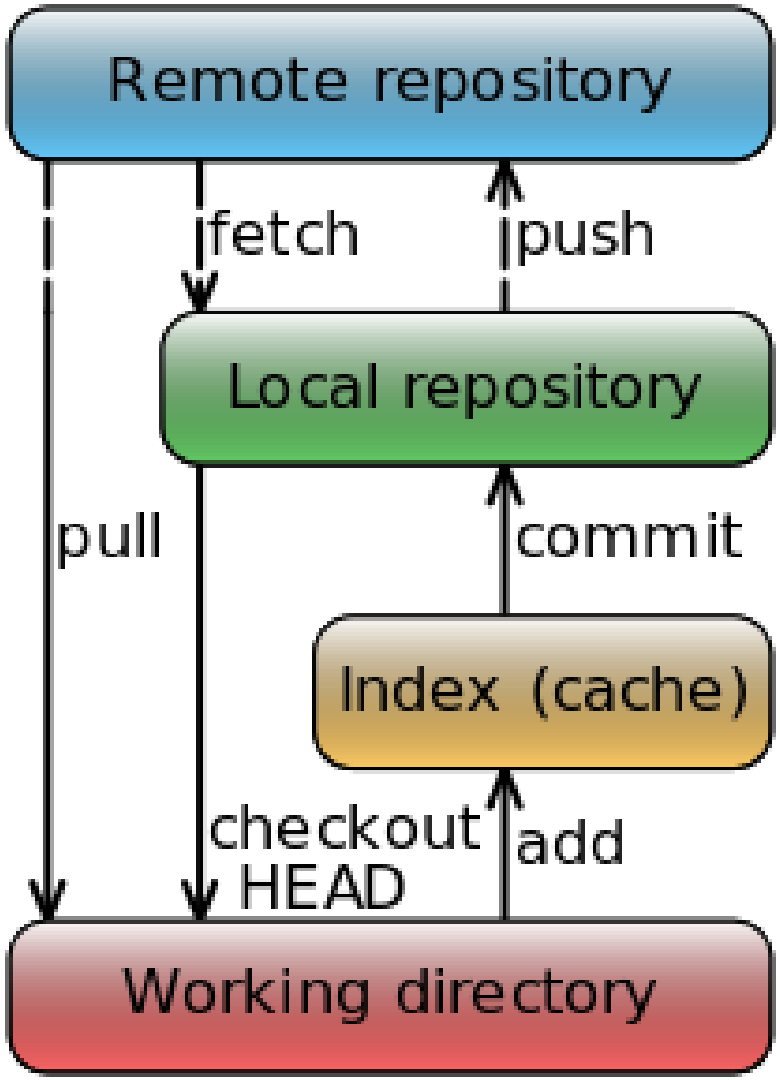
Understanding git architecture: Working areas

There are basically 4 areas you have to work with:

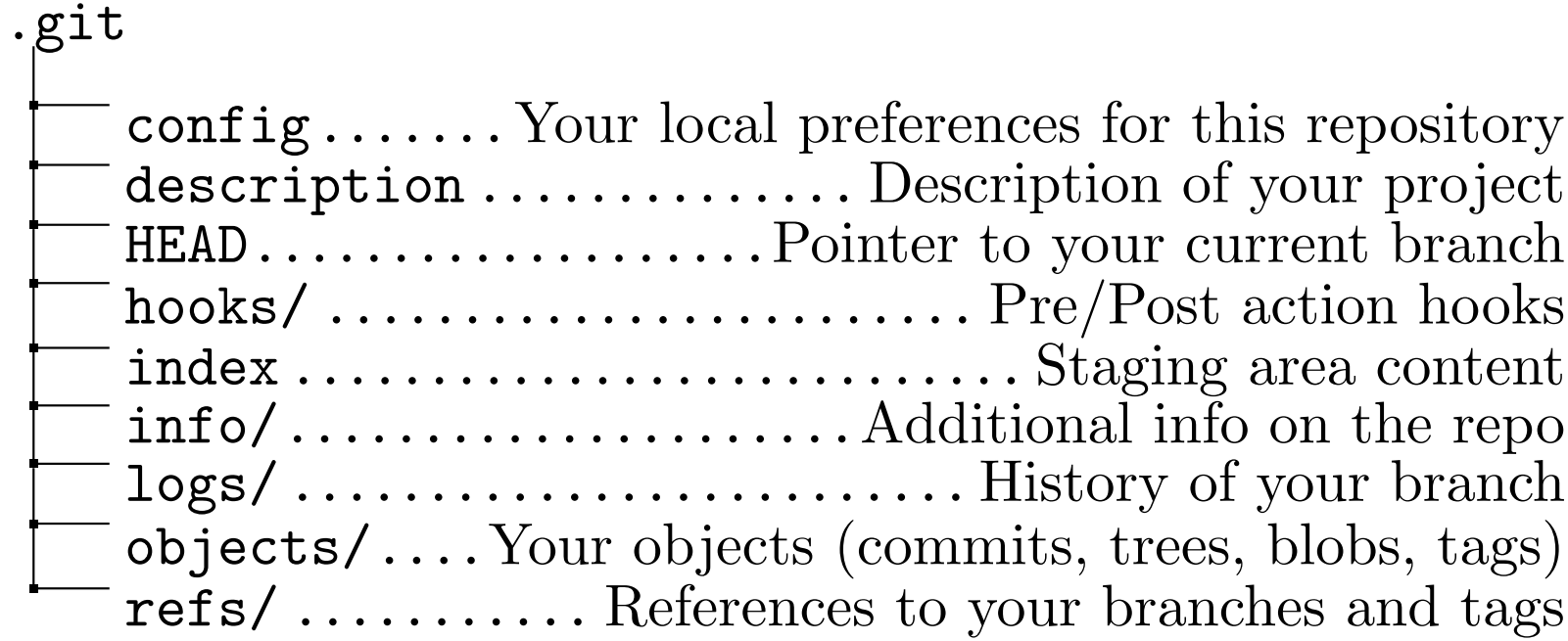
- The *working directory*: it holds your project files ; this is were you make changes.
- The *staging area*: this is were you **add** the snapshot of the files you want to commit to your repository.
- The *local repository*: this is were you **commit** your changes ; this is held in the `.git` directory.
- The *remote repository*: this is the reference that you use to **pull** the changes made by other developpers and **push** your own changes ; this repository is *bare* (it contains no working copy) ; in Smile context, this will be a GitLab repository on `https://git.smile.fr/` that you access over http or ssh.

Understanding git architecture: Operations overview



Understanding git architecture: Anatomy of the .git folder

Every working directory contains a single `.git` file at its root containing the local git repository.



To go further see:

```
git help repository-layout
```

Understanding git architecture: Review of git hooks

Hooks samples are embedded in any git repository in `.git/hooks`. A hook is basically a shell script in any language (*shabang* / *shebang* usage).

```
.git/hooks
├── applypatch-msg.sample ..... local
├── commit-msg.sample ..... local
├── post-update.sample ..... server
├── pre-applypatch.sample ..... local
├── pre-commit.sample ..... local
├── pre-push.sample ..... local
├── pre-rebase.sample ..... local
├── prepare-commit-msg.sample ..... local
└── update.sample ..... server
```

Many more hooks exist. To go further see:

```
git help hooks
```

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Plumbing vs. Porcelain

Git was first made as a VCS toolkit which embeds a large set of *low-level* commands to interact with the `.git` directory contents (store contents, hash objects, create an index, see git objects contents ...). These commands are called *plumbing commands* as they mostly concern the low-level internal processes.

- **git cat-file** / **git symbolic-ref** / **git rev-parse**/ **git update-index** / **git read-tree** / **git write-tree** ...

Git also comes with a user-friendly command line interface for common usage, which is a set of *user-level* commands. They are mostly shortcuts for *plumbing* ones to facilitate a day-to-day usage. These commands are called *porcelain commands* as they represent the user-friendly couch of git.

- **git push** / **git pull** / **git status** / **git log** / **git add** / **git commit** ...

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Installing git and needed tools

- Linux debian/ubuntu

```
apt-get install git git-svn gitk meld
```

- Windows
  - msysgit
  - tortoiseGit
- Mac
  - http://code.google.com/p/git-osx-installer
  - http://www.macports.org

```
sudo port install git-core +svn +doc \
    +bash_completion +gitweb
```

- Eclipse
  - egit

Installing git and needed tools: Practice

- Install **git** on your machine
- Make sure the **git** command is available in your terminal
- Check which **git** version is in use

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Getting help

- For all sub-commands, git integrates a detailed help accessible with:

```
git help <command>
```

- All configuration variables can be inspected with a good detail level with command:

```
git help config
```

- Most commands and references can be autocompleted on the commande line, so do not hesitate to hit the TAB key:

```
git [TAB]              # list of commands
git cmd [TAB]          # list of options
git cmd -o [TAB]       # list of remotes/branches
```

Getting help: Practice

- Look at global help
- Use autocompletion with the **help** command (type the first letter of a git subcommand)

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Configuration

- Git can be configured via the command line:

```
git config (--local | --global) scope.var "value"
```

- You can also edit configuration files (`INI` like format):
  - file `~/.gitconfig` for global per user configurations (like using option **–global**)
  - file `.git/config` for local repository configurations (like using option **–local**)

Configuration: Practice

- Have a look at available config variables
- Have a look at your *global* and *local* config values

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Telling git who you are

Before you start any work in git, you must set your identity correctly. It will be used to identify your as an author or committer:

```
git config --global user.name "Olivier Clavel"
git config --global user.email \
    "olivier.clavel@smile.fr"
```

Telling git who you are: Practice

- Configure your full name and email

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Setting editors

- You can choose your favorite editor as you wish. Default is **$EDITOR** (most probably **vi**). Examples:

```
git config --global core.editor nano
git config --global core.editor gedit
```

- You should as well define your diff editor. The recommended one is **meld** on linux:

```
git config --global merge.tool meld
```

- For other diff editor possibilities see:

```
git help mergetool
```

Setting editors: Practice

- Set your favorite text editor
- Set your favorite diff editor ; if you don't have one, install *Meld* and set it as default

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Colors in your terminal

- Git can colorize most of its output in the terminal for better readability. To globaly enable colors:

```
git config --global color.ui auto
```

- For fined grained color tuning see all **color.*** config variables.

Colors in your terminal: Practice

- Have a look at color variables in config help
- Set default auto color for output

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Know where you are in your bash prompt

The git package comes with **PS1** macro your can add to your prompt. It will display the current branch if your are inside a git repository. Here is an example customized from a default `.bashrc` under Ubuntu. Adapt it to your needs.

```
# Find this line in your .bashrc
if [ "$color_prompt" = yes ]; then
    PS1='${debian_chroot:+($debian_chroot)}
        \[\033[01;32m\]
        \u@\h\[\033[00m\]:\[\033[01;34m\]
        \w$(__git_ps1 " (%s)")\[\033[00m\]\$ '
else
    PS1='${debian_chroot:+($debian_chroot)}
        \u@\h:\w$(__git_ps1)\$ '
fi
unset color_prompt force_color_prompt
#.bashrc continues
```

Know where you are in your bash prompt: Practice

- Make sure the **PS1** macro is available for your platform (hint: see `/etc/bash_completion.d/` directory)
- Locate your **PS1** prompt definition (hint: have a look at `~/.bashrc`)
- Make a backup copy of that file
- Try to modify your **PS1** prompt
- Run **mkdir test && cd $_ && git init**
- See what happens on your prompt

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Creating a local repository

- Initialise an empty local repository

```
mkdir my_project
cd my_project
git init
```

- Clone an existing remote repository

```
git clone \
    git@git.smile.fr/my_group/my_project.git \
    my_project_local_dir
```

Creating a local repository: Practice

- Basic set up of your Gitlab account (preferences, ssh key ...)
- Create a folder for today's training
- Move to that folder
- Initialise a git dir from scratch and copy some files in there
- Create another repo by cloning the example for today's training

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Adding files to the staging area

Once you have modified some files in your workdir, you must add the changes to the staging to prepare them for commit.

- First have a look at what has changed:

```
git status
git diff
```

- You should *always over-use these commands* (with options eventually)
- Add some files to the staging area:

```
git add [file | folder | ...] [file2 | folder2 | ...]
```

- For partial add operations, use the patch mode:

```
git add -p / git add --patch
```

- For fine tuning of add operation, use the interactive mode:

```
git add -i / git add --interactive
```

Adding files to the staging area: Practice

- Work on your own empty created repo
- Examine the state of your dir
- Add some more files or make some changes if needed
- Add some changes to your staging area
- Add an external library
- Use the **git add** *interactive* and *partial* modes to add the library to the index

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Listing differences

- See differences between your working copy and the staging area:

```
git diff
```

- See differences between your working copy + staging area and the last commit on your branch:

```
git diff HEAD
```

- See differences between your staging area and the last commit:

```
git diff --staged
```

Listing differences: Practice

- List differences for files you did not yet add
- List differences already added to your staging area

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Commiting changes and viewing history

To create a new commit with the content of the staging area, use **git commit**.

- With no option, it will launch your external editor to let you write commit's message:

```
git commit
```

- Specify the message on the commmand line:

```
git commit -m "my commit message"
```

- You can add all changes to the staging and commit them at once:

```
git commit -a -m  "my commit message"
```

- You can modify a commit:

```
git commit --amend
```

Commiting changes and viewing history

To look at history of commits, use **git log**.

- Full default history:

```
git log
```

- Show history since one minute ago:

```
git log -p --since="1 minute ago"
```

- Show history of last 2 commits:

```
git log -p HEAD~2..HEAD
```

Commiting changes and viewing history: Practice

- Commit your staged changes
- Add some more changes and commit them
- Have a look at the history
- Get help on git show and examine some commits with it

Commiting changes and viewing history: Use case

Problem: how to update a commit with new files or modifications.

```
# initial commit with forgotten modifications
git commit -m "commit message"
> [master 1234567] commit message
> ...

# add missing new files or modifications
# to the staging area
git add <path>

# redraw the last HEAD commit
# with last commit message
git commit --amend -C HEAD
> [master 7654321] commit message
> ...
```

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Creating branches

- By default the repository contains the master branch
- To create a dev branch based on the latest commit of the current one:

```
git branch dev
```

- To switch on the newly create branch:

```
git checkout dev
```

Creating branches: Practice

- Create a **dev** branch from **master**
- Switch to **dev** branch
- Make some changes, add, commit them
- Switch back to **master**
- List differences between **master** and **dev** branches (hint: get help on diff)
- Get help on the checkout command and figure out how to create and switch to a branch named **experimental** in a single command
- Make some changes in branch **experimental**, commit them

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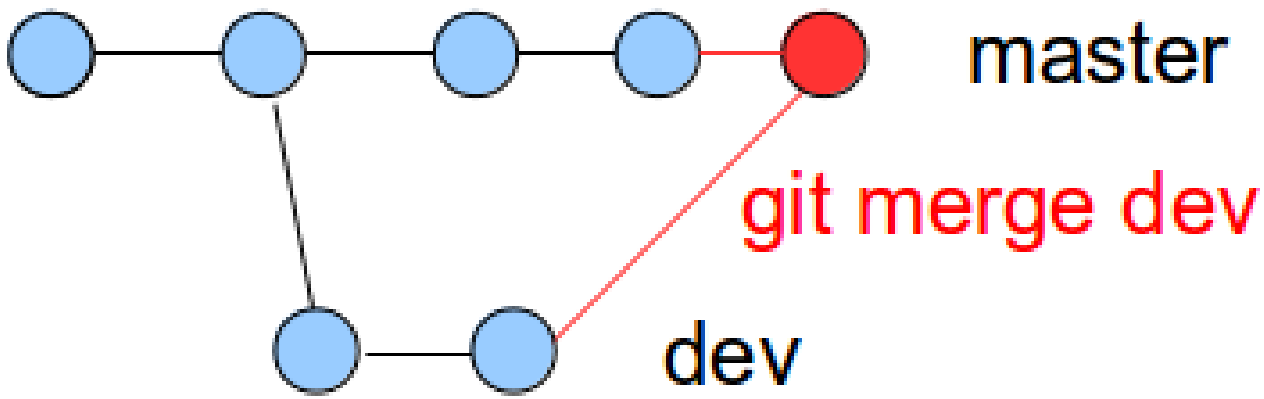
Merging branches

- To merge the changes from one branch into another (e.g. dev into master):

```
git checkout master
git merge dev
```

- Branches can be merged multiple times. Git keeps trace of the merge history.

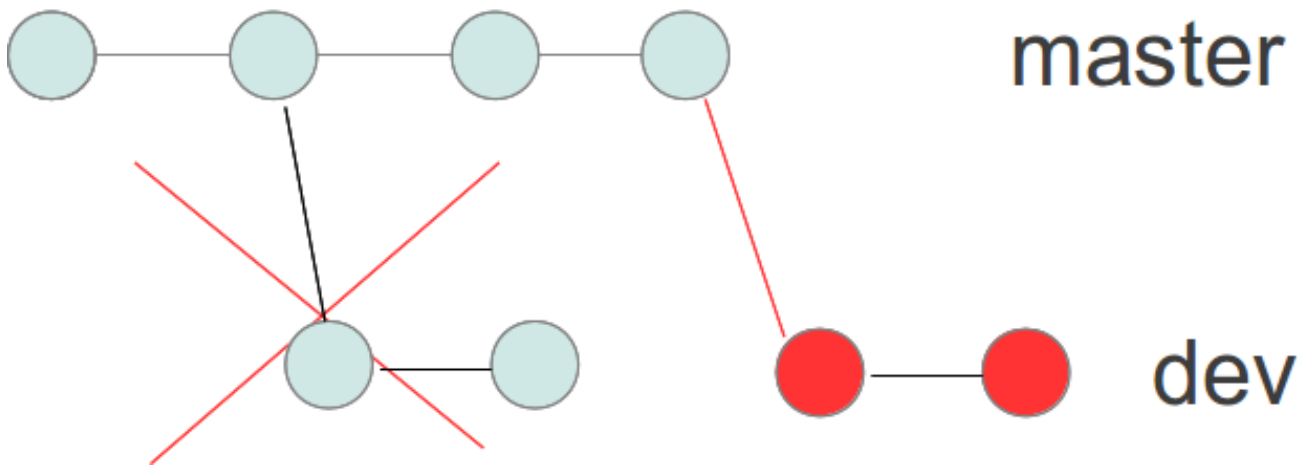


Content

Rebasing

- You can rebase one branch on the work done on another.
- When you rebase, you are basically adding your work after the one done on the other branch

```
git pull --rebase
git rebase master
```



Merging and Rebasing: Practice

- Merge **dev** into **master** and show logs
- Rebase **experimental** on **master** and show logs
- Merge **experimental** into **master** and show logs
- Delete branch **experimental** (hint: git help on branch)

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Cherry-picking

- You can pick a single commit from one branch and insert it in another:

```
git cherry-pick <hash>
```

- When you *cherry-pick*, the original commit is patched in current history and a new commit is done
- You can compare commits between branches:

```
git cherry -v master dev
```

Cherry-picking: Practice

- Checkout the **dev** branch, make some updates and commit them
- Checkout **master** and list commits diff
- Cherry-pick your commit from **dev** to **master**
- List commits diff again

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Sharing work with the remote repository

- If you have cloned a remote, git already has the master as a remote tracking branch. Else you need to add the remote, publish the branch and set it as upstream:

```
git remote add origin \
    git@git.smile.fr:my_group/my_project.git
git push --set-upstream origin master
```

- You proceed the same way with new branches you want to publish and track:

```
git push -u origin dev
```

- To retrieve changes pushed by others on the remote, you must fetch them and merge them in your branch:

```
git pull
# or in two steps
git fetch && git merge
```

Sharing work with the remote repository

- In most cases, on long living branches, you will want to rebase your work on the remote branch:

```
git pull --rebase
```

- To rebase automatically for a specific branch each time you pull:

```
git config branch.master.rebase true
git pull
```

- To rebase automatically for all new branches (add –**global** to have it permanent on the machine):

```
git config branch.autosetuprebase always
```

Remote interaction: Practice

- Create a **training** repository under your name on gitlab.
  Please remember to clean it up after the training. Thanks :)
- Add this new remote as **origin** on your local home made repository
- Push **master** on origin and set origin/master as remote tracking branch
- Move to the example clone repository
- Config **master** to always rebase on upstream on pull
- Push your changes (if you can)
- Pull changes from others

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Working with tags

- Tags are used to identify a specific version of a specific branch, typically to identify a version pushed to production
- Tags can be organised with prefixes like for folders on a disk
- You can create a lightweight tag (default):

```
git tag production/20140116_0902 master
```

- Or a full tag object, even with a *GPG* signature:

```
git tag -s -m "pushing release XXX to \
    uat for testing" uat/20140112_1735 master
```

- Signed tags can be verified:

```
git tag -v uat/20140112_1735
```

Working with tags: Practice

- Create some tags
- Push those tags to the **origin** remote (hint: help push)

Content

Moving and deleting files

- Delete files (must commit after to send to repo):

```
git rm file1 file2
```

- Rename or move a file (must commit after to send to repo):

```
git mv old_file new_file
```

Moving and deleting files: Practice

- Delete and move some files arround
- Commit and push your changes

Content

Ignoring files

- Personnal ignore file globally applied on your machine:

```
git config --global core.excludesfile \
    /home/<USER>/.gitignore
vim /home/<USER>/.gitignore
```

- Local and personnal ignore file for a specific repository:

```
vim .git/info/exclude
```

- Local shared ignore file commited in the repository:

```
cd my_project
vim .gitignore
git add .gitignore
git commit -m "Ignoring y and z in project"
```

- Those files all contain list of *GLOBS* file patterns to exclude

Ignoring files: Practice

- Exclude your favourite backup extension globally for all your git repositories
- Exclude `.phps` locally for your current repositories
- Create a `cache` and `log` directories and ignore all their contents for anyone working on the project

Content

Going back to a previous state

- Remove a change in staging keeping the working file unchanged (opposite of **add**):

```
git reset -- path/to/file
```

- Discard all changes come back to the HEAD revision in repository:

```
git reset --hard HEAD
```

- Recover a file accidentaly deleted:

```
# recover from HEAD revision in repository
git checkout HEAD path/to/file
# recover from staging area
git checkout -- path/to/file
```

- Repair an error that was commited to the repository. This creates a new commit undoing the change. In this example only undo last commit:

```
git revert HEAD
```

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Include submodules

Git comes with the ability to include another git repository in a project treating it as a git clone. It only stores the remote URL of the module and the commit you want to use in your project:

```
# add a new submodule
git submodule add /URL/of/git/submodule/ \
    local/submodule/path/
# update the submodule
cd local/submodule/path/
git pull --rebase origin master
# commit the state you want for your submodule
cd -
git add local/submodule/path/
git commit -m "update submodule to XXX"
```

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Git attributes

Git comes with the ability to define special behaviors:

- Behavior for a file type (such as identation, binary contents)
- Exclude some files or directories from tarballs
- Define a merge strategy for specific files or directories

```
# get help about available attributes
git help attributes
# setup a local .gitattributes file
vim .gitattributes
# setup a global .gitattributes file
vim ~/.gitattributes
```

Git attributes: Practice

- Add a submodule to project and commit and push it
- Have a look at it at GitLab
- Setup git to consider any `*.html` file as a text file
- Exclude any `*.tmp` file from tarball exports

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Workflow basics

- Git branches are light and easy to manage: *use them !*
- You do not have to push all branches you create locally
- Type of branches on the remote:
  - *Long living* or Environment branches
  - *Short living* or Topic/Feature branches
- Topic branches are usually derived from **master** and eventually rebased against it (dependencies, long term work)
- Topic branches are merged in Environment branches. Merge to higher level, never backwards.
- Topic branches are created from *development* branch, and rebased against it.
- Git is only the repository tool. *It does not replace procedures, planning and communication !*

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Environment branches

- A *master* branch should always exist:
  - It must be the *production-ready* sources
  - You should always be able to deploy it on production (no development or unstable stuff)
  - Best practice: any commit on master should create a new tag (version) or deployment
- A *development* branch should always exist:
  - It must centralize all developments to be tested before including them on **master**
  - It must always be ahead **master** (or at least at the same point)
  - It receives merges from Topic/Feature branches
- Any other environment branches can exist

Environment branches: examples

- master = production
- dev (=continuous integration ?)
- uat
- staging
- preprod
- ...

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Feature branches

- Topic or Feature branches have a short life
- They should be up-to-date with current **master** (at least) by merging it regularly
- They must be merged in the *development* branch when the work is done
- Once fully integrated in environment branches, they can be deleted
- Remember: you don't have to push all your local branches to the remote

Feature branches: examples

- feature-12345 (redmine ticket)
- checkout_redesignV2 (project)
- local_cutting_edge_newfeat
- hotfix-654677 (redmine ticket)

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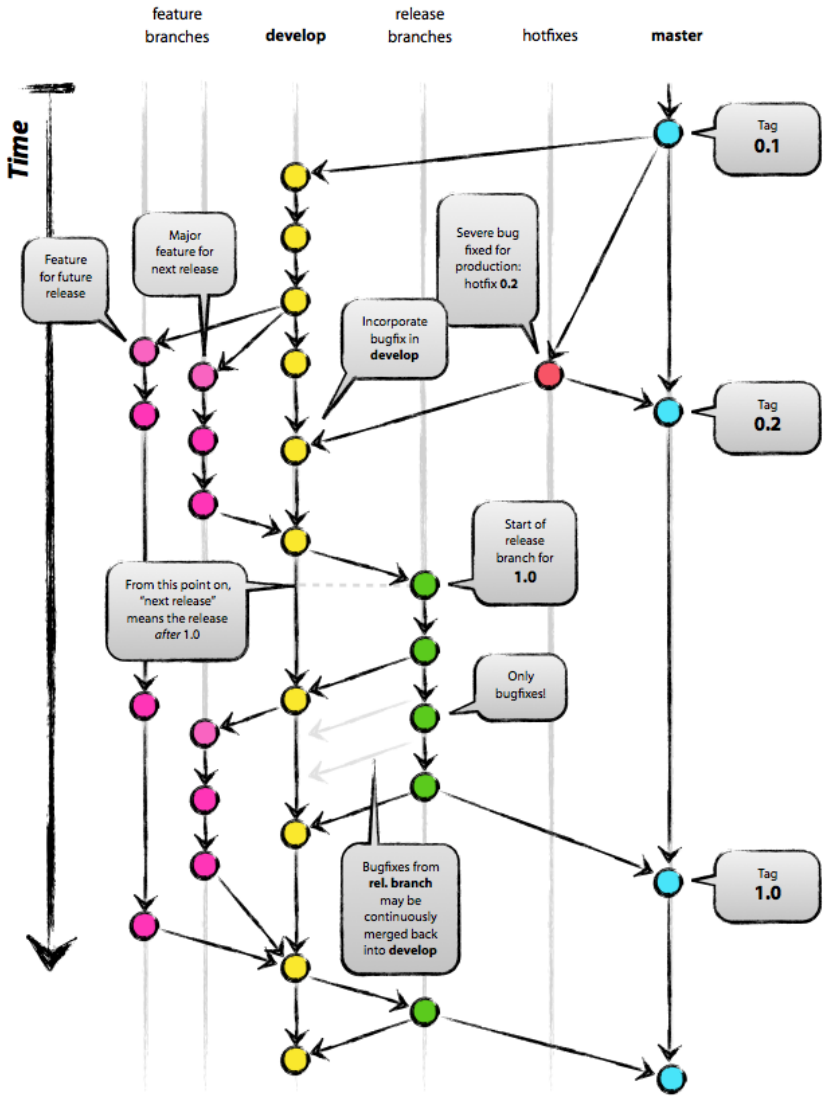
Branches organisation overview



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Tips & tricks

- When merging a short-living branch, use the **–no-ff** option to force git to make a merge commit:

```
git merge --no-ff my-feature-branch
```

- Use the “fork” and “pull-request” concepts of GitLab (and GitHub)

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Workflow practice

Examples:

- Teams constitution: define roles and tasks
- Create long living branches
- Create feature branches (one for each team)
- Work separately on features
- Deliver individual developements up to production in different orders
- Clean up local and remote references (hint: git help push/branch)
- ... and any other operations you want to try and discuss :)

Content

References

- Learn git online in 15 minutes on github: `http://try.github.io/levels/1/challenges/1`
- Visual git Cheatsheet: http://ndpsoftware.com/git-cheatsheet.html
- Pro Git book: `http://git-scm.com/book`
- Git community book: `http://alx.github.io/gitbook/`
- Git - the simple guide: `http://rogerdudler.github.io/git-guide/`
- git-workflows for agilist: https://github.com/stevenharman/git-workflows

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One last thing...

- How to "stash": `https://git-scm.com/book/en/v2/Git-Tools-Stashing-and-Cleaning`
- Rewriting history: `https://git-scm.com/book/en/v2/Git-Tools-Rewriting-History`
- Using bisect debugging: https://git-scm.com/book/en/v2/Git-Tools-Debugging-with-Git
- Mono/many repos: https://speakerdeck.com/fabpot/a-monorepo-vs-manyrepos