Distributed
Version Control

http://d3s.mff.cuni.cz

Pavel Parízek
parizek@d3s.mff.cuni.cz
Key concepts

- Each developer uses a private local repository
  - *clone*: full mirror of some existing repository

- Operations performed on the local repository
  - very fast, off-line

- Synchronization
  - Operations *push* and *pull*
  - Exchanging code patches
Comparing distributed and centralized VCS

• Centralized
  ▪ Everything visible in the central repository
  ▪ Private branches (work) not possible

• Distributed
  ▪ Private repositories (and branches) useful for experimental development
Tools

- Git
- Mercurial
- Bazaar
Git

Software Development Tools

Distributed Version Control
Main features

- Versions: snapshots of the project (working dir)
- Committed revisions form a direct acyclic graph
  - Multiple “latest” versions (leaf nodes)
- Each commit has an author and committer
  - Distributing changesets via patches (email)
- Whole repository stored in `.git` (files, metadata)
- Confusing for most people (good for advanced users)
- Commands have names similar to SVN
Usage scenario

Local Operations

- working directory
- staging area
- git directory (repository)

checkout the project

stage files

commit

Task 1

- **Configure your identity**
  - `git config --global user.name “<your full name>”`
  - `git config --global user.email “<your email address>”`

- **Stored in** $HOME/.gitconfig
Basic commands

- Help for specific command: `git help <command>`
- Create repository in the current directory: `git init`
- Print status of the working tree: `git status`
- Start tracking new files: `git add <work dir path>`
- Add files to the staging area: `git add <path>`
- Commit staged modifications: `git commit -m "..."`
- Print uncommitted unstaged changes: `git diff`
- Print staged uncommitted changes:
  ```
  git diff --staged
  ```
- Automatically stage every tracked file and commit
  ```
  git commit -a -m "..."
  ```
- Revert modifications: `git checkout -- <path>`
  - Alternative: `git restore <path>`
File status lifecycle

- Untracked
- Unmodified
- Modified
- Staged

- Add the file
- Edit the file
- Stage the file
- Remove the file
- Commit

Task 2

- Create repository in a specific directory
- Create some new files (e.g., hello world)
- Print current status of your repository and the working directory
- Stage all the new files
- Print current status
- Modify one of the files
- Print current status
  - Inspect differences from the previous invocation
- Commit all staged modifications
- Print current status
Managing files

- Make the given file untracked
  
  ```
  git rm <work dir path>
  ```

- Renaming file (directory)
  
  ```
  git mv <old path> <new path>
  ```
Pick your changes

- Full interactive mode: `git add -i`

- Select patch hunks: `git add -p`

- Additional information with examples
Project history

• List all the commits

  \texttt{git log [-p] [-<N>] [--stat]}

  ▪ More options

    [--pretty=oneline|short|full|fuller]
    [--graph]
    [--since=YYYY-MM-DD]
    [--until=YYYY-MM-DD]
    [--author=<name>]

• Show author name and revision for modifications

  \texttt{git blame <file path>
Task 3

- Try out file management commands \((\textsf{rm, mv})\)

- Play with the "\texttt{git log}" command
  - Explore different parameters \((-p, -<N>, \texttt{--stat}, \texttt{--pretty}, \texttt{--graph})\)

- Run the program "\texttt{gitk}" and try it

- Make some changes to a particular file and use interactive staging
Using remote repositories

- Clone a remote repository in the current local directory: `git clone <repo url>`
- Get recent changes in all branches from the remote repository: `git fetch origin`
- Get recent changes in the “master” branch and merge into your working copy: `git pull`
  - Announcements via *pull requests*
- Publish local changes in the remote repository: `git push origin master`
Task 4

- Create new repository in your personal space at https://gitlab.mff.cuni.cz/

- Try out important commands for manipulation with remote repositories
  - clone, pull, push, fetch

- How to set (new) remote for your local Git repo
  
git remote add origin <repo url>

- Ask questions if something is not clear (!!)
Branches in Git
Branches in Git

- Branch: pointer to a node in the revision DAG
- Default branch: `master`
- Commit: branch pointer moves forward

What happens after concurrent modification

Branches in Git: commands

- **Create new branch**: `git branch <name>`
- **Switch to given branch**: `git checkout <name>`
- **Shortcut**: `git checkout -b <name>`
- **Alternative for creating new branch and switching**
  - `git switch <branch name>`
  - `git switch -c <new branch>`
- **Merge branch into current working directory**
  - `git merge <branch name>`
- **Deleting unnecessary branch**
  - `git branch -d <branch name>`
- **List all branches**: `git branch [-a]`
  - Current branch marked with `*`
Comparing branches

- `git diff <branch 1>..<branch 2>`
  - Compare heads of the two branches
  - Note the characters ‘..’

- `git diff <branch 1>...<branch 2>`
  - Print changes on the branch 2 (e.g., master) since the branch 1 (feature) was created from it
  - Note the characters ‘...’
Three-way merge

- Common ancestor
- Target branch
- Source branch

- Conflicts happen also with Git
  - Standard markers `<<<<<< ====== >>>>>>`
  - Marking resolved files: `git add`

- Graphical merging tool: `git mergetool`
Task 5

- Create new branch B and switch to it
- Modify some files and commit them
- Switch back to the master branch
- Modify some files and then commit
- Merge your branch B into the master
- Delete the now unnecessary branch

- Try switching branches with uncommitted changes in the working copy
- Try graphical merging tool on some conflicts
Advanced features I.

- Using stack of unfinished changes (stashing)
  - `git stash [push]`
  - `git stash pop`
  - `git stash apply [<stash name>]`
  - `git stash list`

- How to undo some changes
  - `git reset <commit>`
    - Moves the branch HEAD to a given commit
  - Several variants
    - `--soft`: undo commit (just in history of revisions)
    - `--mixed` (default): undo commit and changes in staging area
    - `--hard`: undo everything (commit, staging area, working dir)
Advanced features II.

- Symbolic names of versions
  - HEAD, HEAD~1, HEAD^2

- `git rebase`
  - Replaying changes done in some branch onto another branch
  - Very powerful command but also tricky (be really careful !!)
  - Usage: `git rebase <source branch> in target branch`

- Modifying committed history
  - e.g., commit messages (`git commit --amend`)

- Ignoring certain files
  - List patterns in the file `.gitignore`

- Tagging: `git tag`

- Bare repository
  - No working copy
Mercurial

- Basic principles: like Git
- Simpler learning curve
- Commands very similar
  - init, clone, add, commit, merge, push, pull
Work-flow models (cooperation)
Work-flow models (cooperation)

- Anything possible technically with DVCS
- “Network of trust” between developers

Examples of possible organizations
- Single “central” repository (branch)
- Multiple release repositories (branches)
- Many public repositories
- Total anarchy

Different workflow models
- especially regarding branches
Git workflow models

- Centralized (and comparison)
  - [https://www.atlassian.com/git/tutorials/comparing-workflows](https://www.atlassian.com/git/tutorials/comparing-workflows)

- Feature branch

- Trunk-based

- Forking
  - [https://www.atlassian.com/git/tutorials/comparing-workflows/forking-workflow](https://www.atlassian.com/git/tutorials/comparing-workflows/forking-workflow)
Single “central” repository (branch)

Central Repository (branch)

- Privileged Developer Repository
- Normal Developer Repository (branch)
- Privileged Developer Repository
- Normal Developer Repository (branch)
Multiple release repositories (branches)

Main Repository (branch) development

- Developer Repository GUI branch
- Developer Repository DB branch
- Release 1 Repository (branch)
- Release 2 Repository (branch)
- Release 3 Repository (branch)
Many public repositories or branches

- Linux kernel

Diagram:

- Official Release
  - Vendor Release
  - Main Development integration
  - Module Development experiments
  - Module Development experiments
  - Module Development experiments
Total anarchy
Contributing to [open-source] projects

• Typical scenario
  - Project hosted on some public repository server
  - Write access to official repository is not possible

• Important concepts
  - Forking of the official repository
  - Publishing via pull requests
Contributing to [open-source] projects

- Official central repository (upstream)
  - https://github.com/projectname

- Fork on the same server
  - https://github.com/user/projectname

- Clone to local repository
  - From https://github.com/user/projectname to $HOME/projectname

- Synchronizing fork with official repository
  - git fetch upstream
  - git merge upstream/master

- Publishing changes to the upstream repository
  - Creating pull requests (processed later by maintainer)
Links

- Git documentation
  - http://git-scm.com/doc

- Mercurial

- Repository servers
  - https://github.com/
  - https://bitbucket.org/
  - https://gitlab.com/

- Tools
  - Git for Windows (http://msysgit.github.io/), TortoiseGit (Win), SmartGit (http://www.syntevo.com/smartgit/)
  - TortoiseHg (Mercurial GUI, Windows)
  - SourceTree (https://www.sourcetreeapp.com/, Git and Mercurial)
Homework

- Assignment
  - [https://d3s.mff.cuni.cz/files/teaching/nswi154/ukoly/](https://d3s.mff.cuni.cz/files/teaching/nswi154/ukoly/)

- Deadline
  - 23.10.2022