1 Introduction

1.1 Learning Objectives

- Explain benefits of version control systems (e.g., in the context of university study) and contrast decentralized ones with centralized ones
- Explain states of files under Git and apply commands to manage them
- Explain Feature Branch Workflow and apply it in sample scenarios
- Edit simple Markdown documents

1.2 Core Questions

- How to collaborate on shared documents as distributed team?
Consider multiple people working on multiple files
* Potentially in parallel on the same file
* Think of group exercise sheet, project documentation, source code

- How to keep track of who changed what why?
- How to support unified/integrated end result?

1.3 Version Control Systems (VCSs)

- Synonyms: Version/source code/revision control system, source code management (SCM)
- Collaboration on repository of documents
  - Each document going through various versions/revisions
    * Each document improved by various authors
      - April 2012, Linux kernel 3.2: 1,316 developers from 226 companies

1.3.1 Major VCS features

- VCS keeps track of history
- Who changed what/why when?

Figure 2: “Image” under CC0 1.0; rotated from Pixabay

- VCS supports **merging** of versions into **unified/integrated** version
  - Integrate intermediate versions of single file with changes by multiple authors
- Copying of files is obsolete with VCSs
  - Do **not** create copies of files with names such as Git-Intro-Final-1.1.txt or Git-Intro-Final-reviewed-Alice.txt
    * Instead, use VCS mechanism, e.g., use tags with Git

2 Git Concepts

2.1 Git: A Decentralized VCS

- Various VCSs exist
  - E.g.: Git, BitKeeper, SVN, CVS
    * (Color code: decentralized, centralized)
- Git created by Linus Torvalds for the development of the kernel Linux
  - Reference: Pro Git book

Figure 3: “Git Logo” by Jason Long under CC BY 3.0; from git-scm.com

- Git as example of **decentralized** VCS
  * Every author has **own copy** of all documents and their history
  * Supports **offline** work without server connectivity
    - Of course, collaboration requires network connectivity
2.2 Key Terms: Fork, Commit, Push, Pull

- **Fork/clone repository**

  ![Image of fork/clone repository](image-url)

  Figure 4: “Image” under CC0 1.0; derived from Pixabay

  - Create your own copy of a repository

- **Commit** (aka check-in)

  ![Image of commit](image-url)

  Figure 5: “Image” under CC0 1.0; derived from Pixabay

  - Make (some or all) changes permanent; announce them to version control system
  - **Push**: Publish (some or all) commits to remote location
  - **Fetch** (pull): Retrieve commits from remote location (also merge them)

2.3 Key Terms: Branch, Merge

- **Branches**
- Alternative versions of documents, on which to commit
  - Without being disturbed by changes of others
  - Without disturbing others
    - You can share your branches if you like, though

- **Merge**
  - Combine changes of one branch into another branch
    - May or may not need to resolve conflicts

### 2.4 Git explained by Linus Torvalds

- Video at archive.org (Tech Talk, 2007, by Google Talks under CC BY-NC-SA 3.0)

  - Total length of 84 minutes, suggested viewing: 7:40 to 29:00

### 2.4.1 Review Questions

Prepare answers to the following questions

- What is the role of a VCS (or SCM, in Torvald’s terminology)?

- What differences exist between decentralized and centralized VCSs?
  - By the way, Torvald distinguishes centralized from distributed SCMs. I prefer “decentralized” over “distributed”. You?

### 3 Git Basics

#### 3.1 Getting Started

- Install Git
• You may use Git without a server
  − Run `git init` in any directory
    * Keep track of your own files
  − By default, you work on the `master` branch
    * `master` is not more special than any other branch you may create

### 3.2 Git with Remote Repositories

- **Download** files from public repository: `clone`
  - `git clone https://gitlab.com/oer/cs/programming.git`
    * Later on, `git pull` merges changes to bring your copy up to date
- **Contribute** to remote repository
  - Create account first
    * Typically, `ssh` key pairs ([next slide]) are used for strong authentication; register under your account’s settings
  - Fork project
    * either in GUI
    * or clone your copy, add upstream

#### 3.2.1 Secure Shell

- **Secure Shell** (`ssh`): network protocol for remote login with end-to-end encryption based on [asymmetric cryptography](#)
  - Popular free implementation: [OpenSSH](#)
    * Tool to create key pair: `ssh-keygen`
- **Instructions on GitLab**
  - (In case you are affected, note that Git Bash on Windows is mentioned)

### 3.3 First Steps with Git

- **Prerequisites**
  - You installed Git
  - You performed the First time Git setup
- **Part 0**
  - Create repository or clone one
    * `git clone https://gitlab.com/oer/cs/programming.git`
    * Creates directory `programming`
      - Change into that directory
      - Note presence of sub-directory `.git` (with Git meta-data)
3.3.1 Part 1: Inspecting Status

- Execute `git status`
  - Output includes current branch (master) and potential changes
- Open some file in text editor and improve it
  - E.g., add something to Git-Introduction.org
- Create a new file, say, test.txt
- Execute `git status` again
  - Output indicates Git-Introduction.org as not staged and modified
  - test.txt as untracked
  - Also, follow-up commands are suggested
    - `git add` to stage for commit
    - `git checkout` to discard changes

3.3.2 Part 2: Staging Changes

- Changes need to be staged before commit
  - `git add` is used for that purpose
  - Execute `git add` Git-Introduction.org
  - Execute `git status`
    - Output indicates Git-Introduction.org as to be committed and modified
- Modify Git-Introduction.org more
- Execute `git status`
  - Output indicates Git-Introduction.org as
    - To be committed and modified
      - Those are your changes added in Part 1
    - As well as not staged and modified
      - Those are your changes of Part 2

3.3.3 Part 3: Viewing Differences

- Execute `git diff`
  - Output shows changes that are not yet staged
    - Your changes of Part 2
- Execute `git diff --cached`
  - Output shows changes from last committed version
    - All your changes

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• Execute `git add Git-Introduction.org`
• Execute both `diff` variants again
  – Lots of other variants exists
    * Execute `git help diff`
    * Similarly, help for other `git` commands is available

3.3.4 Part 4: Committing Changes
• Commit (to be committed) changes
  – Execute `git commit -m "<what was improved>"`
    * Where `<what was improved>` should be meaningful text
    * 50 characters or less
• Execute `git status`
  – Output no longer mentions `Git-Introduction.org`
    * Up to date from Git’s perspective
  – Output indicates that your branch advanced; `git push` suggested for follow-up
• Execute `git log`
  – Output indicates commit history
  – Note your commit at top

3.3.5 Part 5: Undoing Changes
• Undo premature commit that only exists **locally**
  – Execute `git reset HEAD~`
    * *(Don’t* do this for commits that exist in remote places)*
  – Execute `git status` and `git log`
    * Note that state before commit is restored
    * May applied more changes, commit later
• Undo `git add` with `git reset`
  – Execute `git add Git-Introduction.org`
  – Execute `git reset Git-Introduction.org`
• Restore committed version
  – Execute `git checkout -- <file>`
  – **Warning**: Local changes are **lost**
3.3.6 Part 6: Stashing Changes

- Save intermediate changes without commit
  - Execute `git stash`
  - Execute `git status` and find yourself on previous commit
- Apply saved changes
  - Possibly on different branch or after `git pull`
  - Execute `git stash apply`
    * May lead to conflicts, to be resolved manually

3.3.7 Part 7: Branching

- Work on different branch
  - E.g., introduce new feature, fix bug
  - Execute `git checkout -b testbranch`
    * Option `-b`: Create new branch and switch to it
  - Execute `git status` and find yourself on new branch
    * With uncommitted modifications from `master`
    * Change more, commit on branch
    * Later on, merge or rebase with `master`
  - Execute `git checkout master` and `git checkout testbranch` to switch branches

3.3.8 Review Questions

- As part of First Steps with Git, `git status` inspects repository, in particular file `states`
  - Recall that files may be untracked, if they are located inside a Git repository but not managed by Git
  - Other files may be called tracked
- Prepare answers to the following questions
  - Among the tracked files, which states can you identify from the demo? Which commands are presented to perform what state transitions?
    * Optional: Draw a diagram to visualize your findings

3.4 Merge vs Rebase

- Merge and rebase unify two branches
- Illustrated subsequently
  - Same unified result
3.4.1 Merge vs Rebase (1)

- Suppose you created branch for new feature and committed on that branch; in the meantime, somebody else committed to master.

![A forked commit history](image)

Figure 7: “A forked commit history” by Atlassian under CC BY 2.5 Australia; from Atlassian

3.4.2 Merge vs Rebase (2)

- Merge creates new commit to combine both branches
  - Including all commits
  - Keeping parallel history

![Merging master into the feature branch](image)

Figure 8: “Merging” by Atlassian under CC BY 2.5 Australia; from Atlassian
3.4.3 Merge vs Rebase (3)

- Rebase rewrites feature branch on master
  - Applies commits of feature on master
  - Cleaner end result, but branch’s history lost/changed

Figure 9: “Rebasing” by Atlassian under CC BY 2.5 Australia; from Atlassian

3.5 Git Workflows

- Team needs to agree on git workflow
  - Several alternatives exist
- Feature Branch Workflow may be your starting point
  - Clone remote repository
  - Create separate branch for each independent contribution
    * E.g., bug fix, new feature, improved documentation
    * Enables independent work
  - Once done, push that branch, create pull/merge request, receive feedback
    * Pull/Merge request: special action asking maintainer to include your changes
    * Maintainer may merge branch into master
3.5.1 Sample Commands

```bash
# Sample commands for Git

git clone <project-URI>
# Then, later on retrieve latest changes:
git fetch origin
# See what to do, maybe pull when suggested in status output:
git status
# Create new branch for your work and switch to it:
git checkout -b nameForBranch
# Modify/add files, commit (potentially often):
git add newFile
git commit -m "Describe change"
# Push branch:
git push -u origin nameForBranch
# Ultimately, merge or rebase branch nameForBranch into branch master
 git checkout master
git merge nameForBranch
# If conflict, resolve as instructed by git, commit. Finally push:
git push
```

4 GitLab

4.1 GitLab Overview

- Web platform for Git repositories
  - https://about.gitlab.com/
  - Free software, which you could run on your own server
- Manage Git repositories
  - Web GUI for forks, commits, pull requests, issues, and much more
  - Notifications for lots of events
    - Not enabled by default
  - So-called Continuous Integration (CI) runners to be executed upon commit
    - Based on Docker images
    - Build whatever needs building in your project (executables, documentation, presentations, etc.)

4.2 GitLab in Action

- In class
5 Aside: Lightweight Markup Languages

5.1 Lightweight Markup

- Markup: “Tags” for annotation in text, e.g., indicate sections and headings, emphasis, quotations, ...

- Lightweight markup
  - ASCII-only punctuation marks for “tags”
  - Human readable, simple syntax, standard text editor sufficient to read/write
  - Tool support
    - Comparison and merge, e.g., three-way merge
    - Conversion to target language (e.g., (X)HTML, PDF, EPUB, ODF)
      - Wikis, blogs
      - pandoc can convert between lots of languages

5.2 Markdown

- Markdown: A lightweight markup language
- Every Git repository should include a README file
  - What is the project about?
  - Typically, README.md in Markdown syntax

- Learning Markdown
  - In-browser tutorial (source code under MIT License)
  - Cheatsheet (under CC BY 3.0)

5.3 Org Mode

- Org mode: Another lightweight markup language
  - My favorite one
- For details see source file for this presentation as example

6 Conclusions

6.1 Summary

- VCSs enable collaboration on files
  - Source code, documentation, theses, presentations
- Decentralized VCSs such as Git enable distributed, in particular offline, work
- Keeping track of files’ states
  - With support for subsequent merge of divergent versions
- Workflows may prescribe use of branches for pull requests

- Documents with lightweight markup are particularly well-suited for Git management

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