Git

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THIS IS GIT. IT TRACKS COLLABORATIVE WORK ON PROJECTS THROUGH A BEAUTIFUL DISTRIBUTED GRAPH THEORY TREE MODEL.
COOL. HOW DO WE USE IT?
NO IDEA. JUST MEMORIZE THESE SHELL COMMANDS AND TYPE THEM TO SYNC UP. IF YOU GET ERRORS, SAVE YOUR WORK ELSEWHERE, DELETE THE PROJECT, AND DOWNLOAD A FRESH COPY.

https://xkcd.com/1597/

Outline

- Motivation
- Architecture and Terminology
- Popular Commands (Local Repository)
- Working with Remote Repository

Motivation

- You edit a file
- You change it some more
- And then some more…
- Darn!!! You messed up the file
- If only you know how the file changed!
  - Can revert to some older version and carry on from there

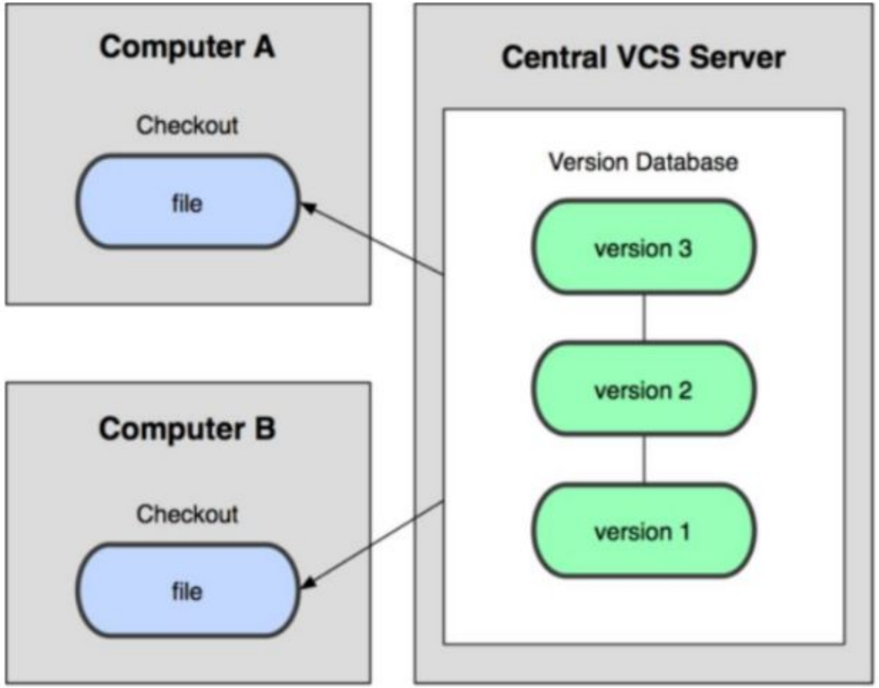
Version Management

- Version control: a system that records changes to (set of) files over time
  - Files can be code, scripts, documents, configuration files, data etc
- Roll-back functionality:
  - Mistakes happen! Can undo mistakes and go back to a working version

- Branching:
  - Can work on different issues/features in different branches (and discard branch if bad idea)
- Merging: Efficient collaboration
  - Different people can work on same code/project without interfering
- Traceability: who made the changes, and when and why the changes were made?

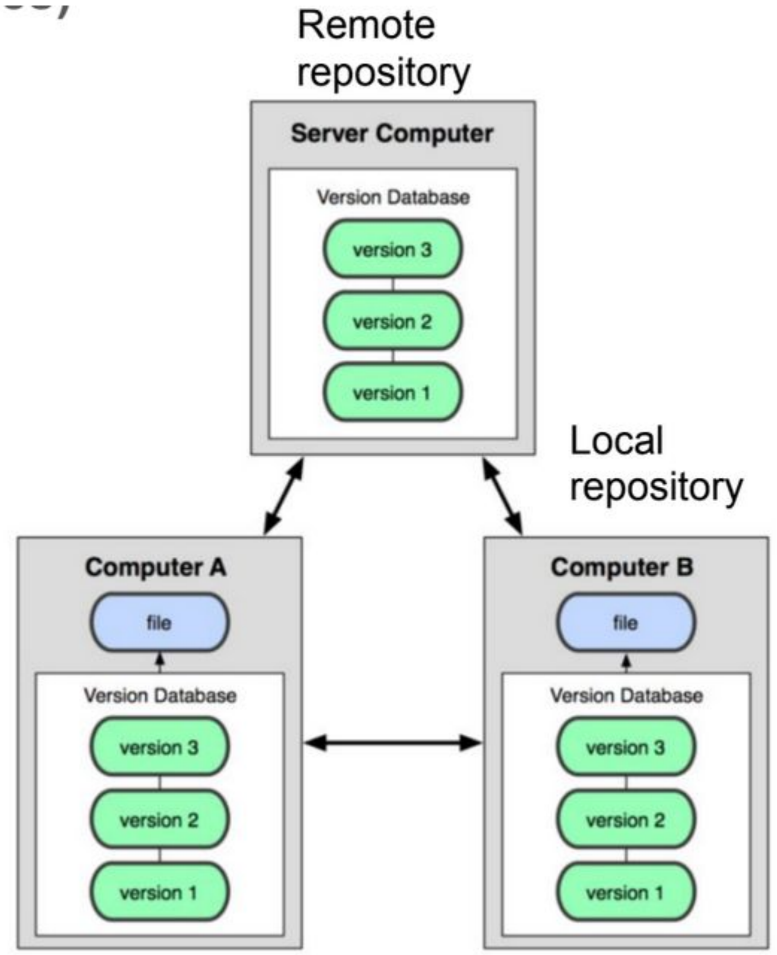
Centralized

- Example: cvs, svn
- Centralized server is vulnerable

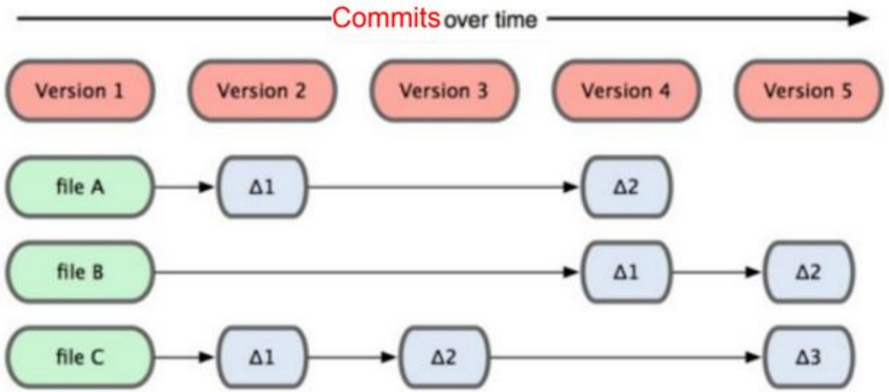


Distributed

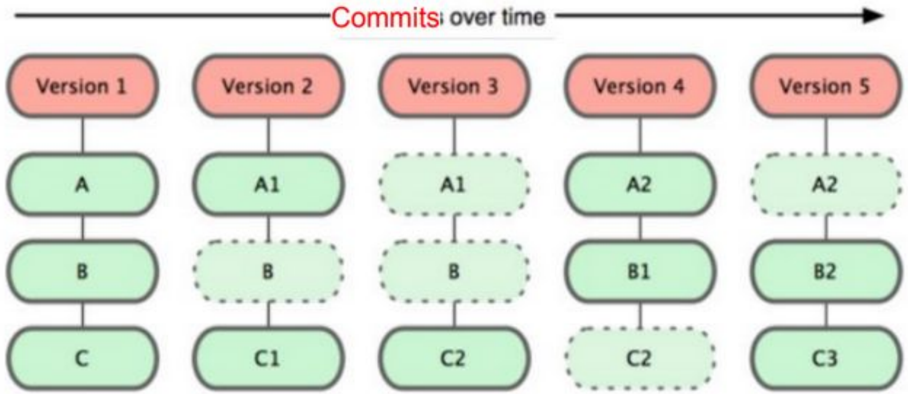
- Example: git, Darcs
- Each client fully mirrors the repository.
  - If the server dies, any of the clients can help
  - User can interact with other users independent of central repo



other vc systems

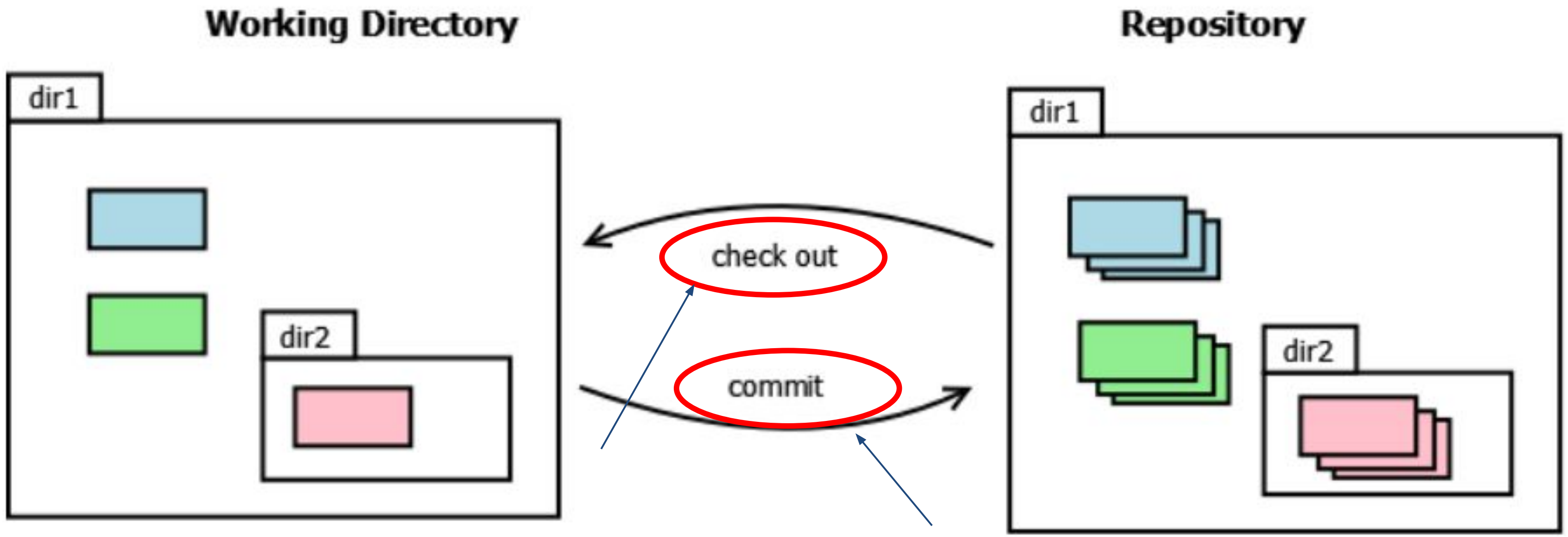


git



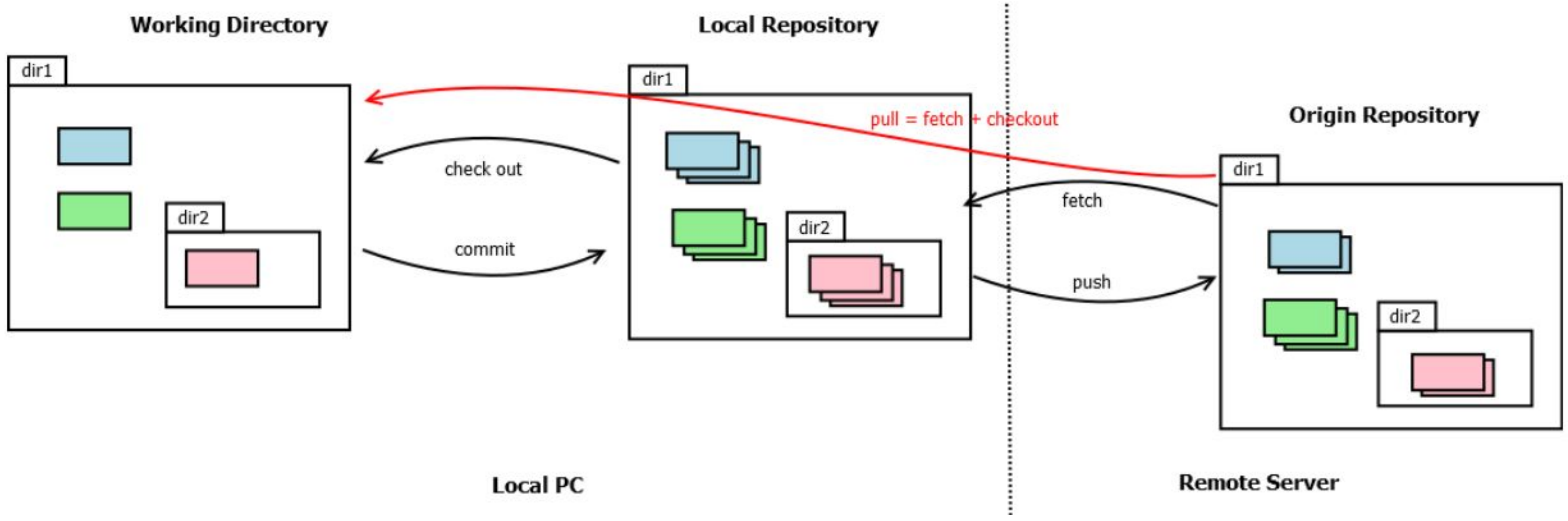
Repositories and Working Directory

- Repository: collection of versions of files
  - Tracks deleted and newly added files
  - Users do not edit or even read files in the repo
- Working Directory: Current version of files
  - Users work on a copy of the files in their working directory



- Commit: send current contents of file(s) to the repository
  - current contents become a new version.
- Checkout: ask repository to give a copy of file(s)

Git Architecture

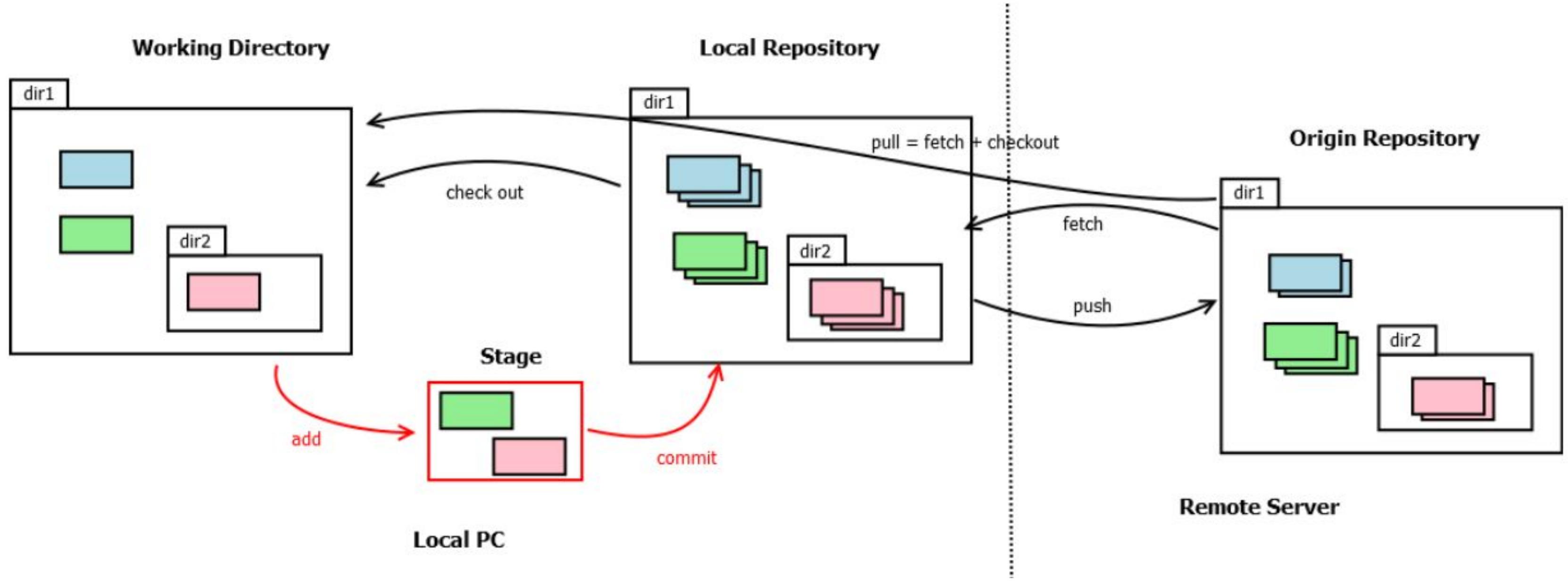


- Local Repository: On local machine
- Origin repository: Remote for reliability
  - Many users will share origin
  - Kept more or less in sync with local repository
- Push: push changes from local repository to the origin
- Fetch: fetch changes anyone else may have made from the origin to local repository
  - Fetching simply updates local repository
  - Need checkout for them to reflect in working directory.
- Pull: combines a fetch and a check out (most often used)
  - Changes reflect directly in working directory

Origin

- Where is the origin repository?
- Any machine which supports SSH/HTTPS will do
- Cloud Options: GitLab, GitHub, BitBucket, AWS CodeCommit etc
  - A git hosting system with lots of additional features
  - E.g. project management, ticket management, bug tracking, access management etc
- Our focus: Local Repository

Staging



- Commit/checkout/fetch/push/pull happen at directory level!
- What if we want to commit some files, not all?
- Staging: We “add” files to stage and then commit from stage instead of the working directory

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Outline for Commands

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- Staging and committing changes (status, add, commit)
- Viewing history and changes (log, show, diff)
- Branching and Merging (checkout, branch, switch, merge)
- ~~Undoing and Resetting changes (reset, revert)~~
- ~~Synching with remote repository (remote, pull, push, fetch)~~
- ~~Deleting and Clean up (branch, clean)~~

Creating a (local) git repository

- Config command: you can configure git via “config”
- Set user details
  - git config --global user.name "Your Name"
  - git config --global user.email "your@email.com"
- Check configuration
  - git config --list # Shows all settings
  - git config user.name # Shows specific setting
- Set default editor
  - git config --global core.editor "vim"

- git init – Initializes a Git Repository
  - Converts a directory into a Git repo
    - Used when starting a new project or making an existing folder version-controlled
  - Creates a hidden .git folder that stores all version control data
- .gitignore file: helps specify files that git should ignore
  - Specfies files/folders to exclude from tracking.
  - E.g. temporary files (.o files)

Example .gitignore

```
# Ignore compiled files
*.o
*.out
*.exe

# Ignore backup and temporary files
*.swp
*.bak
*.tmp

# Ignore build directories; root in explanation refers to the main folder where git init ran
#will ignore build folder anywhere in the root folder
#will ignore dist folder only in the root folder
build/
/dist/
```

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git status

- Tells current state of the repository and staging area
  - Current working branch
  - What files are in staging area and not committed
  - What files are untracked etc
- Note: files specified in .gitignore won’t show in status

git add

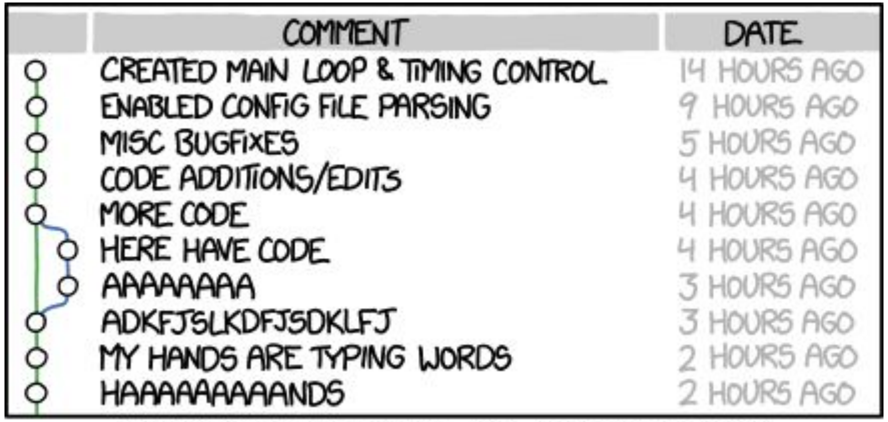
- Add files to staging area
- Basic Usage:
  - git add <file> # Stage a specific file
    - Can also add multiple files: git add file1.txt file2.txt
  - git add .   # Stages all modified and new files but does not include deleted files.
  - git add -A   # Stage all changes, including deletions
  - git add *.txt   # Stage all `.txt` files

git commit

- Saves staged changes to the local repository
  - Also launches a text editor for commit message
- git commit: Commit the staged snapshot
- git commit -a: Commit a snapshot of all changes in the working directory
  - Only includes modifications to tracked files (those added with git add at some point in the past)

- git commit -m "commit message": shortcut to avoid editor
  - Use meaningful messages here, see xkcd comic :-)
  - Can also do git commit -am "commit message" (combines both)
- git commit --amend: modifies the last commit
  - Instead of creating a new commit, staged changes will be added to the previous commit

https://xkcd.com/1296/



	COMMENT	DATE
○	CREATED MAIN LOOP & TIMING CONTROL	14 HOURS AGO
○	ENABLED CONFIG FILE PARSING	9 HOURS AGO
○	MISC BUGFIXES	5 HOURS AGO
○	CODE ADDITIONS/EDITS	4 HOURS AGO
○	MORE CODE	4 HOURS AGO
○	HERE HAVE CODE	4 HOURS AGO
○	AAAAAAAA	3 HOURS AGO
○	ADKFJSLKDFJSDKLFJ	3 HOURS AGO
○	MY HANDS ARE TYPING WORDS	2 HOURS AGO
○	HAAAAAAAANDS	2 HOURS AGO

AS A PROJECT DRAGS ON, MY GIT COMMIT MESSAGES GET LESS AND LESS INFORMATIVE.

- `create file.txt`

Working area	Staging area	Commit
`file.txt - v1`		

- `git add file.txt`

Working area	Staging area	Commit
`file.txt - v1`	`file.txt - v1`	

- `git commit -m “msg”`

Working area	Staging area	Commit
`file.txt - v1`	`file.txt - v1`	`file.txt - v1`

- `edit file.txt`

Working area	Staging area	Commit
`file.txt - v2`	`file.txt - v1`	`file.txt - v1`

- add `file.txt`

Working area	Staging area	Commit
`file.txt - v2`	`file.txt - v2`	`file.txt - v1`

- `edit file.txt`

Working area	Staging area	Commit
`file.txt - v3`	`file.txt - v2`	`file.txt - v1`

- `git commit -m "msg"`
  `git commit file.txt -m "msg"`

Working area	Staging area	Commit
`file.txt - v3`	`file.txt - v2`	`file.txt - v2`
`file.txt - v3`	`file.txt - v3`	`file.txt - v3`

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git log

- Displays the commit history of a repository
  - A long hexadecimal number is commit’s hash
    - Helps identify a commit
    - can use just 5 digits mostly in commands
- Can also find commit history of a specific file
  - git log file1.txt
- Key options:
  - git log --oneline ⟶ Shows a compact view (commit hash + message)
  - git log -p ⟶ Shows commit diffs
  - git log --graph --decorate --all ⟶ Visualizes branches and merges
  - git log --since="2025-01-01" ⟶ Shows commits after a date

git diff

- git diff shows differences between Git states
- git diff <commit>: shows the diff between the current working repo and the <commit>
  - git diff HEAD → Compares working directory + staged changes against the latest commit
- git diff --cached <commit>: shows the diff between your staged changes and the <commit>
- git diff <commit1> <commit2> → Compares two commits

Linux command: diff

- diff stands for difference
- Compares the contents of two files and display the differences between them
  - highlight changes, additions, and deletions in a clear and readable format
- Tells us which lines in one file have to be changed to make the two files identical

Content of a.txt:

```
apple
banana
cherry
date
papaya
fig
grape
```

Content of b.txt

```
apple
blueberry
cherry
papaya
fig
grapefruit
melon
kiwi
```

```
diff a.txt b.txt

2c2
< banana
---
> blueberry
4d3
< date
7c6,8
< grape
---
> grapefruit
> melon
> kiwi
```

```
diff -u a.txt b.txt

--- a.txt       2025-02-08 16:17:06.304669604 +0530
+++ b.txt       2025-02-08 16:17:14.840549365 +0530
@@ -1,7 +1,8 @@
 apple
-banana
+blueberry
 cherry
-date
 papaya
 fig
-grape
+grapefruit
+melon
+kiwi
```

Explanation

- diff a.txt b.txt
  - Output:
    - Line numbers corresponding to the first file; A special symbol; Line numbers corresponding to the second file
    - E.g. 7c6,8
      - line 7 in the first file needs to be changed to match line number 6-8 in the second file
    - Lines preceded by a < are lines from the first file.
    - Lines preceded by > are lines from the second file.
    - The three dashes ("—") merely separate the lines of file 1 and file 2

- diff -u a.txt b.txt (unified mode)
  - Output:
    - The first file is indicated by `---`, and the second file is indicated by `+++`.
    - The first two lines provide information about file 1 and file 2, including the modification date and time
    - @@ -1,7 +1,8 @@denote the line range for both files
      - In this example, first file is 7 lines and second file is 8 lines
    - Subsequent lines represent the contents of the files with specific indicator
      - Unchanged lines are displayed without any prefix
      - Lines in the first file to be deleted are prefixed with -
      - Lines in the second file to be added are prefixed with +.

git show

- Displays detailed information about a commit or an object
- git show :filename
  - Example: git show :file1.txt
    - Shows the content of file1.txt in the staging area
- git show commit:filename
  - Example: git show HEAD:file1.txt
    - Shows the content of file1.txt in HEAD
  - Example: git show 5b80ea8:file1.txt
    - Shows the content of file1.txt in the commit object 5b80ea8

- git show <commit> → Shows commit details (message, diff, author, date)
  - git show HEAD → Shows the latest commit
  - git show <branch> → Shows the latest commit on a branch

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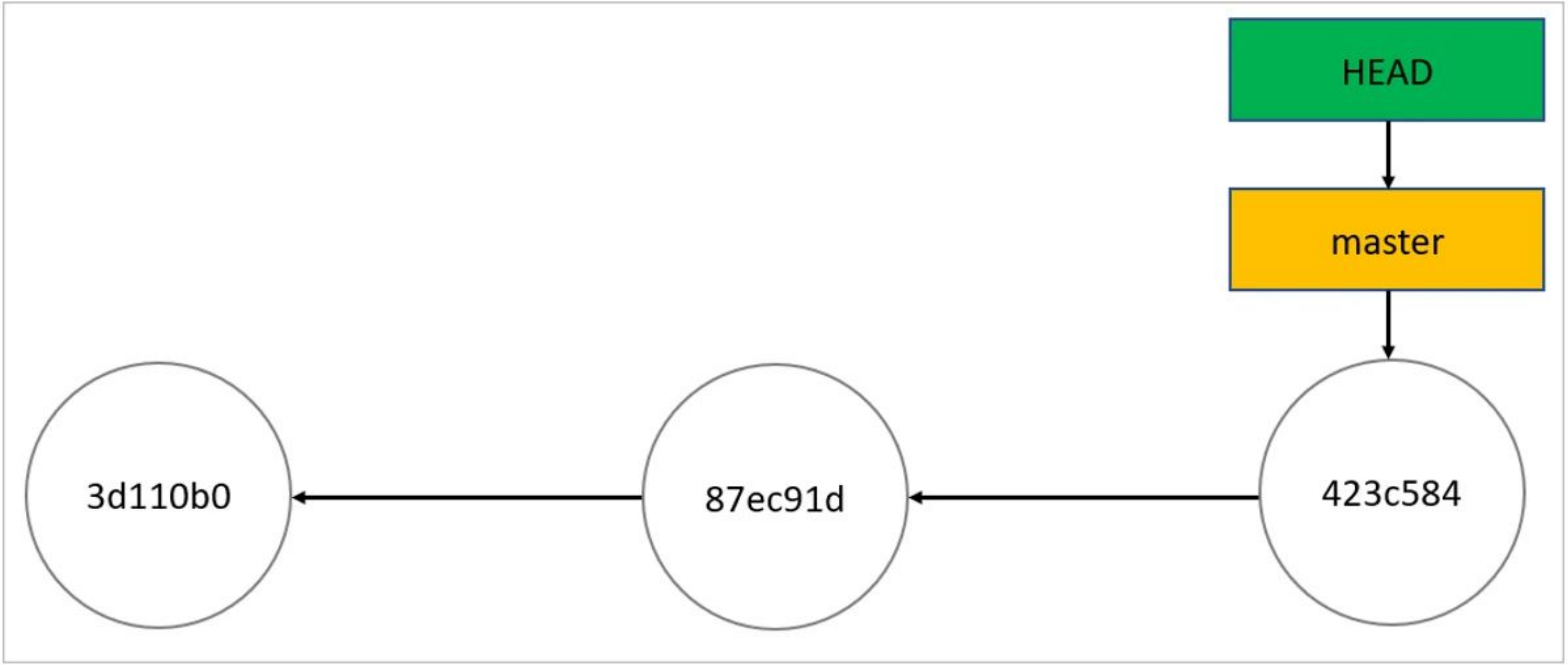
checkout

- You can move backwards in time by checking out an older commit
  - git checkout commit-id
  - Will replace contents of working directory by contents of older commit
  - Useful for “look but don’t touch” way to explore the older code
  - Then get back to most recent commit via git checkout master

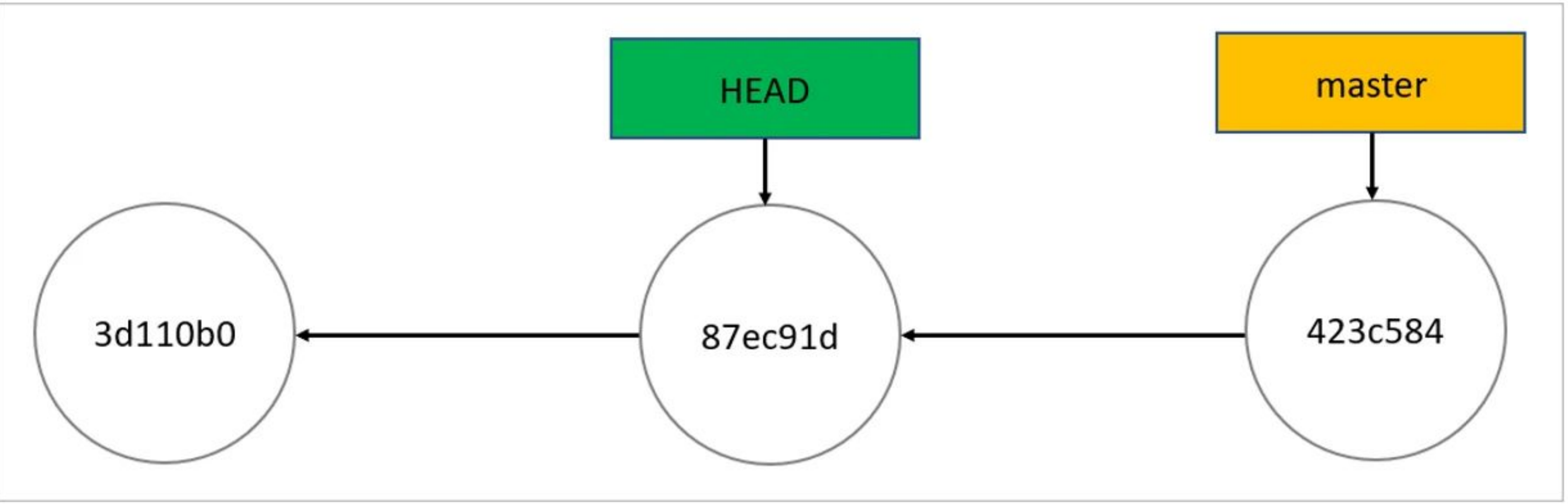
- Can also rollback individual files to old versions
  - git checkout commit-id path-to-file
  - Then use git commit
    - Everything else is what is in current repo and this file is some older version
- Note: git restore can also be used instead of git checkout
  - Recommended in newer Git versions!
  - Restore does not move the HEAD

HEAD

- HEAD answers the question: “Where am I right now?”
- Most of the time, HEAD points to a branch name
  - So far we have seen only one branch, master!
  - HEAD is synonymous with “last commit in the current branch.”
    - This is the normal state
- In a detached HEAD state; HEAD is pointing directly to a commit instead of a branch

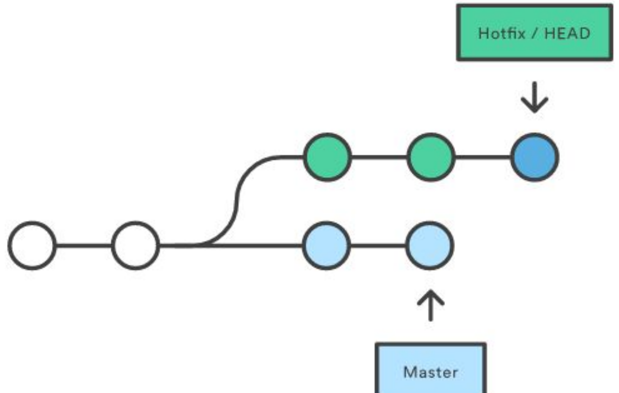

HEAD
master
3d110b0
87ec91d
423c584

After running git checkout 87ec91d, the repo looks like this



Branching

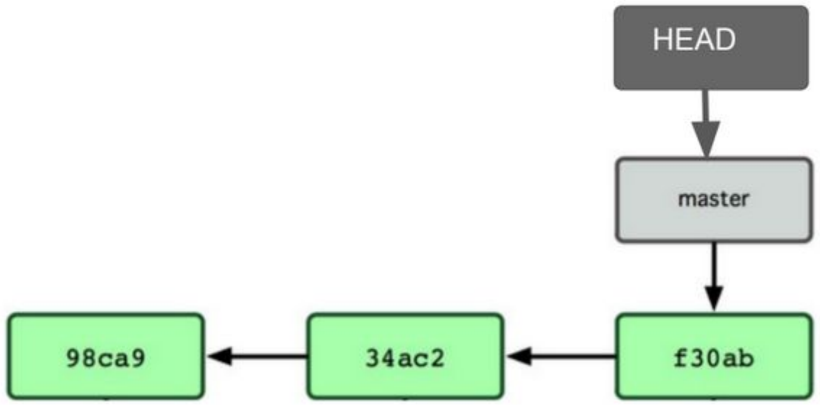
- Useful in solo projects, but critical in team projects
- So far, linear development; can move forward and backward
- What if you want to fix a bug (or try a feature), but don't want to mess up the master?

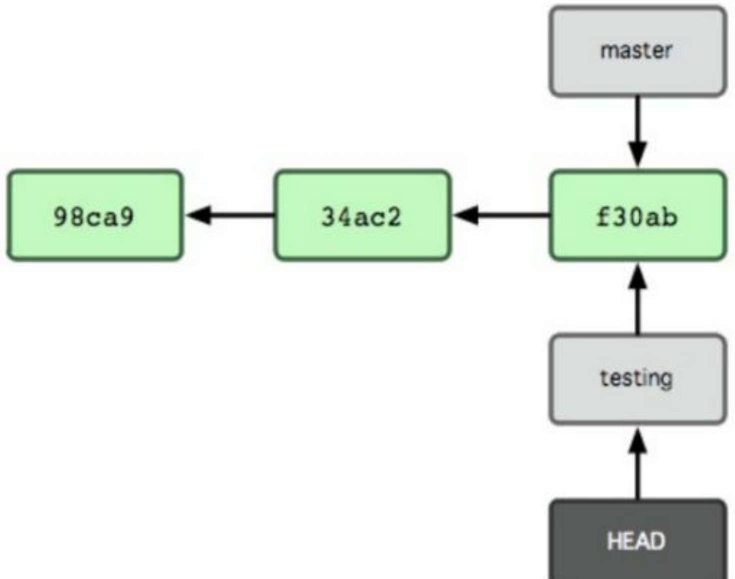


git branch/switch

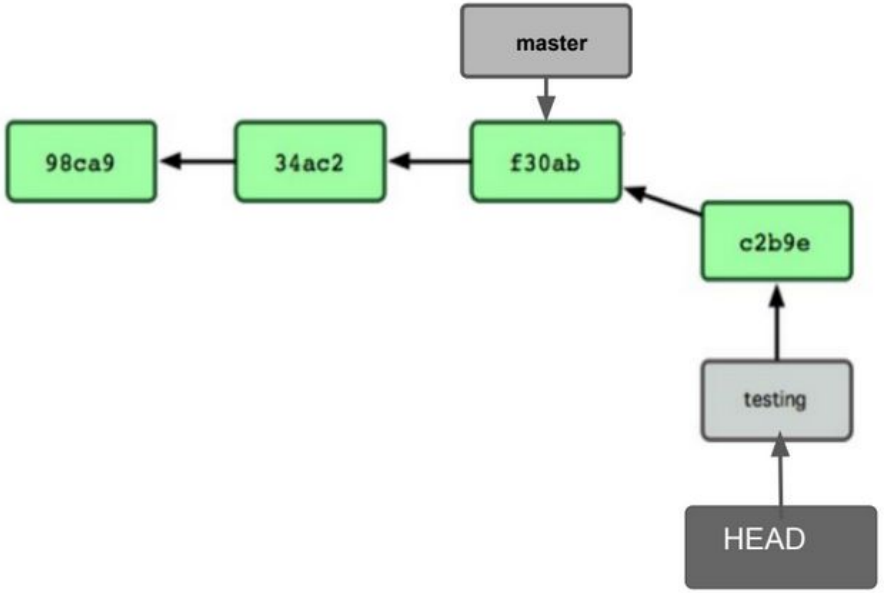
- List branches: git branch (local branches)
- Create branch: git branch new-branch
- Switch branch: git switch new-branch (git checkout new-branch)
- Create & switch: git switch -c new-branch (git checkout -b new-branch)
- Delete branch: git branch -d new-branch (-D to force)
- Rename branch: git branch -m old-name new-name
- List remote branches: git branch -r
- List all branches: git branch -a (both local and remote)

git branch/switch

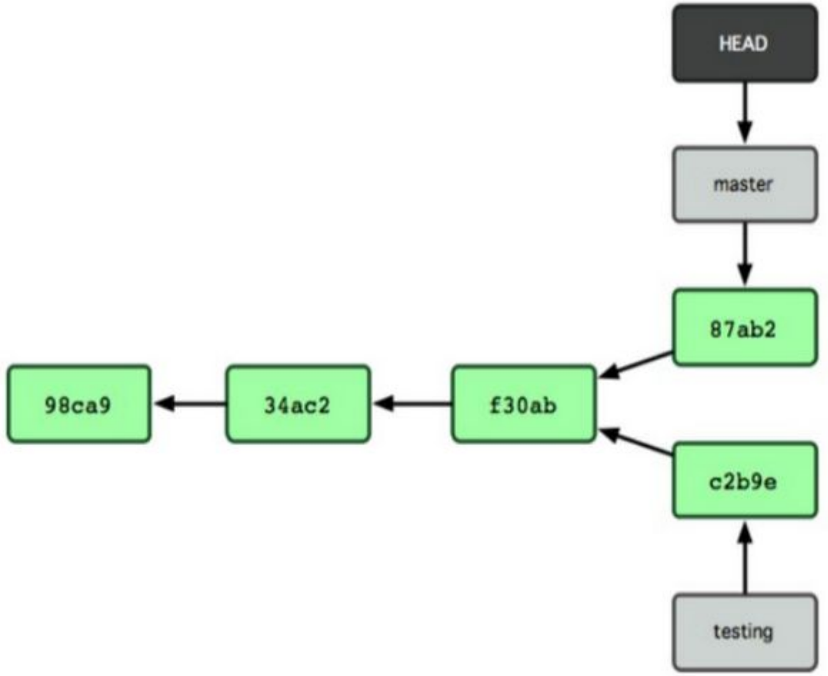




Development along testing



Separate development along master

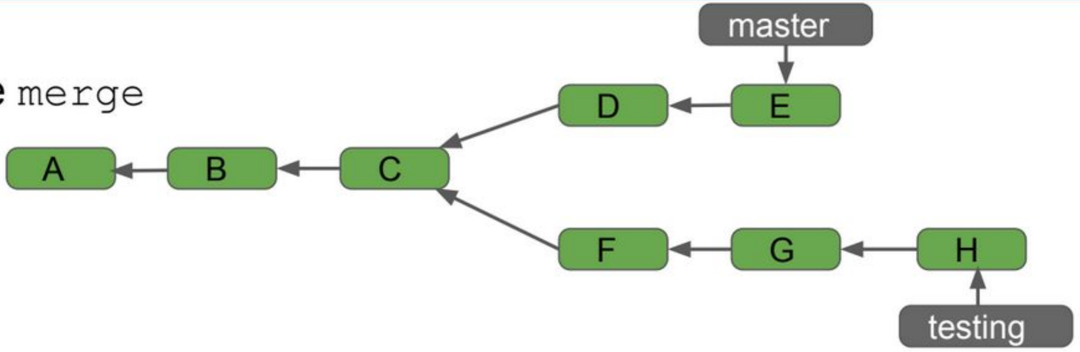


git merge

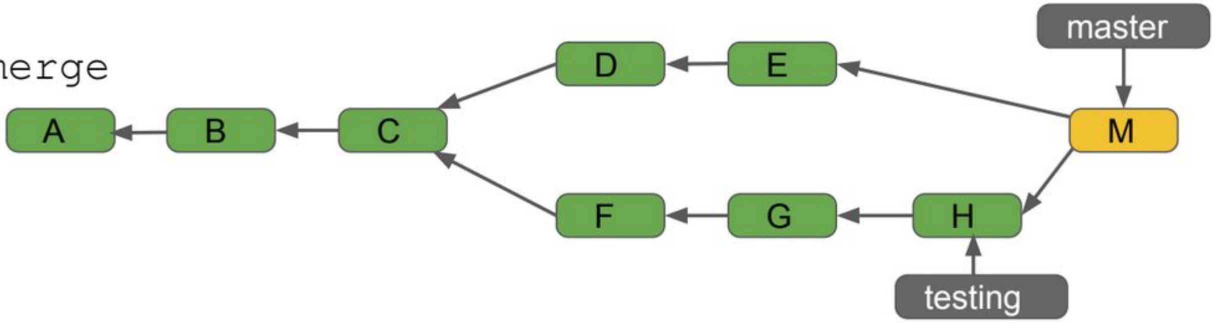
- git checkout master (you are in master branch; want to merge testing into this)
- git merge -m "merging" testing (merge testing into master)
- May result in a conflict, which needs to be resolved
  - After resolution, need to add and commit the files into master
  - Note testing still exists and not affected by merge
    - Try git checkout testing

git merge

- Before `merge`



- After `merge`



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Working with remote repository

- Not part of syllabus but useful to know
- See git notes on how to set this up
  - Demo!

More Commands (not part of syllabus)

Checkout yourself

- git revert
- git reset
- git rebase
- git restore
- git clean

Reference

https://www.cs.odu.edu/~zeil/cs252/latest/Public/git/index.html

https://sillevl.gitbooks.io/git/content/advanced/reset-checkout-revert/ (advanced-reverting changes, not in syllabus)

https://www.geeksforgeeks.org/diff-command-linux-examples/