Project Groups: To Do

1. Find your group on Carmen (People)
2. Exchange contact information
   - Phone, discord
   - Schedules
3. Choose a group name
4. Each person chooses a tech area
   - HTML/CSS, JavaScript, or Ruby
   - Group constraints on choices:
     - No more than 2 people per technology
     - Ideal: Each technology represented
5. Also choose a backup tech area
   - "Don't Care" is fine (as primary or secondary)

Git: Advanced Topics

Lecture 4

Basic Workflow: Overview

1. Configure git locally (everyone, once)
2. Create central repo (1 person)
3. Create local repo (everyone)
4. Local development (everyone):
   - Commit locally
   - Fetch/merge as appropriate
   - Push to share

Step 1: Configure Git Locally

- Each team member, in their own VM
  - Req'd: Set identity for authoring commits

```
$ git config --global user.name "Brutus Buckeye"
$ git config --global user.email bb@osu.edu
```

  - Rec'd: set default initial branch name (2.28+)

```
$ git config --global init.defaultBranch main
```

  - Tips
    - Add email to GitHub account (Settings > Email)
    - Alternative: use GitHub-generated fake address:
      - Settings > Email > Keep my address private
      - Find *ID+USERNAME*`@users.noreply.github.com`
    - Add your public SSH key to your GitHub account

Step 2: Initialize Central Rep

- One person, once per project
- Hosting services (GitHub, GitLab, BitBucket…) use a web interface for this step
  - In 3901, this will be done for you
- No magic: any location ok, so long as the group can access (*e.g.* coelinux):
  - Create central repository in group's project directory (/project/c3901aa03)

```
$ cd /project/c3901aa03
$ mkdir proj1  # an ordinary directory
```

  - Initialize this directory as a *bare* git repository, with group permissions

```
$ git init --bare --shared proj1
```

Step 3: Create Local Repository

- Each team member, once, in their VM
  - Create local repo by *cloning* the central one

```
$ git clone git@github.com:bb/proj1.git
```

  - Copies entire repo, including store, and sets a remote called "origin"

```
$ cd proj1
proj1$ git remote -v # display info
   origin git@github.com:bb/proj1.git (fetch)
   origin git@github.com:bb/proj1.git (push)
```

- Different ways to clone
  - SSH
  - Git Credential Manager

Step 4: Local Development

- Each team member repeats:
  - Edit and commit (to local repository) often

```
$ git status/add/rm/commit
```

  - Pull others' work when you can benefit

```
$ git fetch origin # bring in changes
$ git log/checkout # examine new work
$ git merge, commit # merge work
```

  - Push to central repository when confident

```
$ git push origin main # share
```

Demo

- https://git-school.github.io/visualizing-git/#upstream-changes
- Try:

```
git commit
git fetch origin # see origin/feature
git merge origin/feature # see feature
git push origin feature # see remote
```

Your Turn: Playing with Git

- Navigate to class org on GH and find the repo called *first-commits*
- Clone the repo to your VM
- Do some development!
  - Edit
  - Inspect the store's DAG

    ```
    $ git log --graph --oneline --all
    ```
  - Commit, fetch, merge, push…
  - Rinse, repeat

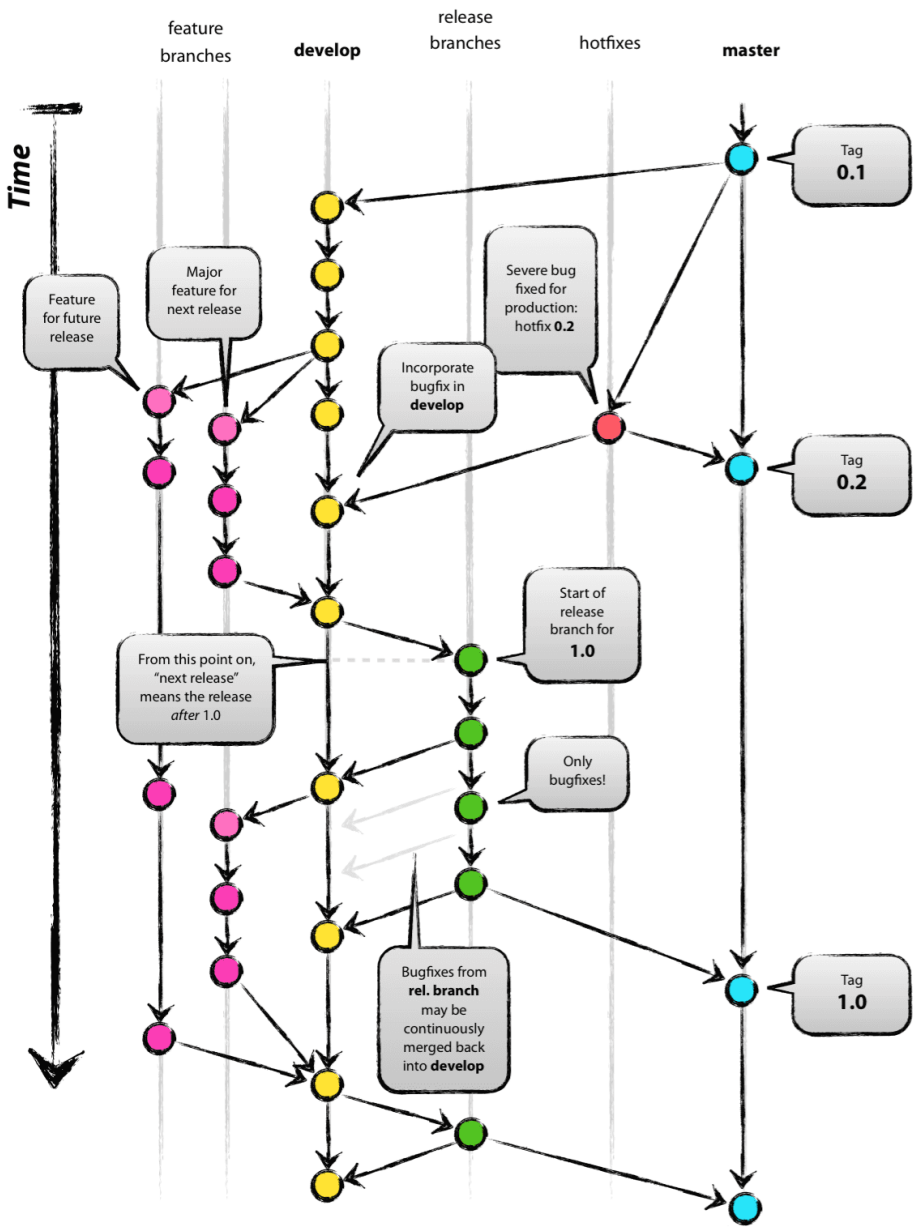
Professional Git

- Commit/branch conventions
- Deciding what goes in, and what stays out of the store
  - Share all the things that should be shared
  - Only share things that should be shared
- Normalizing contents of the store
  - Windows vs linux line endings

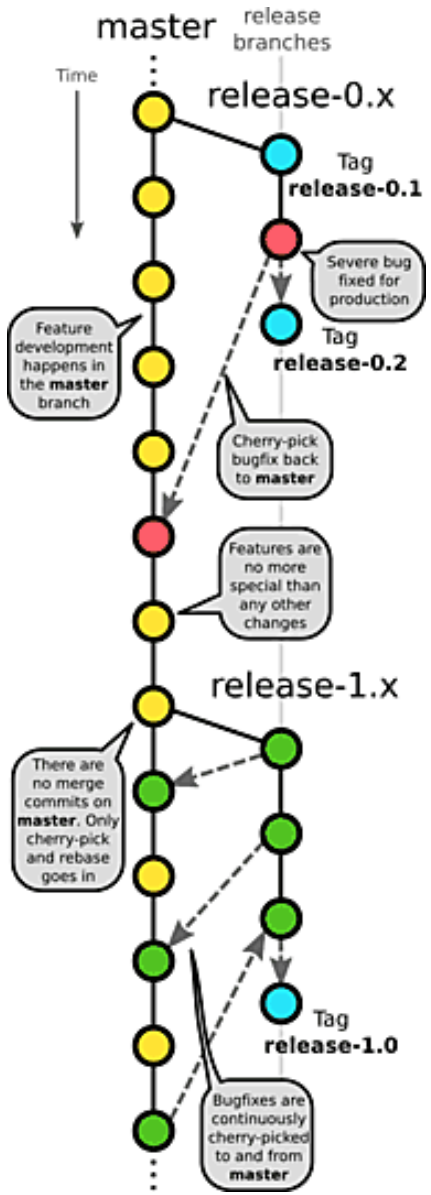
Commit/Branch Conventions

- Team strategy for managing the DAG (ie the store)
- Examples:
  - "Main is always deployable"
    - All work is done on other branches, merged with main only when result is executable
  - "Feature branches", "developer branches"
    - Each feature developed on its own branch vs. each developer works on their own branch
  - "Favor rebase over merge"
    - Always append to latest origin/branch

Example: Branch-Based Dev



Example: Trunk-Based Dev



What Goes Into Central Repo?

- Avoid developer-specific environment settings
  - Hard-coded file/directory paths from local machine
  - OK to include a sample config (each developer customizes but keeps their version out of store)
- Avoid living binaries (docx, pdf)
  - Meaningless diffs
- Avoid generated files
  - compiled files, the build
- Avoid IDE-specific files (.settings)
  - Some generic ones are OK so it is easier to get started by cloning, especially if the team uses the same IDE
- Avoid private information
  - Passwords, secret tokens
  - Better: Use *environment variables* instead
- Agree on code formatting
  - Auto-format is good, but only if everyone uses the same format settings!
  - Spaces vs tabs, brace position, etc

Ignoring Files from Working Tree

- Use a .gitignore file in root of project
  - Committed as part of the project
  - Consistent policy for everyone on team
- Examples: https://github.com/github/gitignore

```
# github:gitignore/Java.gitignore
# Compiled class file
*.class

# Log file
*.log

# Package Files #
*.jar
*.war
*.ear
*.zip
*.tar.gz
*.rar
```

Problem: End-of-line Confusion

- Differences between OS's in how a new line is encoded in a text file
  - Windows: 2 bytes, CR + LF ("\r\n", 0x0D 0x0A)
  - Unix/Mac: 1 byte, LF ("\n", 0x0A)
- Difference is hidden by most editors
  - An IDE might recognize either when opening a file, but convert all to \r\n when saving
  - Demo: hexdump (or VSCode hex editor)
- But difference matters to git when comparing files!
- Problem: OS differences within team
  - Changing 1 line causes every line to be modified
  - Flood of spurious changes masks the real edit

Solution: Normalization

- Convention: Store uses \n (ie linux)
  - Working tree uses OS's native eol
  - Convert when moving data between the two (e.g., commit, checkout)
- Note: Applies to text files only
  - A binary file, like a jpg, might contain 0x0D and/or 0x0A, but they should never be converted
- How does git know whether a file is text or binary?
  - Heuristics: auto-detect based on contents
  - Configuration: filename matches a pattern

Normalization With .gitattributes

- Use a .gitattributes file in root of project
  - Committed as part of the project
  - Consistent policy for everyone on team
- Example:

```
# Auto detect text files and perform LF normalization
* text=auto

# These files are text, should be normalized (crlf=>lf)
*.java       text
*.md         text
*.txt        text
*.classpath  text
*.project    text

# These files are binary, should be left untouched
*.class      binary
*.jar        binary
```

Ninja Git: Advanced Moves

- Temporary storage

  `stash`

- Undoing big and small mistakes in the working tree

  `reset`, **`checkout`**

- Undoing mistakes in store

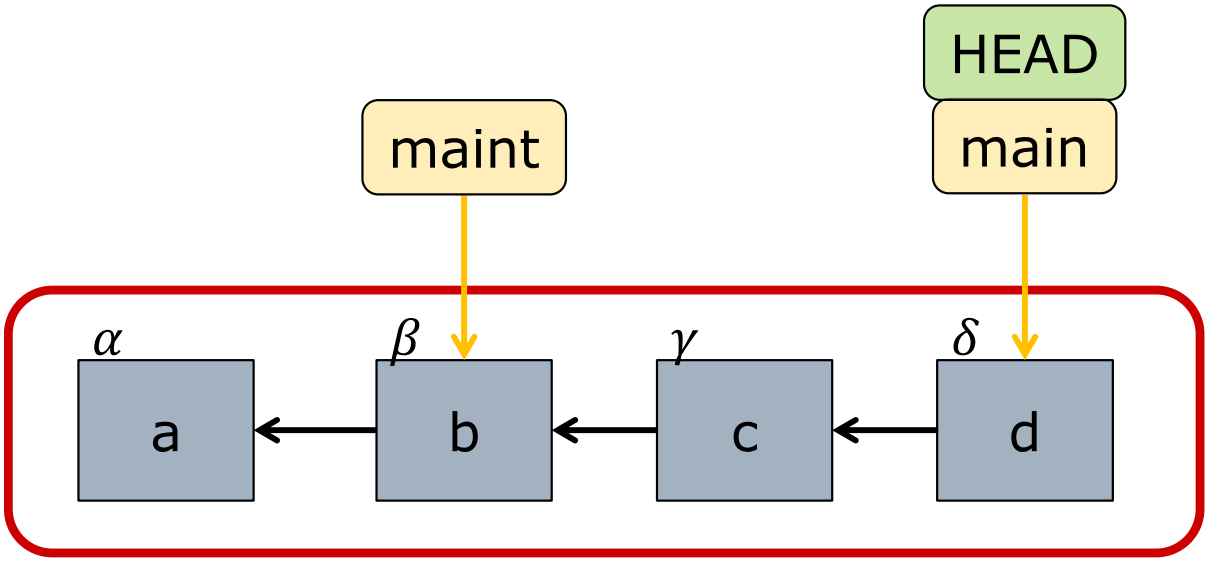
  `amend`

- DAG surgery

  `rebase`

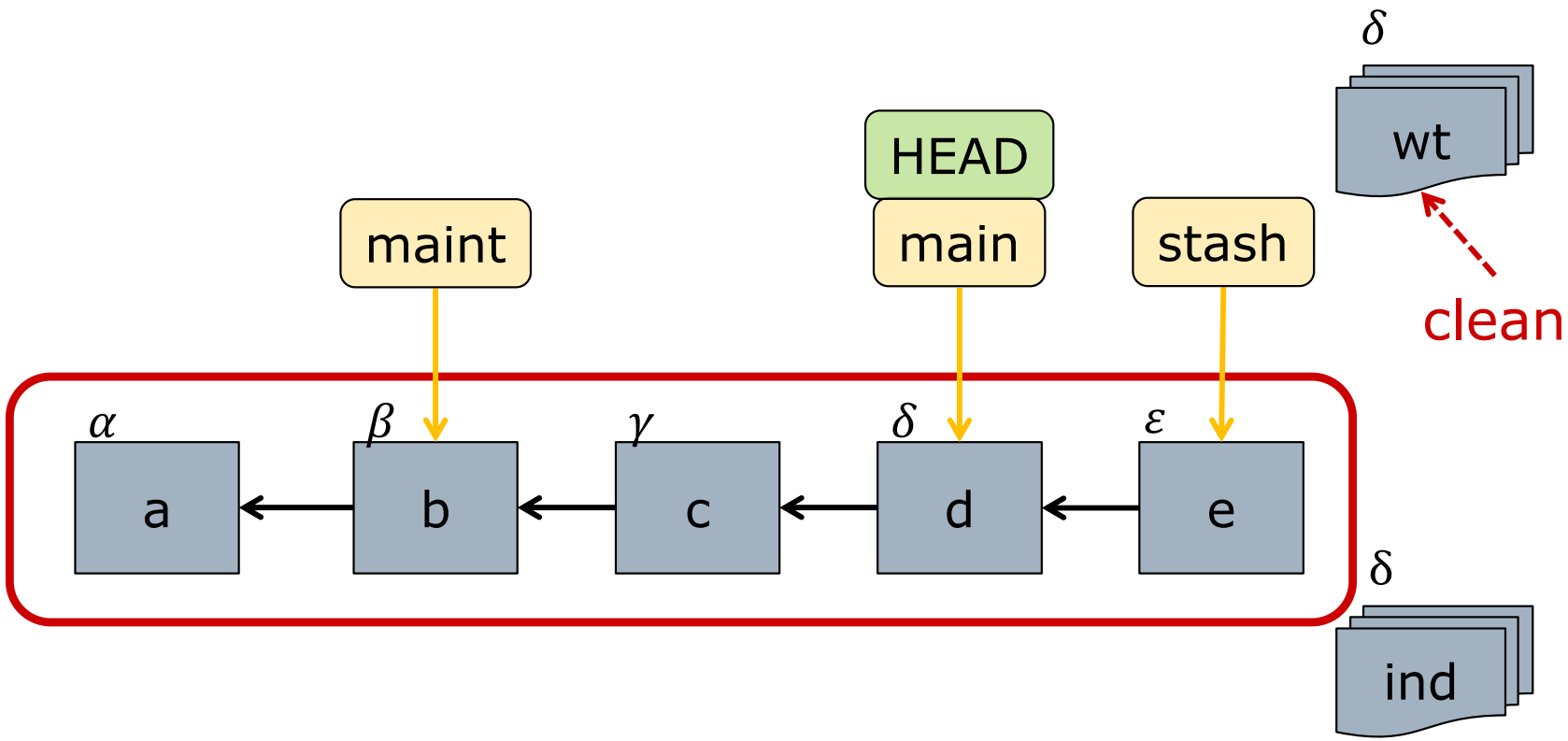
Advanced: Temporary Storage

- Say you have uncommitted work and want to look at a different branch
- Checkout won't work! (Recall: "only checkout when wt is clean")



Stash: Push Work Onto a Stack

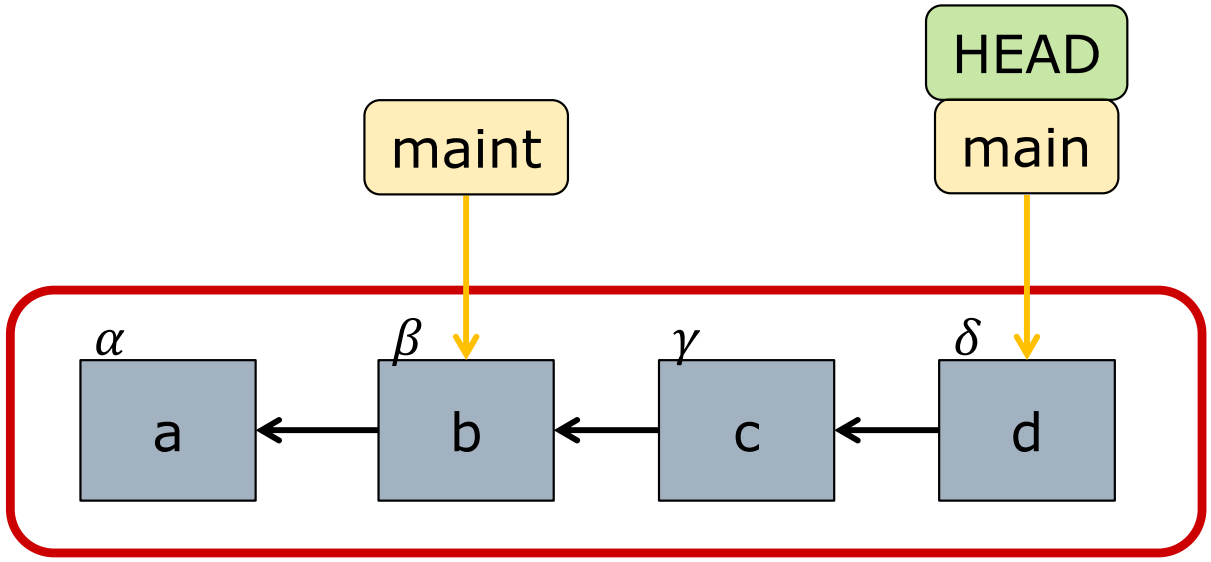

```
$ git stash # repo now clean
$ git checkout …etc… # feel free to poke around
```



Stash: Pop Work Off the Stack

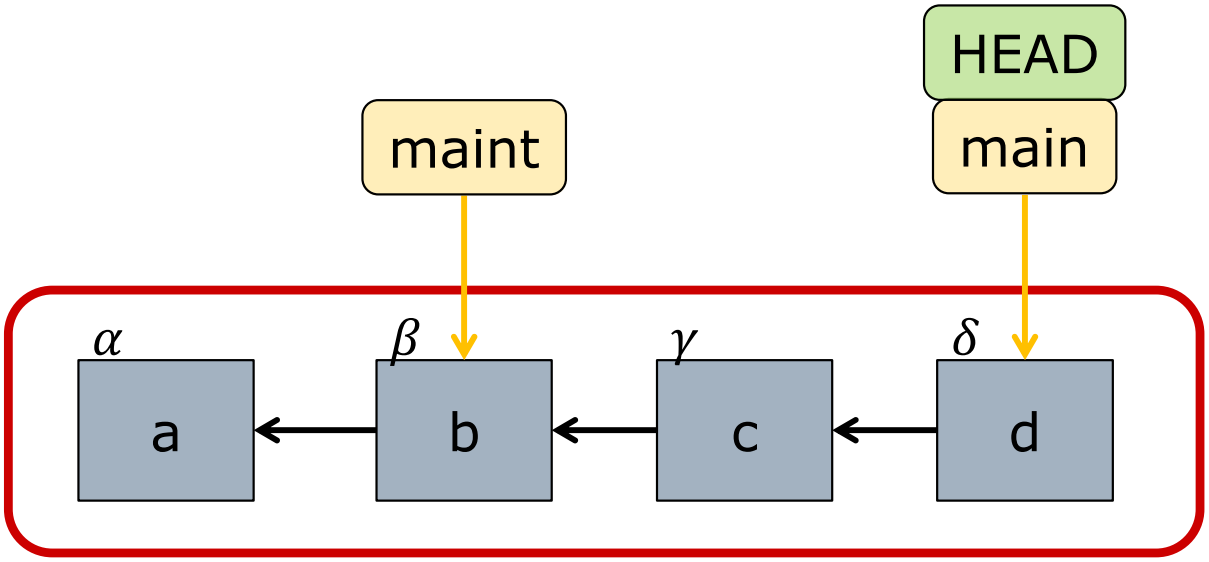

```
$ git stash pop # restores state of wt/index

# equivalent to:
$ git stash apply # restore wt and index
$ git stash drop # restore store
```



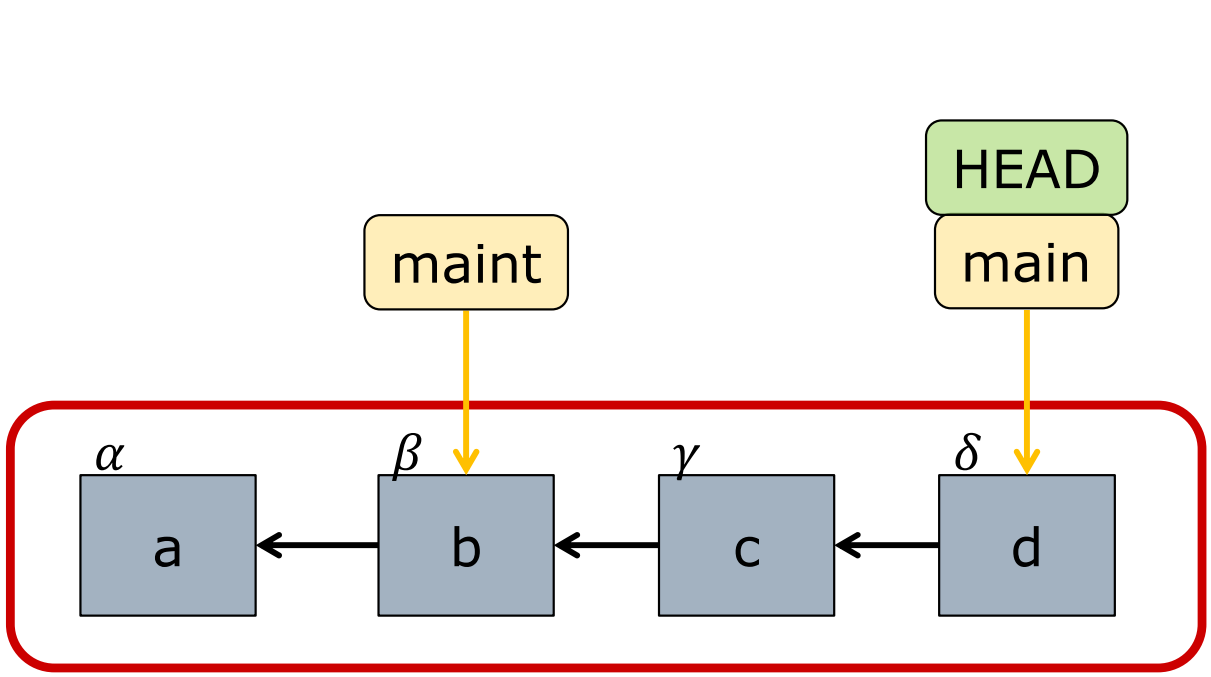
Advanced: Undoing Big Mistakes

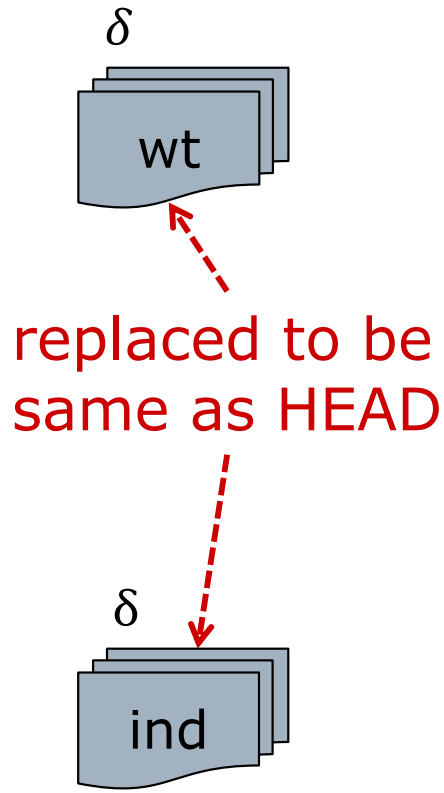
- Say you want to throw away *all* your uncommited work
  - ie "Roll back" to last commited state
- Checkout HEAD won't work!



Reset: Discarding Changes

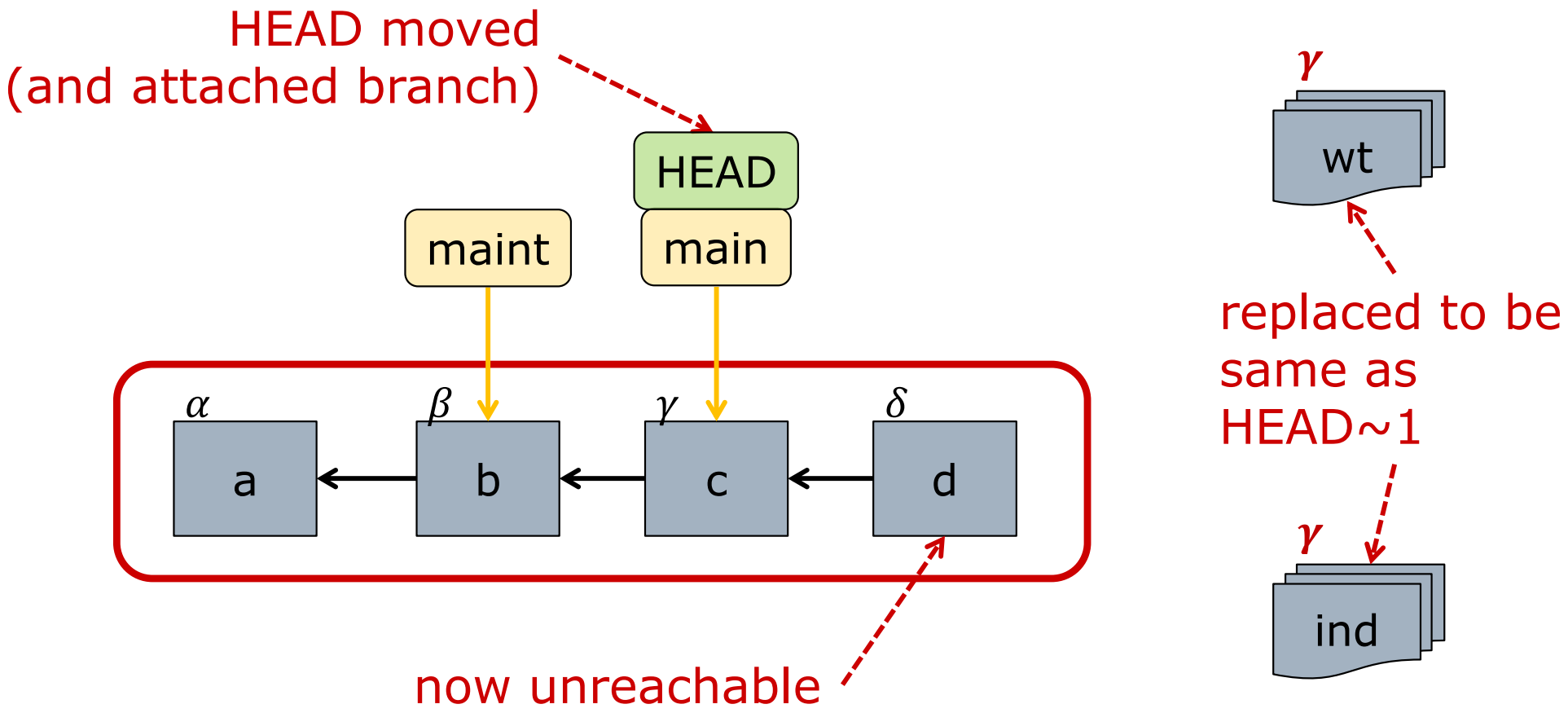

```
$ git reset --hard     # updates wt to be HEAD
$ git clean --dry-run  # list untracked files
$ git clean --force    # remove untracked files
```





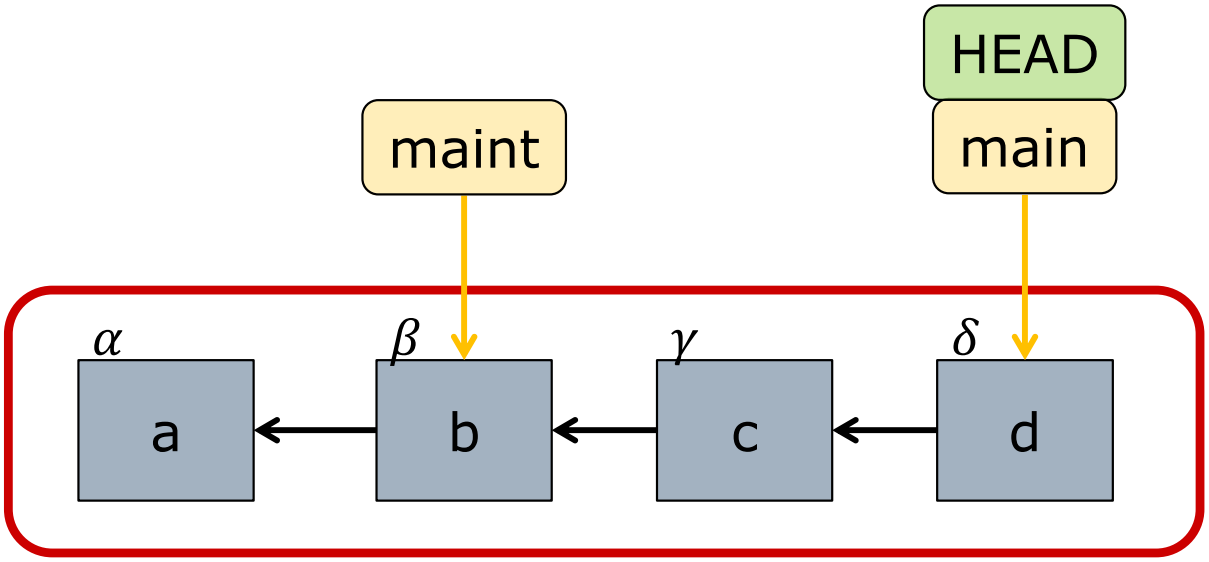
Reset: Discarding Commits


```
$ git reset --hard HEAD~1
# no need to git clean, since wt was already clean
```



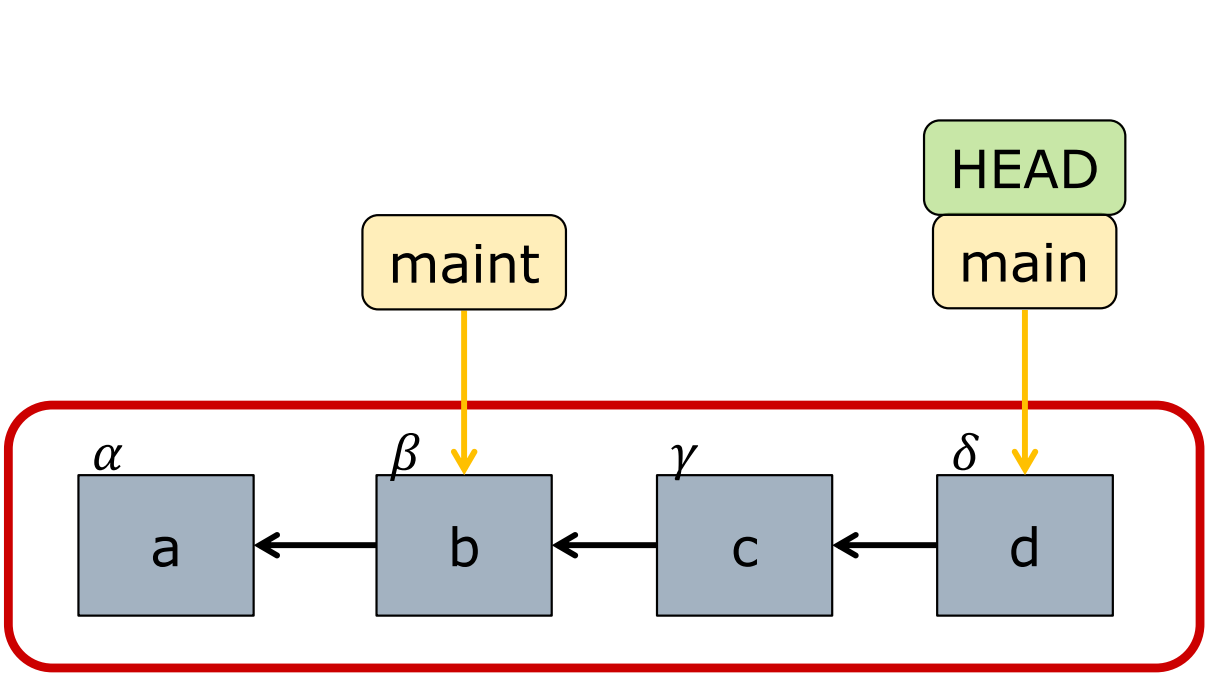
Advanced: Undo Small Mistakes

- Say you want to throw away *some of* your uncommited work
  - Restore a file to last committed version



Advanced: Undo Small Mistakes


```
$ git checkout -- README.md
# -- means: rest is file/path (not branch)
# git checkout README.md ok, if not ambiguous
```



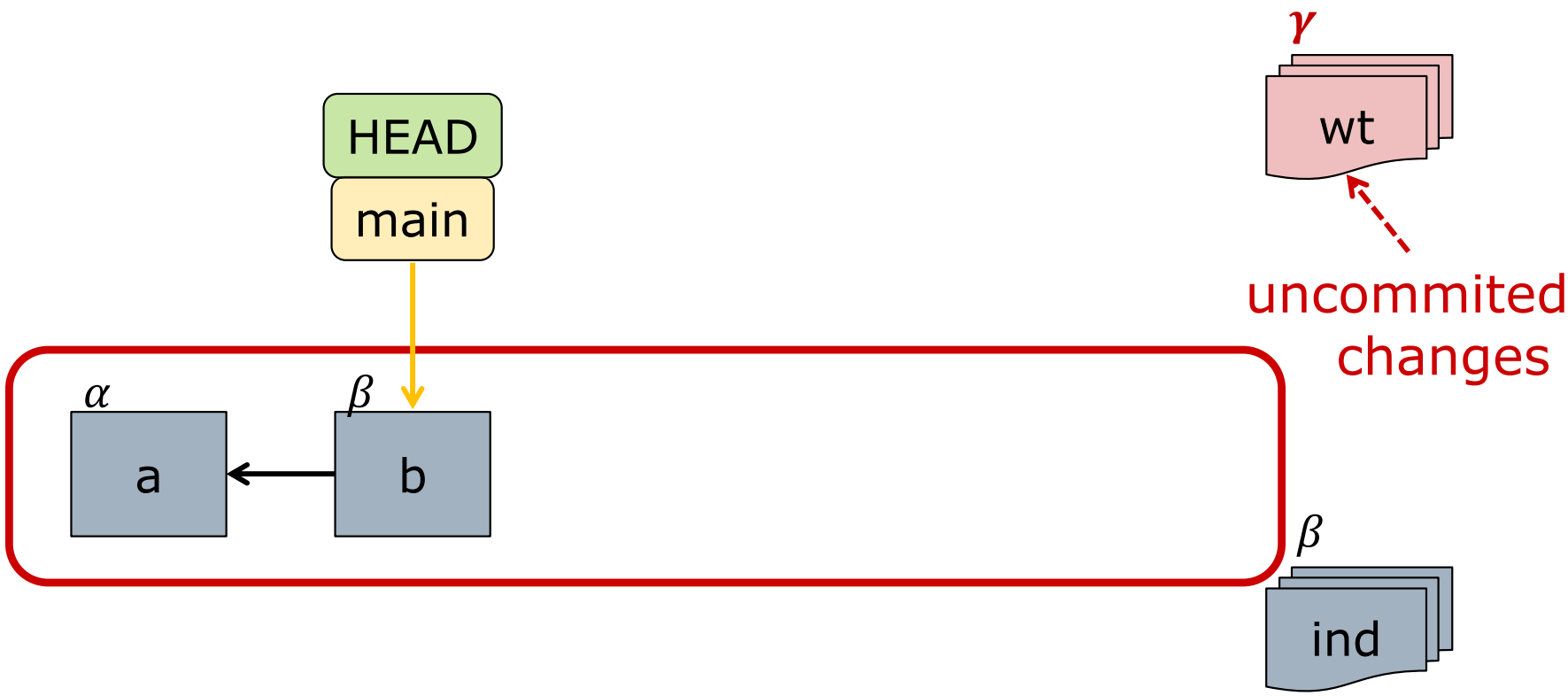
Advanced: Rewriting History

The Power to Change History

- Changing the store lets us:
  - Fix mistakes in recent commits
  - Clean up messy DAGs to make history look more linear
- Rule: Never change *shared* history
  - Once something has been pushed to a remote repo (*e.g.*, origin), do not change that part of the DAG
  - So: A *push* is really a *commit*ment!

Advanced: Rewriting History

- Problem 1: Wrong or incomplete commit



Advanced: Rewriting History

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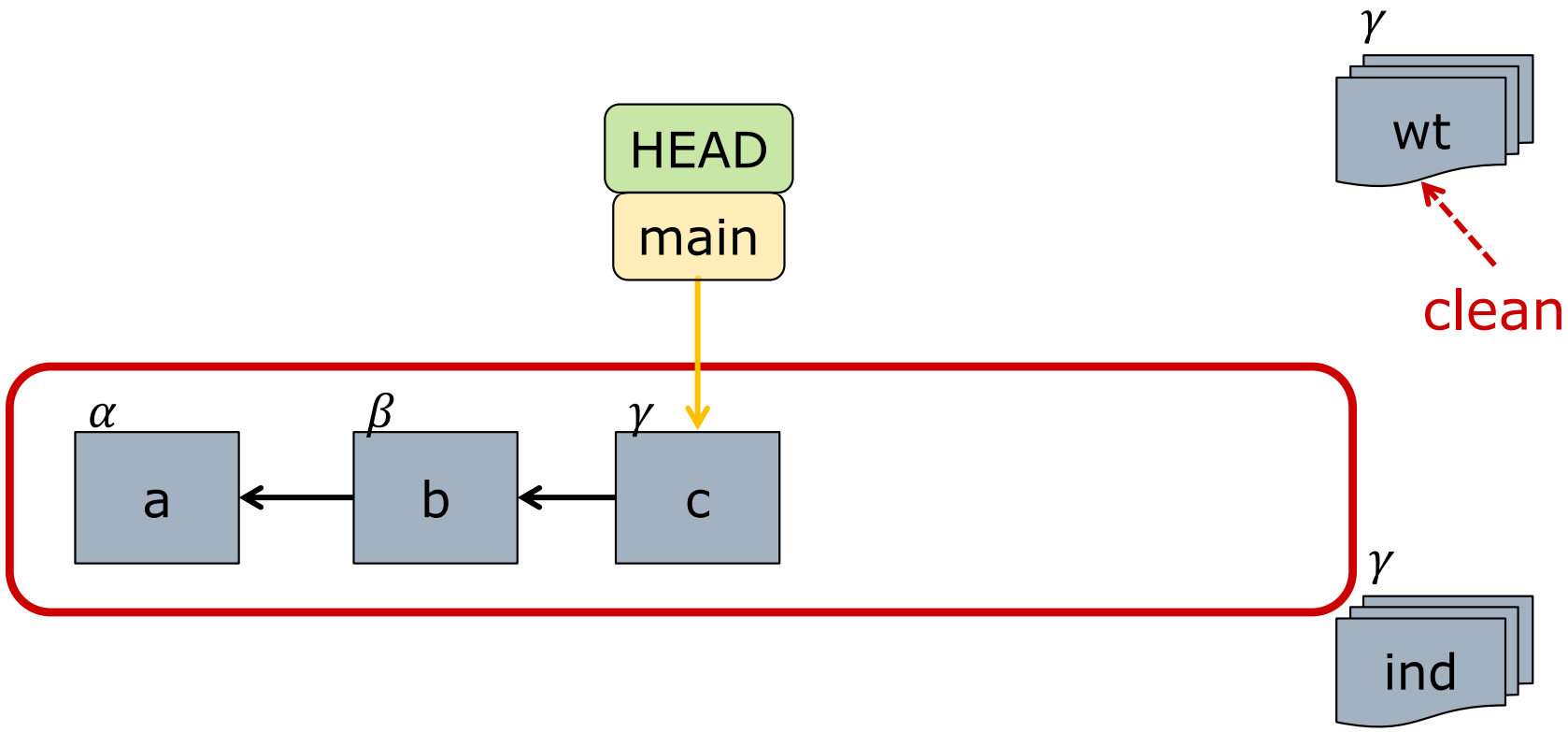
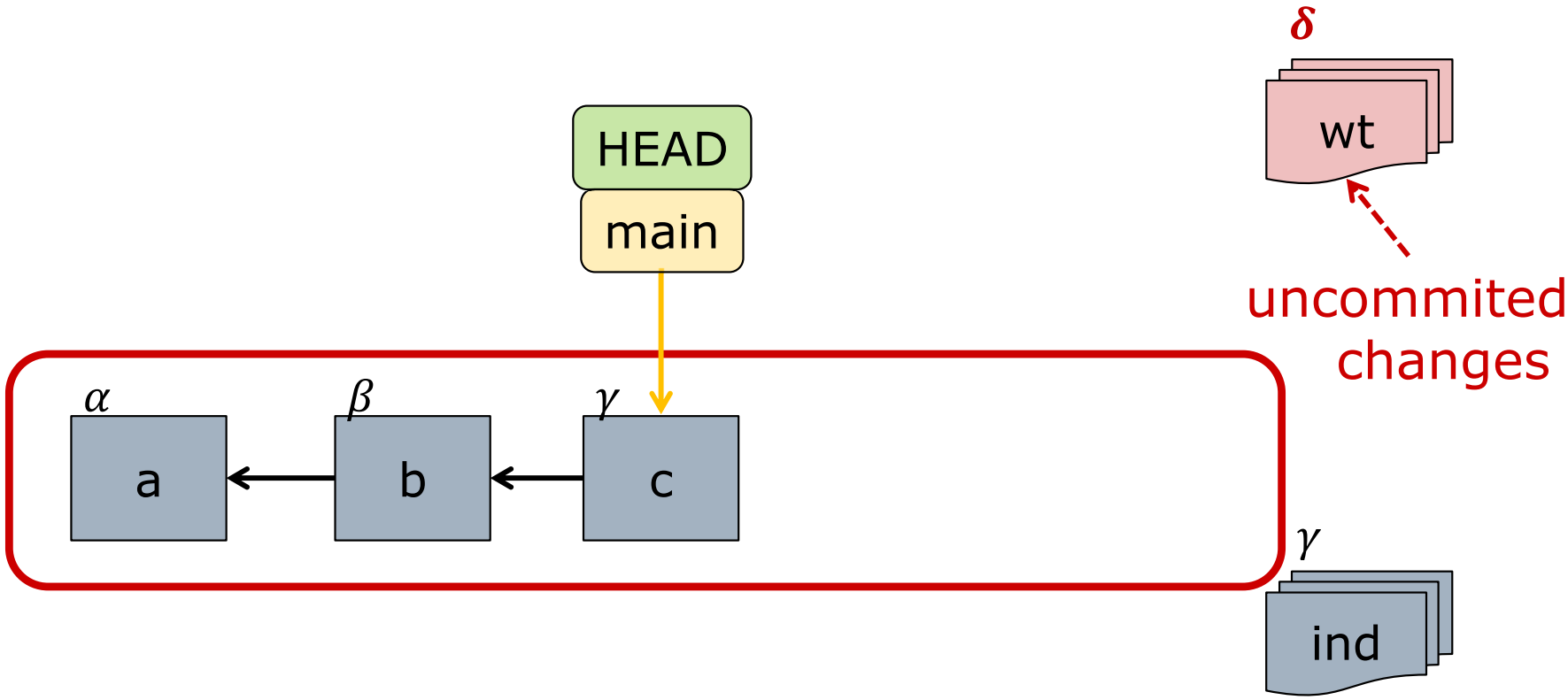


Advanced: Rewriting History

- Problem 1: Wrong or incomplete commit
  - Oops! That wasn't quite right…



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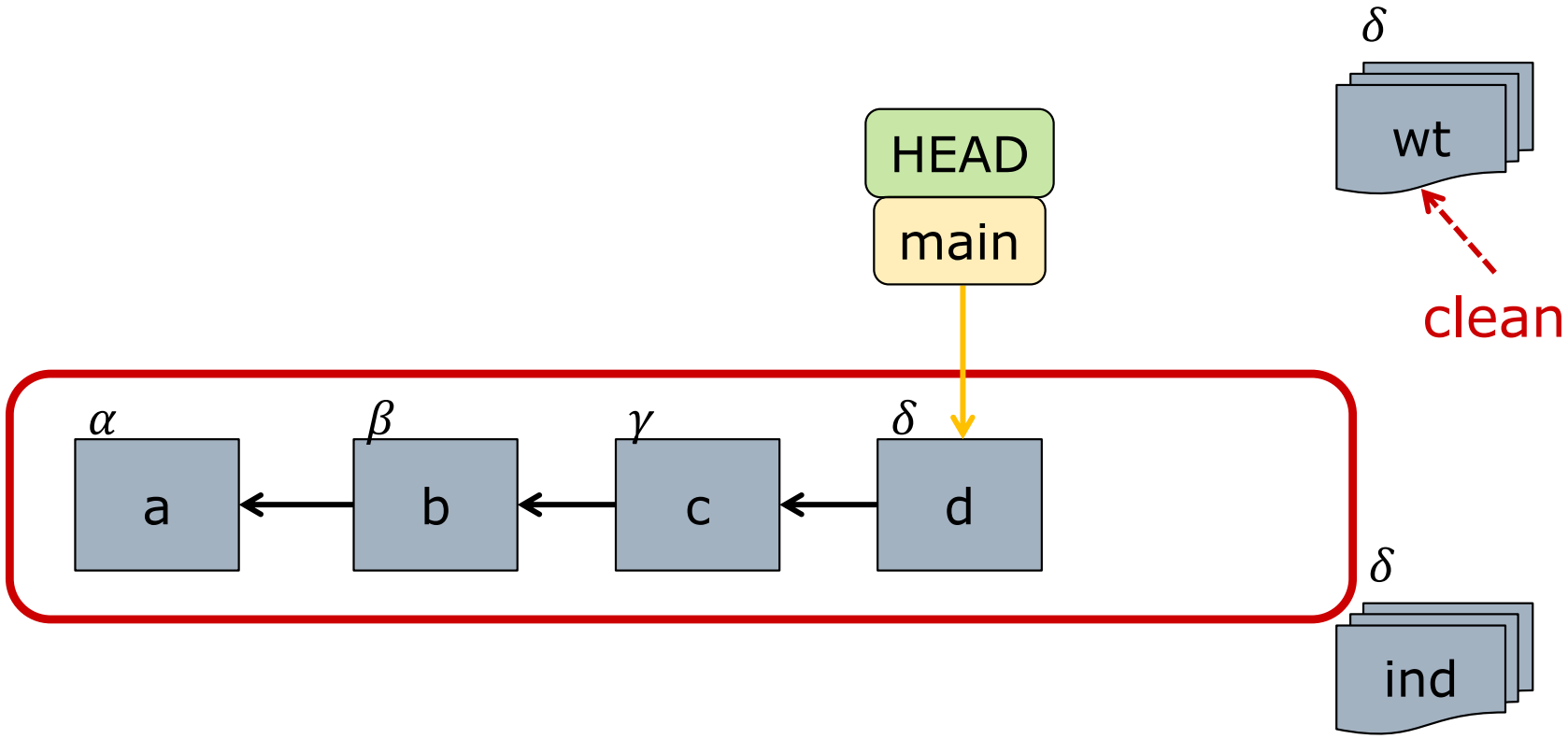

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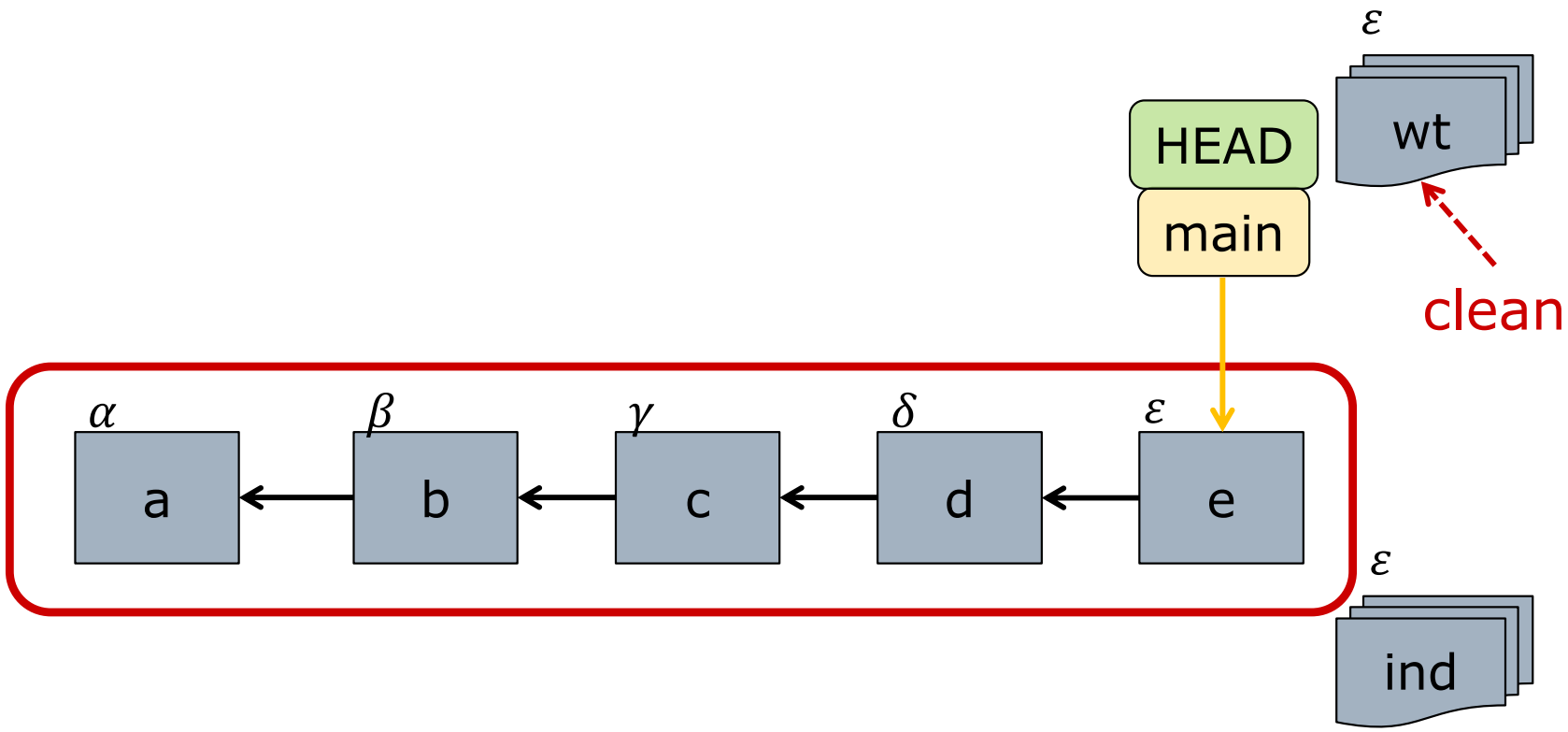
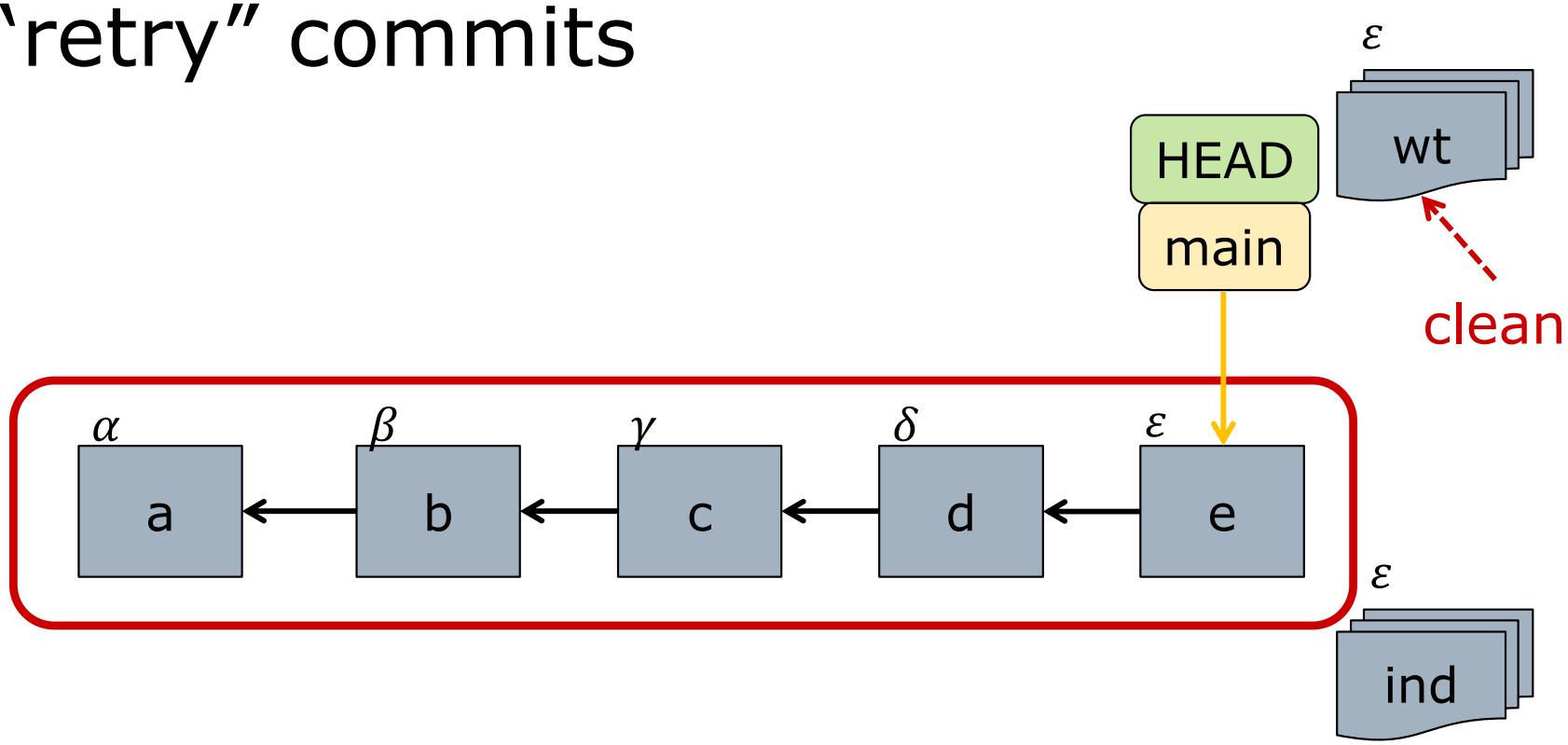


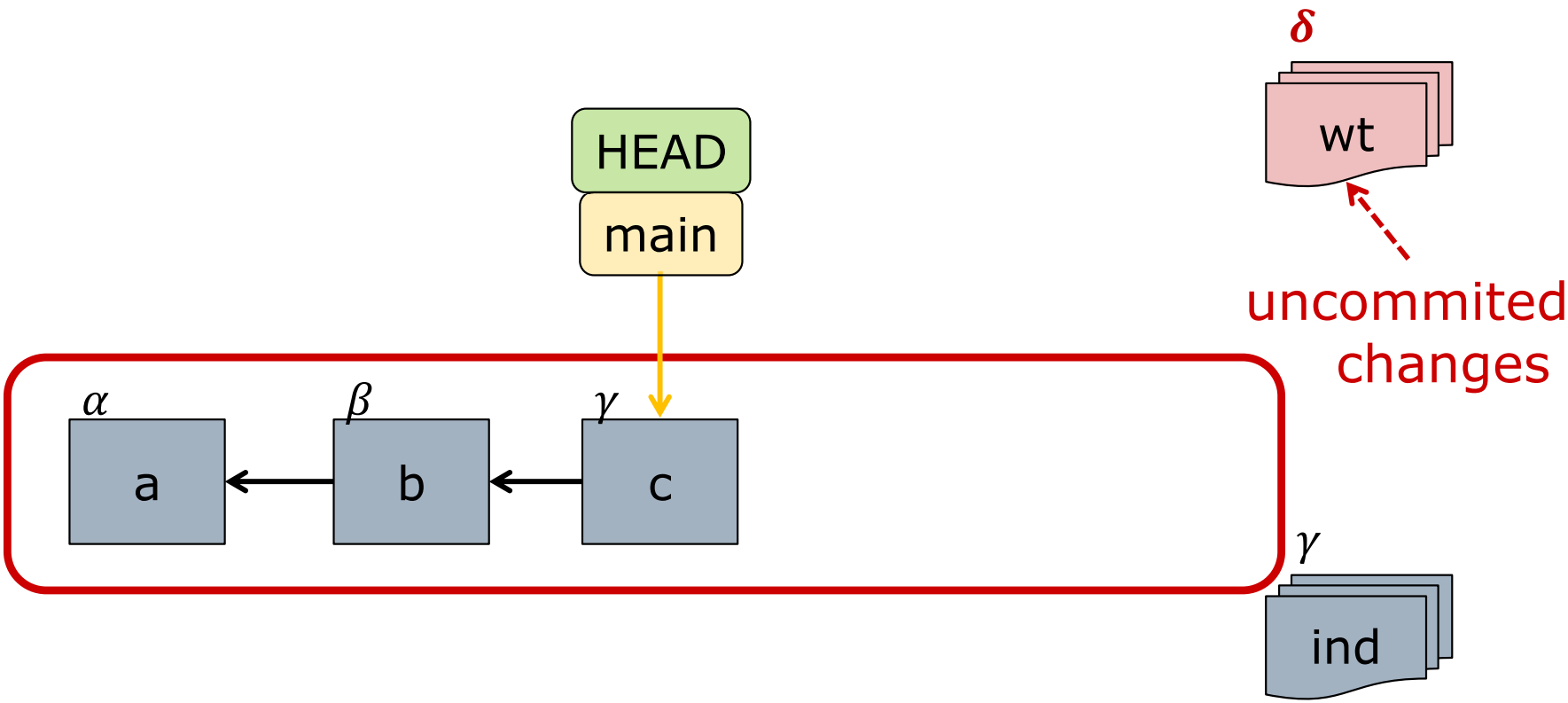
Advanced: Rewriting History

- Problem 1: Wrong or incomplete commit
- Result: Lots of tiny "fix it", "oops", "retry" commits



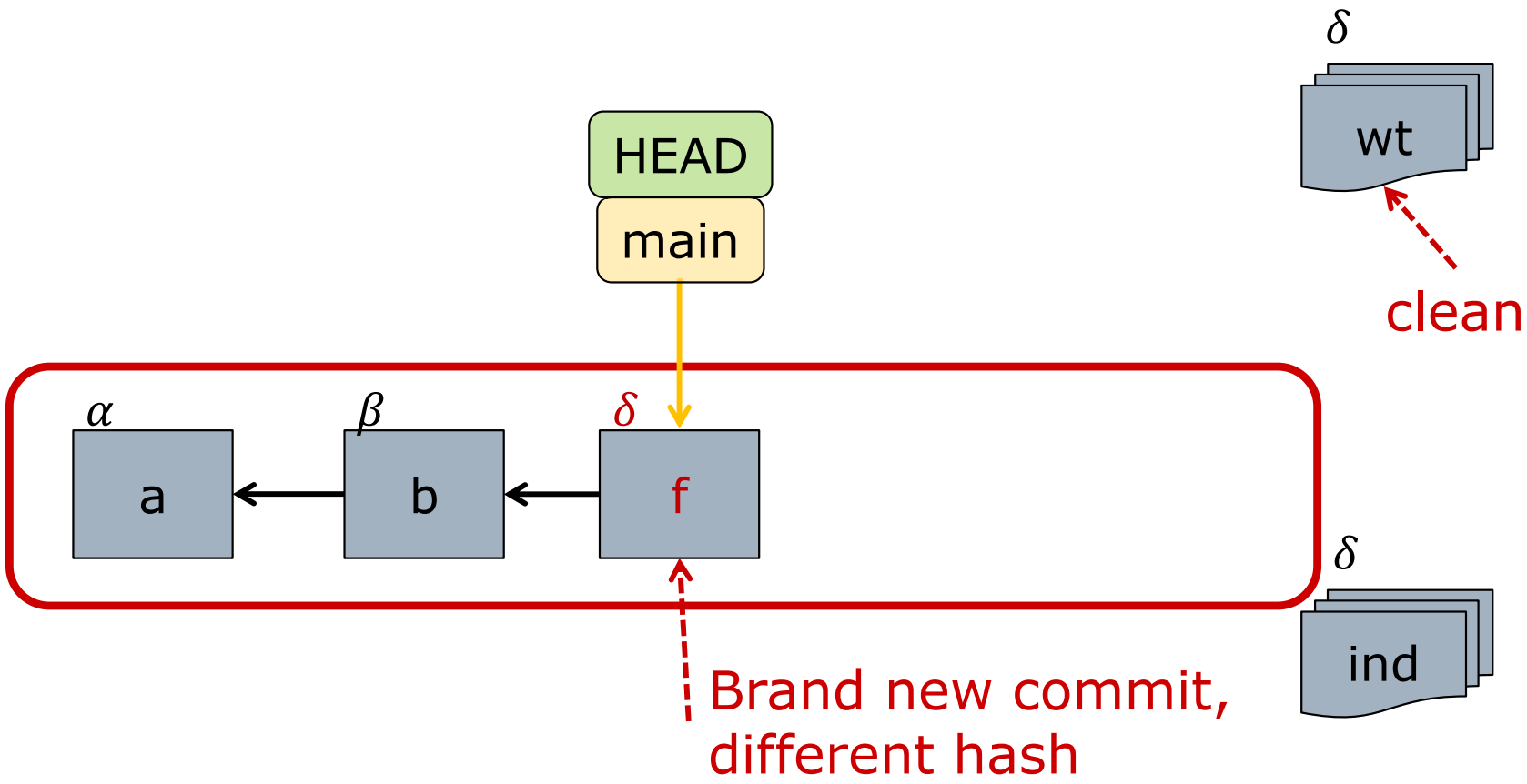
Commit --amend: Tip Repair

- Alternative: Change most recent commit(s)



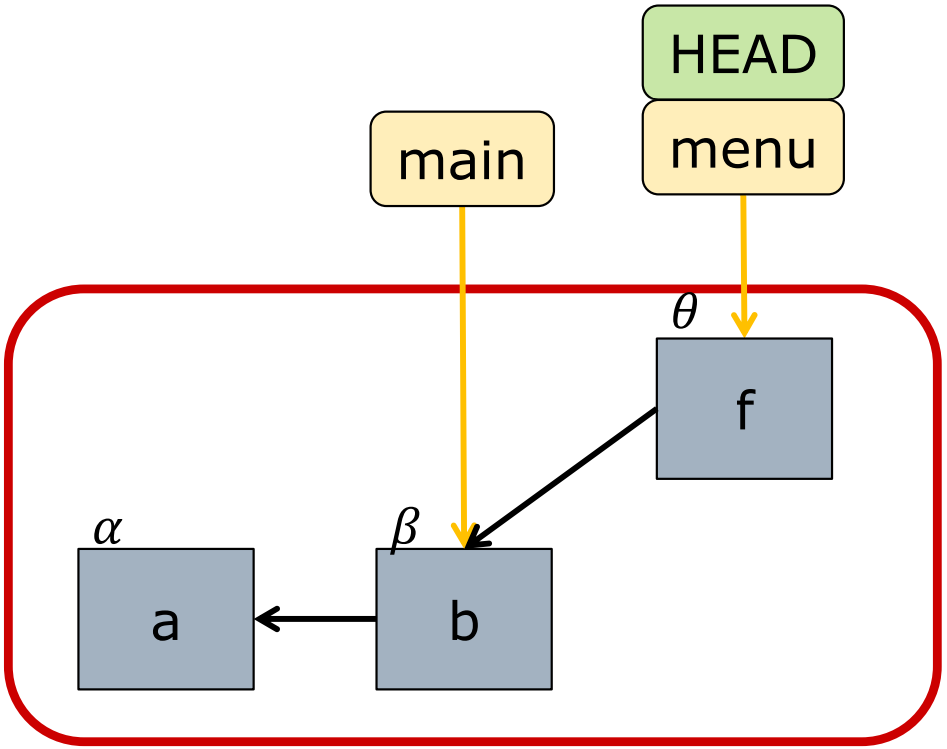
Commit --amend: Tip Repair


```
$ git add .
$ git commit --amend --no-edit
# no-edit keeps the same commit message
```



Advanced: Rewriting History

- Problem 2: As an independent branch is being developed, main also evolves



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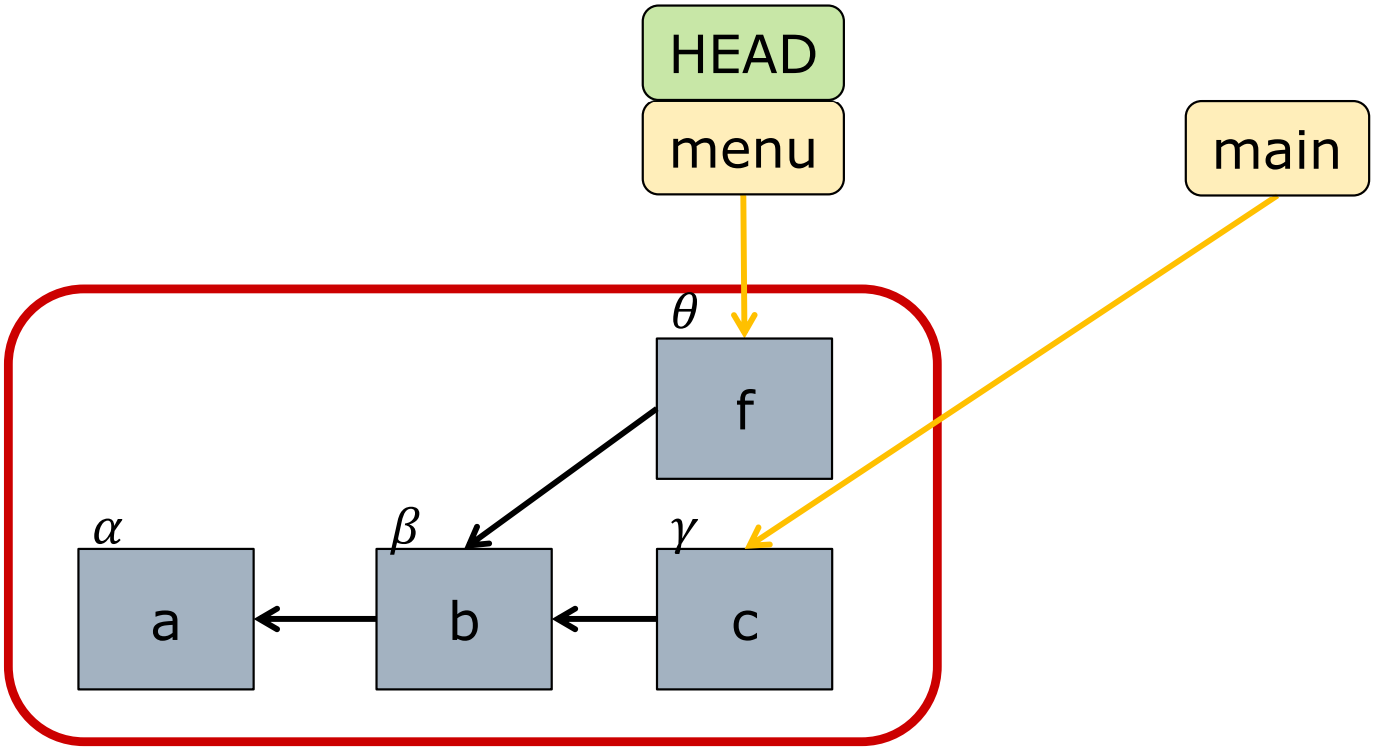
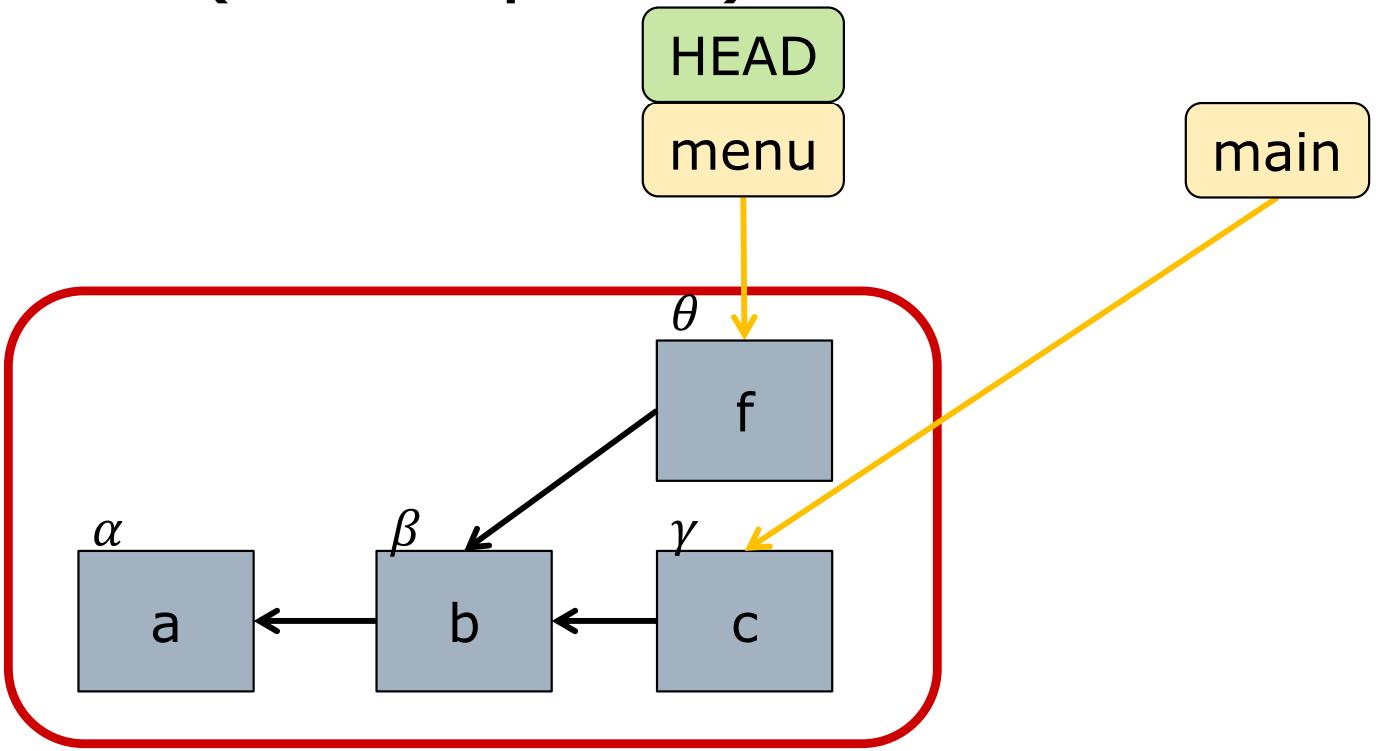


Advanced: Rewriting History

- Problem 2: As an independent branch is being developed, main also evolves
- Result: Need periodic merges of main with (incomplete) branch



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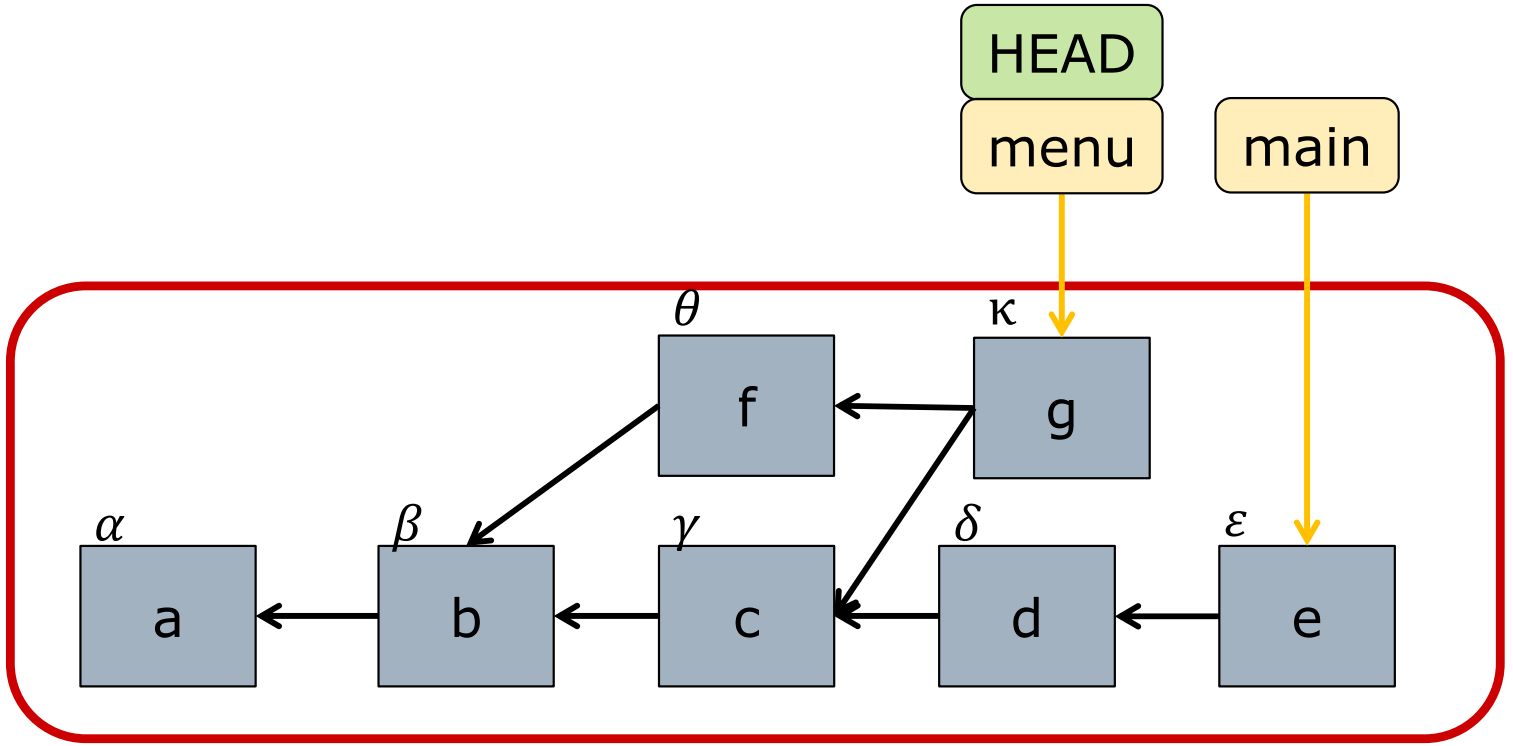

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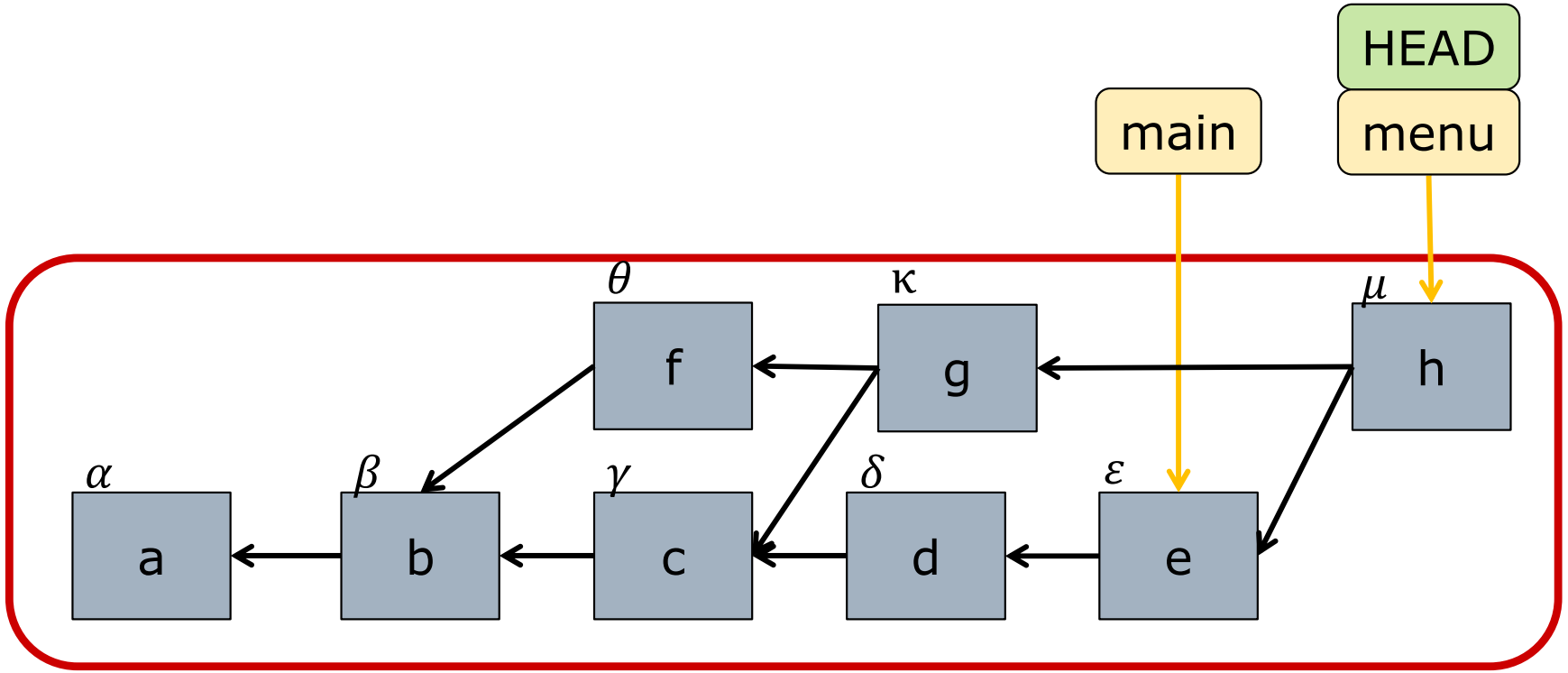
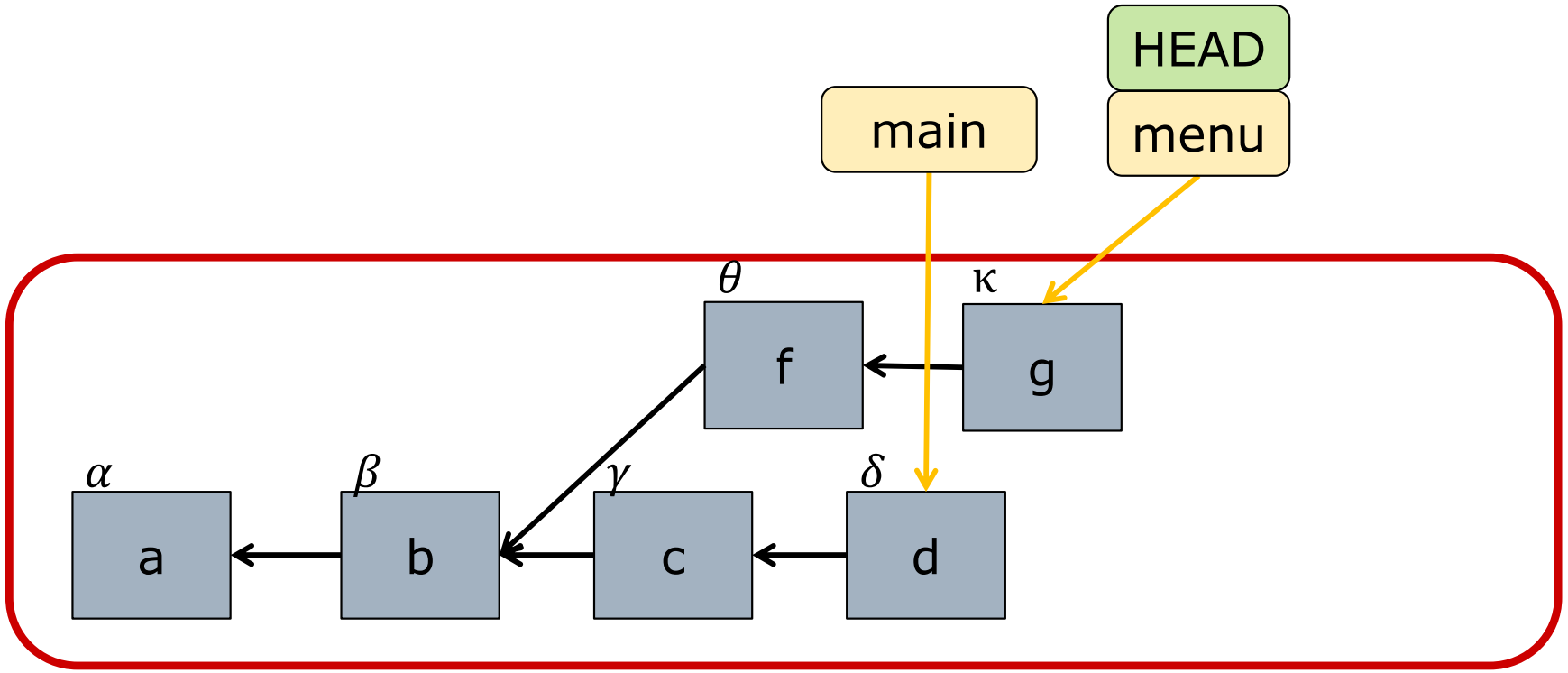


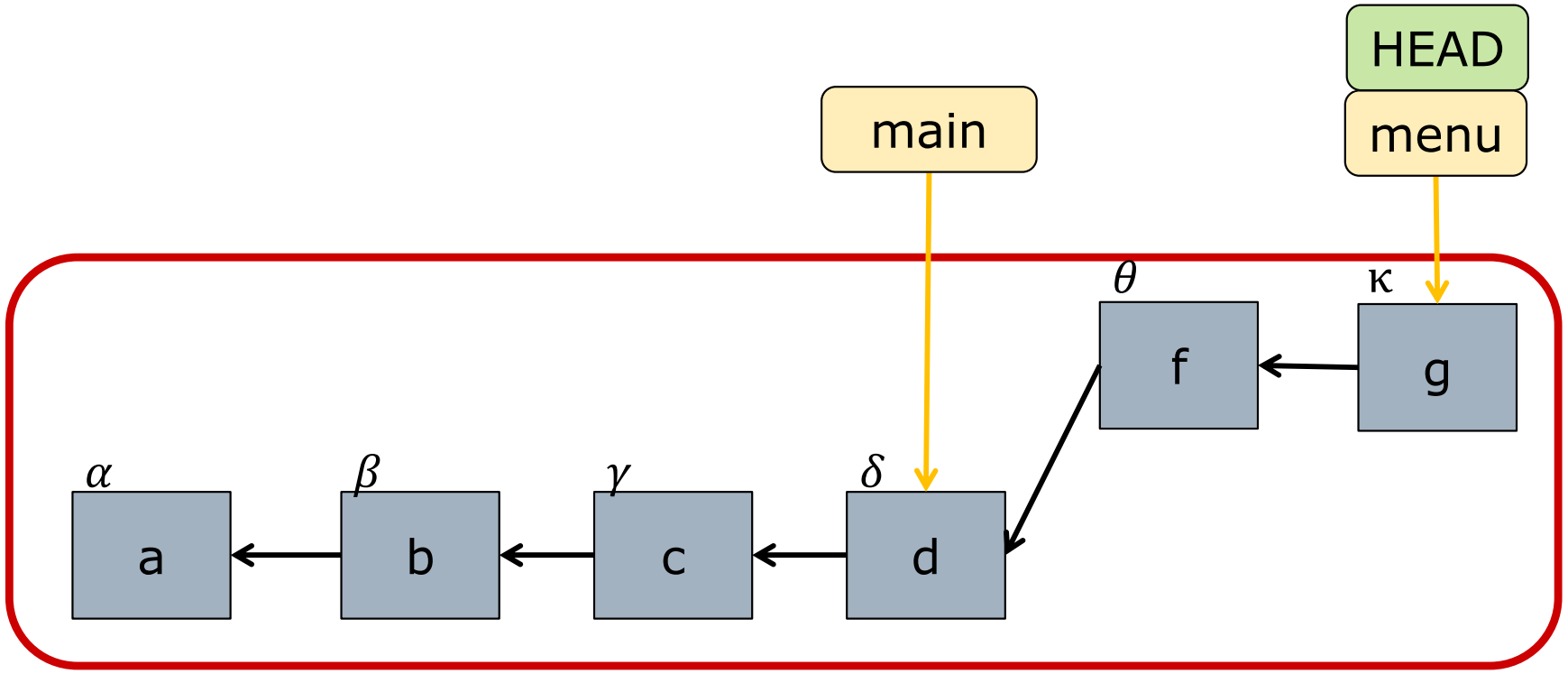
Rebase: DAG Surgery

- Alternative: Move commits to a different part of the DAG



Rebase: DAG Surgery


```
$ git rebase main
# merging main into menu is now a fast-forward
```



Git Clients and Hosting Services

- Recommend'n: Know the command line!
- IDEs are helpful too
  - VSCode, plus Git Graph extension
- Lots of sites for hosting your repos:
  - GitHub, GitLab, Bitbucket, SourceForge…
  - See: git.wiki.kernel.org/index.php/GitHosting
- These cloud services provide
  - Storage space, account/access management
  - Pretty web interface
  - Issues, bug tracking
  - Workflow (eg forks) to promote contributions from others

Clarity

git != GitHub

Warning: Academic Misconduct

- GitHub is a very popular service
  - New repos are *public* by default
  - Even free plan allows unlimited *private* repo's (and collaborators)
  - 3901 has an organization for your private repo's and team access
- Other services (*e.g.* GitLab, Bitbucket) have similar issues
- Public repo's containing coursework can create academic misconduct issues
  - Problems for poster
  - Problems for plagiarist

Summary

- Workflow
  - Fetch/push frequency
  - Respect team conventions for how/when to use different branches
- Central repo is a shared resource
  - Contains common (source) code
  - Normalize line endings and formats
- Advanced techniques
  - Stash, reset, rebase
- Advice
  - Learn by using the command line
  - Beware academic misconduct