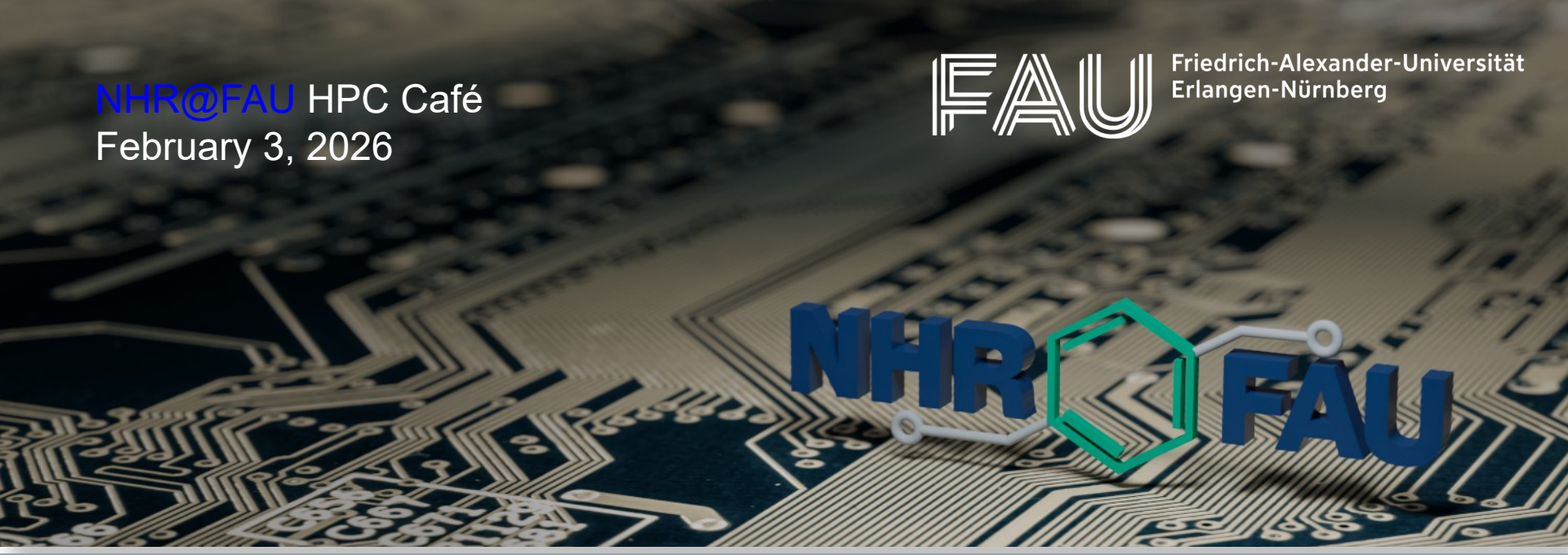

NHR@FAU HPC Café
February 3, 2026

Friedrich-Alexander-Universität
Erlangen-Nürnberg

Git advanced usage

Michael Panzlaff

Erlangen National High Performance Computing Center (NHR@FAU)

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HPC Café, February 3, 2026

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Mar 10-11	... for multiple GPUs	
Mar 27	... with CUDA Python	
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Introduction

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Don’t worry, this won’t be a “just theory” lesson :-)

Introduction

Have you seen those “errors” before?

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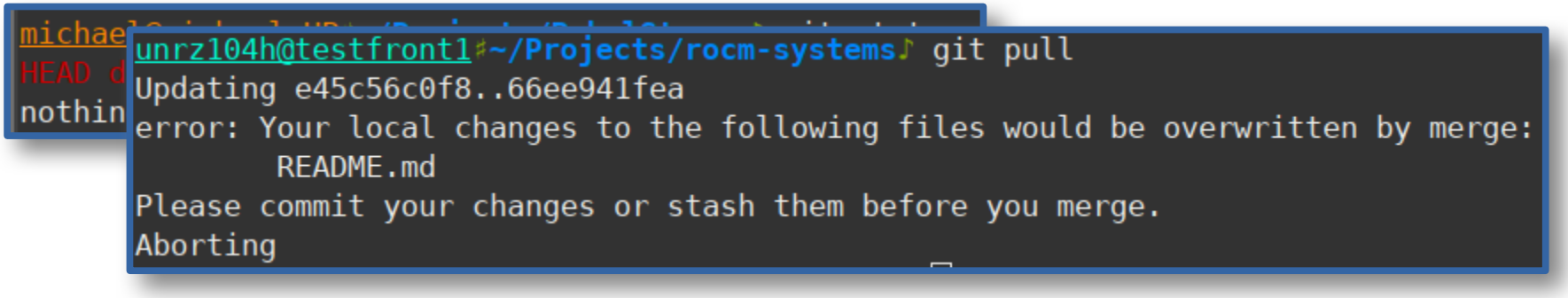
```
michael@michael-HP♯~/Projects/BabelStream♪ git status
HEAD detached at 78ba4ff
nothing to commit, working tree clean
```

Introduction

Have you seen those “errors” before?



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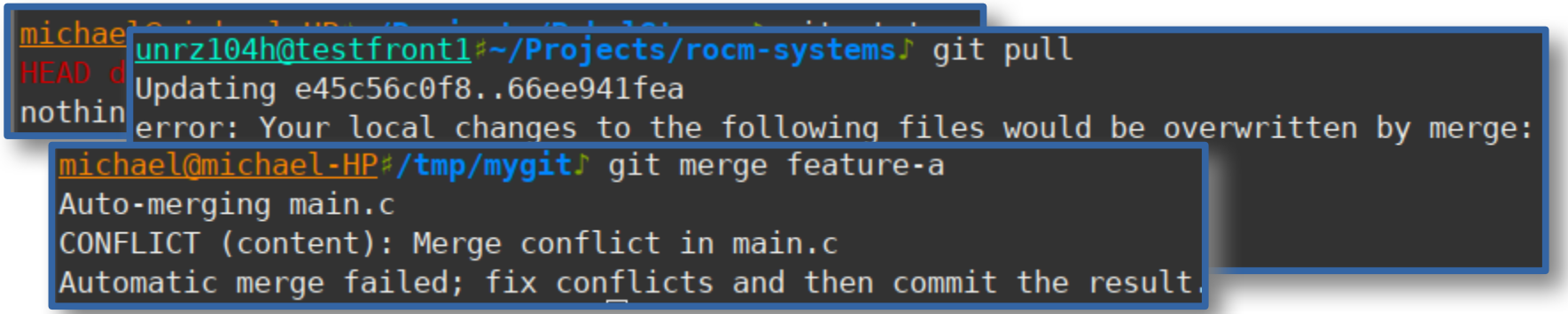

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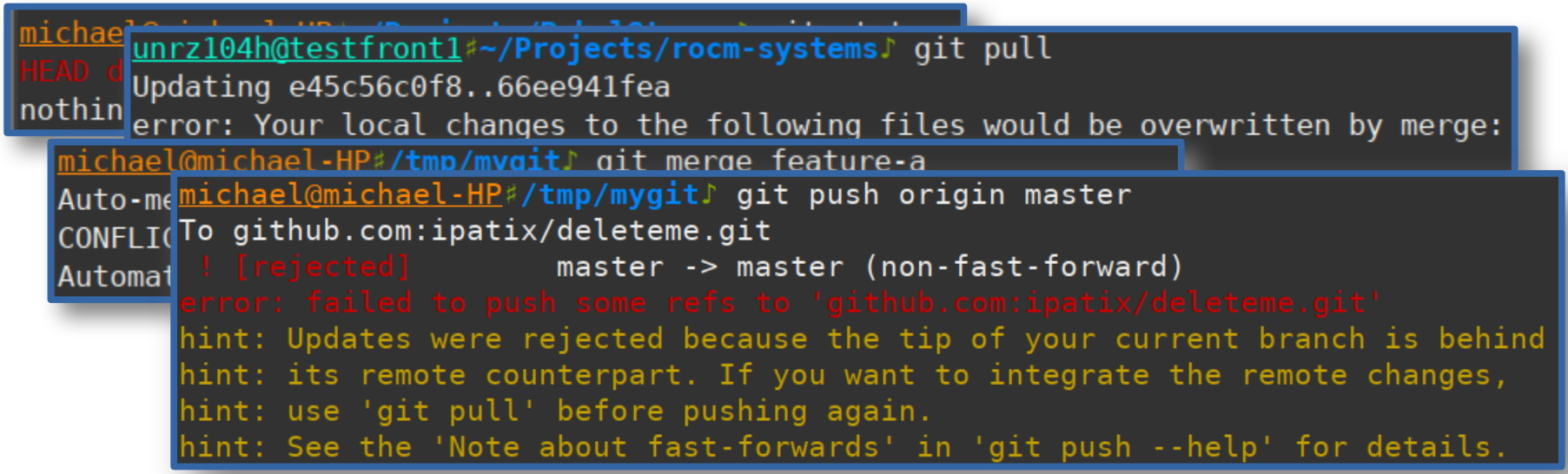

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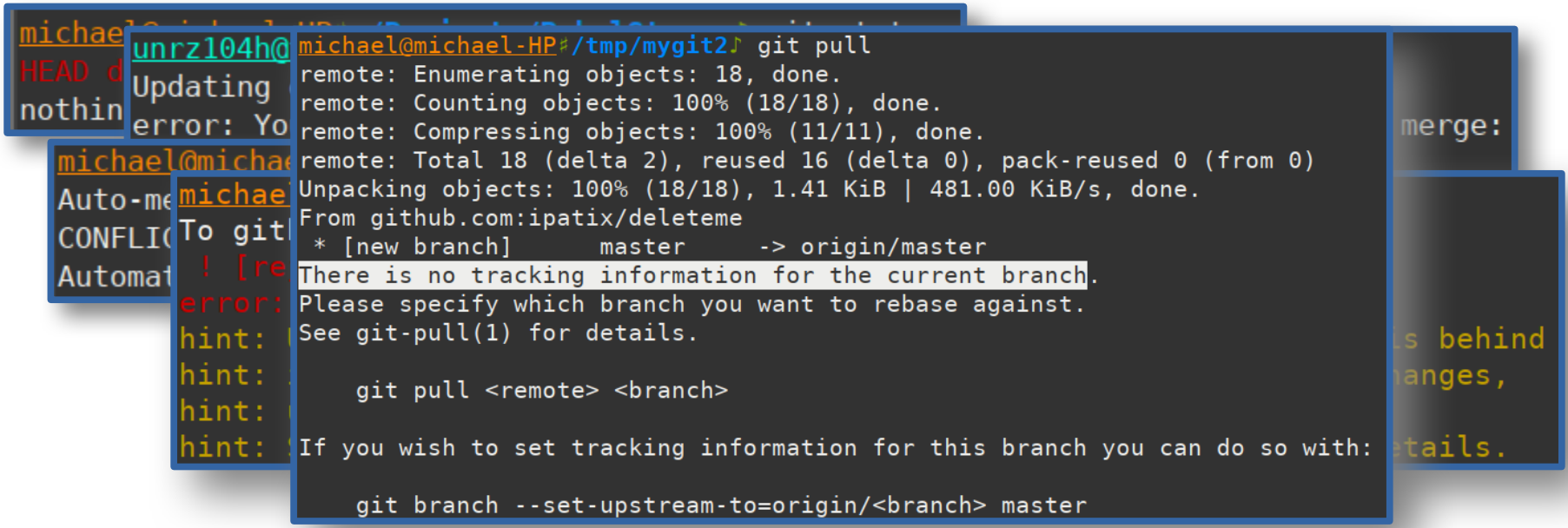

Introduction

“solid fundamentals → advanced user”

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Git history

Git history

First things first:

- What it is not: The history of the tool Git itself

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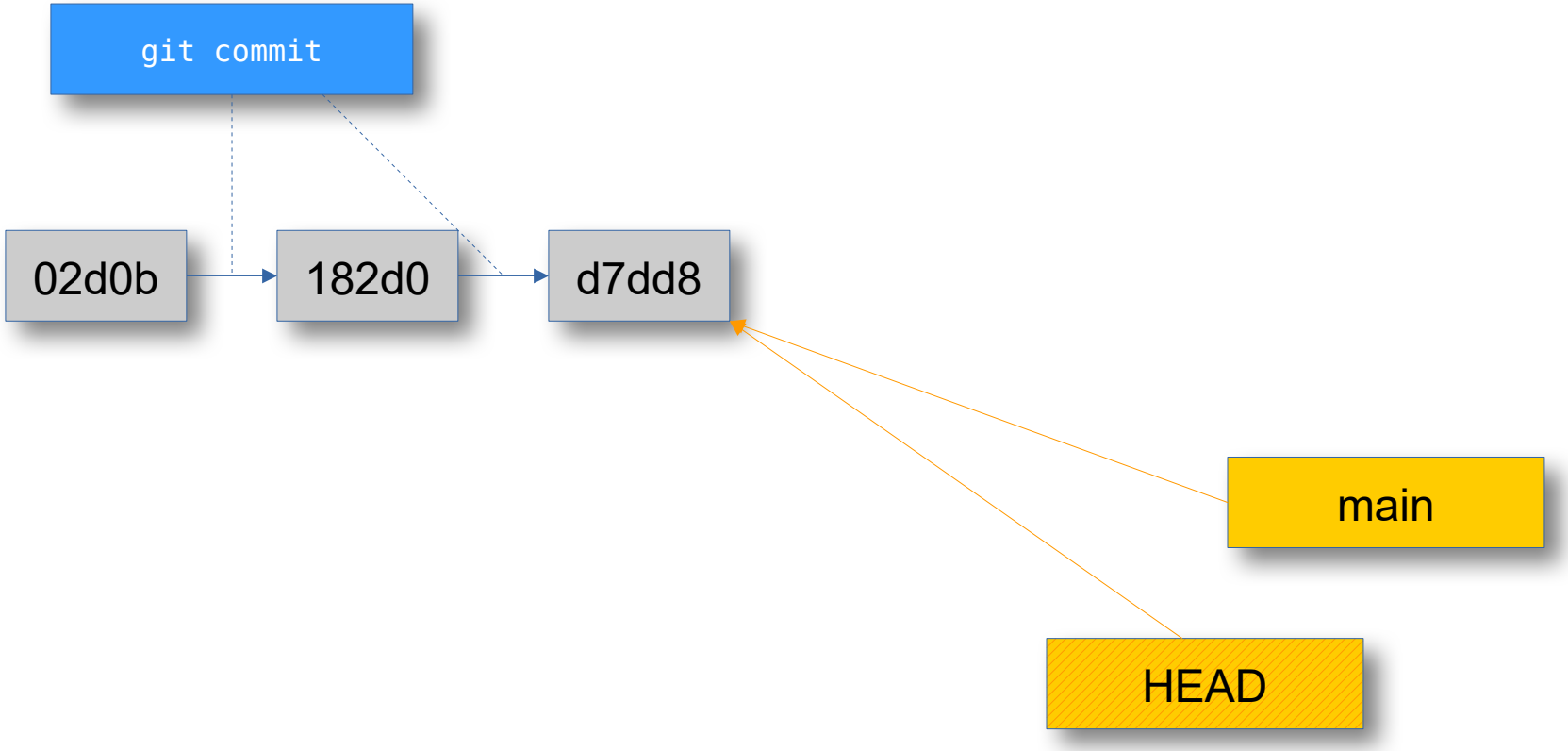
- What it is: The history of commits of a Git repository

Why is history relevant?

- We use it to look back in time.
  → It should be easy to look back in time
- Because it is non-linear (directed acyclic graph)
  → complications during merge/rebase

Git history (with merge)



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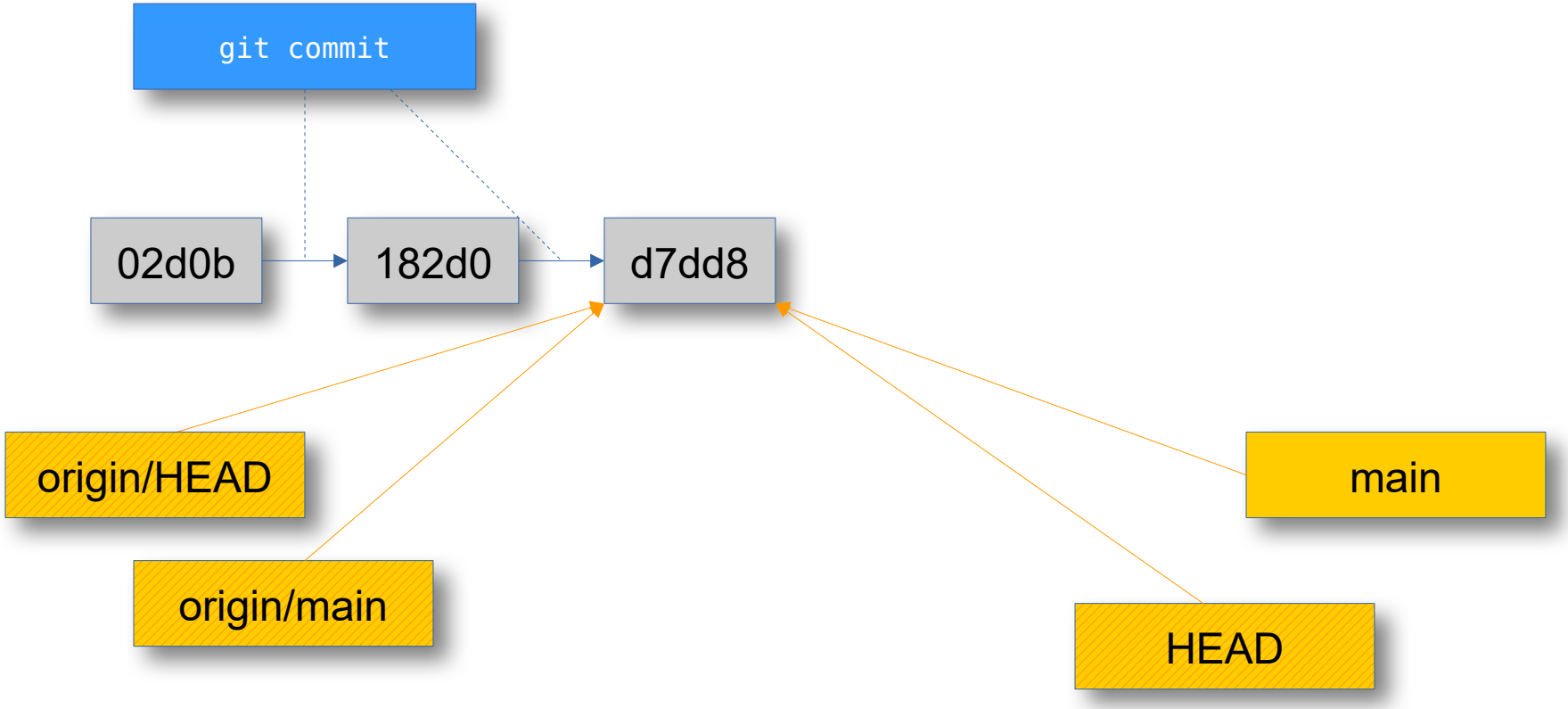

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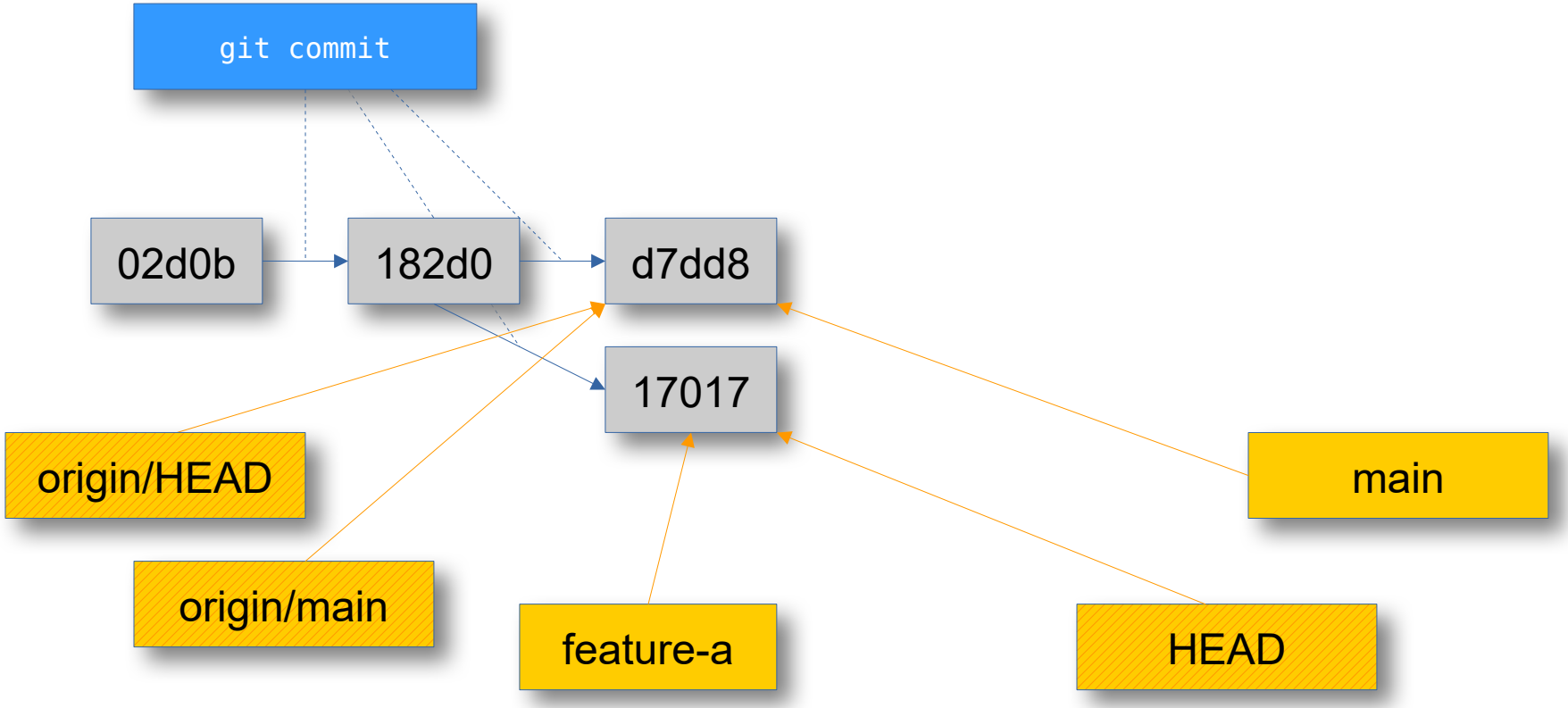

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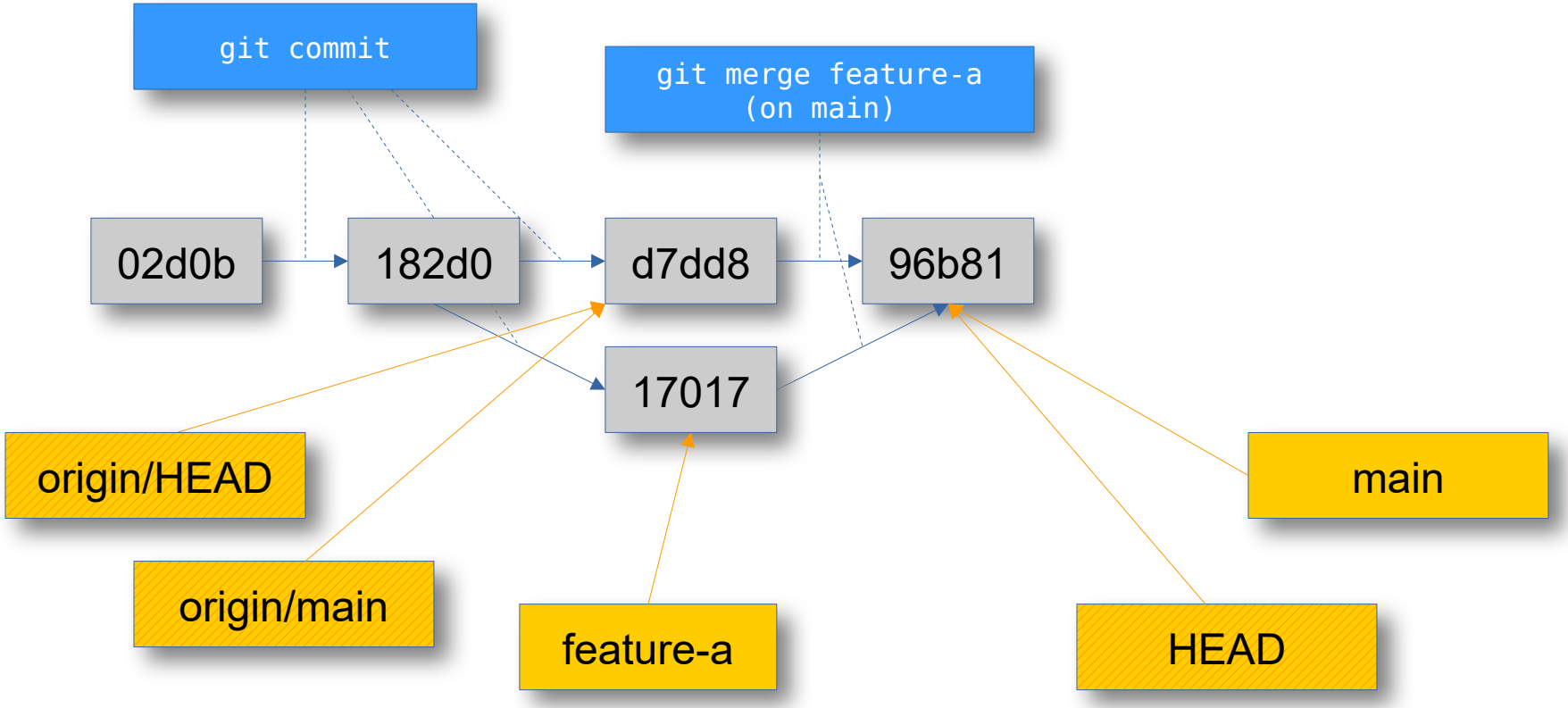

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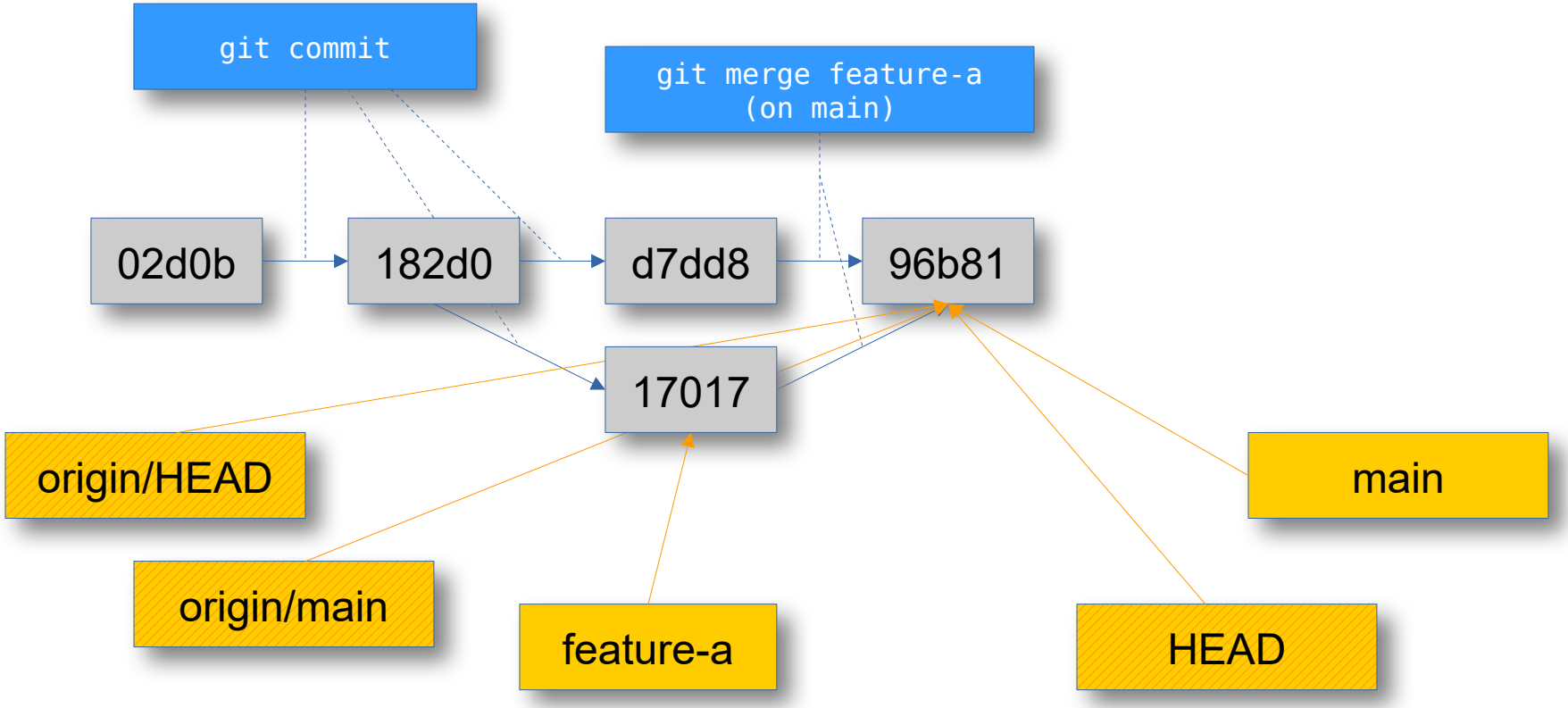

Git history (with merge)

Reproduce step 1:

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- `echo “there” >> file.txt` `# Add some content to` **`file.txt`**

Git history (with merge)

Reproduce step 1:

- `mkdir myrepo && cd myrepo` # Create directory
- `git init` # Init Git repository
- `echo “hello” > file.txt` # Create **file.txt** with some content
- `git add file.txt && git commit` # Create commit #1 (**02d0b**)
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Git history (with merge)

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- `echo “there” >> file.txt` # Add some content to **file.txt**
- `git add file.txt && git commit` # Create commit #2 (**182d0**)
- `echo “NHR” >> file.txt` # Add more content to **file.txt**

Git history (with merge)

Reproduce step 1:

- `mkdir myrepo && cd myrepo` # Create directory
- `git init` # Init Git repository
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- `git add file.txt && git commit` # Create commit #2 (**182d0**)
- `echo “NHR” >> file.txt` # Add more content to **file.txt**
- `git add file.txt && git commit` # Create commit #3 (**d7dd8**)

Git history (with merge)

Reproduce step 1:

- `mkdir myrepo && cd myrepo` # Create directory
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- `echo “NHR” >> file.txt` # Add more content to **file.txt**
- `git add file.txt && git commit` # Create commit #3 (**d7dd8**)

Commit hashes will differ for you!

Git history (with merge)

Reproduce step 2:

- `git remote add origin “git@github.com:myuser/myrepo.git”`
  `# Add a remote called` **`origin`**

Git history (with merge)

Reproduce step 2:

- `git remote add origin “git@github.com:myuser/myrepo.git”`
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Reproduce step 3:

- `git switch 182d0` `# Switch to a previous commit`

Git history (with merge)

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- `git remote add origin “git@github.com:myuser/myrepo.git”`
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- `git push --set-upstream-to origin main`
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Reproduce step 3:

- `git switch 182d0` `# Switch to a previous commit`
- `git switch --create feature-a` `# Create branch` **`feature-a`** `and switch to it`

Git history (with merge)

Reproduce step 2:

- `git remote add origin “git@github.com:myuser/myrepo.git”`
  `# Add a remote called` **`origin`**
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  `# Push the current branch remote` **`origin`** `and mark it as upstream`

Reproduce step 3:

- `git switch 182d0` `# Switch to a previous commit`
- `git switch --create feature-a` `# Create branch` **`feature-a`** `and switch to it`
- `echo “FAU” > file2.txt` `# Create` **`file2.txt`**

Git history (with merge)

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- `git remote add origin “git@github.com:myuser/myrepo.git”`
  `# Add a remote called` **`origin`**
- `git push --set-upstream-to origin main`
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Reproduce step 3:

- `git switch 182d0` `# Switch to a previous commit`
- `git switch --create feature-a` `# Create branch` **`feature-a`** `and switch to it`
- `echo “FAU” > file2.txt` `# Create` **`file2.txt`**
- `git add file2.txt && git commit` `# Create commit #4 (`**`17017`**`)`

Git history (with merge)

Reproduce step 4:

- `git switch main` `# Switch back to **main** branch`

Git history (with merge)

Reproduce step 4:

- `git switch main` `# Switch back to **main** branch`
- `git merge feature-a` `# Merge changes from **feature-a** into **main**`

Git history (with merge)

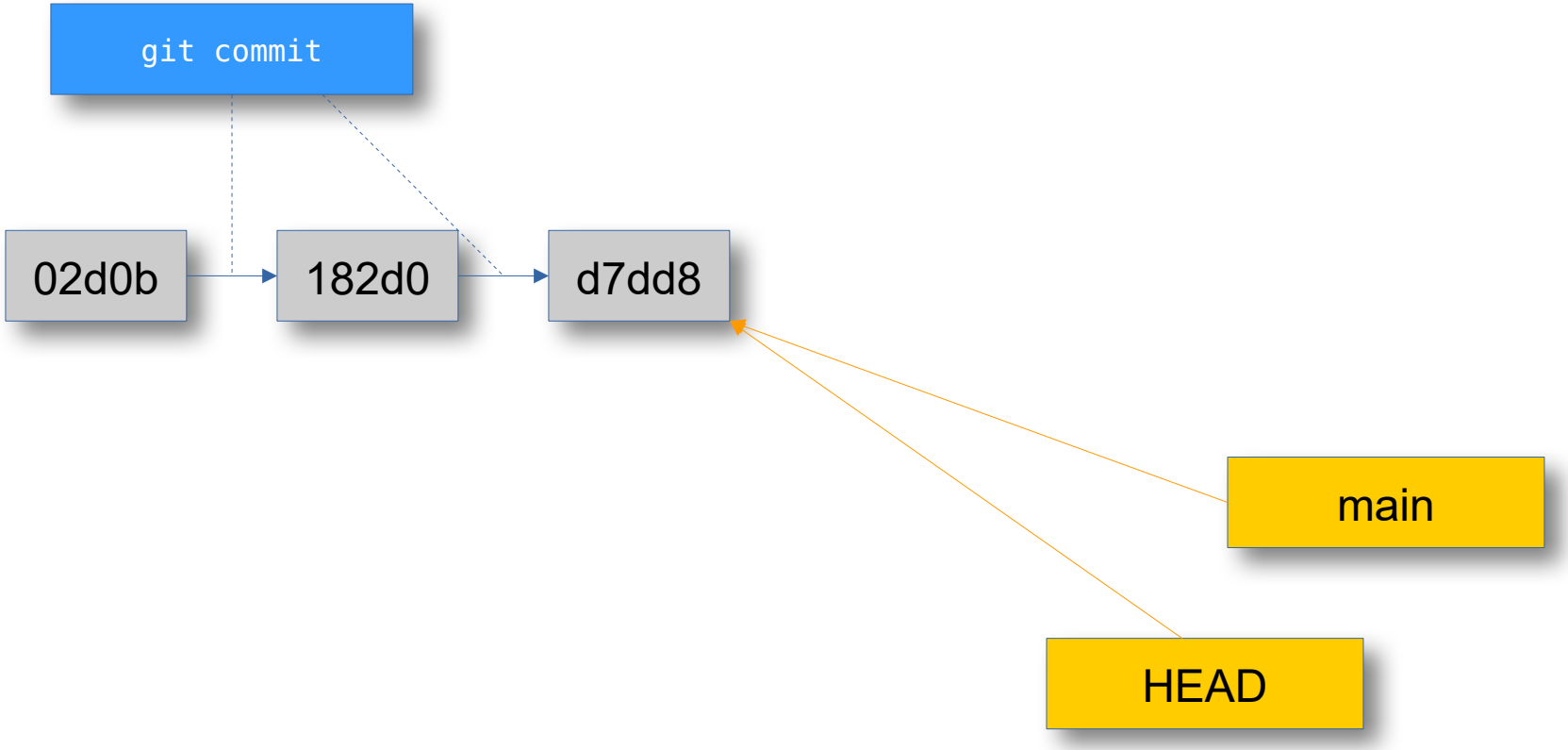
Reproduce step 4:

- `git switch main` `# Switch back to **main** branch`
- `git merge feature-a` `# Merge changes from **feature-a** into **main**`

Reproduce step 5:

- `git push` `# Push new state of **main** branch to **origin**`

Git history (with rebase)



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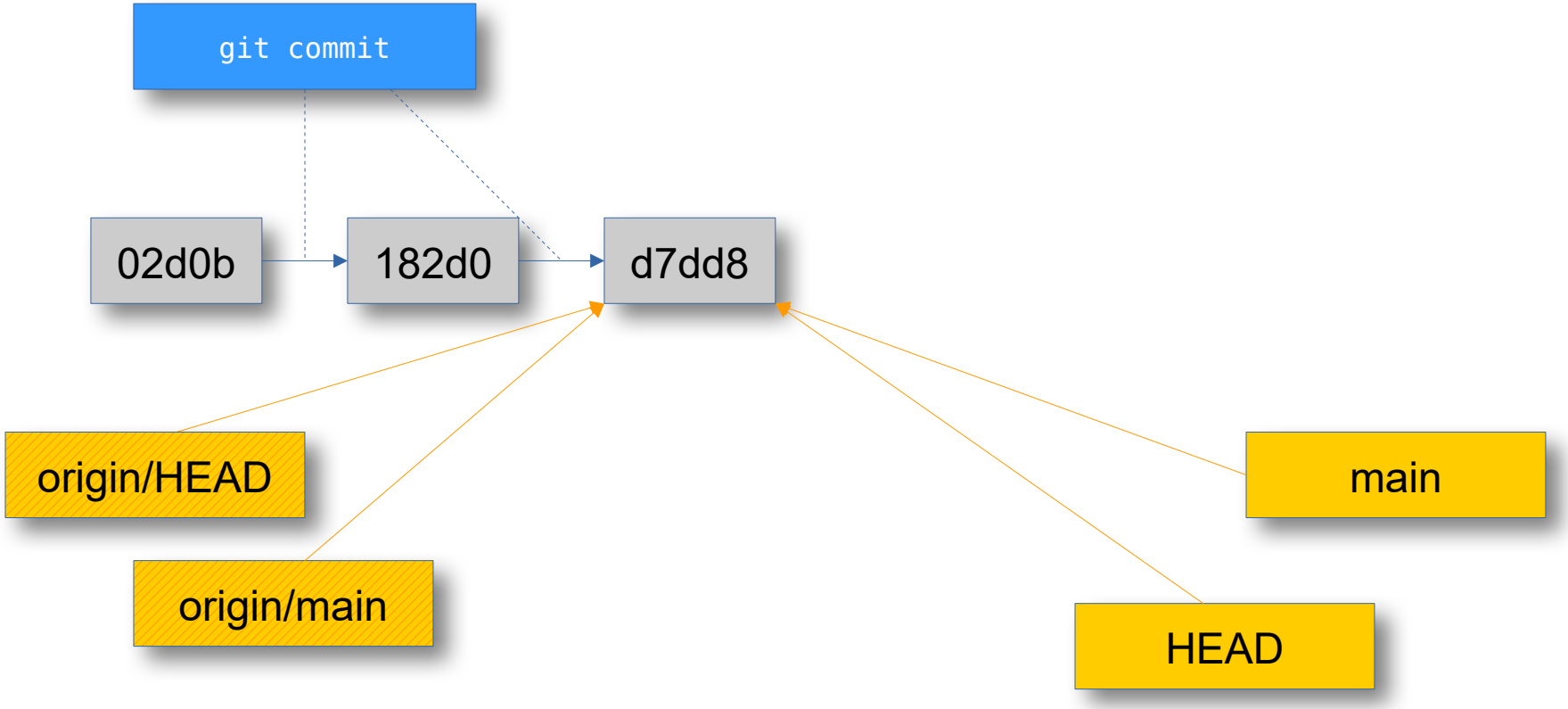

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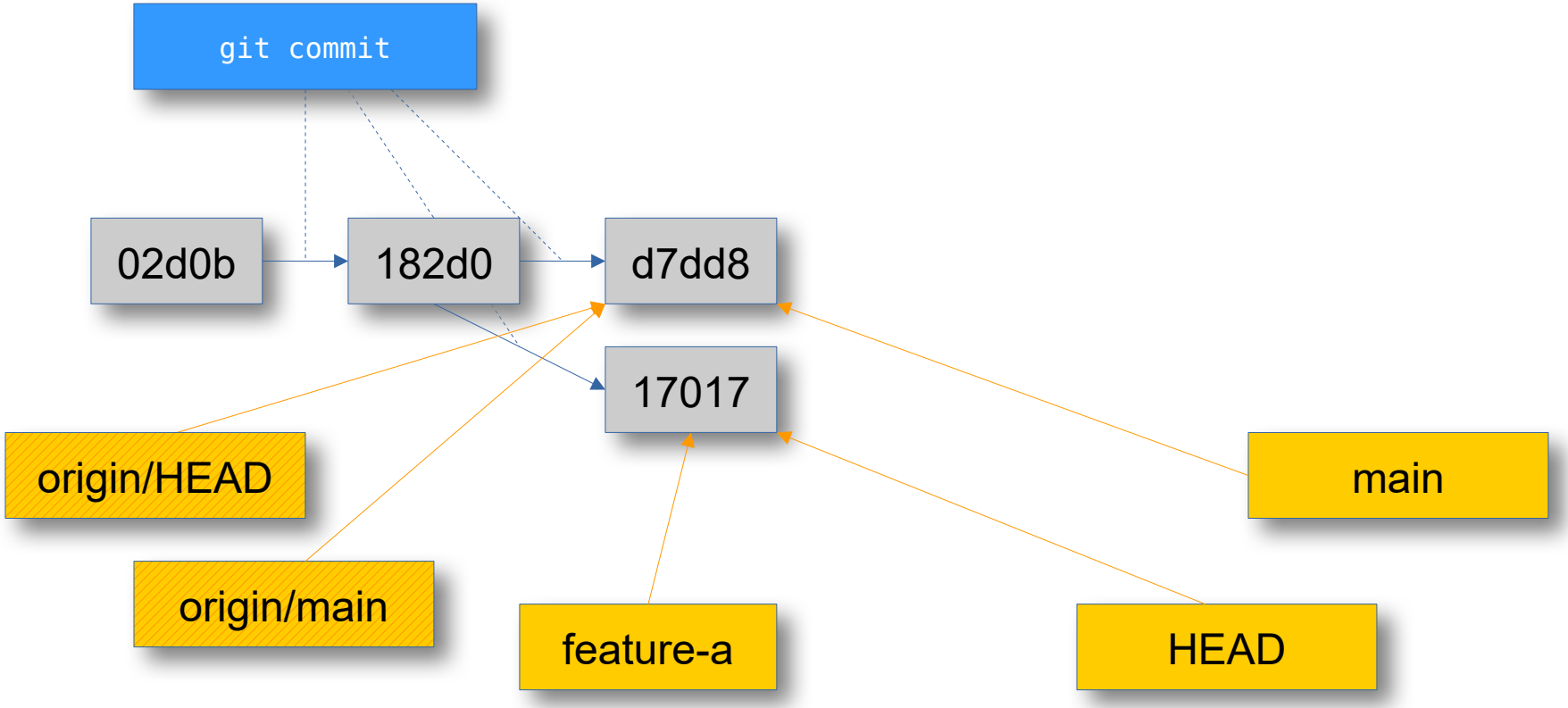

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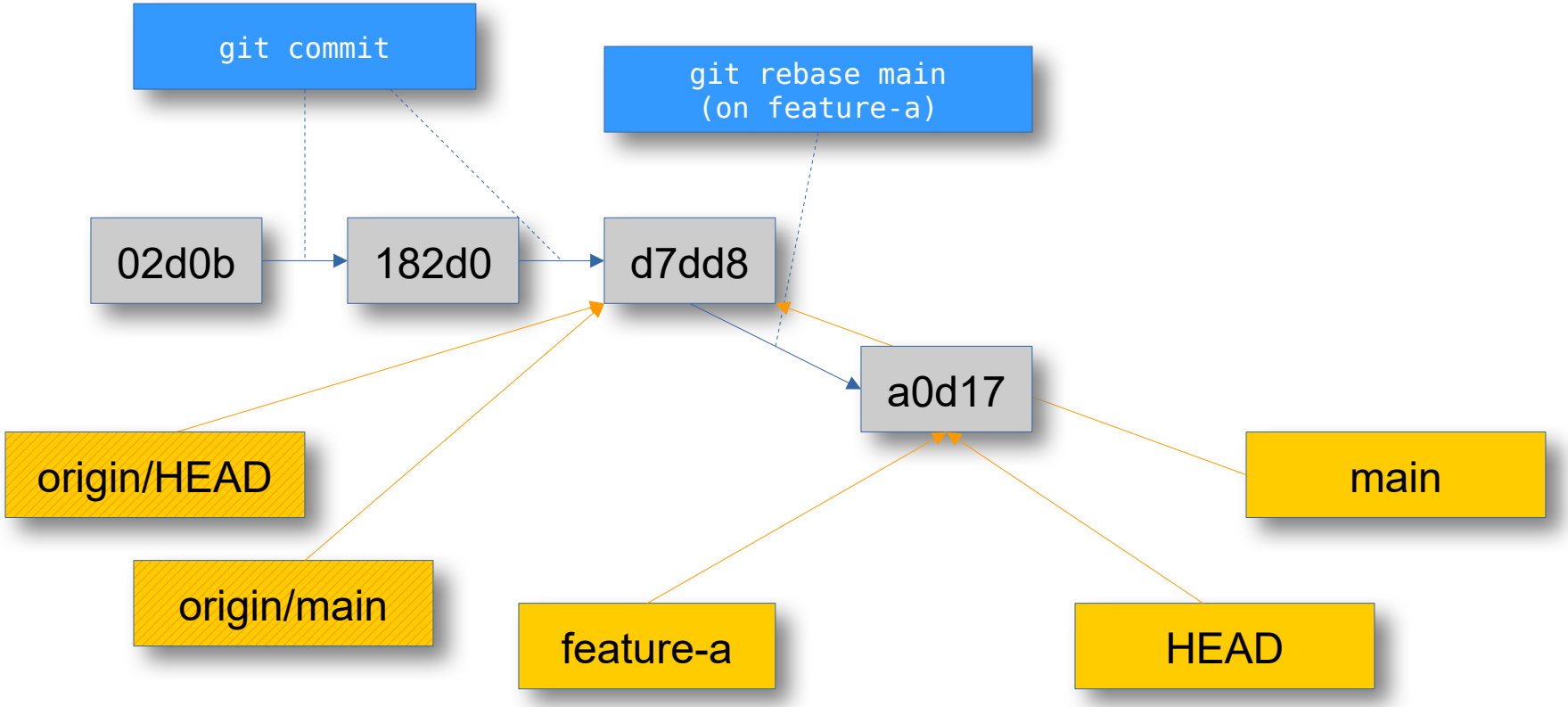

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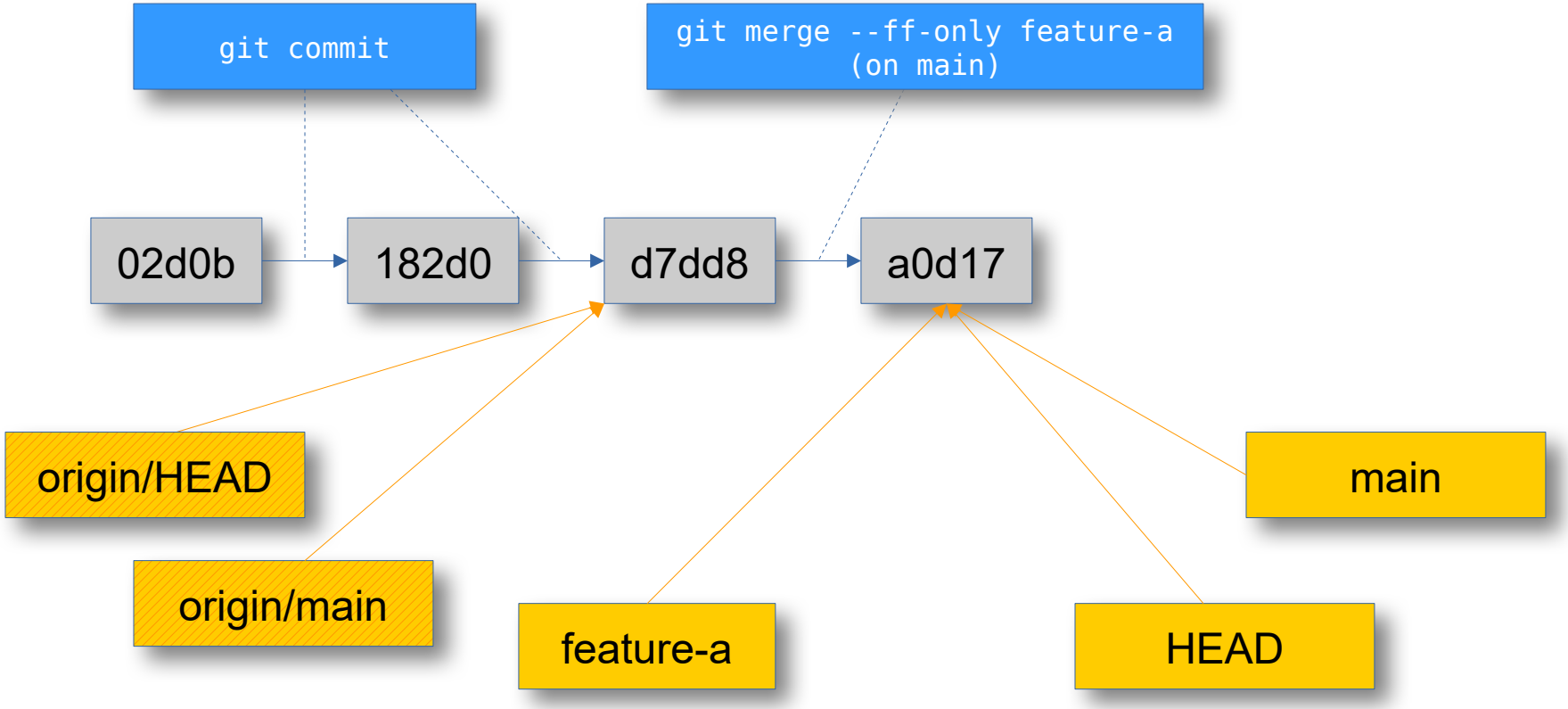
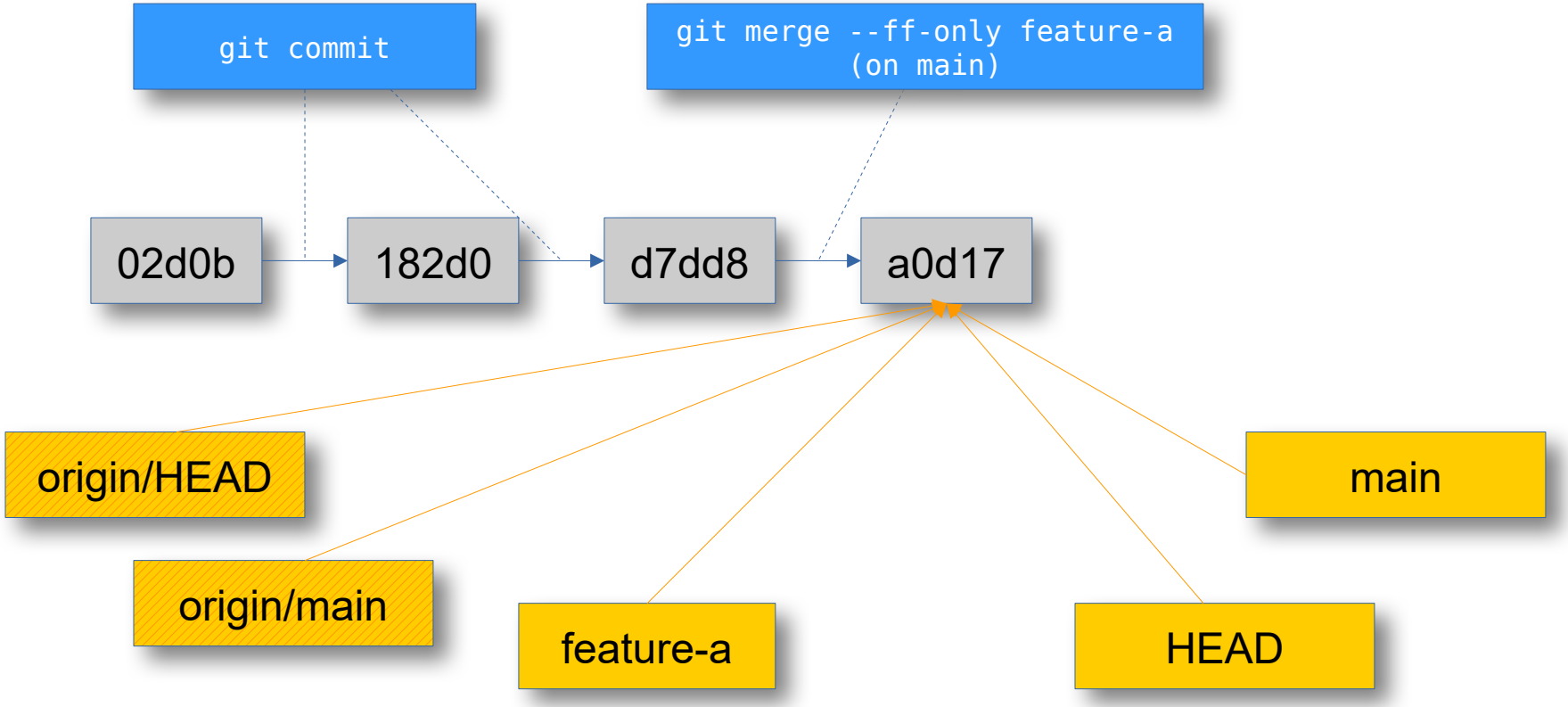


Git history (with rebase)



Git history (with rebase)

Reproduce step 4:

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- `git switch main` # Switch to **main**
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Reproduce step 6:

- same as "merge" example

Git history (merge vs. rebase)

Why rebase (at all)?

- Project maintainers may ask you to do so

Git history (merge vs. rebase)

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- Avoids future merge conflicts. Immediate resolution is required on rebase.

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- One conflict may have to be resolved more than once (→ more work).

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- → clean and linear “easy to read” history

Why not rebase?

- One conflict may have to be resolved more than once (→ more work).
- Other people are working on your branch (→ do not delete someone’s base commit).

Git history (merge vs. rebase)

*Example: history comparison **cc-backend** and **likwid***

Git history (pull)

So what does `git pull` actually do?

Git history (pull)

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- `git fetch`
- `git merge` **`origin/mybranch`** (remote and branch determined via “tracking”)

Git history (pull)

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It can also rebase (with `git config --global pull.rebase true`):

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It can also rebase (with `git config --global pull.rebase true`):

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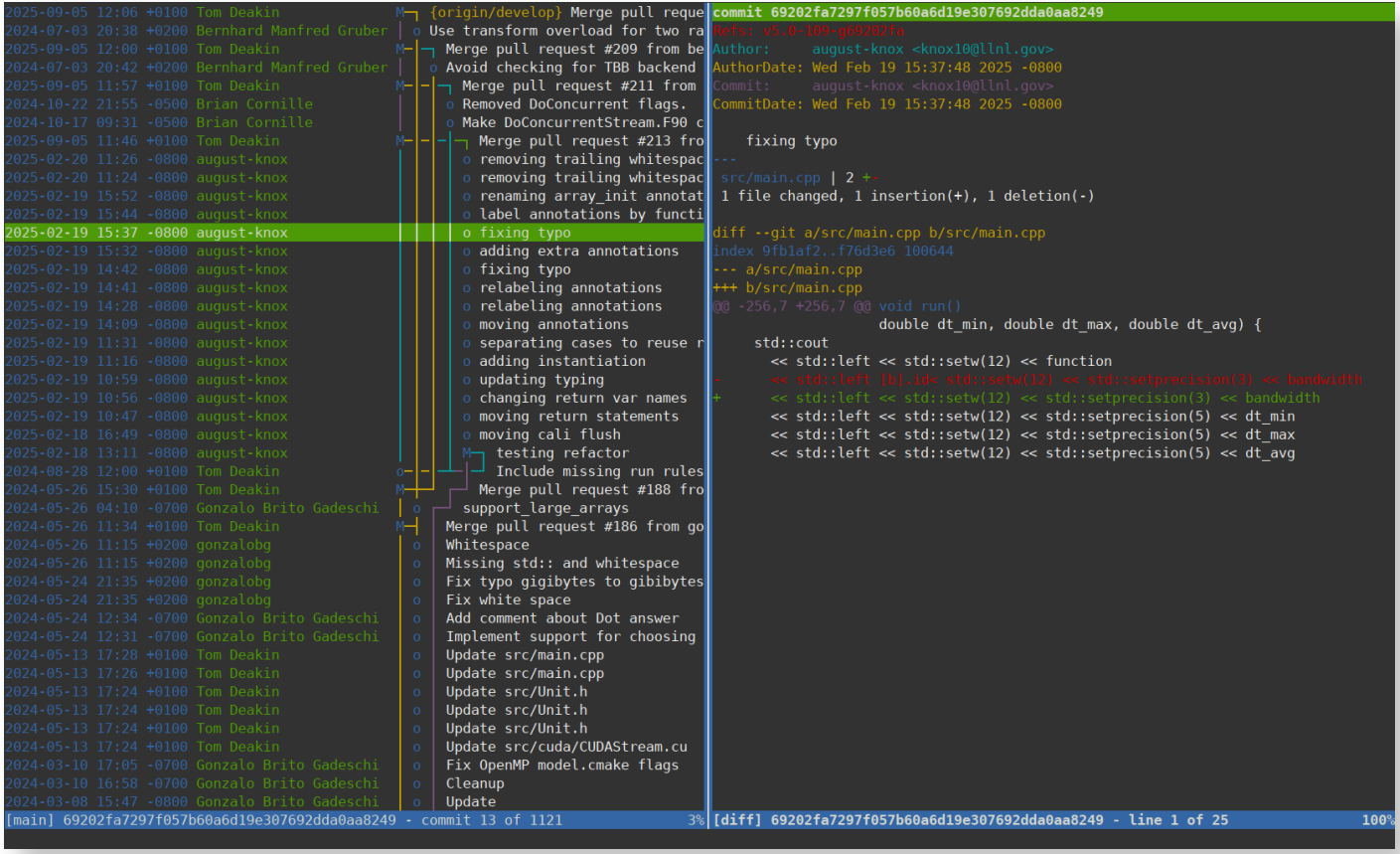
I highly suggest to use git pull with rebase enabled

Useful commands - tig

Interactively browse history

Use --all to see all branches



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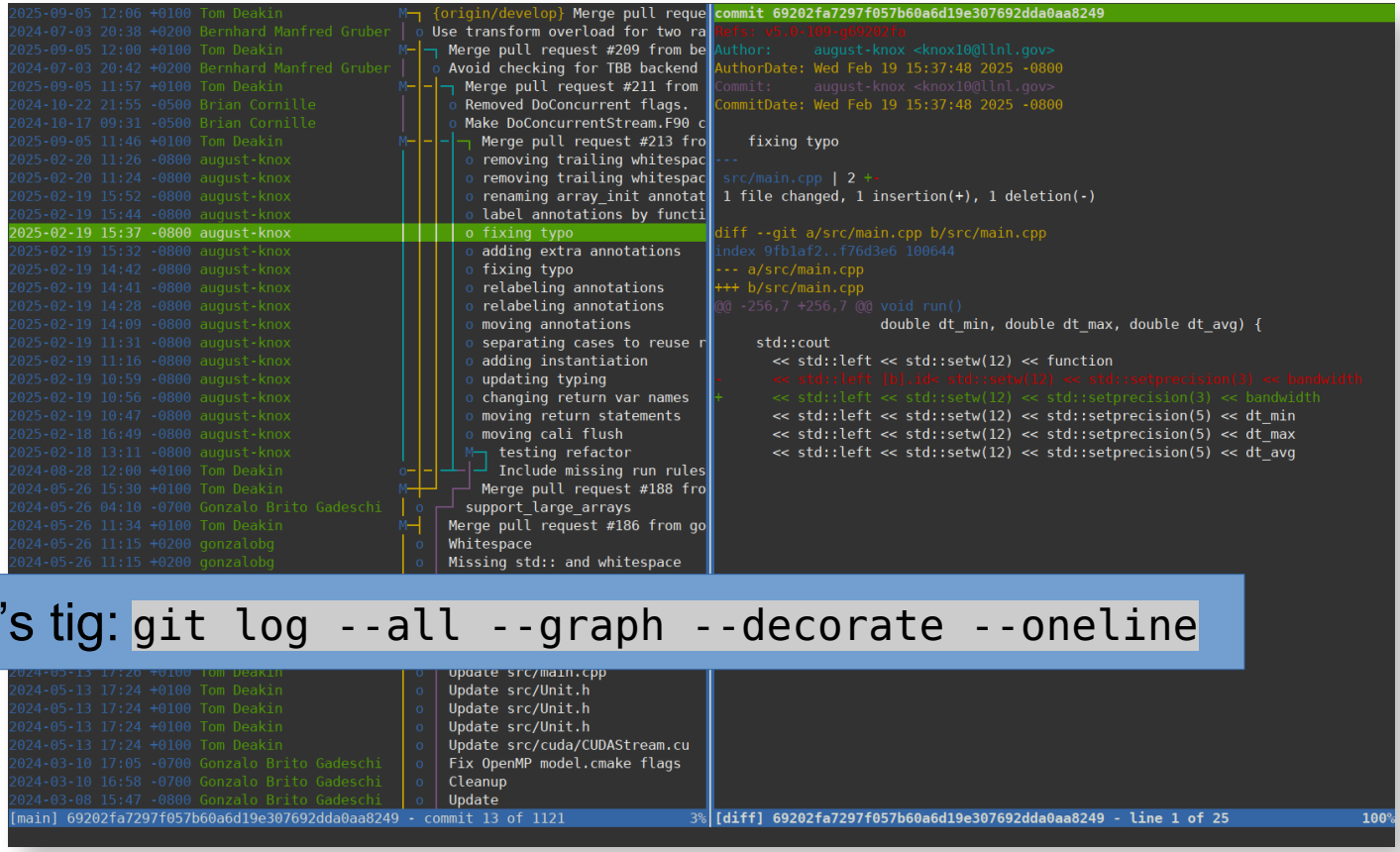

Poor man's tig: `git log --all --graph --decorate --oneline`

Git history (interactive rebase)

Rebase can do much more than reordering commits:

- Edit/fix commits
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- Insert new commits
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→ `git rebase -i 0d8fdf1`: Edit history down to (excluding) commit **0d7fdf1**

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- Merge/split commits

→ `git rebase -i 0d8fdf1`: Edit history down to (excluding) commit **0d7fdf1**

→ `git rebase -i HEAD~8`: Edit history of previous 8 commits

Git history (interactive rebase)

Rebase can do much more than reordering commits:

- Edit/fix commits
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- Insert new com
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→ `git rebase -i`

→ `git rebase -i`

```
1 pick c07e433b # rocmon: Remove obsolete destroyMarkerFileRocm
2 pick f7fa60ab # rocmon: Remove debug printf
3 edit 82fa47ce # rocmon: Fix memory leak in Lua API
4 pick b1a81528 # rocmon: Fix error handling for memory allocation
5 pick 37d6f907 # rocmon: Do not fail if metric cannot be calculated
6 pick 5f8bbcd8 # rocmon: Fix new counter last/full counting
7 pick 2e196ee2 # rocmon: Fix agent selection
8 pick fbf01bb3 # rocmon: Print more detailed device info
9
10 # Rebase fce4598b..fbf01bb3 onto fce4598b (8 commands)
11 #
12 # Commands:
13 # p, pick <commit> = use commit
14 # r, reword <commit> = use commit, but edit the commit message
15 # e, edit <commit> = use commit, but stop for amending
16 # s, squash <commit> = use commit, but meld into previous commit
17 # f, fixup [-C | -c] <commit> = like "squash" but keep only the previ
```

Git history (interactive rebase)

“I messed something up during my rebase. What do I do?”

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- Reflogs contain previous commits (even “deleted” commits).

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- `git reset --hard 84d72f1`

Git history (interactive rebase)

“I messed something up during my rebase. What do I do?”

- You can always abort a rebase with `git rebase --abort`
- This also works for merging, e.g. during a conflict, via `git merge --abort`

If you have already completed the rebase, use the reflogs for recovery.

- Reflogs contain previous commits (even “deleted” commits).
- `git reflog`
- `git reset --hard 84d72f1`
- Caution: “deleted” commits expire eventually

Git history (“clean” commits)

Tips:

- “I forgot something”: You can update (without creating a new one) the last commit via: `git commit --amend`.

Git history (“clean” commits)

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- Use verbose `git commit`. Either via -v or `git config --global commit.verbose true`.

Git history (“clean” commits)

Tips:

- “I forgot something”: You can update (without creating a new one) the last commit via: `git commit --amend`.
- Abort committing by leaving the commit message blank or clearing it.
- Use verbose `git commit`. Either via -v or `git config --global commit.verbose true`.
- My opinion: Avoid git commit -m “…”. Review your commits via verbose commit.

Git history (“clean” commits)

Tips:

- “I forgot somethi
  last commit via: `g`
- Abort committing
- Use verbose `git`
  `commit.verbose t`
- My opinion: Avoi
  commit.

```
1  Added more text.
2
3  The paragraph after the first line gives you opportunity to explain your
4  commit in more detail. Why did you change things?
5
6  # Please enter the commit message for your changes. Lines starting
7  # with '#' will be ignored, and an empty message aborts the commit.
8  #
9  # Date:      Mon Feb 2 16:51:53 2026 +0100
10 #
11 # On branch master
12 # Changes to be committed:
13 #       modified:   myfile
14 #
15 # ------------------------ >8 ------------------------
16 # Do not modify or remove the line above.
17 # Everything below it will be ignored.
18 diff --git a/myfile b/myfile
19 index 1756cf9..5427306 100644
20 --- a/myfile
21 +++ b/myfile
22 @@ -1 +1,3 @@
23  Hello people.
24 +
25 +Nobody there.
```

Git history (conclusion)

Don’t be afraid of rewriting/rebasing history!

Git history (conclusion)

Don’t be afraid of rewriting/rebasing history!

Unless it is already public!

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Git staging area

Git staging area

“I want to commit. I have to type git add file.txt and git commit”:

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"I want to commit. I have to type git add file.txt and git commit":

- Yes, but why? Not all version control systems have it (e.g. SVN)
- Before we commit we can carefully choose what to commit!

```
michael@michael-HP♯/tmp/mygit3♪ git status
On branch master
Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        modified:   myfile2

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   myfile

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        myfile3
```

Git staging area

"I want to commit. I have to type git add file.txt and git commit":

- Yes, but why? Not all version control systems have it (e.g. SVN)
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        modified:   myfile2

Changes not staged for commit:
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        modified:   myfile2

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        myfile3
```

Git staging area

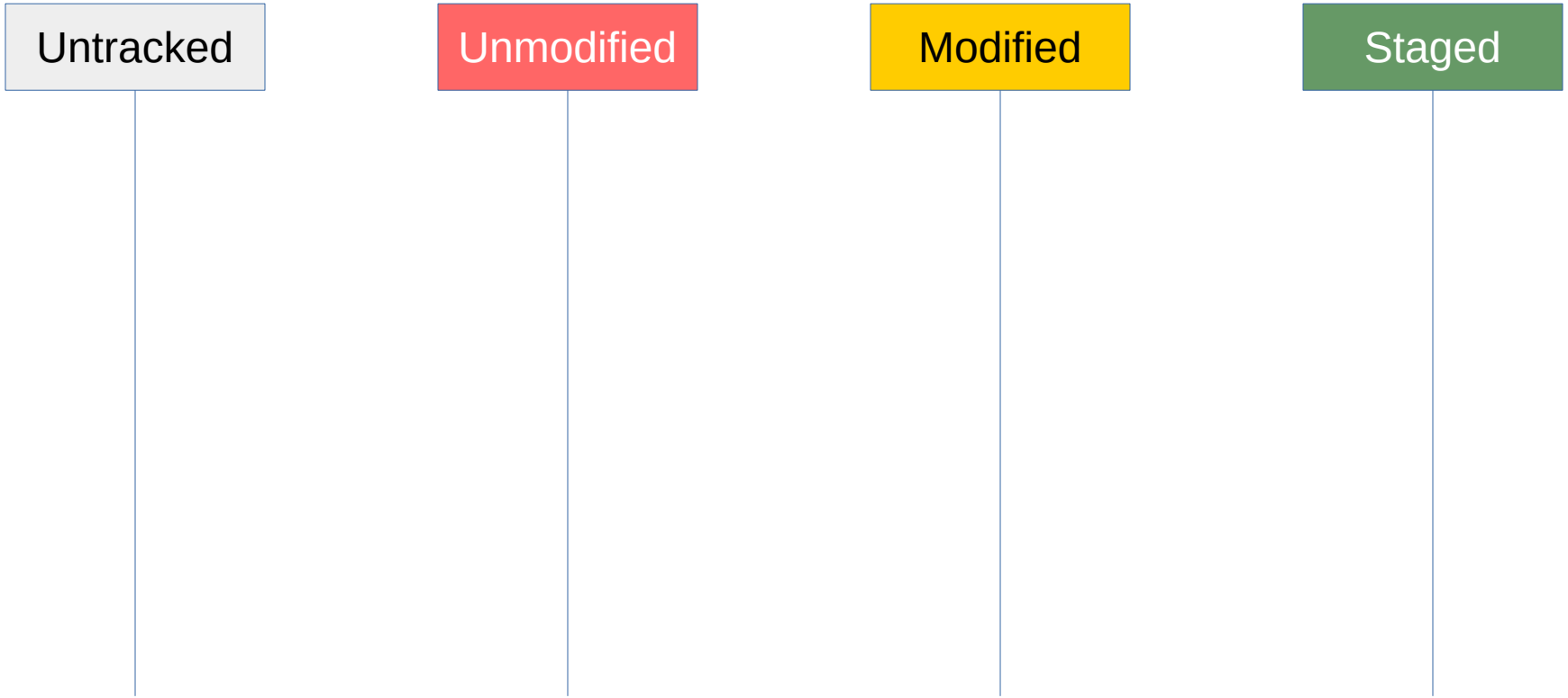
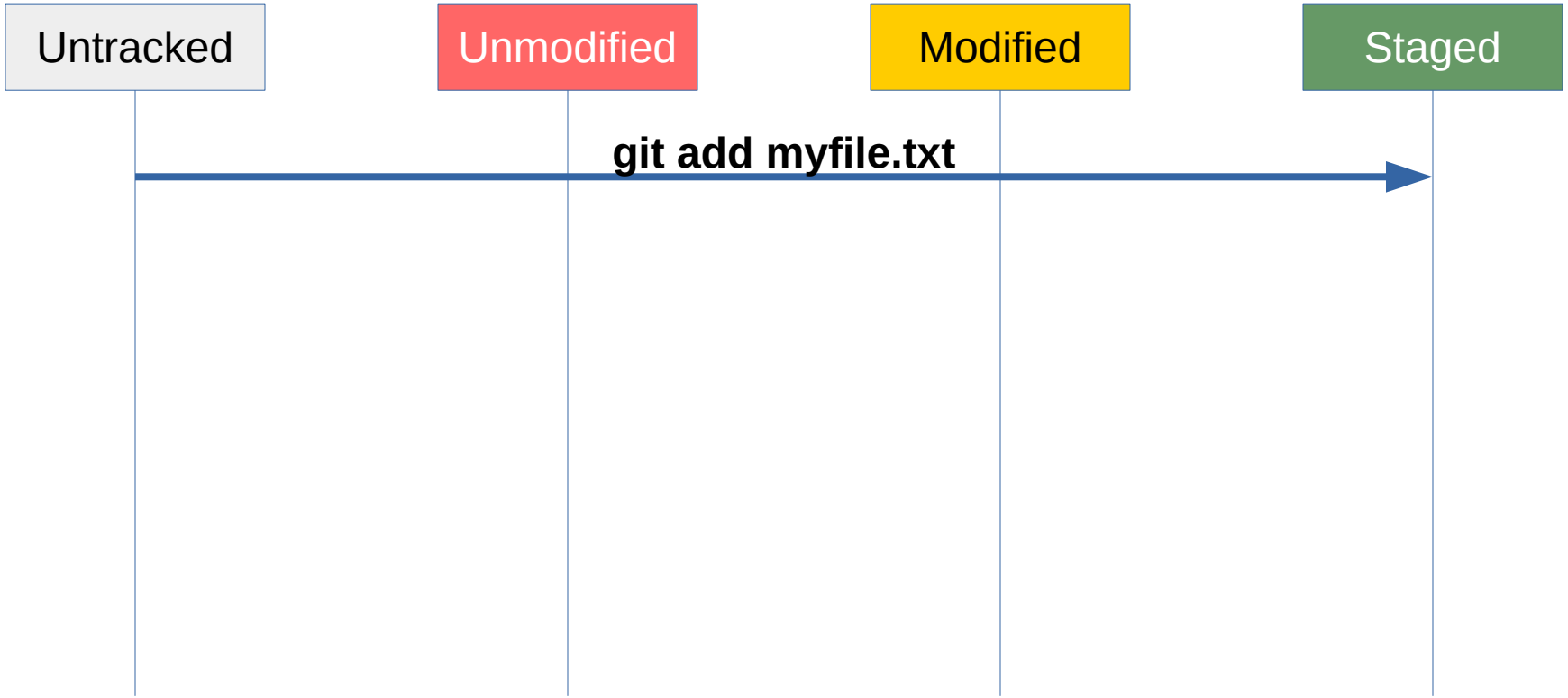


Image inspired by Pro Git chapter 2.2

Git staging area



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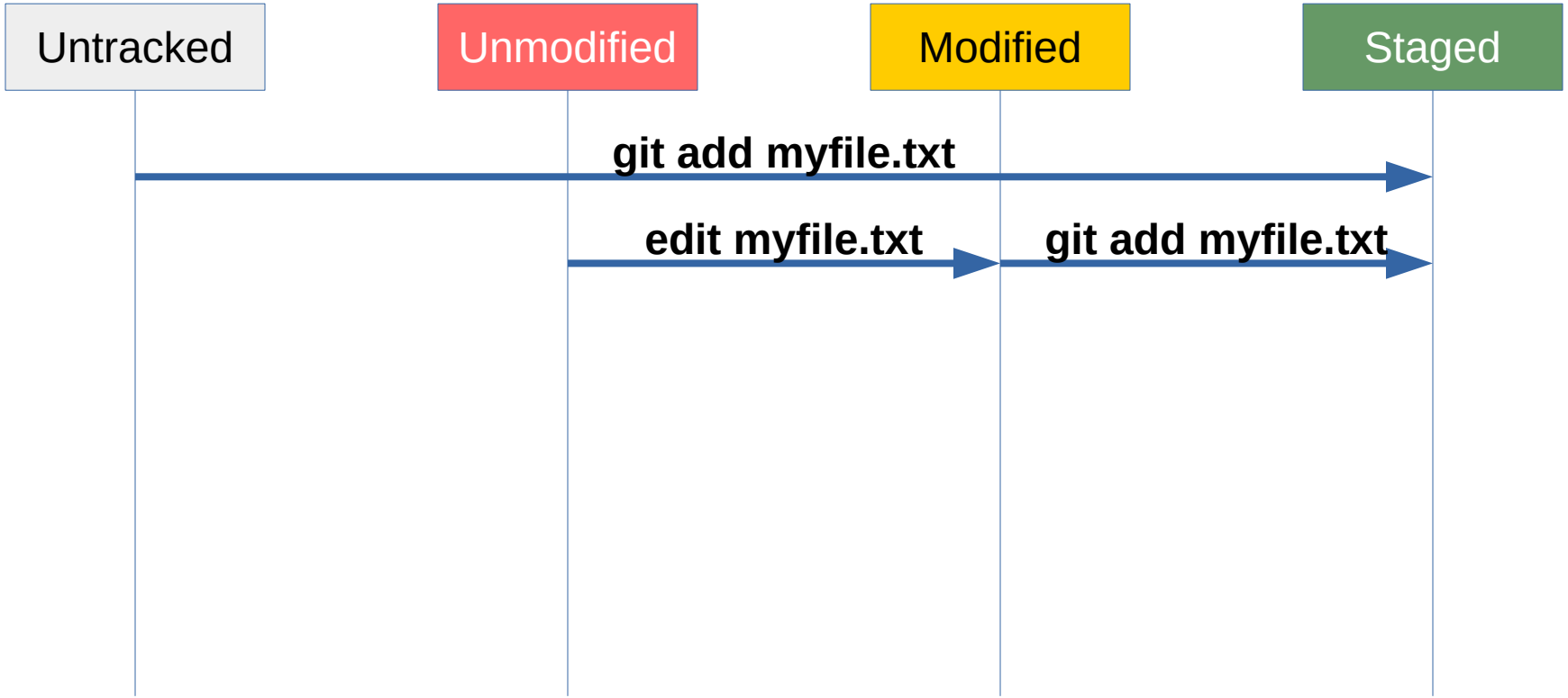

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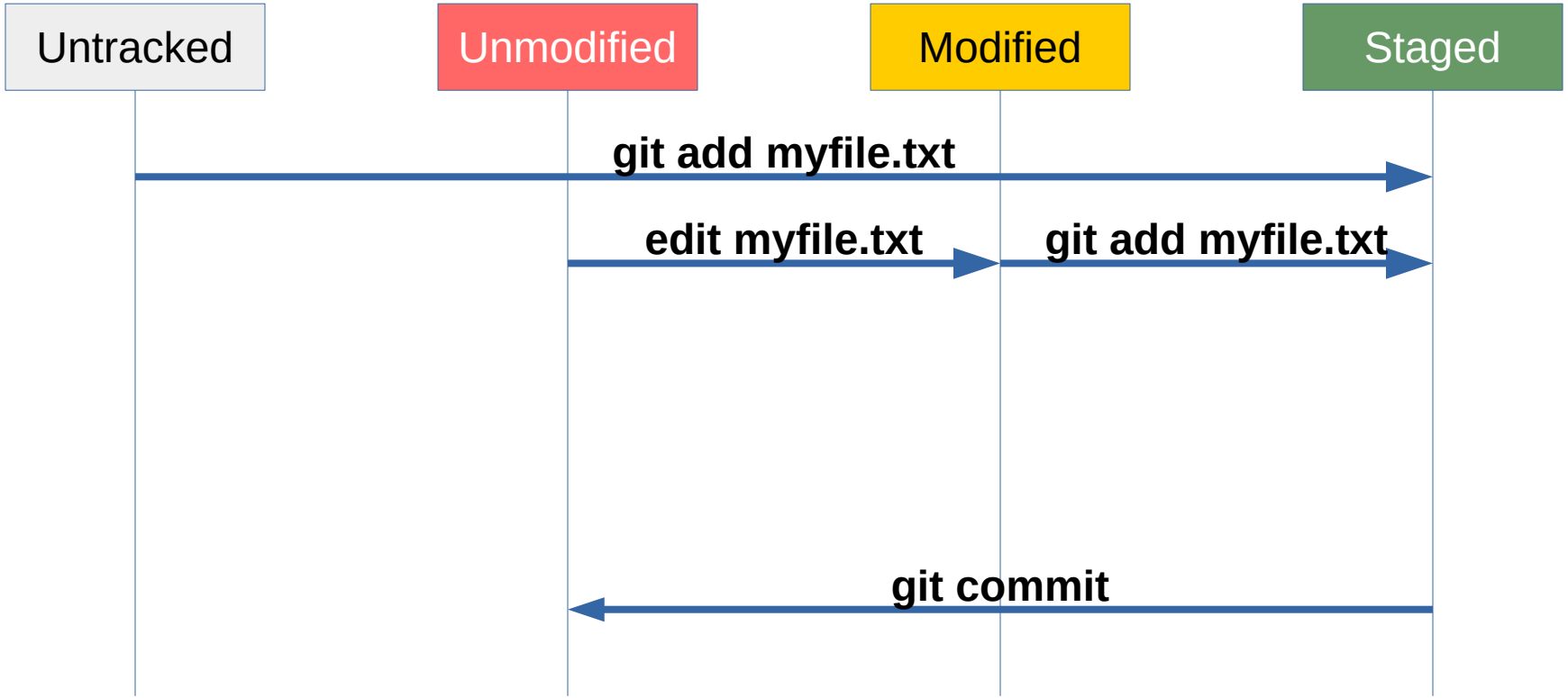

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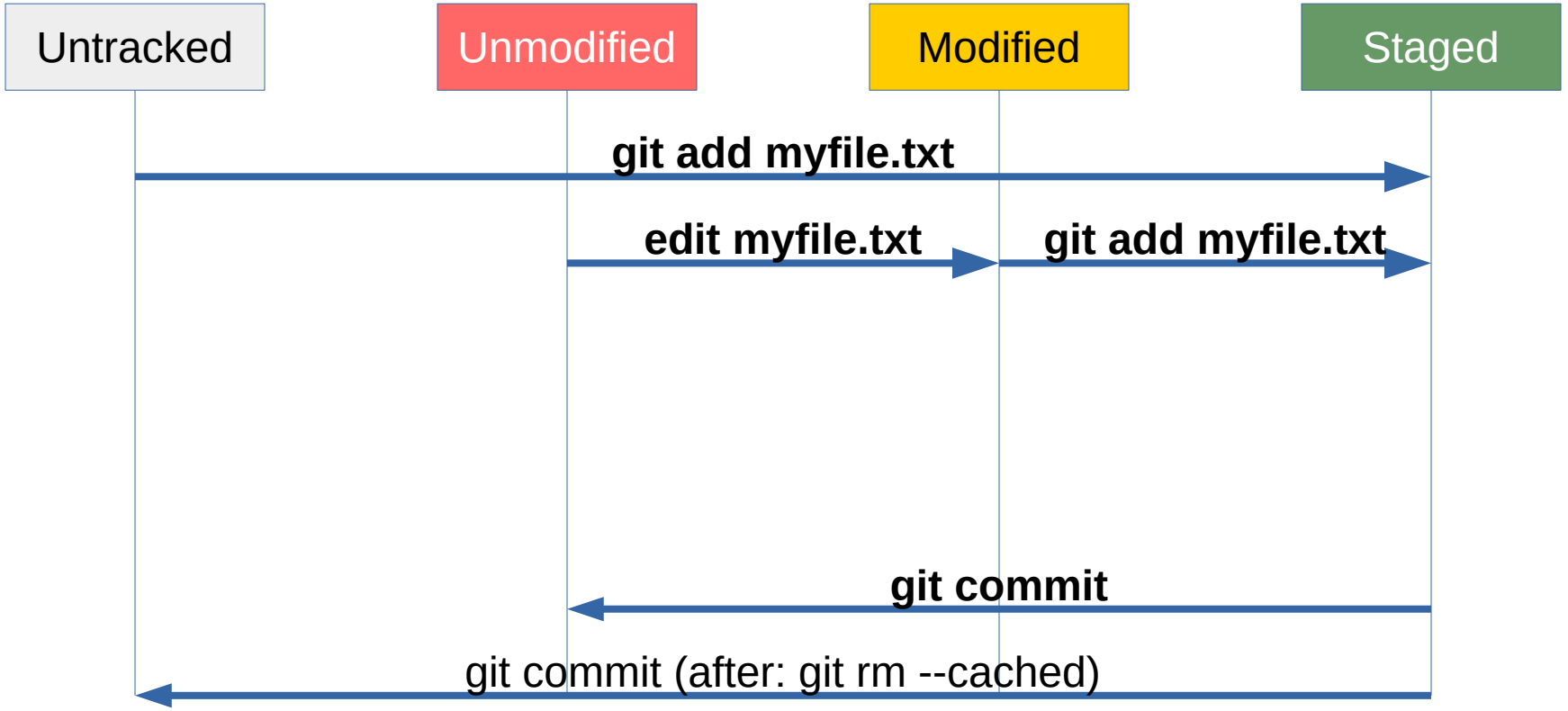

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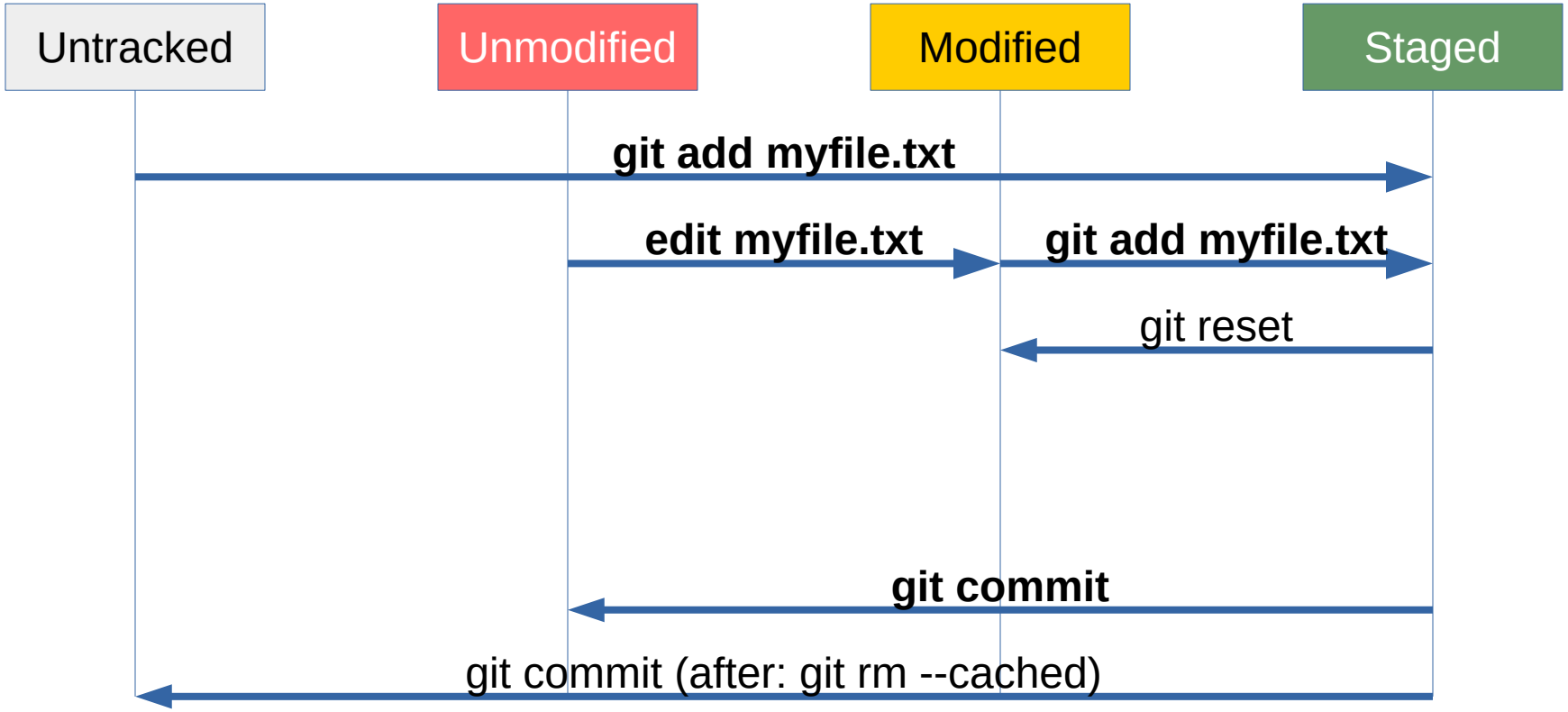

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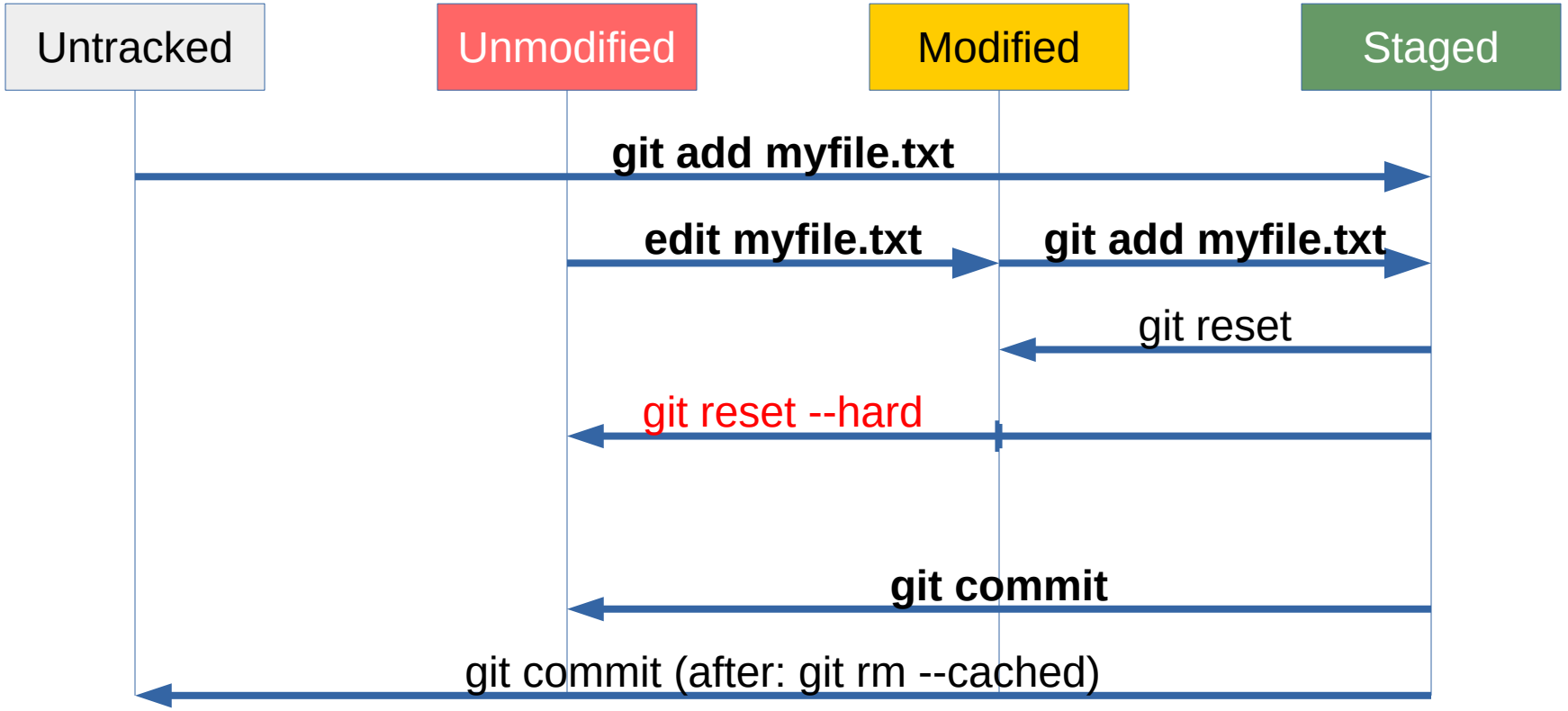

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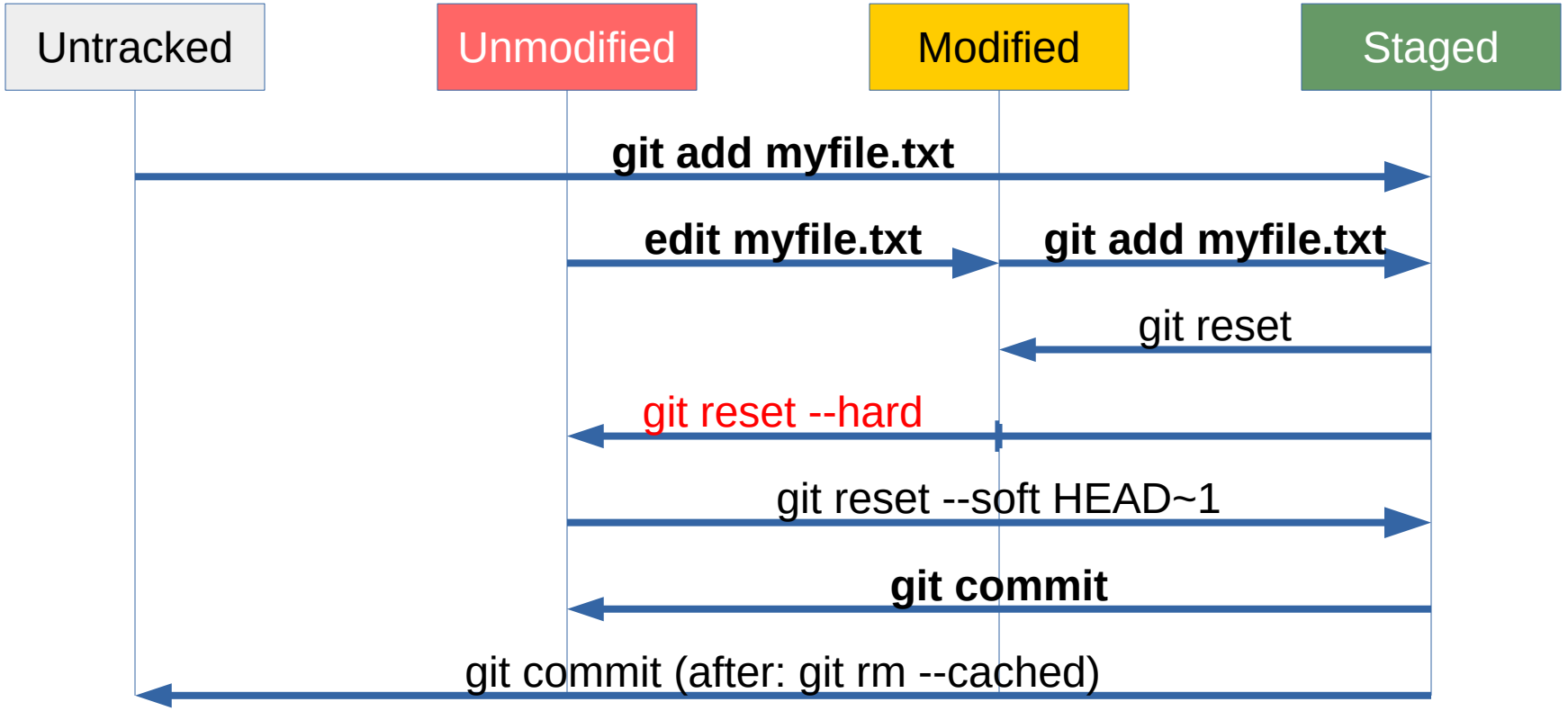

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Git staging area

“But I only want to commit funcA in main.c, not my debug statements”:

Git staging area

“But I only want to commit funcA in main.c, not my debug statements”:

→ `git add -p main.c`

Git staging area

“But I only want to commit funcA”

→ `git add -p main.c`

```
michael@michael-HP♯/tmp/testc♪ git add -p main.c
diff --git a/main.c b/main.c
index cc388fa..c12b2bc 100644
--- a/main.c
+++ b/main.c
@@ -1,11 +1,12 @@
 #include <stdio.h>

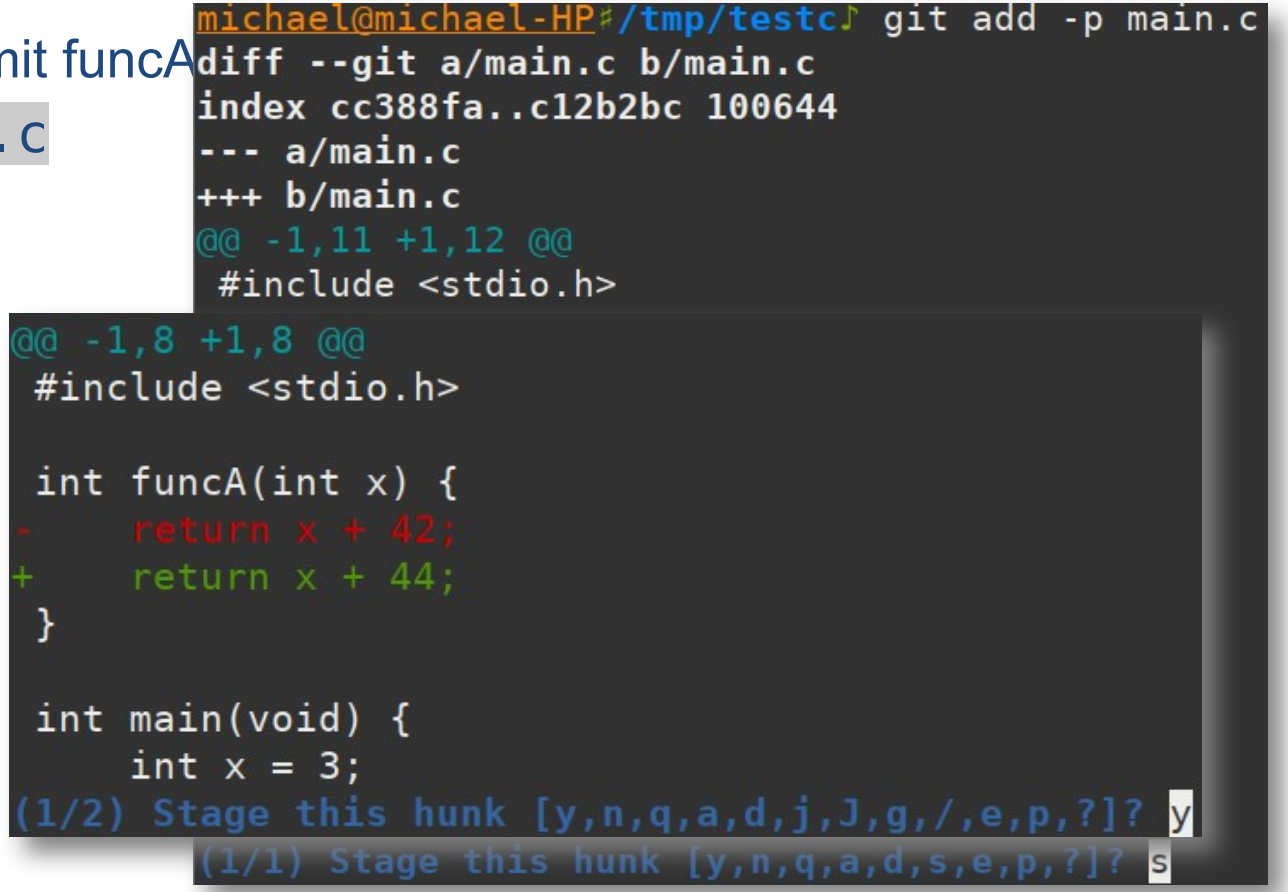
 int funcA(int x) {
-    return x + 42;
+    return x + 44;
 }

 int main(void) {
     int x = 3;
+    printf("debug: \d\n", x);
     x = funcA(x);
     printf("a: \d\n", x);
 }
(1/1) Stage this hunk [y,n,q,a,d,s,e,p,?]? s
```

Git staging area

“But I only want to commit funcA”

→ `git add -p main.c`



Git staging area

“But I only want to commit funcA

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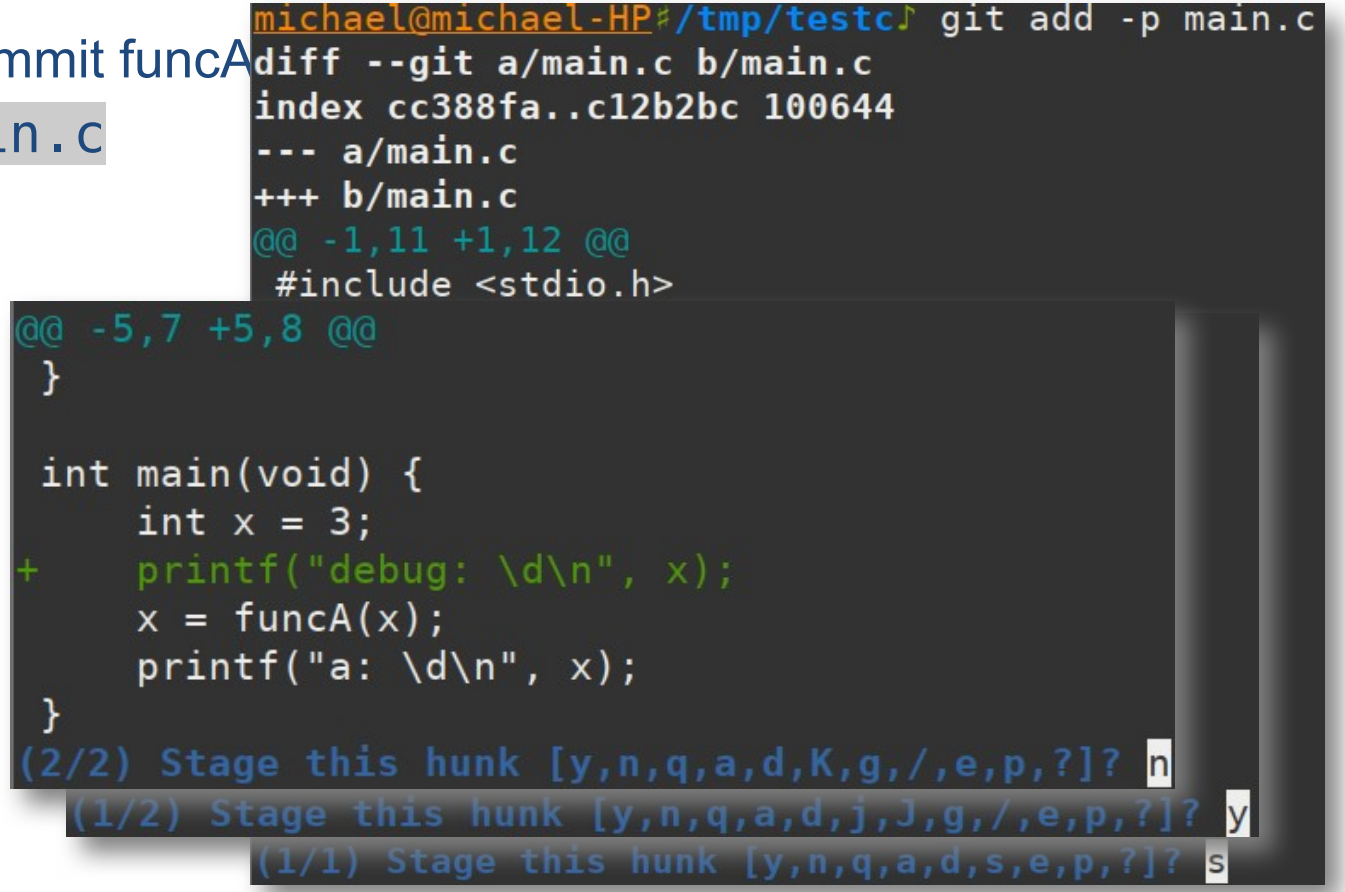

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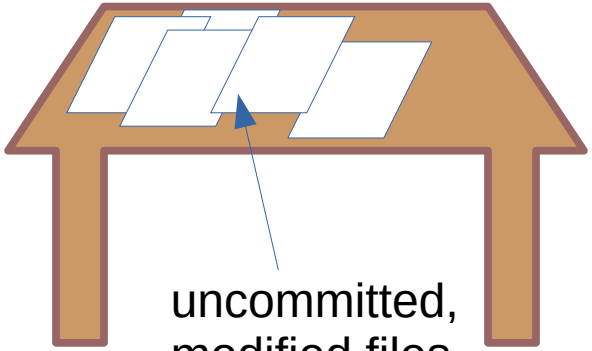
Git stash

git stash

```
unrz104h@testfront1♯~/Projects/rocm-systems♪ git pull
Updating e45c56c0f8..66ee941fea
error: Your local changes to the following files would be overwritten by merge:
        README.md
Please commit your changes or stash them before you merge.
Aborting
```

Current branch: **main**



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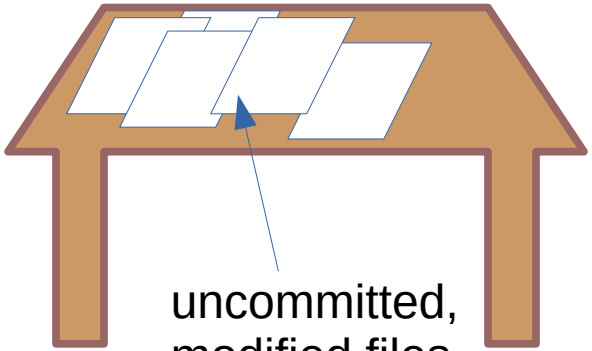

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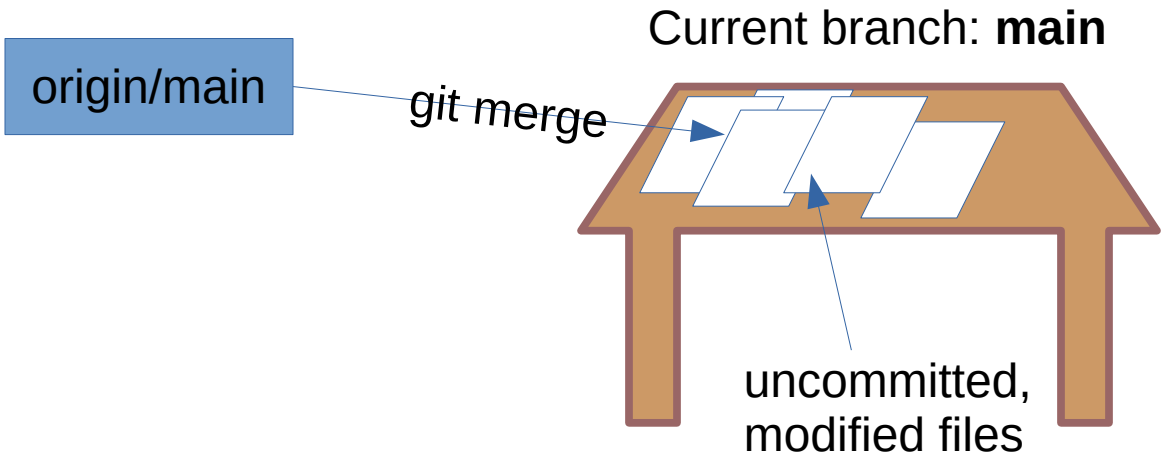

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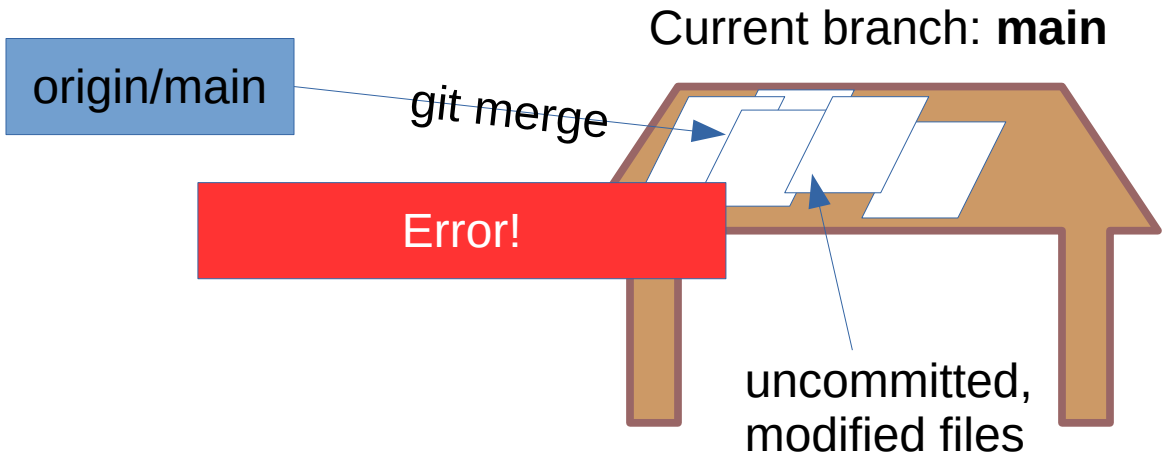

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origin/main

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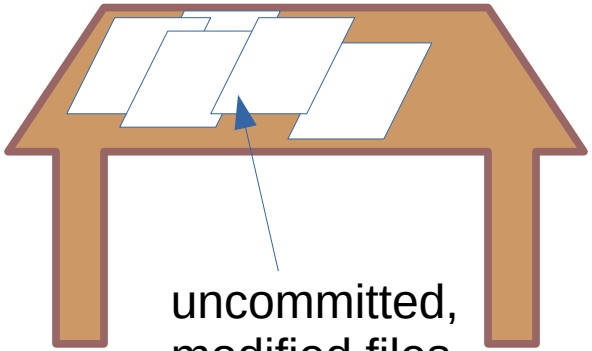

uncommitted,
modified files

git stash

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Solution!

origin/main

Current branch: **main**

stash@{0}

...

git stash

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Solution!

origin/main

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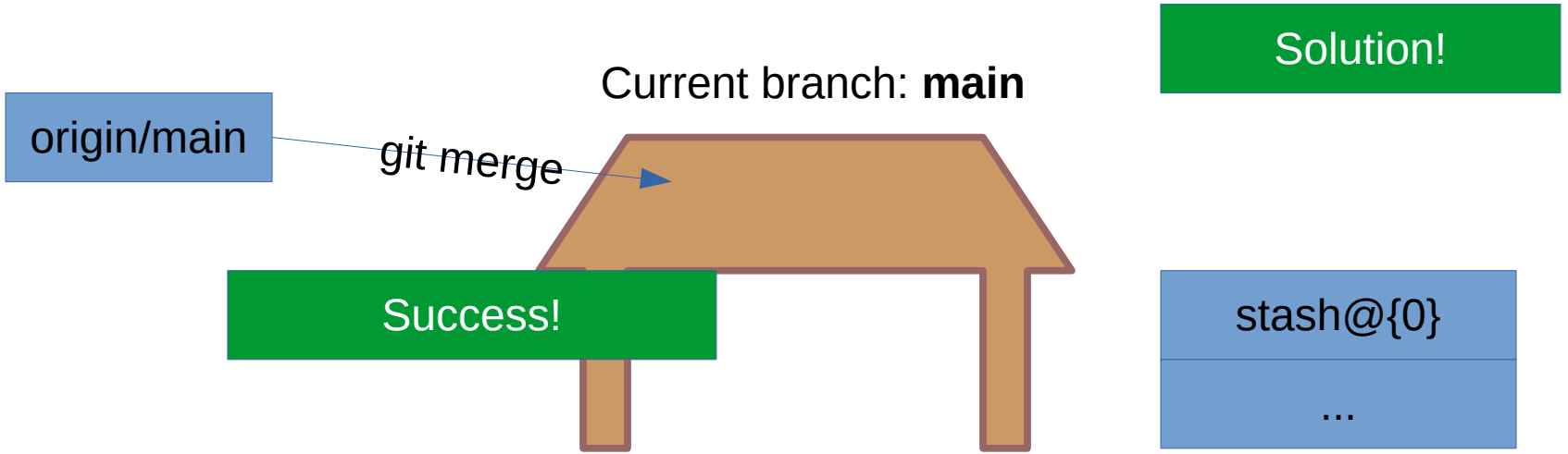

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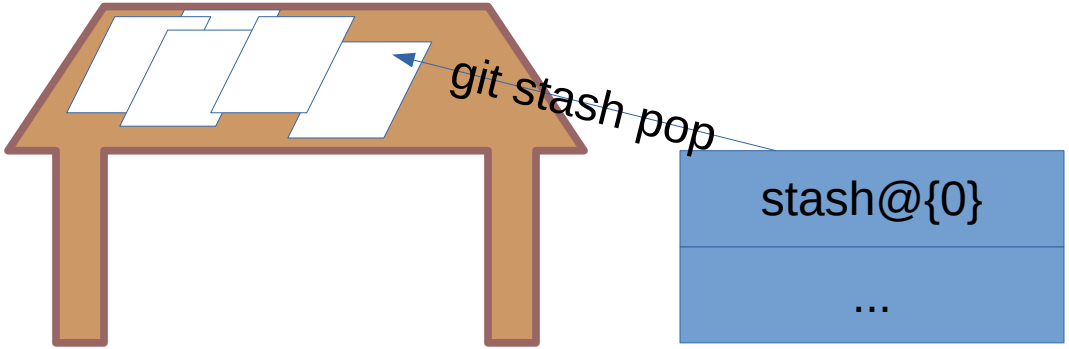

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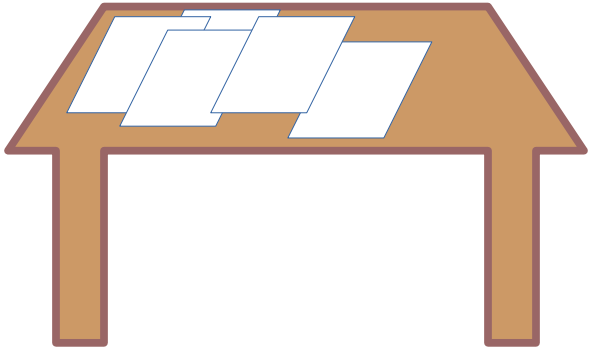

Solution!

...

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Git remotes

Git remotes

“I want to push to my GitHub/GitLab. This is what **origin** is, right?”:

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Git remotes

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Git remotes

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Git remotes

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- `mkdir likwid && cd likwid`
- `git init`
- `git remote add origin ‘https://github.com/RRZE-HPC/likwid’`
- `git switch --track origin/master`

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→ **origin** is Git’s default name for a remote

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→ **origin** is Git’s default name for a remote

→ **master** is the default branch of LIKWID

Git remotes

Interact with repositories outside yours:

- Way of interacting with GitHub / GitLab

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Git remotes

Interact with repositories outside yours:

- Way of interacting with GitHub / GitLab
- “Fancy platforms” are not mandatory. Remote can also be:
  - A folder on a machine reachable via standard SSH
  - A different folder on your local machine
- You can have as many remotes as you like (e.g. mirrors, backups, etc.)

Git remotes

Example: Copy **main** branch from Github repository to GitLab:

- `git clone ‘git@github.com:myuser/myproject.git’`

Git remotes

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Git remotes

Example: Copy **main** branch from Github repository to GitLab:

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Git remotes

Example: Copy **main** branch from Github repository to GitLab:

- `git clone ‘git@github.com:myuser/myproject.git’`
- `cd myproject`
- `git remote add gitlab ‘git@gitlab.com:myuser/myproject.git’`
- `git push gitlab main`

Git remotes

“Why do I sometimes need to specify the remote and sometimes not?”:

Git remotes

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- Branch “tracking” assigns a local branch to a remote

Git remotes

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- `git clone` automatically tracks the remote’s default branch (**origin/HEAD**)

  E.g. **main** automatically tracks **origin/main**

Git remotes

“Why do I sometimes need to specify the remote and sometimes not?”:

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  E.g. **main** automatically tracks **origin/main**
- You can change it any time: `git branch -u neworigin`

Git remotes

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Git remotes

“Why do I sometimes need to specify the remote and sometimes not?”:

- Branch “tracking” assigns a local branch to a remote
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  E.g. **main** automatically tracks **origin/main**
- You can change it any time: `git branch -u neworigin`
- When it doesn’t exist yet on remote: `git push -u neworigin`
- Afterwards you can push/pull “normally”

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Git summary

Summary

Useful commands to remember:

- `git status` → Know what's going on
- `git log -p <filename>` → Show history of a file
- `git log -S <searchterm>` → Search for diff affecting a term
- `git log -G <searchterm>` → Search for diff containing a term
- `git blame <filename>` → Show file with history annotation
- `git reflog` → Show all commits (including "lost" commits)
- `git gc` → Cleanup unreferenced commits (reflog recovery impossible!)
- `git rebase <branch>` → Reapply commits onto *branch*
- `git rebase -i <commit>` → Interactively edit commits up to *commit*
- `git cherry-pick <commit>` → Reapply *commit* to current branch

Summary

Useful commands to remember:

- `git add -p <filename>` → Perform `git add` on parts of *filename*
- `git commit -v` → See what you commit
- `git stash` → Move unstaged changes to “stash” and reset files
- `git stash pop` → Restore all previous unstaged changes
- `git reset <filename>` → Unstage all changes of *filename*
- `git reset --hard` → Discard all uncommited changes
- `git reset --hard <commit>` → Make current branch point to *commit*. Discards all commits that are not part of new branch history!
- `git reset <commit>` → Show changes of commit
- `git bisect start <badcommit> <goodcommit>` → Find a regression between two commits

Summary

Other useful resources:

- Manpages are really good!
- `man gitrevisions` → Explanations how version strings look like
- Pro Git book