Gitting Further

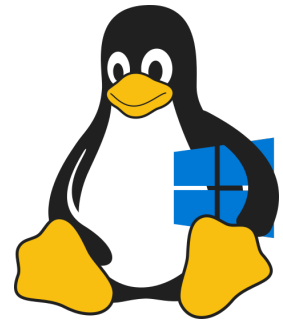
More complex operations with Git

K. Müller[1] J. Verzijden[2]

[1]MasterCLASS
E.T.S.V. Scintilla

[2]Scintilla Operator Team
E.T.S.V. Scintilla

October 14, 2025



About us

Kasper Müller
kasperm@scintilla.utwente.nl

Johan Verzijden
johanv@scintilla.utwente.nl

Contents

Contents

SSH Keys

Why SSH Keys?

SSH Keys

Why SSH Keys?

- Git uses HTTP Basic Auth by default

SSH Keys

Why SSH Keys?

- Git uses HTTP Basic Auth by default
  - Has become cumbersome/impossible with 2FA

SSH Keys

Why SSH Keys?

- Git uses HTTP Basic Auth by default
  - Has become cumbersome/impossible with 2FA
- Git can also connect over SSH

SSH Keys

Why SSH Keys?

- Git uses HTTP Basic Auth by default
  - Has become cumbersome/impossible with 2FA
- Git can also connect over SSH
  - With username/password (still cumbersome)
  - With SSH keys (easy once configured)

SSH Keys - Generate a keypair and upload

- `$ ssh-keygen -t ed25519`
- Specify the location and name, e.g. `/home/user/.ssh/utwente_id_ed25519`
- Set a passphrase and confirm (remember it!)
- Upload your key to
  - Gitlab
  - Github

SSH Keys - Configuration

- Configure SSH
  - Open `~/.ssh/config` and add the following:

```
Host gitlab.utwente.nl
  PreferredAuthentications publickey
  IdentityFile ~/.ssh/utwente_id_ed25519
```

- Verify that it works

  `$ ssh -T git@gitlab.utwente.nl`
- Configure Git

  `$ git remote origin set-url git@gitlab.utwente.nl:<s-number>/<your-project>.git`

GPG Keys - Overview

What are GPG Keys?

[1] Pretty Good Privacy
[2] GNU Privacy Guard

GPG Keys - Overview

What are GPG Keys?

- PGP[1]/GPG[2]
- Used for cryptographic encryption and signing of data
- In this case: signing of commits
- Proves that the Git identity belongs to you

[1] Pretty Good Privacy
[2] GNU Privacy Guard

GPG Keys - Overview

What are GPG Keys?

- PGP[1]/GPG[2]
- Used for cryptographic encryption and signing of data
- In this case: signing of commits
- Proves that the Git identity belongs to you

How to set one up?

[1] Pretty Good Privacy
[2] GNU Privacy Guard

GPG Keys - Overview

What are GPG Keys?

- PGP[1]/GPG[2]
- Used for cryptographic encryption and signing of data
- In this case: signing of commits
- Proves that the Git identity belongs to you

How to set one up?

1. Installation
2. Generate a keypair
3. Upload your public key
4. Configure Git

---

[1] Pretty Good Privacy
[2] GNU Privacy Guard

GPG Keys - Installation

- Run `gpg --version` to see if installed
- Not installed? See https://gnupg.org/download/#binary
- Our advice:
  - Windows
    - Install Gpg4win
  - Linux
    - You already have it (-:
    - Install the RPM package or AppImage
  - MacOS
    - Install Mac GPG from gpgtools

GPG Keys - Generate a keypair

Run `gpg --full-generate-key`. Some remarks:

GPG Keys - Generate a keypair

Run `gpg --full-generate-key`. Some remarks:

- The default key type and size are good
- Set an expiry date
  - In one year is a good default
- Set a name and an email address
  - Useful if same as your Git identity
- Set a passphrase **and store it!**
  - Prevents others from using the key
  - **Keep the passphrase strong and secure!**

GPG Keys - Upload your public key

1. Export your **public key**: `gpg --armor --export <keyid>`
   - `<keyid>` is from the output of `gpg -K --keyid-format=long`: `sec rsa3072/<keyid> 2024-06-01 [SC] ...`
2. Copy everything including `BEGIN PGP PUBLIC KEY BLOCK` and `END PGP PUBLIC KEY BLOCK`
3. Add it to your account on Github/Gitlab. See the manual for
   - Github
   - Gitlab

GPG Keys - Configure Git

1. Tell Git to always sign your commits:
   `git config [--global] commit.gpgsign true`
2. Tell Git which GPG key to use for signing:
   `git config [--global] user.signingkey <keyid>`
   - `<keyid>` is from the output of `gpg -K --keyid-format=long`:
     `sec   rsa3072/<keyid> 2024-06-01 [SC] ...`

Aliases

- Shortcuts for existing commands (aliases)
  - `git gr` instead of `git log --oneline --graph`
  - `git sw other-branch` instead of `git switch other-branch`
  - `git ust` instead of `git stash pop`
- Completely custom commands
  - Get `git ignore <file>` with `git config --global alias.ignore '! echo $1 >> .gitignore; tail .gitignore; :`

Handling multiple identities

- You probably have multiple identities
  - Personal work
  - University projects
  - Study association
  - etc.

[3] Source: https://www.micah.soy/posts/setting-up-git-identities/

Handling multiple identities

- You probably have multiple identities
  - Personal work
  - University projects
  - Study association
  - etc.
- Managing these is difficult
  - You forget to change it
  - There is no easy way to change it

[3] Source: https://www.micah.soy/posts/setting-up-git-identities/

Handling multiple identities

- You probably have multiple identities
  - Personal work
  - University projects
  - Study association
  - etc.
- Managing these is difficult
  - You forget to change it
  - There is no easy way to change it
- Solution: combine custom configuration and aliases![3]

[3] Source: https://www.micah.soy/posts/setting-up-git-identities/

Handling multiple identities

1. Create the alias `git identity <id>`

```
git config alias.identity '!
git config user.name "$(git config user.$1.name)";
git config user.email "$(git config user.$1.email)";
git config user.signingkey "$(git config user.$1.signingkey)"; :'
```

Handling multiple identities

1. Create the alias `git identity <id>`

```
git config alias.identity '!
git config user.name "$(git config user.$1.name)";
git config user.email "$(git config user.$1.email)";
git config user.signingkey "$(git config user.$1.signingkey)"; :'
```

2. Let Git force you to choose an identity
   1. `git config --global --unset user.name`
   2. `git config --global --unset user.email`
   3. `git config --global --unset user.signingkey`
   4. `git config --global user.useConfigOnly true`

Handling multiple identities

1. Create the alias `git identity <id>`

```
git config alias.identity '!
git config user.name "$(git config user.$1.name)";
git config user.email "$(git config user.$1.email)";
git config user.signingkey "$(git config user.$1.signingkey)"; :'
```

2. Let Git force you to choose an identity
   1. `git config --global --unset user.name`
   2. `git config --global --unset user.email`
   3. `git config --global --unset user.signingkey`
   4. `git config --global user.useConfigOnly true`
3. Create your different identities
   - `git config --global user.github.name 'Bob'`
   - `git config --global user.github.email 'bob@example.com'`
   - `git config --global user.ut.name 'Bob (BSc)'`
   - `git config --global user.ut.email 'bob@utwente.nl'`
   - `git config --global user.ut.signingkey A6A6A6A6A6A6A6A6`

Handling multiple identities

1. Create the alias `git identity <id>`

```
git config alias.identity '!
git config user.name "$(git config user.$1.name)";
git config user.email "$(git config user.$1.email)";
git config user.signingkey "$(git config user.$1.signingkey)"; :'
```

2. Let Git force you to choose an identity
   1. `git config --global --unset user.name`
   2. `git config --global --unset user.email`
   3. `git config --global --unset user.signingkey`
   4. `git config --global user.useConfigOnly true`
3. Create your different identities
   - `git config --global user.github.name 'Bob'`
   - `git config --global user.github.email 'bob@example.com'`
   - `git config --global user.ut.name 'Bob (BSc)'`
   - `git config --global user.ut.email 'bob@utwente.nl'`
   - `git config --global user.ut.signingkey A6A6A6A6A6A6A6A6`
4. Choose your identity in a repository

   `git identity github` or `git identity ut`

Contents

Complex Operations

We will look at three commands:

1. Reset
2. Rebase
3. Cherry-pick

Important remarks:

- ! These commands can rewrite history
- ! Should only be used on *private*[4] branches

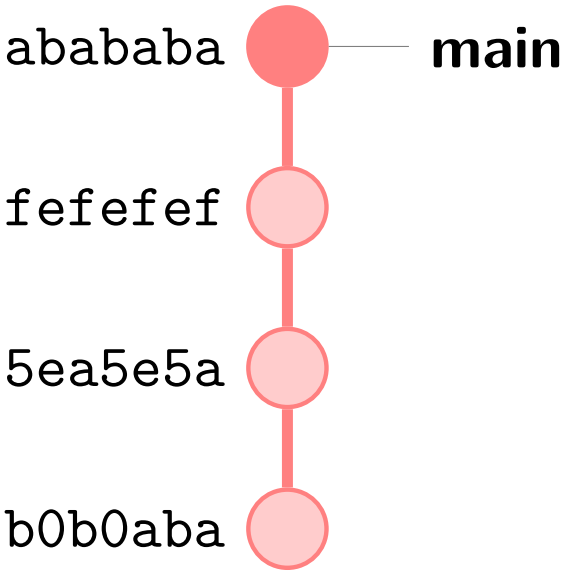
[4] branches on which only you are working

Reset

`git reset [<mode>] <hash>`

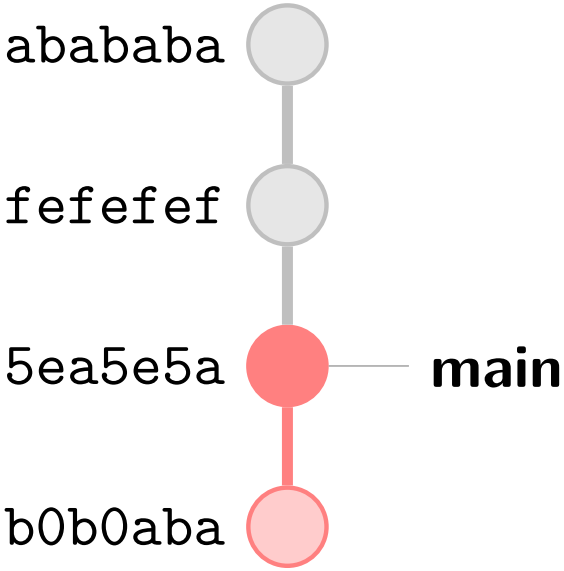
- Always undoes 1 or more commits
- Moves back to the commit hash provided
- Multiple modes
  1. soft - Doesn't touch the index or working tree
  2. mixed - Resets the index (default)
  3. hard - Cleans the index and working tree. Untracked files are deleted

Reset - Example




```
git reset --hard 5ea5e5a
```

Reset - Example



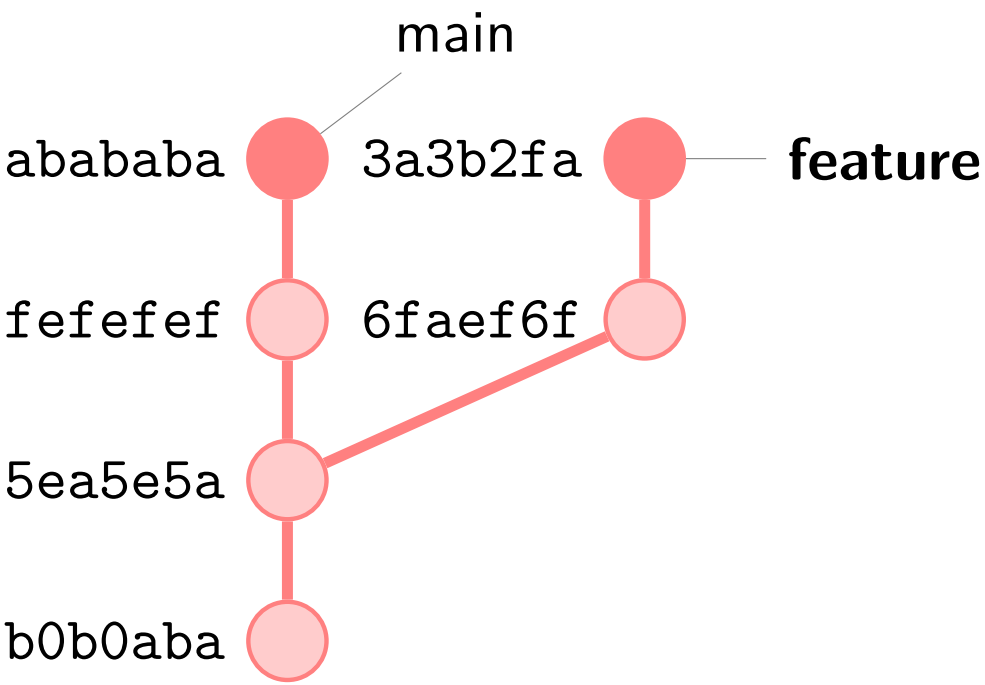

```
git reset --hard 5ea5e5a
```

Rebase

`git rebase [--interactive] [--onto <branch>] <branch>`

- Gives you a lot of power, so be careful!
- Allows you to
  - rebase a branch (duh)
  - edit commits and their order
  - a lot more

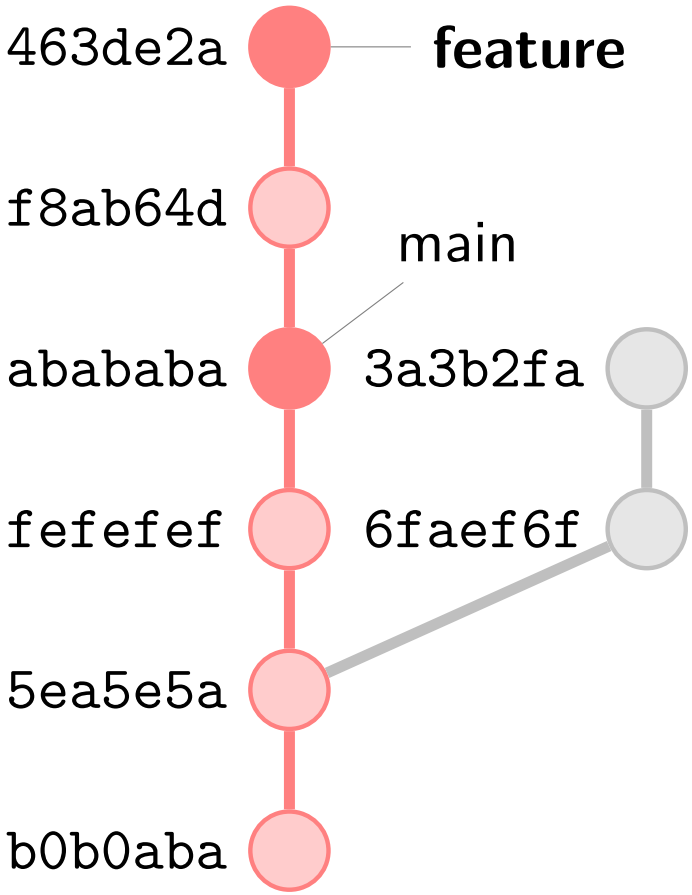
Rebase - Example



Rebase (move the base of) a branch:

```
git rebase main feature
```

Rebase - Example



Rebase (move the base of) a branch:

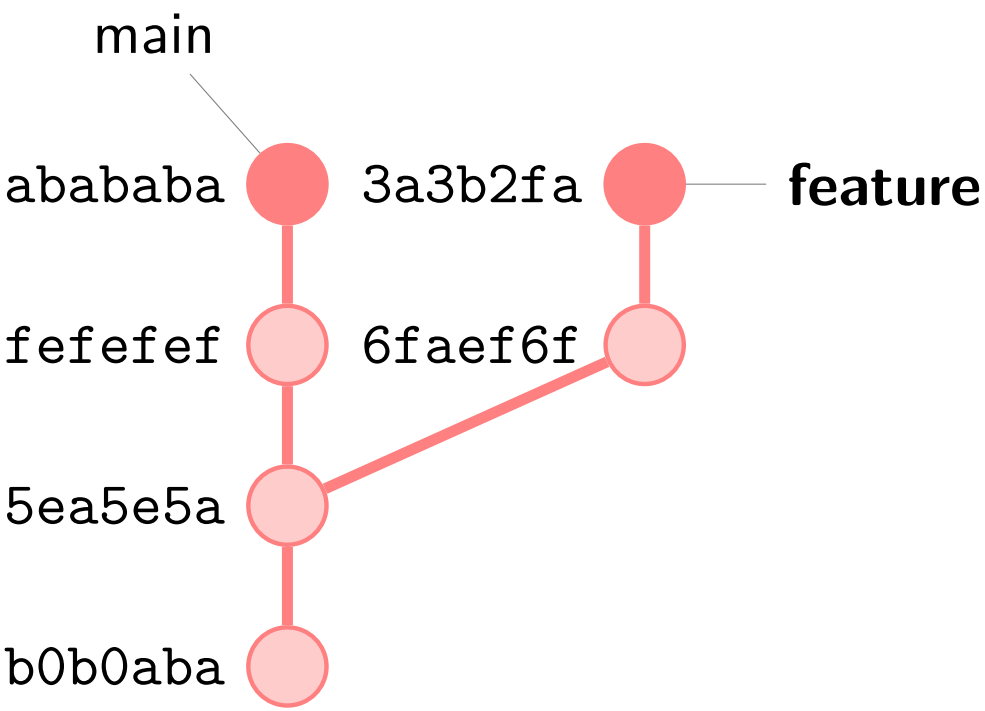
```
git rebase main feature
```

Cherry-picking

`git cherry-pick [--edit] [-x] <hash>`

- Reapply changes by the specified commits onto the head
- `--edit` allows you to edit the commit message
- `-x` adds a reference ("cherry picked from commit") to the commit message

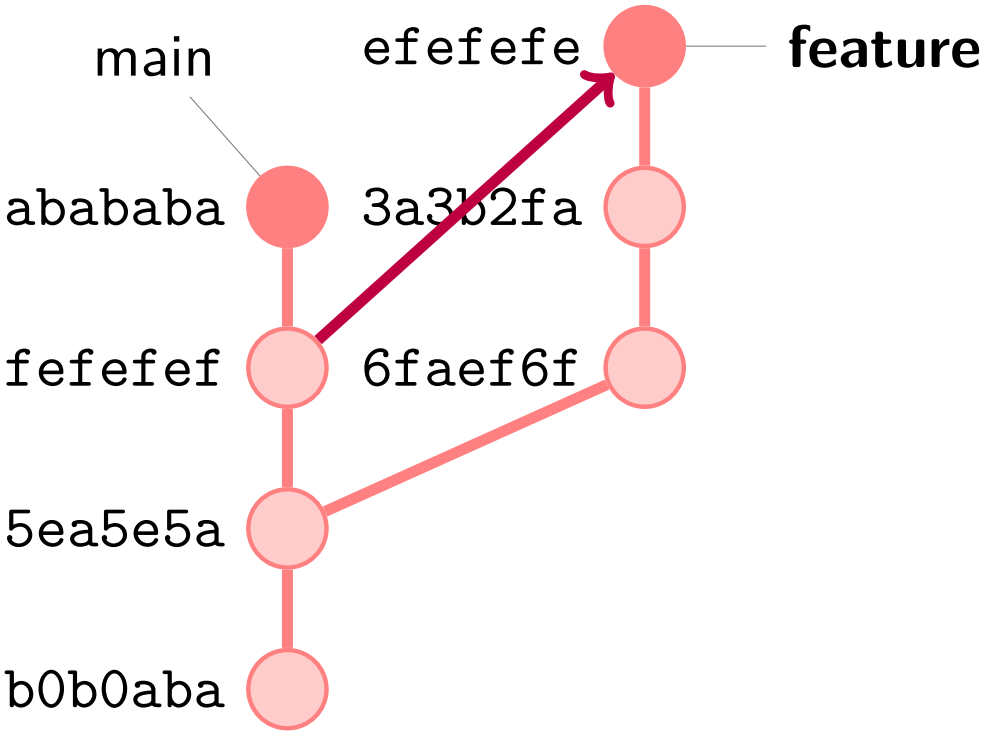
Cherry-pick - Example



Cherry-pick commit `fefefef`:

1. `git switch feature`
2. `git cherry-pick fefefef`

Cherry-pick - Example



Cherry-pick commit `fefefef`:

1. `git switch feature`
2. `git cherry-pick fefefef`

Contents

Forking

Forking

- When contributing to an open-source project, you often don't get permissions to create branches and push code to the repository directly.

Forking

- When contributing to an open-source project, you often don't get permissions to create branches and push code to the repository directly.
- Instead, you should fork the repository, push your changes there and then create a Pull Request.

Forking

- When contributing to an open-source project, you often don't get permissions to create branches and push code to the repository directly.
- Instead, you should fork the repository, push your changes there and then create a Pull Request.
- Another reason to fork a repository is when you want to make changes for yourself and publish it separately.

Stashing

- Saves your uncommitted changes to the side

Stashing

- Saves your uncommitted changes to the side
- Works like a stack (First In; First Out)

Stashing

- Saves your uncommitted changes to the side
- Works like a stack (First In; First Out)
- Commands:
  - `git stash [-m <message>]` - Saves the changes (optionally with a description)
  - `git stash pop` - Moves changes back to your working space *and deletes them from the stash*
  - `git stash drop` - Deletes changes from the stash (*Note: Can cause loss of changes*)

Stashing

- Saves your uncommitted changes to the side
- Works like a stack (First In; First Out)
- Commands:
  - `git stash [-m <message>]` - Saves the changes (optionally with a description)
  - `git stash pop` - Moves changes back to your working space *and deletes them from the stash*
  - `git stash drop` - Deletes changes from the stash (*Note: Can cause loss of changes*)
- Useful when switching between branches while you have uncommitted changes:
  - `git stash` - Save the changes temporarily
  - `git switch <branch>` - Switch to a different branch
  - `git stash pop` - Recover your changes from the stash

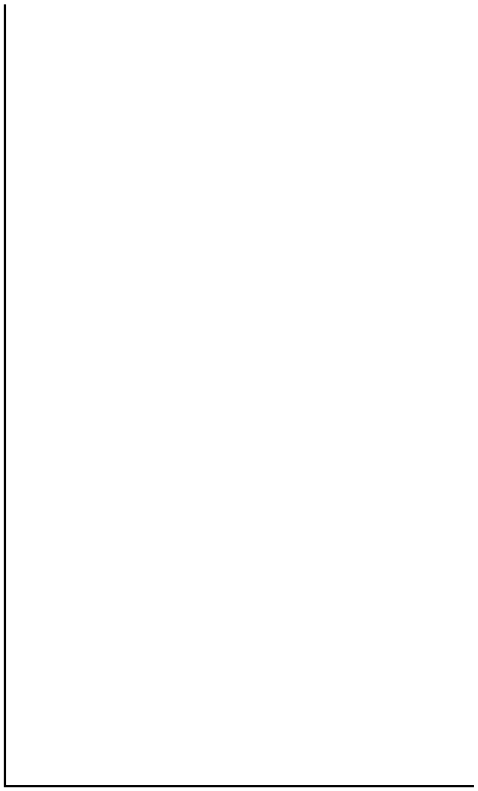
Stashing

- Saves your uncommitted changes to the side
- Works like a stack (First In; First Out)
- Commands:
  - `git stash [-m <message>]` - Saves the changes (optionally with a description)
  - `git stash pop` - Moves changes back to your working space *and deletes them from the stash*
  - `git stash drop` - Deletes changes from the stash (*Note: Can cause loss of changes*)
- Useful when switching between branches while you have uncommitted changes:
  - `git stash` - Save the changes temporarily
  - `git switch <branch>` - Switch to a different branch
  - `git stash pop` - Recover your changes from the stash
- If the stashed changes conflict with the state of the other branch you get a merge conflict.
- In this case `git stash pop` will not delete the stash entry to prevent loss of data.

Multiple stash entries

Stash

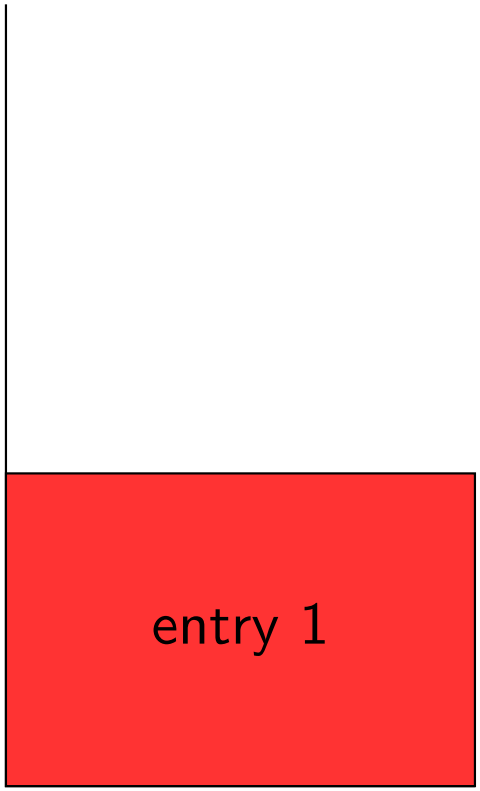
- Let's save something to the stash:



Multiple stash entries

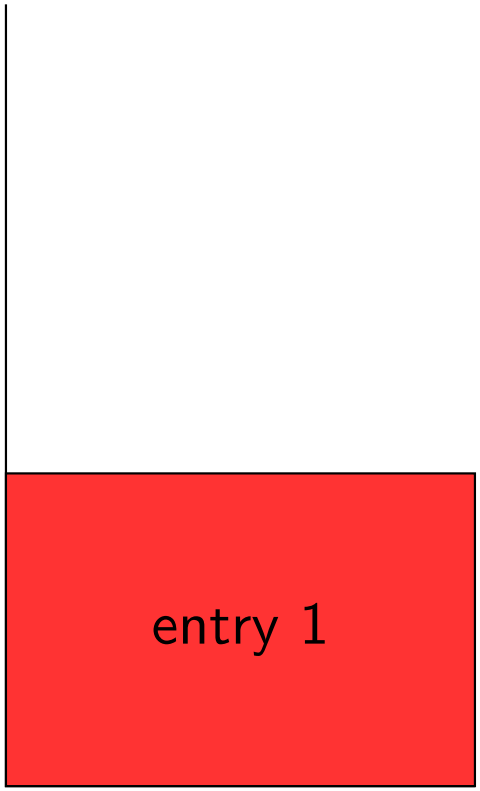
Stash

- Let's save something to the stash:
- `$ git stash`



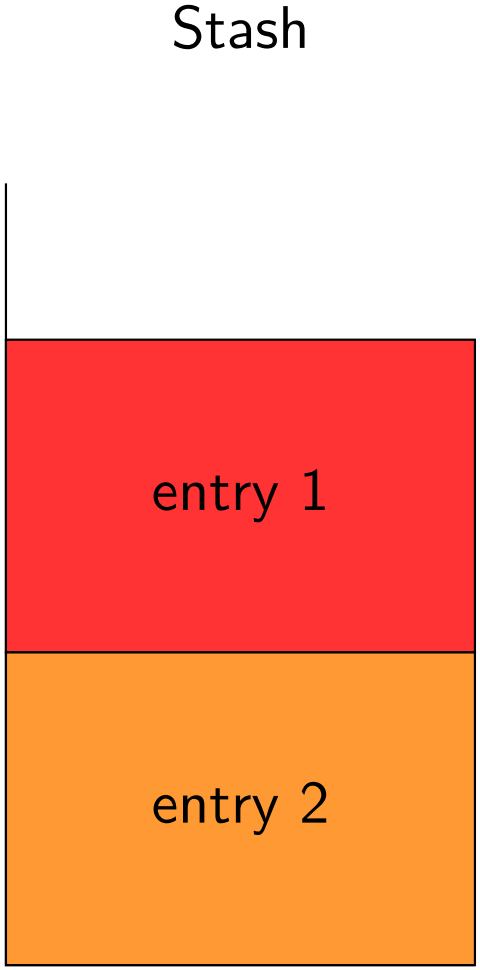
Multiple stash entries

Stash



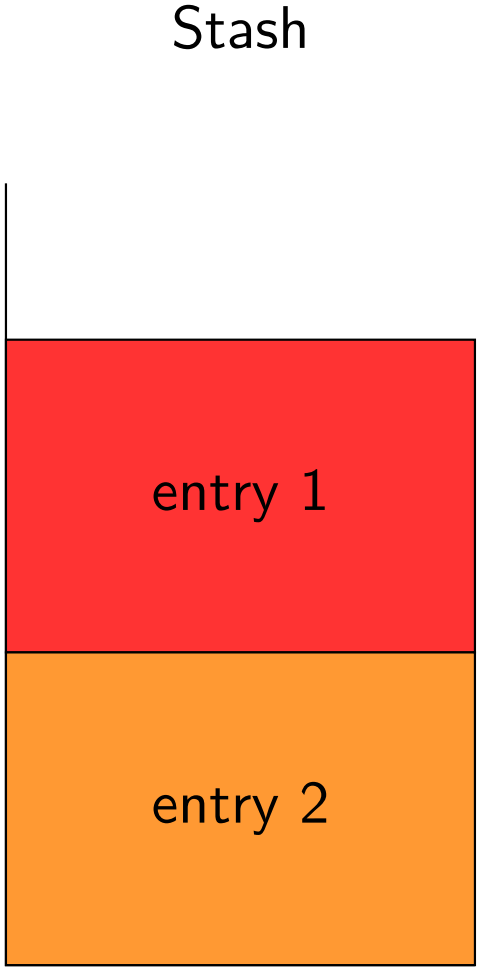
- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:

Multiple stash entries



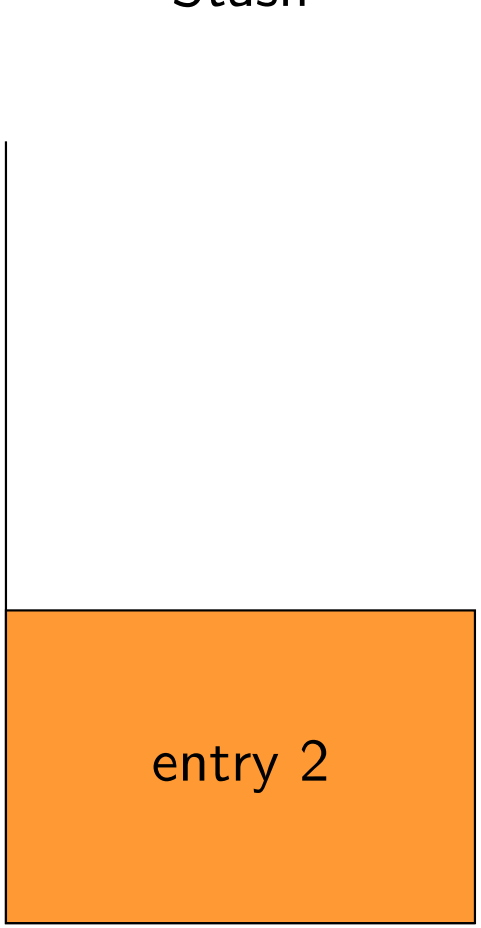
- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:
- `$ git stash`

Multiple stash entries



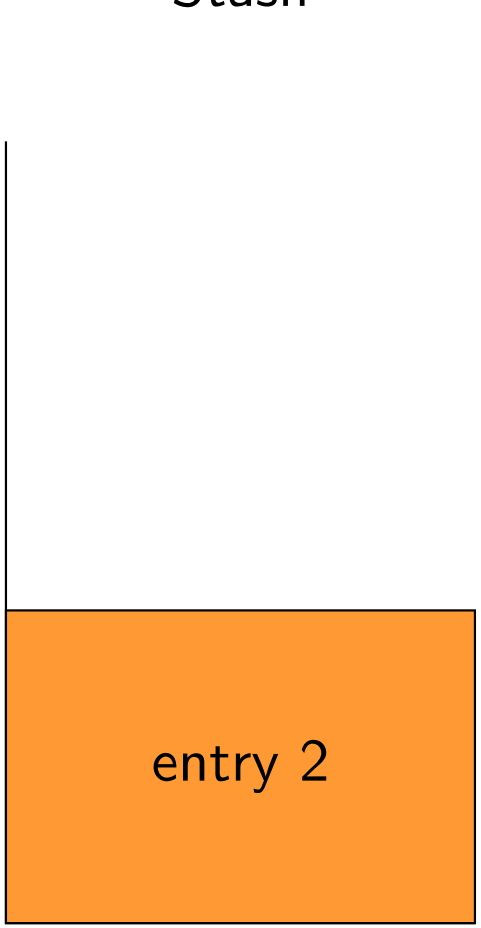
- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:
- `$ git stash`
- If we now pop something off, we can explicitly choose an entry:

Multiple stash entries



- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:
- `$ git stash`
- If we now pop something off, we can explicitly choose an entry:
- `$ git stash pop 1 # returns entry 1`

Multiple stash entries



- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:
- `$ git stash`
- If we now pop something off, we can explicitly choose an entry:
- `$ git stash pop 1 # returns entry 1`
- Otherwise we get the entry which was added last (FIFO):

Multiple stash entries

Stash

- Let's save something to the stash:
- `$ git stash`
- Let's save a second entry:
- `$ git stash`
- If we now pop something off, we can explicitly choose an entry:
- `$ git stash pop 1 # returns entry 1`
- Otherwise we get the entry which was added last (FIFO):
- `$ git stash pop # returns entry 2`

Worktrees

Worktrees

- Mounts a branch of your repository in a different directory

Worktrees

- Mounts a branch of your repository in a different directory
- Useful when you need to compare functionality in multiple branches, or work on multiple branches

Worktrees

- Mounts a branch of your repository in a different directory
- Useful when you need to compare functionality in multiple branches, or work on multiple branches
- Commands:
  - `$ git worktree add [--reason <string>] <path> <branch>`
    Adds a new worktree at *path* of *branch*.
  - `$ git worktree list`
    Lists all current worktrees (including the main worktree).
  - `$ git worktree remove <path>`
    Removes the worktree at *path*.
  - `$ git worktree move <path> <new-path>`
    Moves the worktree at *path* to *new-path*.

Bisect

Bisect

- Helps to find which commit introduced a bug

Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle

Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle
- Start by marking one commit
  - bad - contains the bug
  - good - doesn't contain the bug

Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle
- Start by marking one commit
  - bad - contains the bug
  - good - doesn't contain the bug
- Git will automatically determine the commit halfway and move there

Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle
- Start by marking one commit
  - bad - contains the bug
  - good - doesn't contain the bug
- Git will automatically determine the commit halfway and move there
- Mark it and Git will move to the next commit accordingly

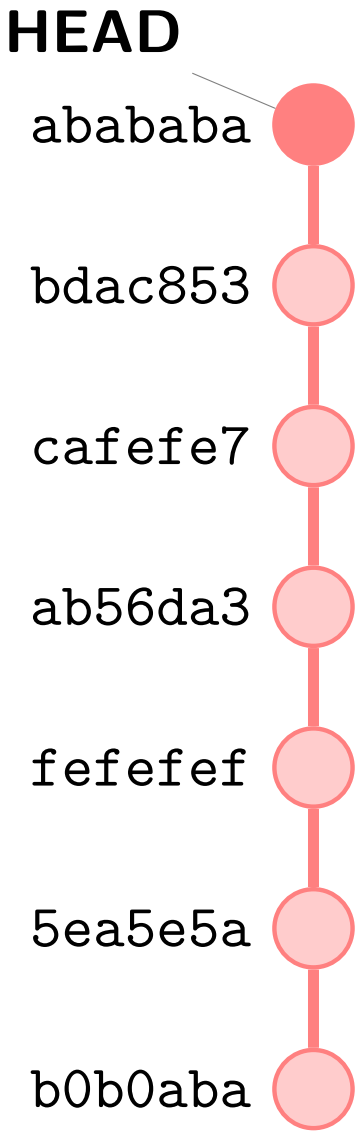
Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle
- Start by marking one commit
  - bad - contains the bug
  - good - doesn't contain the bug
- Git will automatically determine the commit halfway and move there
- Mark it and Git will move to the next commit accordingly
- You end up at the first bad commit (introduced the bug)

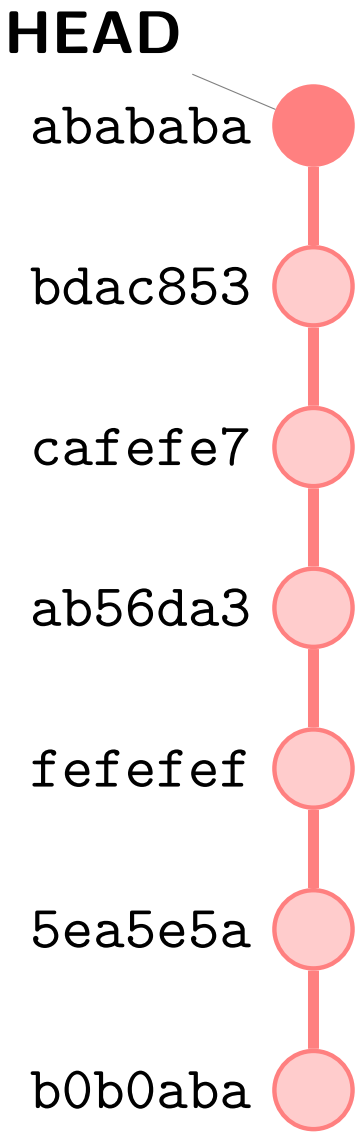
Bisect

- Helps to find which commit introduced a bug
- Based on binary search principle
- Start by marking one commit
  - bad - contains the bug
  - good - doesn't contain the bug
- Git will automatically determine the commit halfway and move there
- Mark it and Git will move to the next commit accordingly
- You end up at the first bad commit (introduced the bug)
- Stop bisect with `$ git bisect reset`

Bisect - Simple example

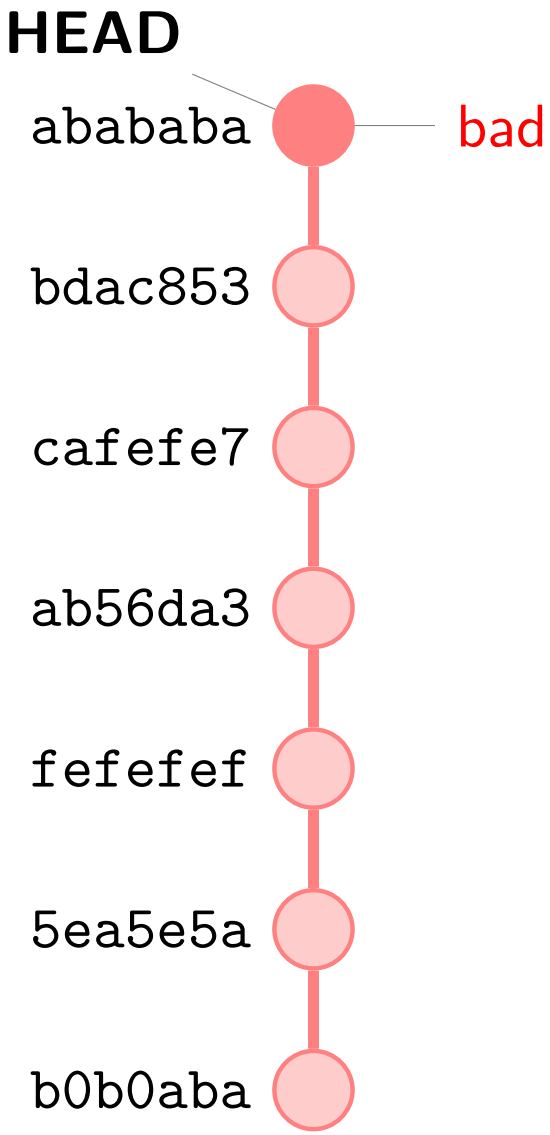


Bisect - Simple example



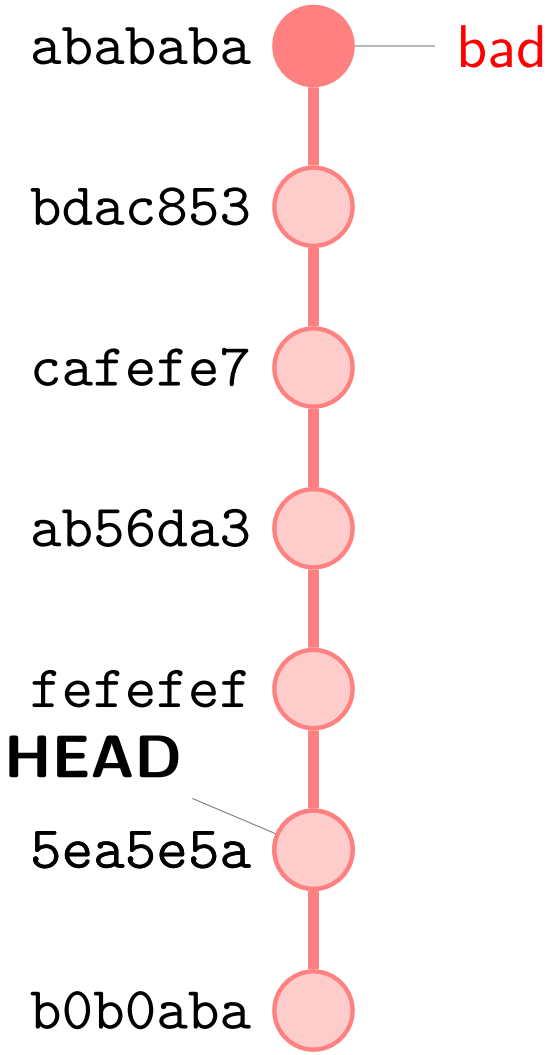
1. `$ git bisect start`

Bisect - Simple example



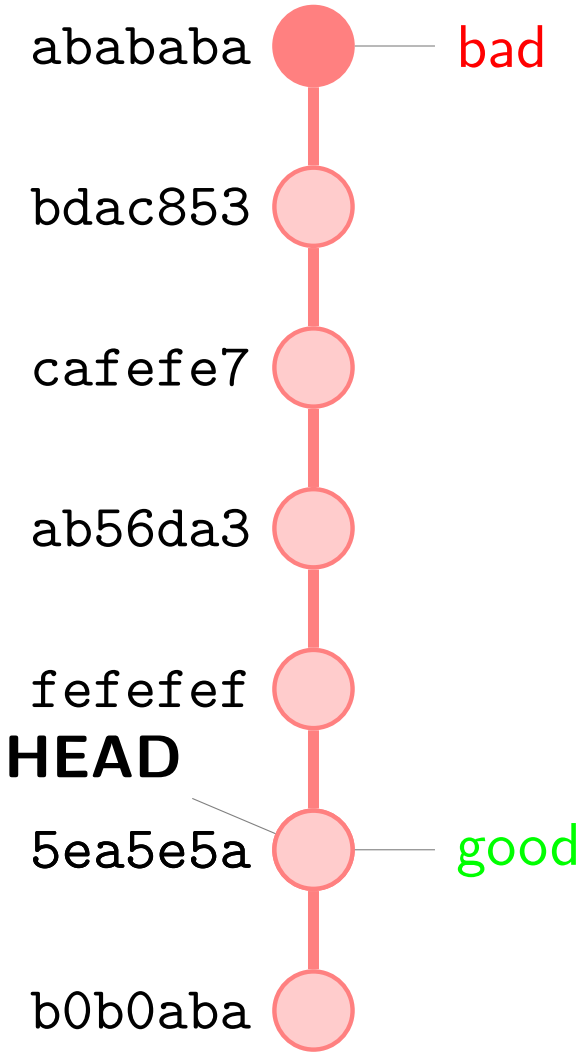
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`

Bisect - Simple example



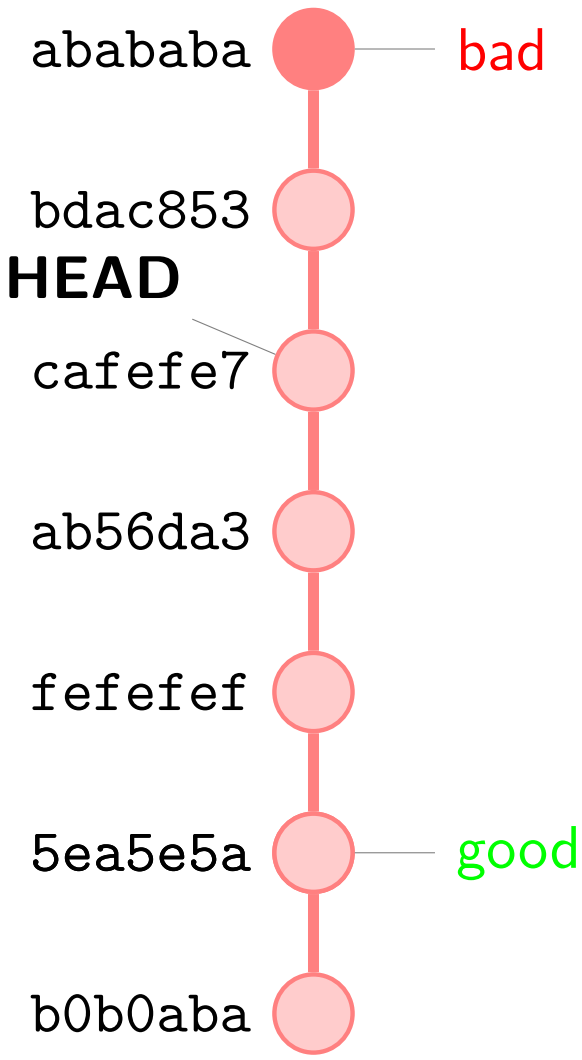
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`

Bisect - Simple example



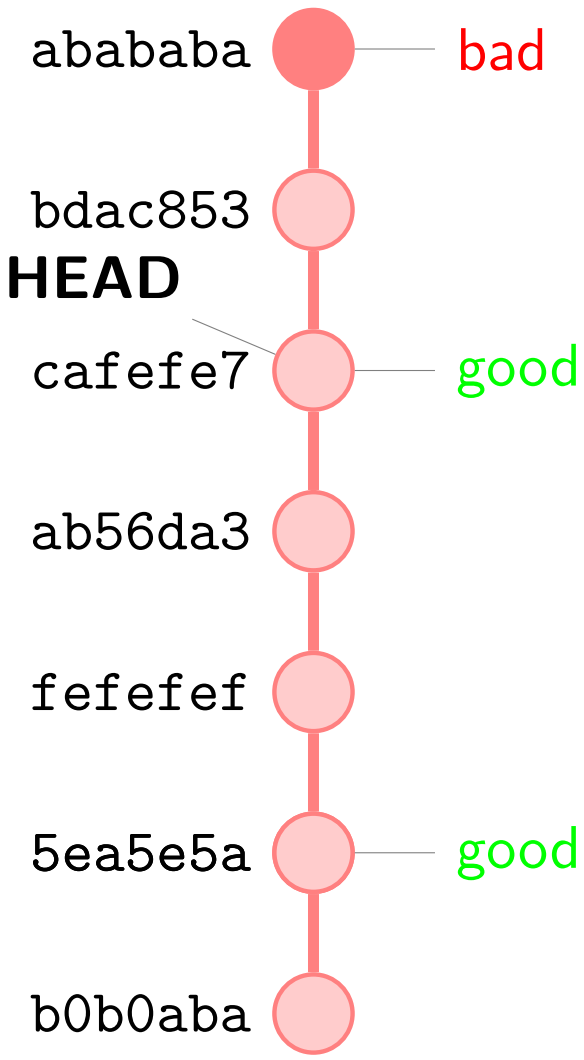
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`

Bisect - Simple example



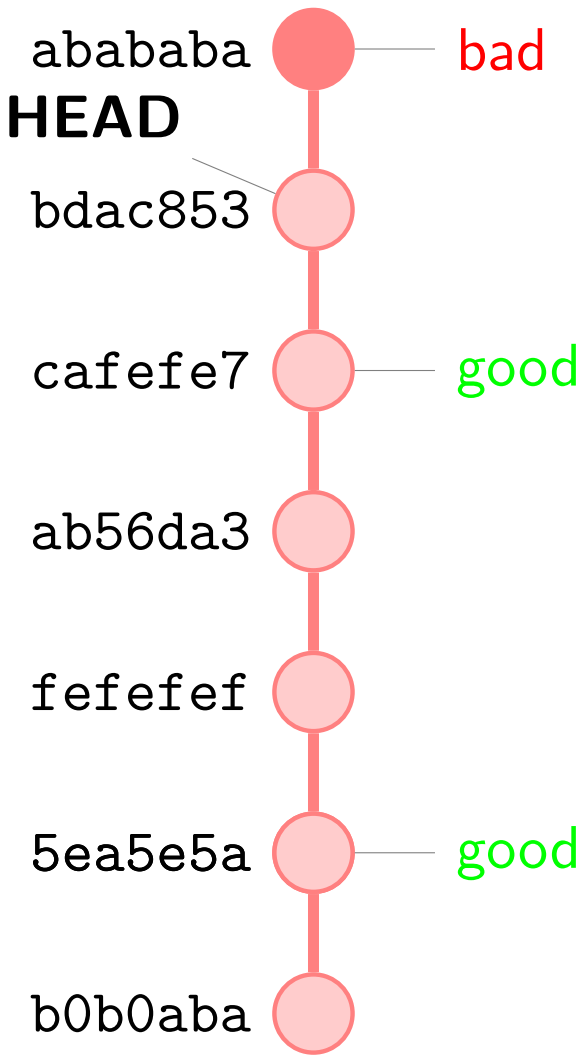
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point

Bisect - Simple example



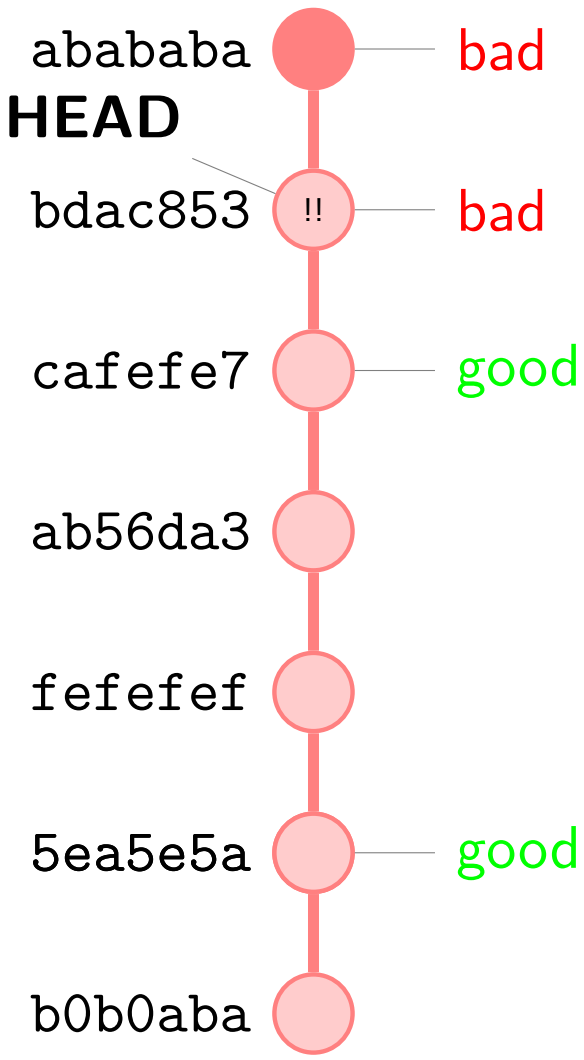
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point
6. Mark it accordingly

Bisect - Simple example



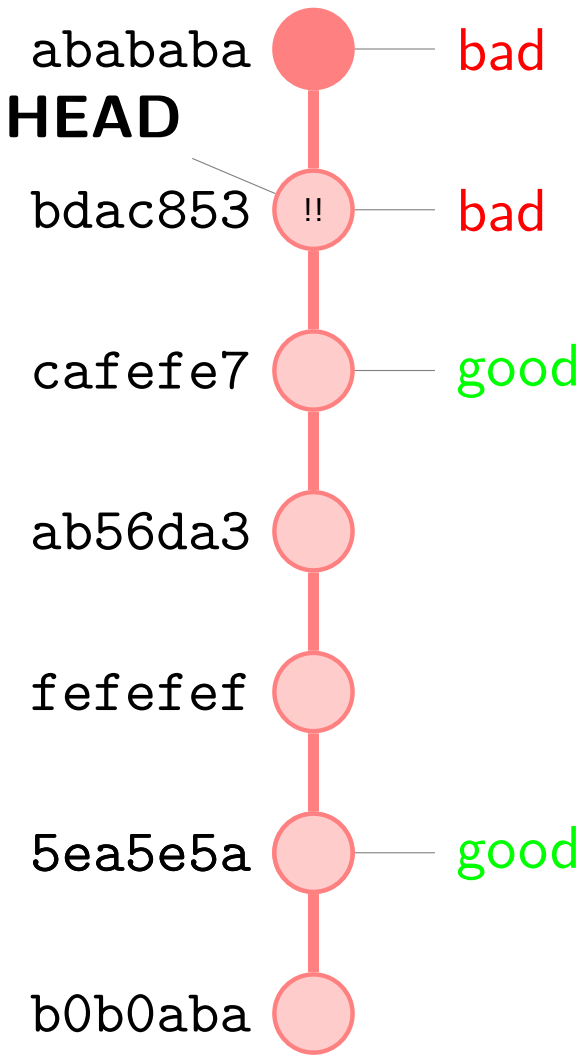
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point
6. Mark it accordingly
7. Repeat last two steps until you've found the faulty commit

Bisect - Simple example



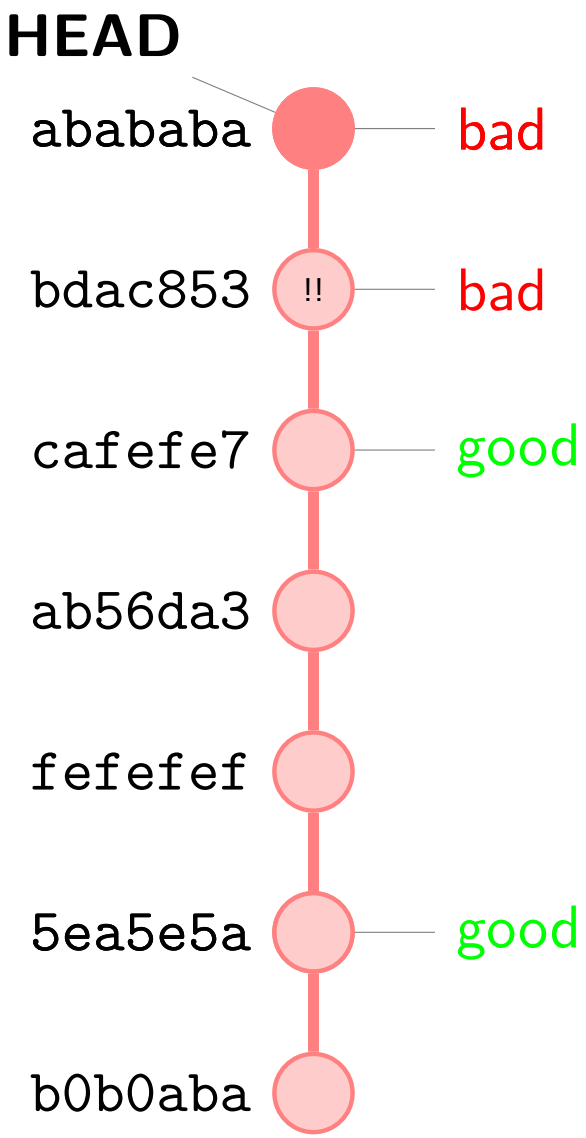
1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point
6. Mark it accordingly
7. Repeat last two steps until you've found the faulty commit

Bisect - Simple example



1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point
6. Mark it accordingly
7. Repeat last two steps until you've found the faulty commit
8. Once done, stop the bisect:
   `$ git bisect reset`

Bisect - Simple example



1. `$ git bisect start`
2. Mark the current commit as bad:
   `$ git bisect bad`
3. Find a commit which doesn't contain the bug, e.g. *5ea5e5a*:
   `$ git checkout 5ea5e5a`
4. Mark the commit as good:
   `$ git bisect good`
5. Git moves to the halfway point
6. Mark it accordingly
7. Repeat last two steps until you've found the faulty commit
8. Once done, stop the bisect:
   `$ git bisect reset`

Sources for future reference

- `git help <command>`
- gitimmersion.com
- Rebase deep-dive: Conference talk about rebase (30m)

Contact details

Think of a question later on? Feel free to reach out to us!

MasterCLASS
masterclass@scintilla.utwente.nl

Kasper Müller
kasperm@scintilla.utwente.nl

Johan Verzijden
johanv@scintilla.utwente.nl