

CSE P 504

Advanced topics in Software Systems

Fall 2022

Best practices and version control

October 10, 2022

Today

- Logistics
- Best practices (or how to avoid bugs)
- Version control with git
- In-class exercise 1

Logistics

- Course material, schedule, etc. on website:
<https://homes.cs.washington.edu/~rjust/courses/CSEP504>
- Submission of assignments via Canvas:
<https://canvas.uw.edu>
- Discussions on Slack:
<https://csep504.slack.com>
- Poll everywhere:
<https://pollev.com/renejust859>

Having trouble accessing any of those – let us know!

Logistics: in-class exercises

How to get the most out of these exercises?

1. Prepare

- Follow set-up instructions: ready to go on Monday.

2. Participate

- Work as a team: focus on problem solving and discussions.

3. Reflect

- Revisit notes;
- Submit deliverables;
- Identify and raise open questions.

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In-class due dates – Friday vs. Sunday?

Best practices

How to avoid bugs in your code?

How to avoid bugs in your code?

It's super simple...don't introduce them during coding!

“Everybody makes mistakes except for me...

But then, there is just one of me.”



How to avoid bugs in your code?

A more realistic approach: 3 steps

1. Make certain bugs impossible by design
2. Correctness: get it right the first time
3. Bug visibility

How to avoid bugs in your code?

A more realistic approach: 3 steps

1. Make certain bugs impossible by design

a. Programming language

- i. Ever had a use-after free bug in a garbage-collected language?
- ii. Ever had an assignment bug (String to Integer) in a statically typed language?
(Even stronger guarantees with custom types and pluggable type systems.)

b. Libraries and protocols

- i. TCP vs. UDP
- ii. No overflows in BigInteger

How to avoid bugs in your code?

A more realistic approach: 3 steps

1. Make certain bugs impossible by design
 - a. Programming language
 - b. Libraries and protocols
2. Correctness: get it right the first time
 - a. A program without a spec is bug free
 - b. Keep it simple, modular, and testable
 - c. Defensive programming and conventions (discipline)

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 - a. A program without a spec is bug free
 - b. Keep it simple, modular, and testable
 - c. Defensive programming and conventions (discipline)
3. Bug visibility
 - a. Assertions (pre/post conditions)
 - b. (Regression) testing
 - c. Fail fast



QUIZ
NIGHT

Quiz: setup and goals

- 3-4 students per team
- 4 code snippets
- 2 rounds
 - **First round**
 - For each code snippet, decide whether it represents good or bad practice.
 - **Goal:** discuss and reach consensus on good or bad practice.
 - **Second round** (known “solutions”)
 - For each code snippet, try to understand why it is good or bad practice.
 - **Goal:** come up with an explanation or a counter argument.

Round 1: good or bad?



Snippet 1: good or bad?



```
public File[] getAllLogs(Directory dir) {
    if (dir == null || !dir.exists() || dir.isEmpty()) {
        return null;
    } else {
        int numLogs = ... // determine number of log files
        File[] allLogs = new File[numLogs];
        for (int i=0; i<numLogs; ++i) {
            allLogs[i] = ... // populate the array
        }
        return allLogs;
    }
}
```


Snippet 2: good or bad?



```
public enum PaymentType {DEBIT, CREDIT}
public void doTransaction(double amount, PaymentType payType) {
    switch (payType) {
        case DEBIT:
            ... // process debit card
            break;
        case CREDIT:
            ... // process credit card
            break;
        default:
            throw new IllegalArgumentException("Unexpected payment type");
    }
}
```

Snippet 3: good or bad?



```
public class ArrayList<E> {  
    public E remove(int index) {  
        ...  
    }  
    public boolean remove(Object o) {  
        ...  
    }  
    ...  
}
```

Snippet 4: good or bad?



```
public class Point {
    private final int x;
    private final int y;

    public Point(int x, int y) {
        this.x = x;
        this.y = y;
    }

    public int getX() {
        return this.x;
    }

    public int getY() {
        return this.y;
    }
}
```

Round 2: why is it good or bad?



My take on this



- Snippet 1: bad



- Snippet 2: good



- Snippet 3: bad



- Snippet 4: good

Snippet 1: this is bad! why?



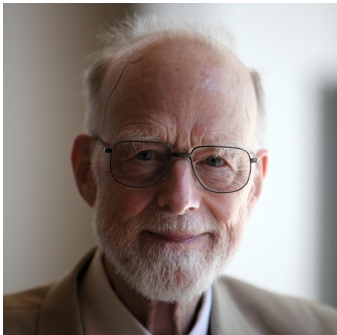
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Snippet 1: this is bad! why?



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        }  
        return allLogs;  
    }  
}
```



Null references...the billion dollar mistake.

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        File[] allLogs = new File[numLogs];  
        for (int i=0; i<numLogs; ++i) {  
            allLogs[i] = ... // populate the array  
        }  
        return allLogs;  
    }  
}
```

```
File[] files = getAllLogs();  
for (File f : files) {  
    ...  
}
```

Don't return null; return an empty array instead.



Snippet 1: this is bad! why?



```
public File[] getAllLogs(Directory dir) {  
    if (dir == null || !dir.exists() || dir.isEmpty()) {  
        return null;  
    } else {  
        int numLogs = ... // determine number of log files  
        File[] allLogs = new File[numLogs];  
        for (int i=0; i<numLogs; ++i) {  
            allLogs[i] = ... // populate the array  
        }  
        return allLogs;  
    }  
}
```



No diagnostic information.

Snippet 2: this is good, but why?



```
public enum PaymentType {DEBIT, CREDIT}
public void doTransaction(double amount, PaymentType payType) {
    switch (payType) {
        case DEBIT:
            ... // process debit card
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Snippet 2: this is good, but why?



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        default:
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    }
}
```



Type safety using an enum; throws an exception for unexpected cases (e.g., future extensions of PaymentType).

Snippet 3: Java API, but still bad! why?



```
public class ArrayList<E> {  
    public E remove(int index) {  
        ...  
    }  
    public boolean remove(Object o) {  
        ...  
    }  
    ...  
}
```



Snippet 3: Java API, but still bad! why?



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public class ArrayList<E> {  
    public E remove(int index) {  
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    }  
    public boolean remove(Object o) {  
        ...  
    }  
    ...  
}
```



```
ArrayList<String> l = new ArrayList<>();  
Integer index = Integer.valueOf(1);  
l.add("Hello");  
l.add("World");  
l.remove(index);
```

What does the last call return?

Snippet 3: Java API, but still bad! why?



```
public class ArrayList<E> {  
    public E remove(int index) {  
        ...  
    }  
    public boolean remove(Object o) {  
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    }  
    ...  
}
```



```
ArrayList<String> l = new ArrayList<>();  
Integer index = Integer.valueOf(1);  
l.add("Hello");  
l.add("World");  
l.remove(index);
```

**Avoid method overloading, which is statically resolved.
Autoboxing/unboxing adds additional confusion.**

Snippet 4: this is good, but why?



```
public class Point {  
    private final int x;  
    private final int y;  
    public Point(int x, int y) {  
        this.x = x;  
        this.y = y;  
    }  
    public int getX() {  
        return this.x;  
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Snippet 4: this is good, but why?



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    }  
    public int getY() {  
        return this.y;  
    }  
}
```



Good encapsulation; immutable object.

Version control

Why use version control?



Common App
Essay

11:51pm

Why use version control?



Common App
Essay

11:51pm



Common App
Essay FINAL

11:57pm

Why use version control?



Common App
Essay



Common App
Essay EDITED
FINAL



Common App
Essay FINAL
FINAL



Common App
Essay FINAL
REVISED



Common App
Essay FINAL



Common App
Essay OKAY THIS
IS THE FINAL
ONE



Common App
Essay REVISED
FINAL

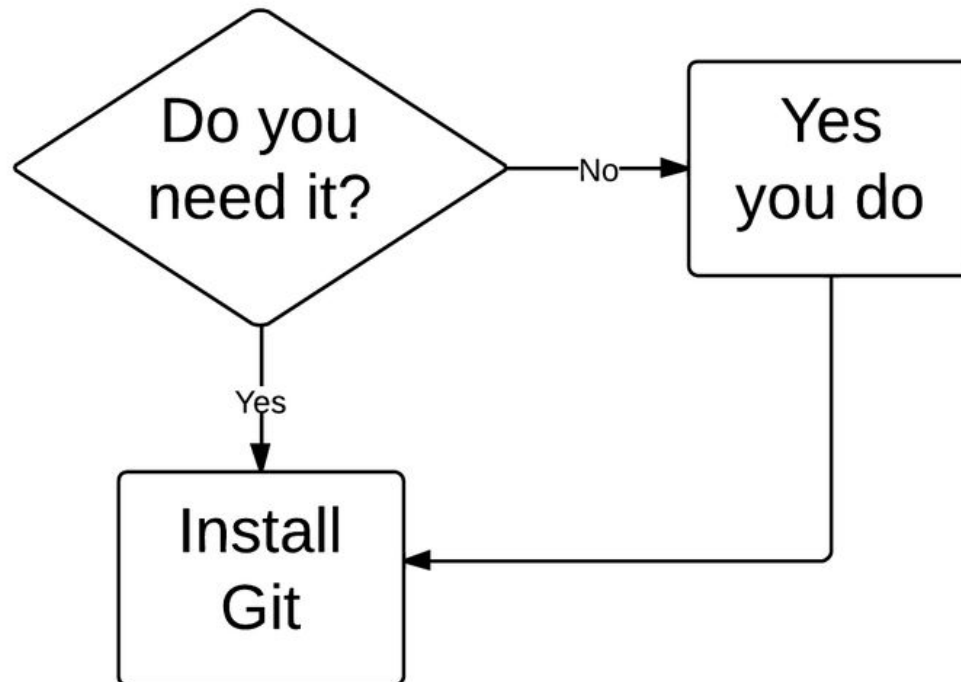


Common App
Essay REVISED

Just kidding... this is far more realistic.

Version control

Version control records changes to a set of files over time. This makes it easy to review or obtain a specific version (later).



Who uses version control?

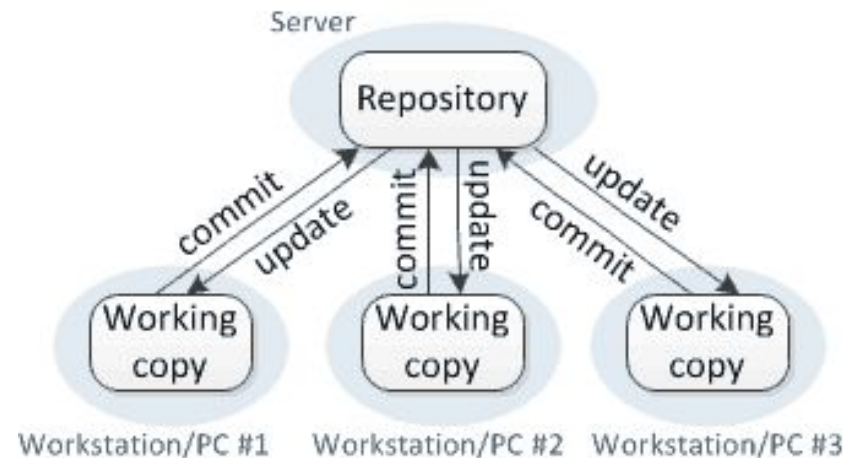
Example application domains

- Software development
- Research (infrastructure and data)
- Applications (e.g., (cloud-based) word processors)

Centralized version control

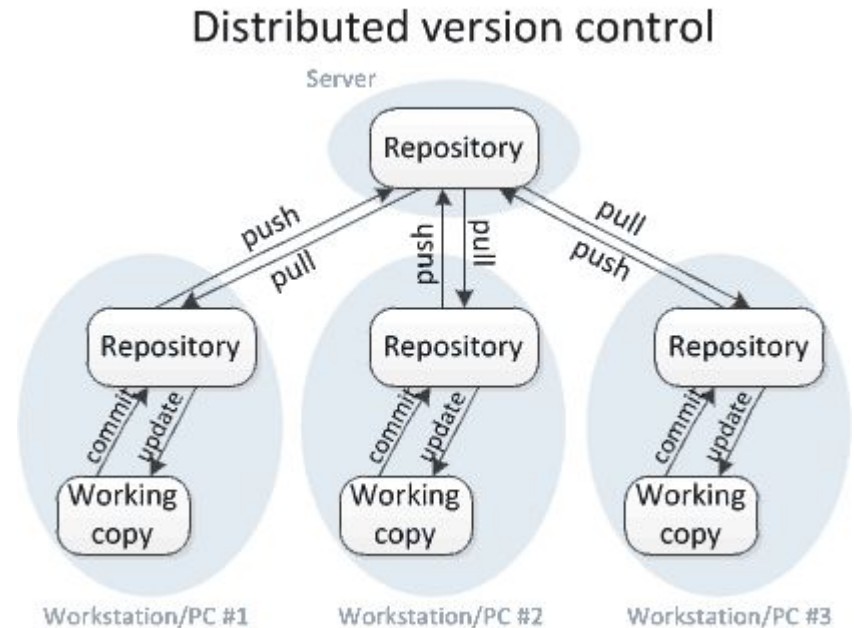
- **One central repository.**
- All users **commit** their changes to a **central repository**.
- Each user has a working copy. As soon as they commit, the repository gets updated.
- Examples: SVN (Subversion), CVS.

Centralized version control



Distributed version control

- **Multiple copies of a repository.**
- Each user **commits** to a **local** (private) repository.
- All committed changes remain local unless **pushed** to another repository.
- No external changes are visible unless **pulled** from another repository.
- Examples: Git, Hg (Mercurial).



Version control with Git

(aka the best thing since sliced bread)

- “I see Subversion as being the most pointless project ever started”
- ” ‘what would CVS never ever do’-kind of approach”



A little quiz

When poll is active, respond at PollEv.com/renejust859

W Which of the following statements are true?

Git requires a repository server

A merge conflict in Git arises as soon as two users change the same file

After editing a file, only some of the edits may end up in a Git commit

When poll is active, respond at PollEv.com/renejust859

W Which of the following is NOT a git command?

git clone

git fork

git branch

git cherry-pick

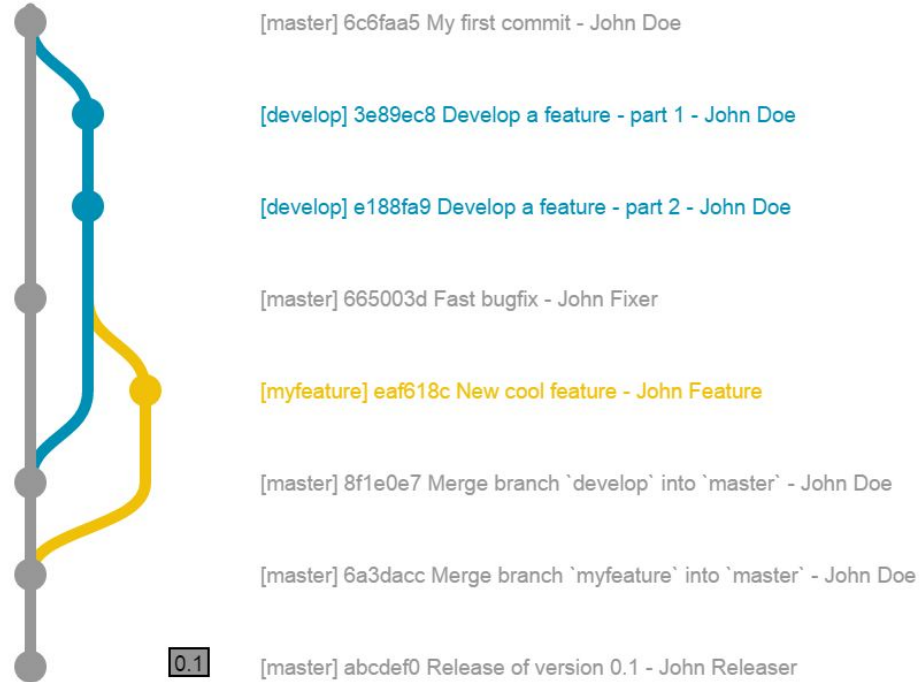
git fetch

git pull

Branch vs. Clone vs. Fork

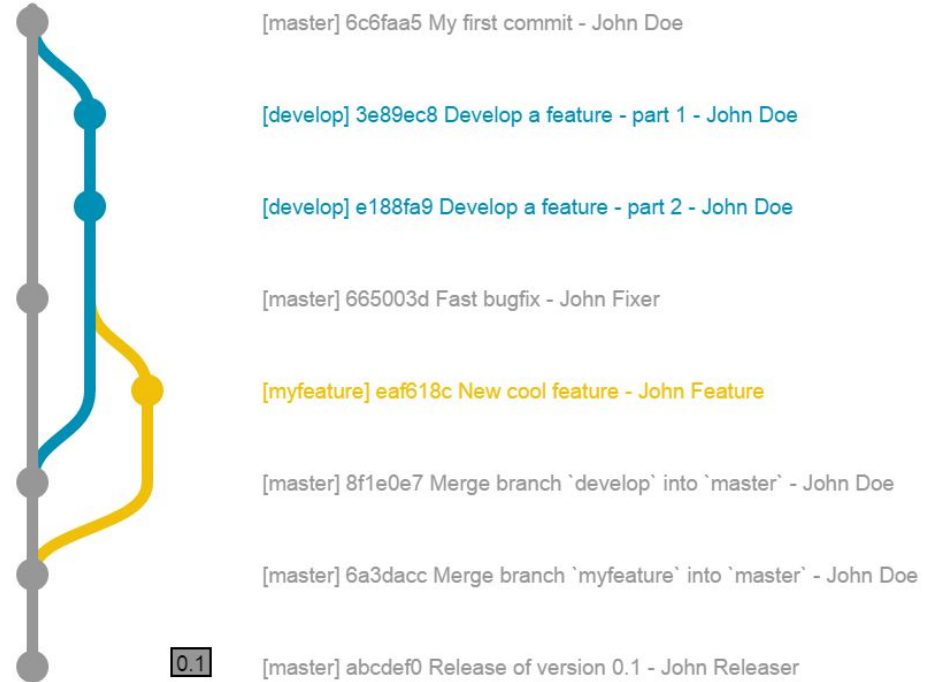
Branches

- One **main** development **branch** (**main**, master, trunk, etc.).
- Adding a new feature, fixing a bug, etc.: create a new **branch** -- a **parallel line of development**.
- **Lightweight** branching (**branch**).
- **Heavyweight** branching (**clone**).
- **Forking** (clone + metadata).

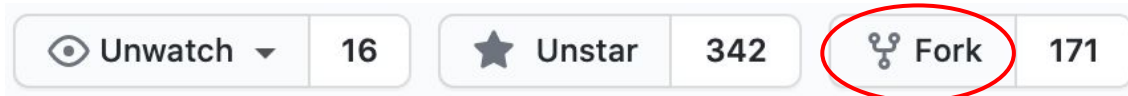


Branches

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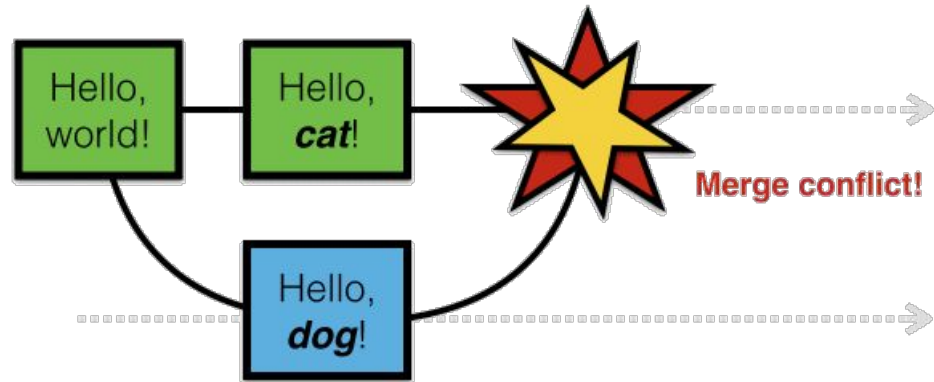


Branch and clone are common version control commands;
forking is a concept used by GitHub etc.



Conflicts

Conflicts



- **Conflicts** arise when two users **change the same line** (or two adjacent lines) of a file.
- When a conflict arises, the last committer needs to resolve it.

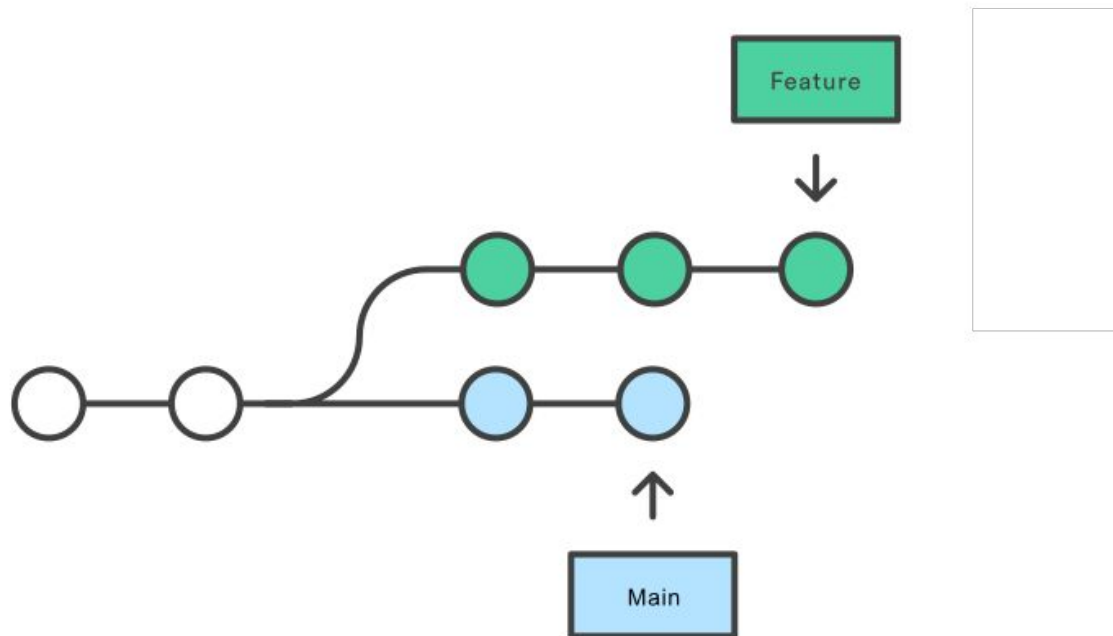
How to avoid merge conflicts?

Merge vs. Rebase

(vs. Interactive Rebase)

Merge vs. Rebase

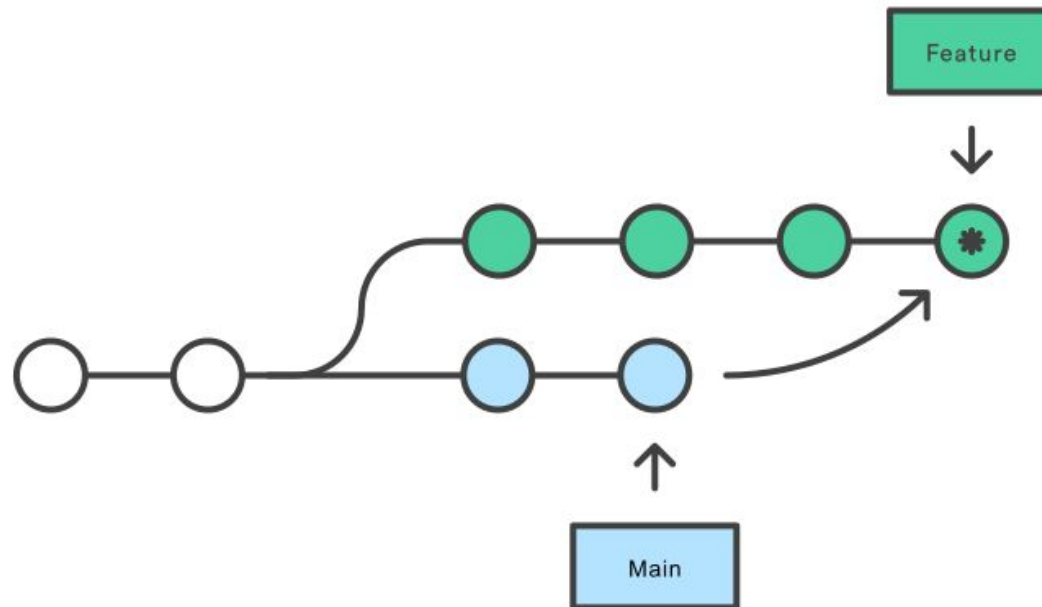
Developing a feature in a dedicated branch



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Merge (integrating changes from main)

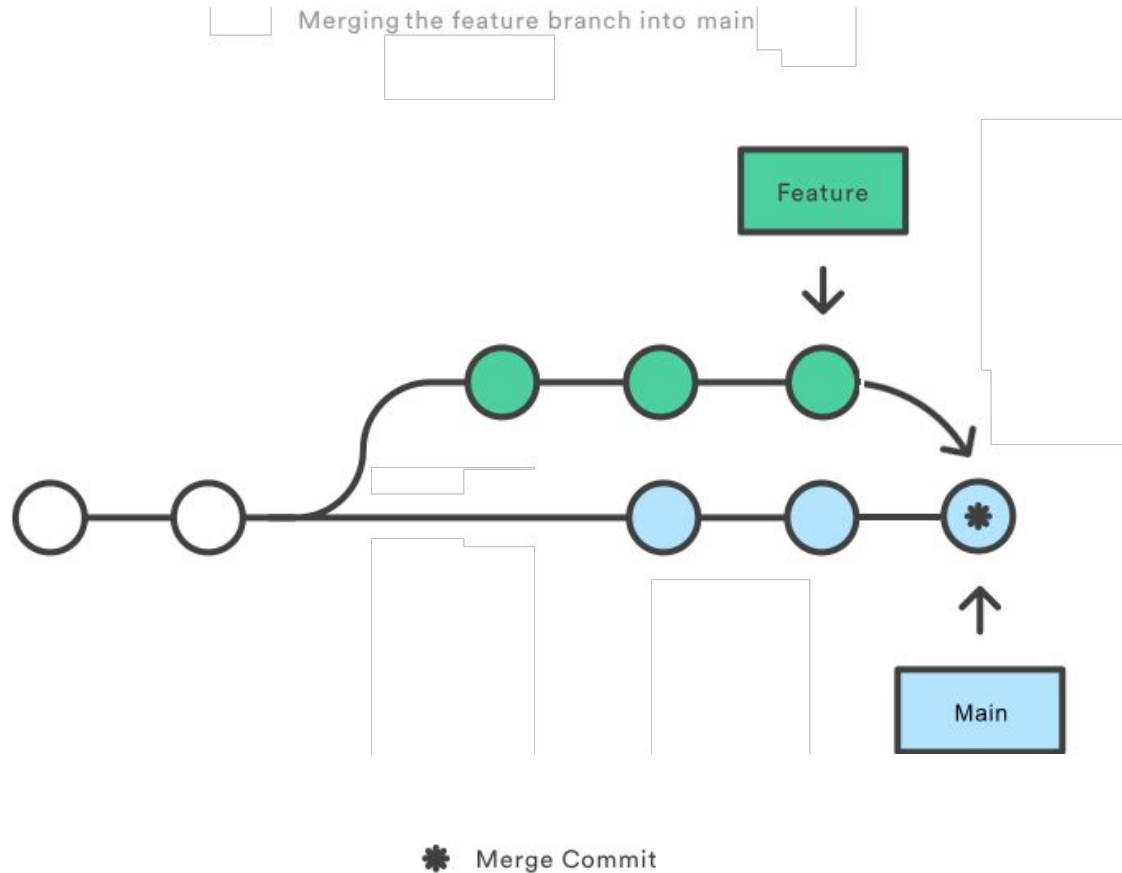
Merging main into the feature branch



* Merge Commit

<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

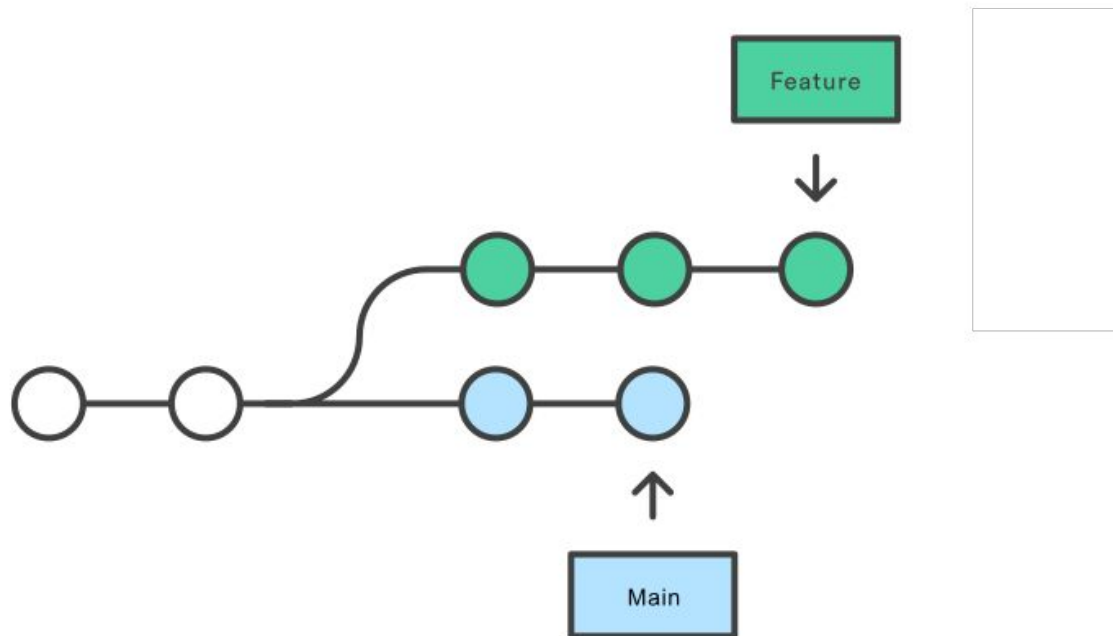
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Merge vs. Rebase

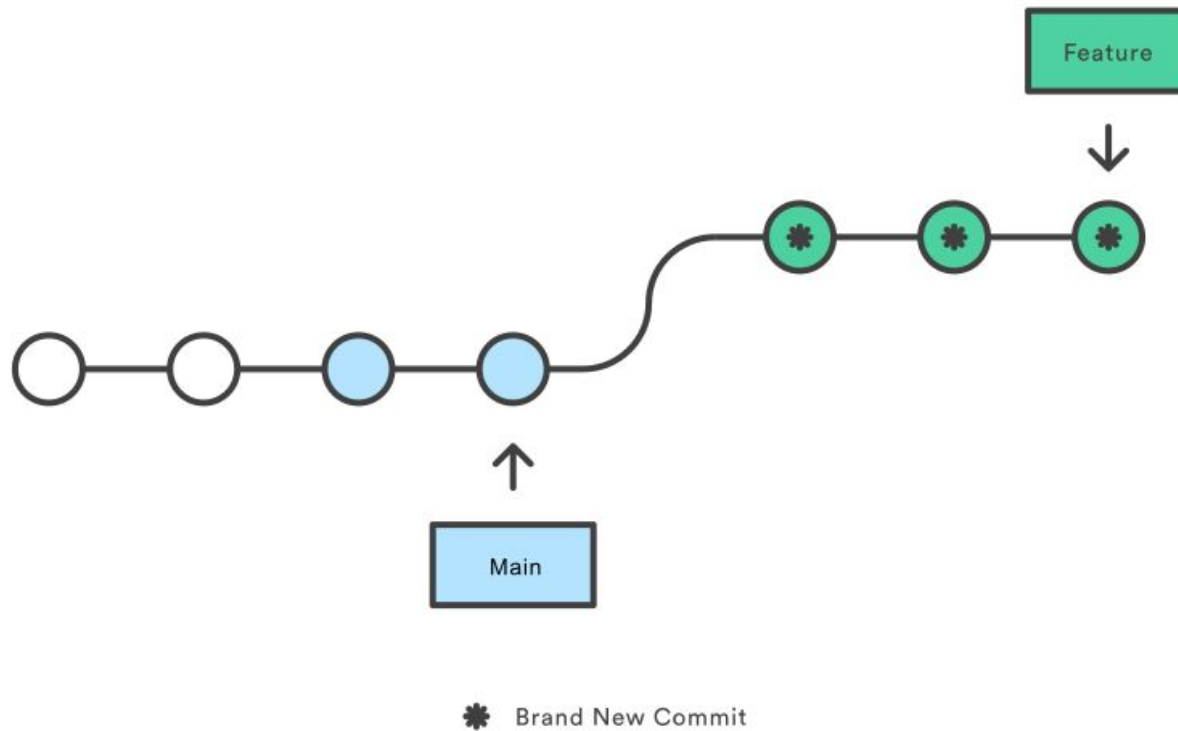
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Merge vs. Rebase

Rebasing the feature branch onto main

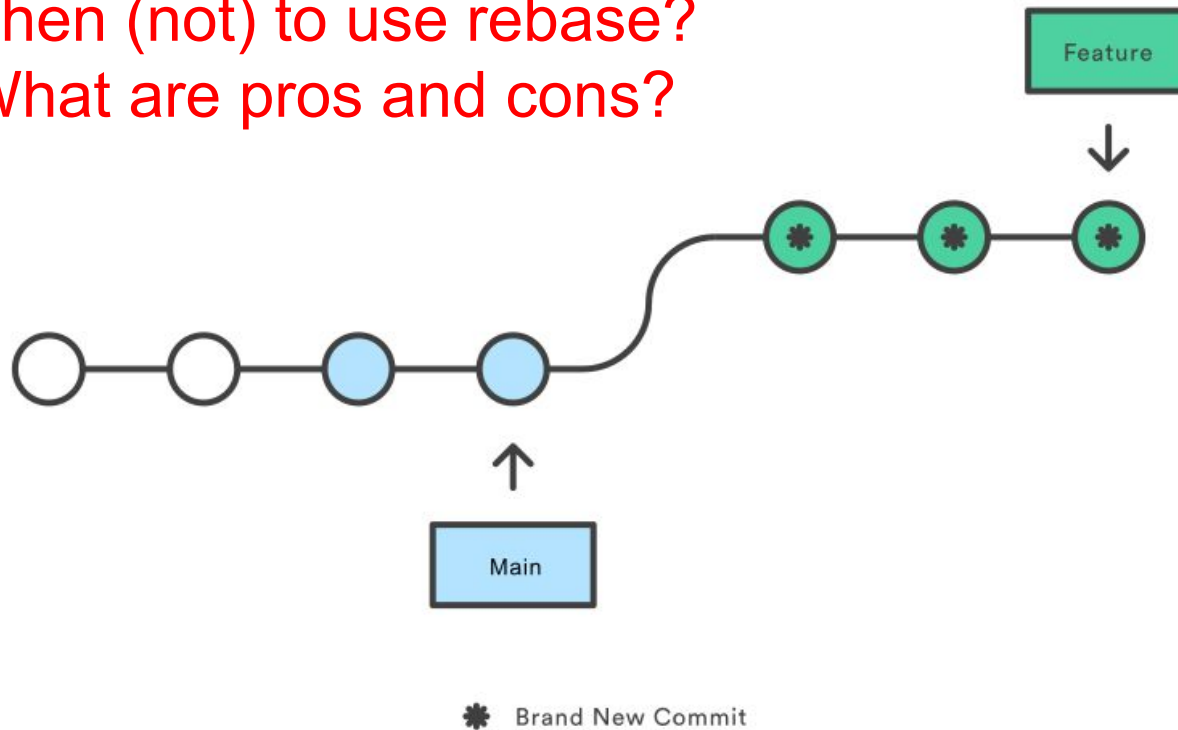


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Merge vs. Rebase

Rebasing the feature branch onto main

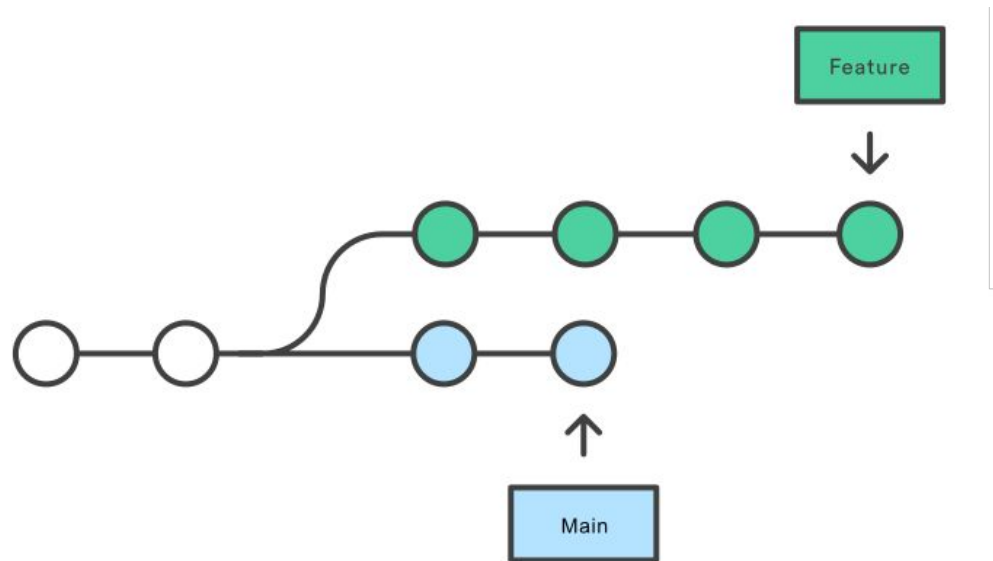
When (not) to use rebase?
What are pros and cons?



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Interactive Rebase

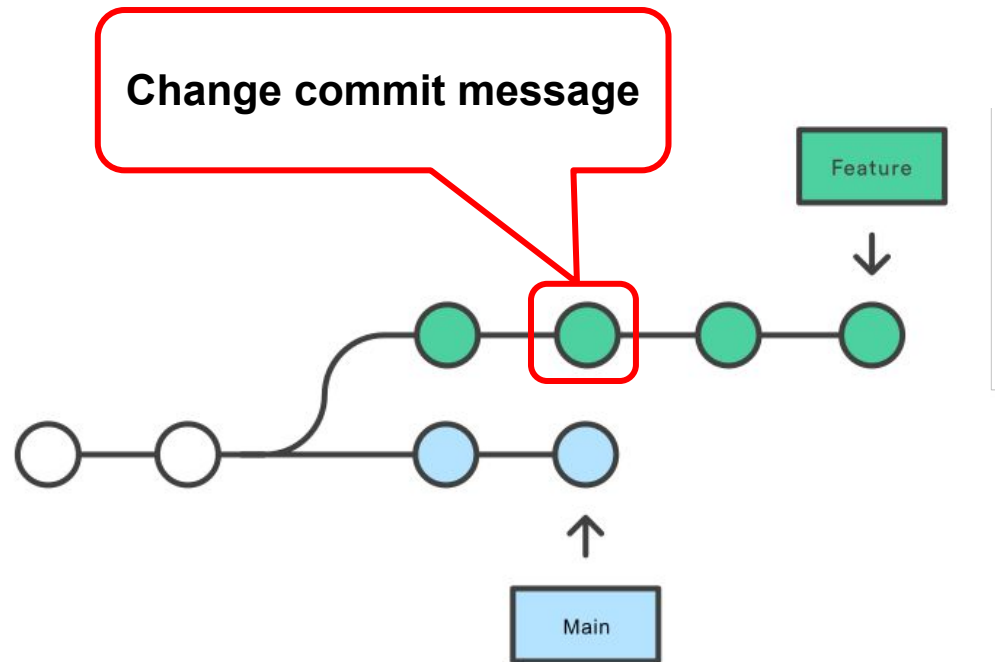
Developing a feature in a dedicated branch



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Interactive Rebase (reword)

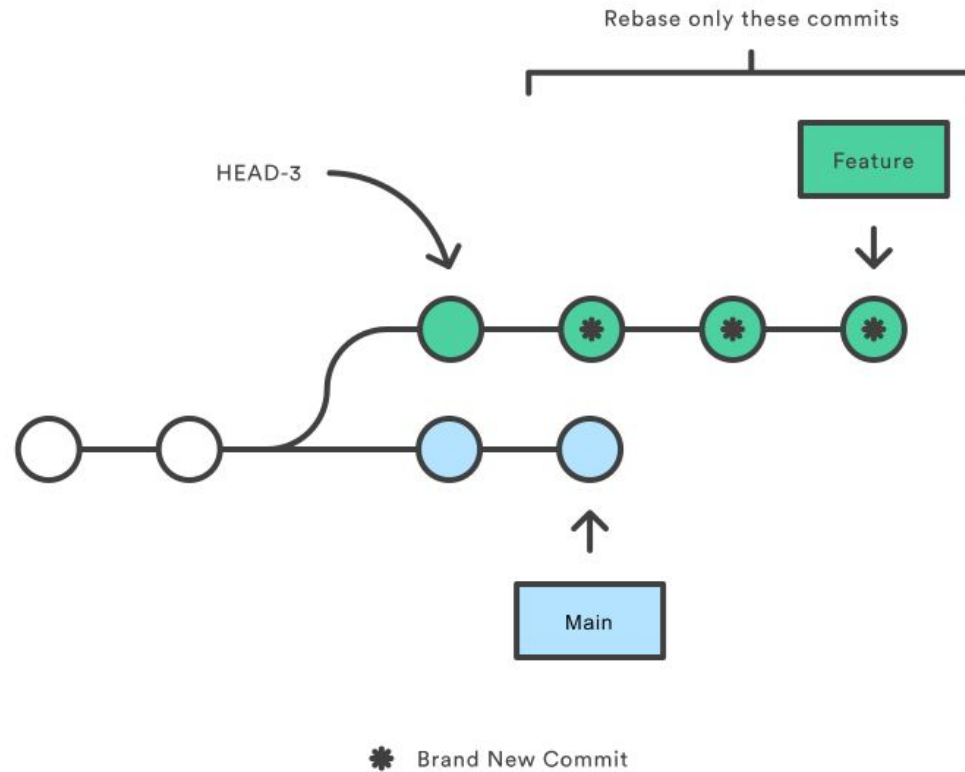
Developing a feature in a dedicated branch



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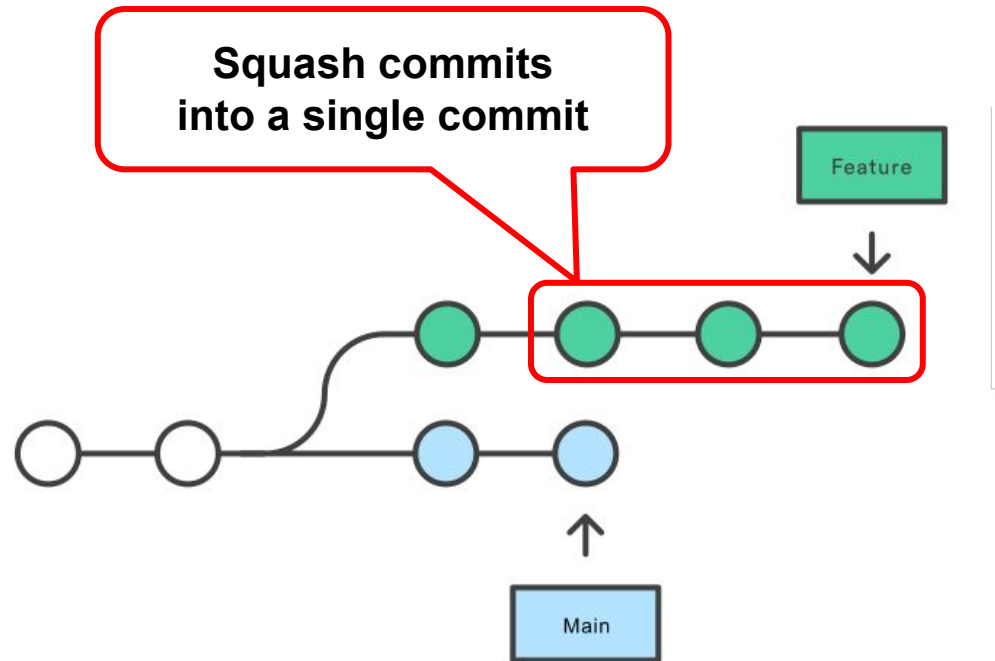
Rebasing onto HEAD-3



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Interactive Rebase (squash)

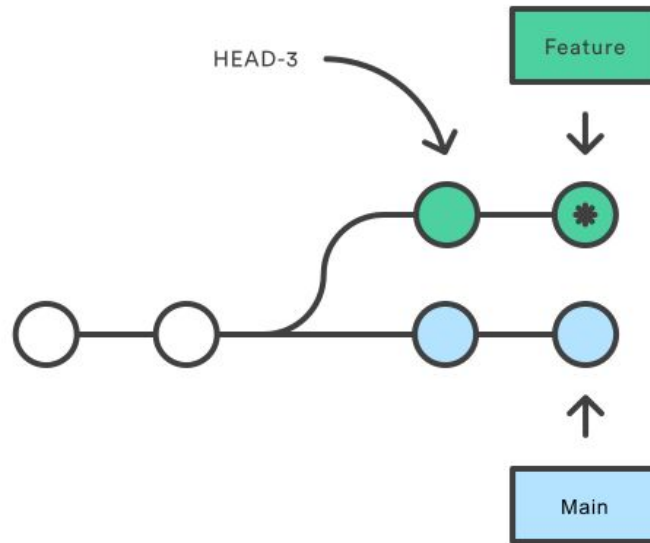
Developing a feature in a dedicated branch



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Interactive Rebase (squash)

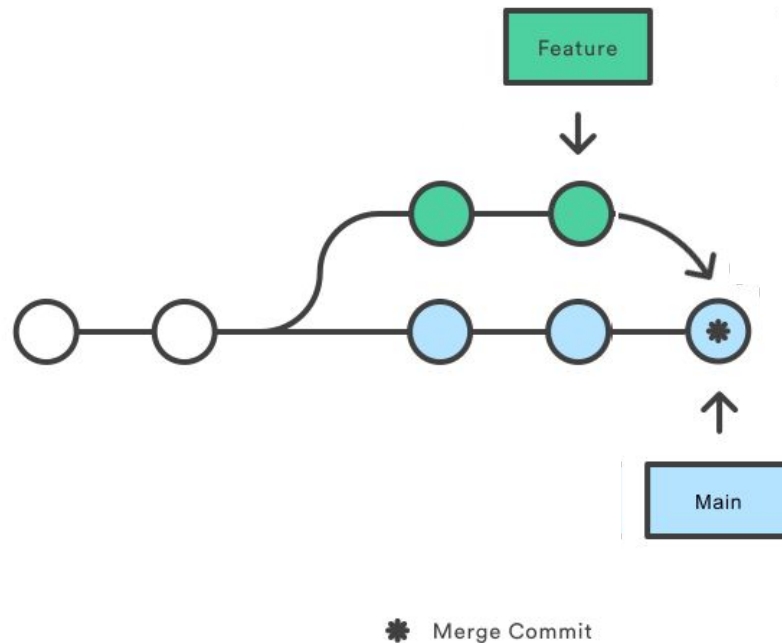
Rebasing onto HEAD-3



* Brand New Commit

<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Interactive Rebase (squash & merge)



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Squash & merge on GitHub

Create a merge commit

All commits from this branch will be added to the base branch via a merge commit.

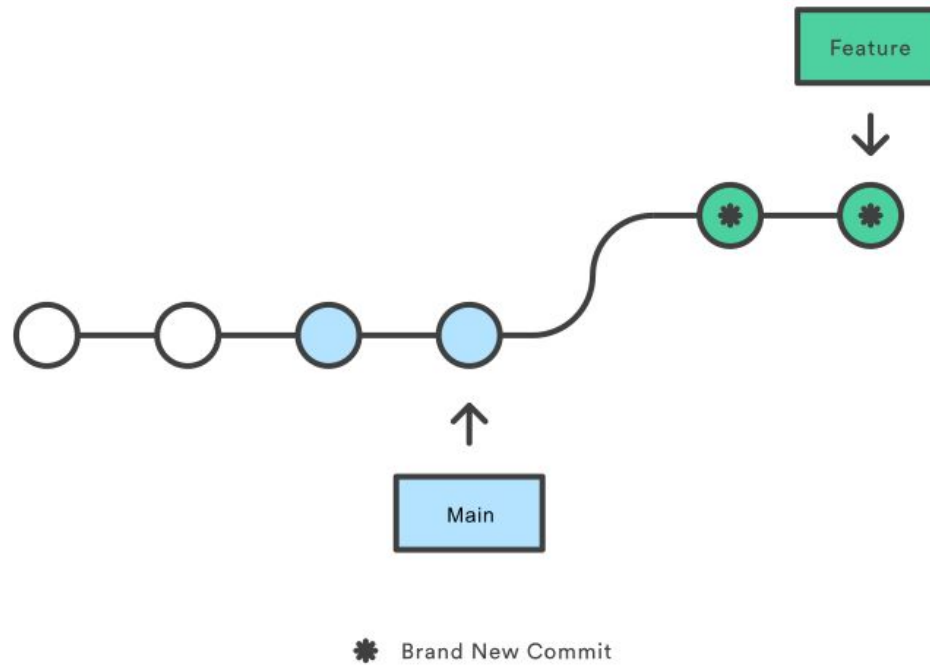
✓ **Squash and merge**

The 14 commits from this branch will be combined into one commit in the base branch.

Rebase and merge

The 14 commits from this branch will be rebased and added to the base branch.

Interactive Rebase (squash & rebase)



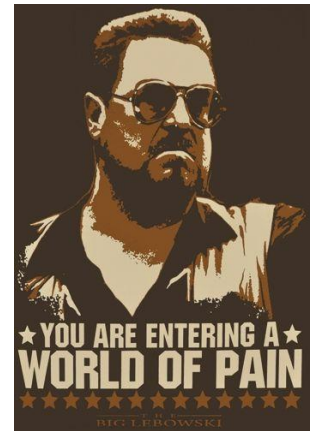
<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Rebase: a powerful tool, but ...

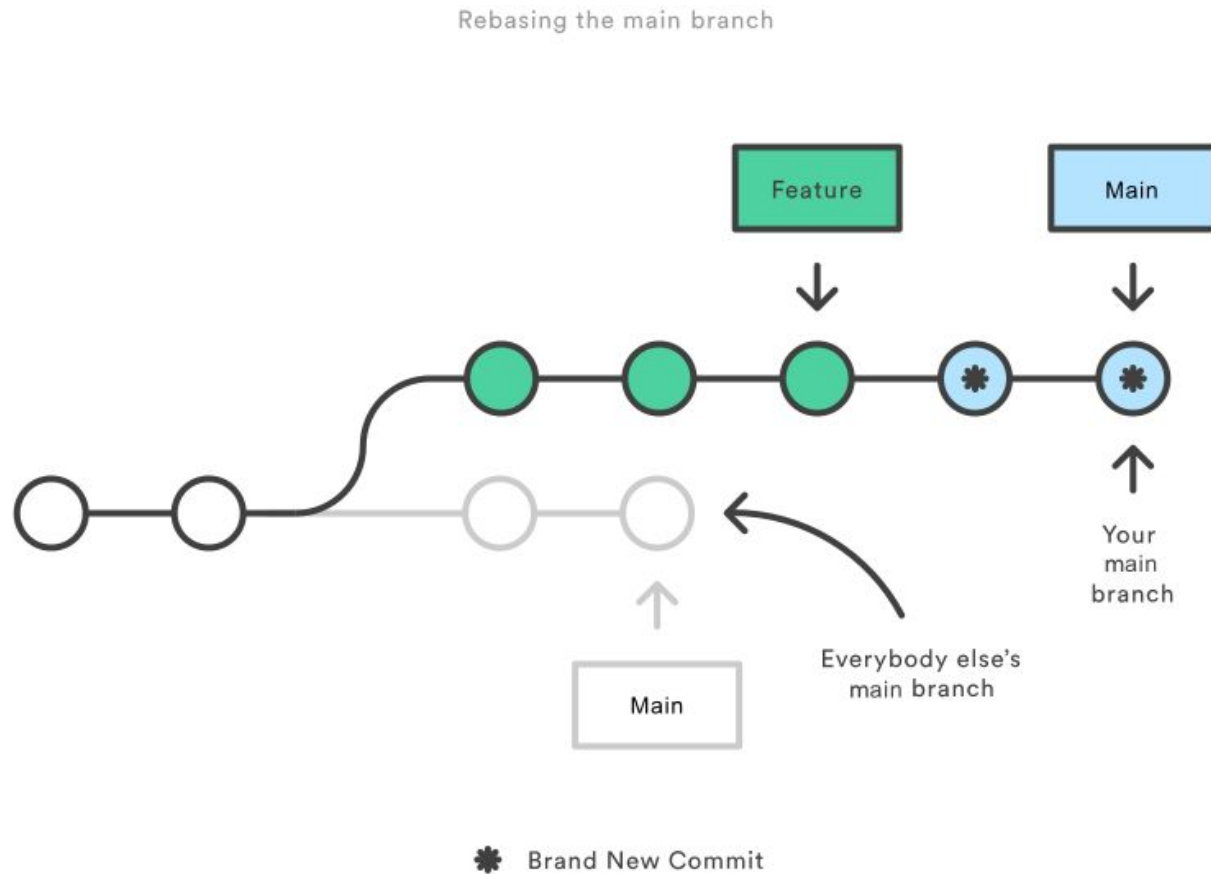
- Results in a sequential commit history.
- Interactive rebasing often used to squash commits.
- **Changes the commit history!**



**Do not rebase public branches
with a force-push!**



Rebase: a powerful tool, but ...



<https://www.atlassian.com/git/tutorials/merging-vs-rebasing>

Git concepts and terminology

Motivating Example: What is this Git command?

NAME

git-_____ - _____ file contents to the index

SYNOPSIS

git _____ [--dry-run | -n] [--force | -f] [--interactive | -i] [--patch | -p]

DESCRIPTION

This command updates the index using the current content found in the working tree, to prepare the content staged for the next commit. It typically _____s the current content of existing paths as a whole, but with some options it can also be used to _____ content with only part of the changes made to the working tree files applied, or remove paths that do not exist in the working tree anymore.

Motivating Example: What is this Git command?

NAME

git-add - Adds file contents to the index

SYNOPSIS

```
git add [--dry-run | -n] [--force | -f] [--interactive | -i] [--patch | -p]
```

DESCRIPTION

This command updates the index using the current content found in the working tree, to prepare the content staged for the next commit. It typically adds the current content of existing paths as a whole, but with some options it can also be used to add content with only part of the changes made to the working tree files applied, or remove paths that do not exist in the working tree anymore.

Git: concepts and terminology

SYNOPSIS

git-diff-index [-m] [--cached] [<common diff options>] <tree-ish> [<path>...]

DESCRIPTION

git-diff-index compares the content and mode of the blobs found in a tree object with the corresponding tracked files in the working tree, or with the corresponding paths in the index.

Git: concepts and terminology

SYNOPSIS

git-diff-index [-m] [--cached] [<common diff options>] <tree-ish> [<path>...]

DESCRIPTION

git-diff-index compares the content and mode of the blobs found in a tree object with the corresponding tracked files in the working tree, or with the corresponding paths in the index.

SYNOPSIS

git-allocate-remote [--derive-head | --massage-link-head | --abduct-commit]

DESCRIPTION

git-allocate-remote allocates various non-branched local remotes outside added logs, and the upstream to be packed can be supplied in several ways.

SYNOPSIS

git-resign-index [--snap-file] [--direct-change]

DESCRIPTION

git-resign-index resigns all non-stashed unstaged indices, and the --manipulate-submodule flag can be used to add a branch for the upstream that is counted by a temporary submodule.

Git: concepts and terminology

SYNOPSIS

git-diff-index [-m] [--cached] [<common diff options>] <tree-ish> [<path>...]

DESCRIPTION

git-diff-index compares the content and mode of the blobs found in a tree object with the corresponding tracked files in the working tree, or with the corresponding paths in the index.

SYNOPSIS

git-allocate-remote [--derive-head | --massage-link-head] <remote-name> [<remote-url>]

DESCRIPTION

git-allocate-remote allocates a new non-branch local remote, possibly adding logs, and the upstream to be packed can be specified in several ways.

SYNOPSIS

git-resign-index [--map <map>] [--direct-checkout <dir>]

DESCRIPTION

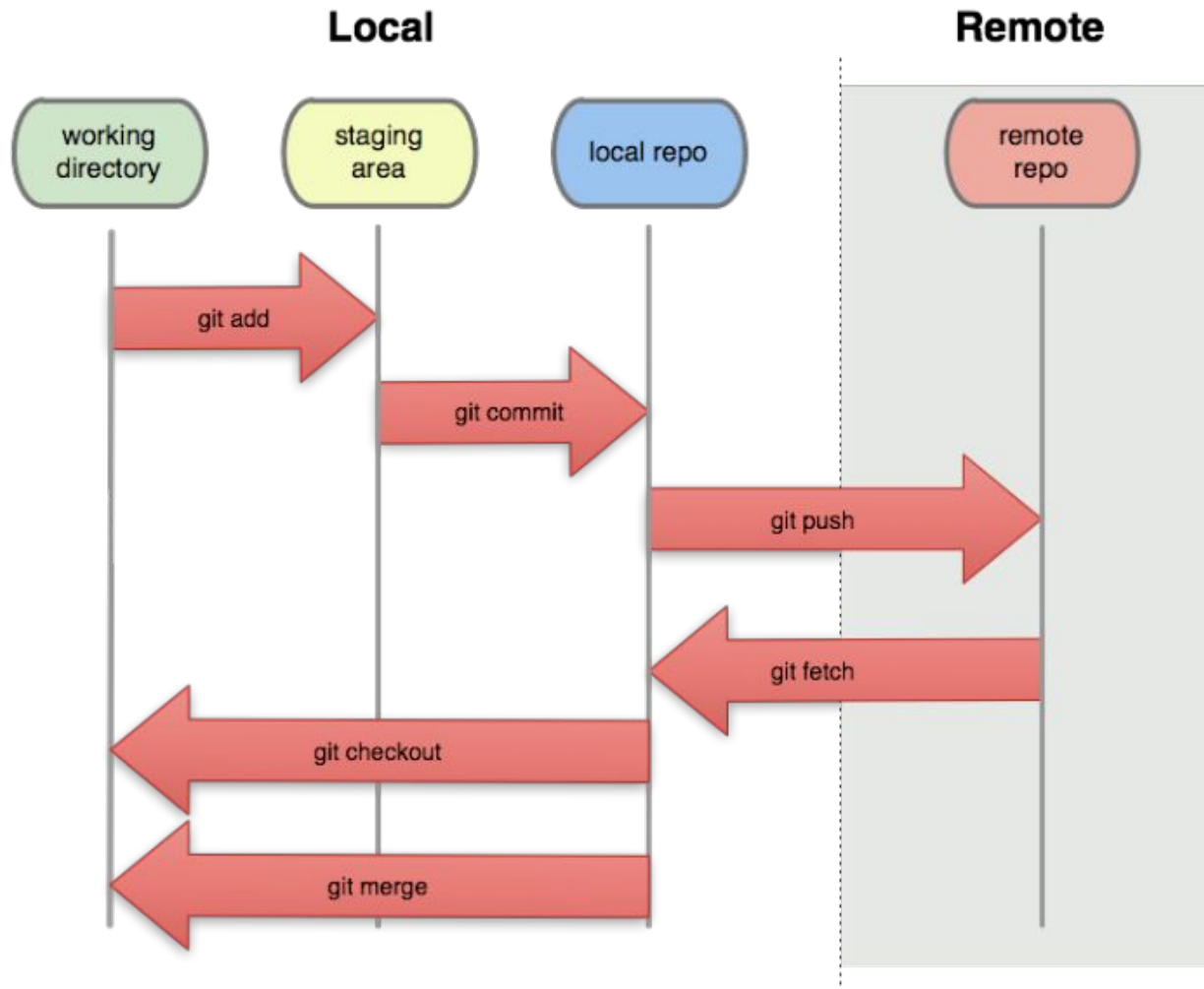
git-resign-index resigns all non-merged unstaged indices, and the `--manipulate-submodule` flag can be used to add a branch for the upstream that is counted by a temporary submodule.



Git: vocabulary

- **index**: staging area (located .git/index)
- **content**: git tracks **what is in a file, not the file itself**
- **tree**: git's representation of a file system
- **working tree**: tree representing the local working copy
- **staged**: ready to be committed
- **commit**: a snapshot of the working tree (a database entry)
- **ref**: pointer to a commit object
- **branch**: just a (special) ref; semantically: represents a line of dev
- **HEAD**: a ref pointing to the working tree

Git: concepts and terminology



In-class exercise 1