Version Control

Martin Kellogg

Testing (part 3)

Today's agenda:

- Reading Quiz
- Finish up slides from last lecture
- Test input generation (**fuzzing**)
- Test oracle generation
- Test prioritization & test suite minimization

This is how far we got on 9/20/24. Before we cover today's topic (version control), we're going to finish this.

Test input generation

- As a human, often **choosing good test inputs** is the hardest part of writing a test
- For a computer, that's not true: computers can pick inputs **very fast** (given some policy)
- **Key problem**: which inputs should we pick?
  - Lens of **Logic**: choose inputs that will maximize coverage
  - Lens of **Statistics**: choose inputs "at random"
  - Lens of **Adversity**: choose inputs that kill mutants

Lens of Statistics: fuzzing and random testing

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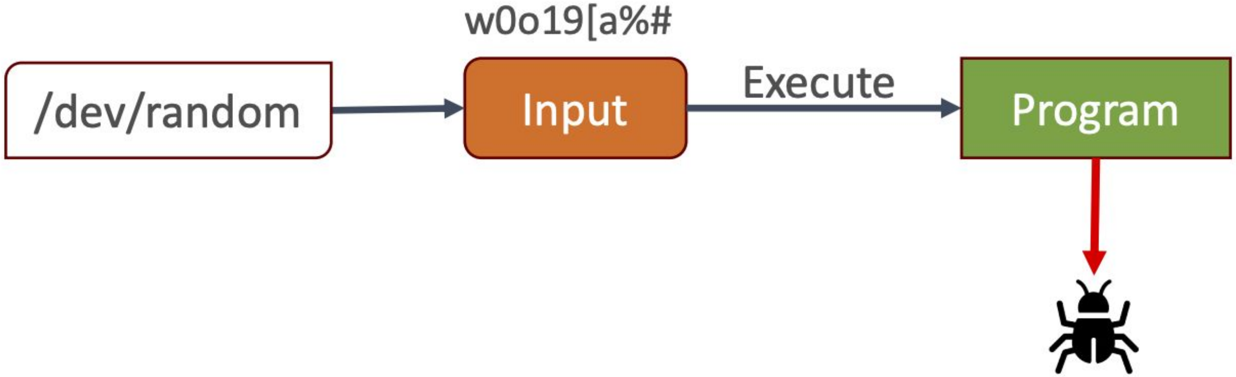

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  - so modern fuzzers use some kind of **semi-random, directed search**

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- Fuzzing **finds real bugs**
  - especially useful for finding security bugs

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Lens of Adversity: killing mutants

- Actually, **not as useful as it seems** for automatic test generation
  - still need to use either path predicates or fuzzing to choose inputs
- Can be a useful **fitness function** or guide for other automated test input generation approaches

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  - A **big cost problem**!

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  - answer: it's "hard" (similar "traditional" problem that you might consider a reduction to: **knapsack**)

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- How does a version control system work?
- How to use your VCS
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Reading Quiz: version control

Q1: When does the author of “Version control concepts and best practices” argue it is appropriate to rewrite history?

A. when you have committed something unintentionally
B. when you have committed a generated file
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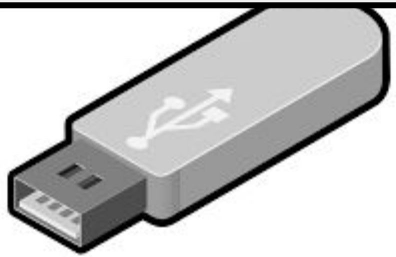

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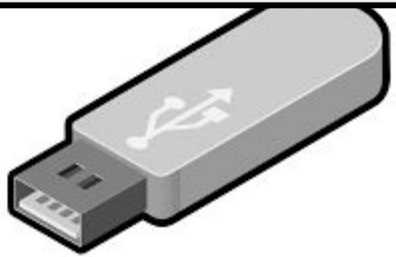
- **but not for code**



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- **Coordinate**/merge work between team members
  - Or yourself, on multiple computers, or multiple features

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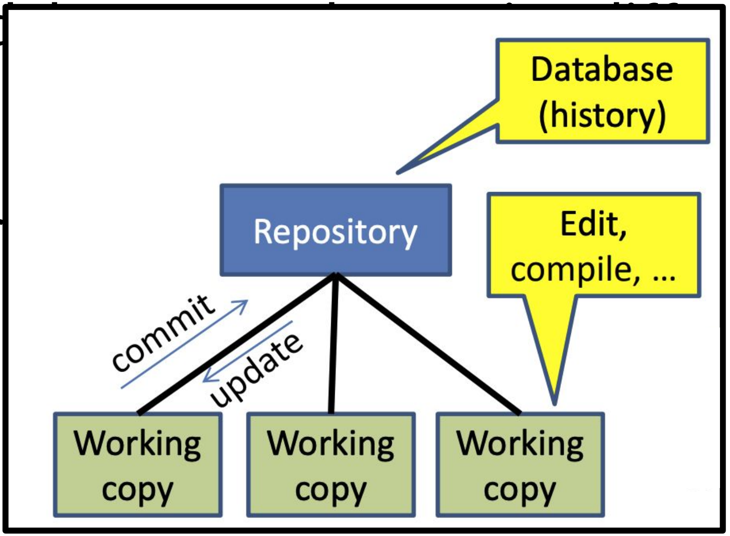

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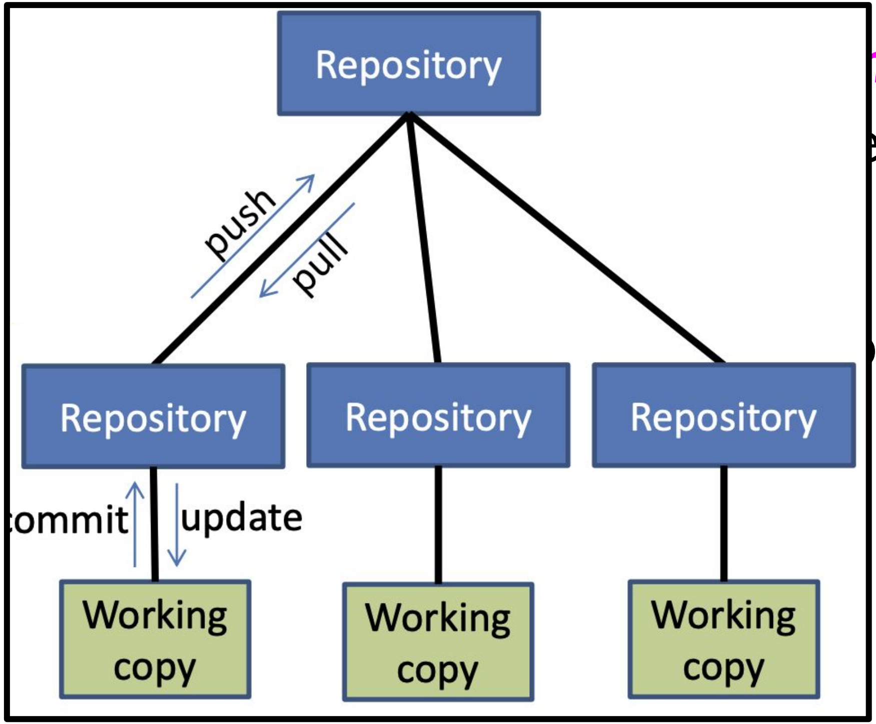

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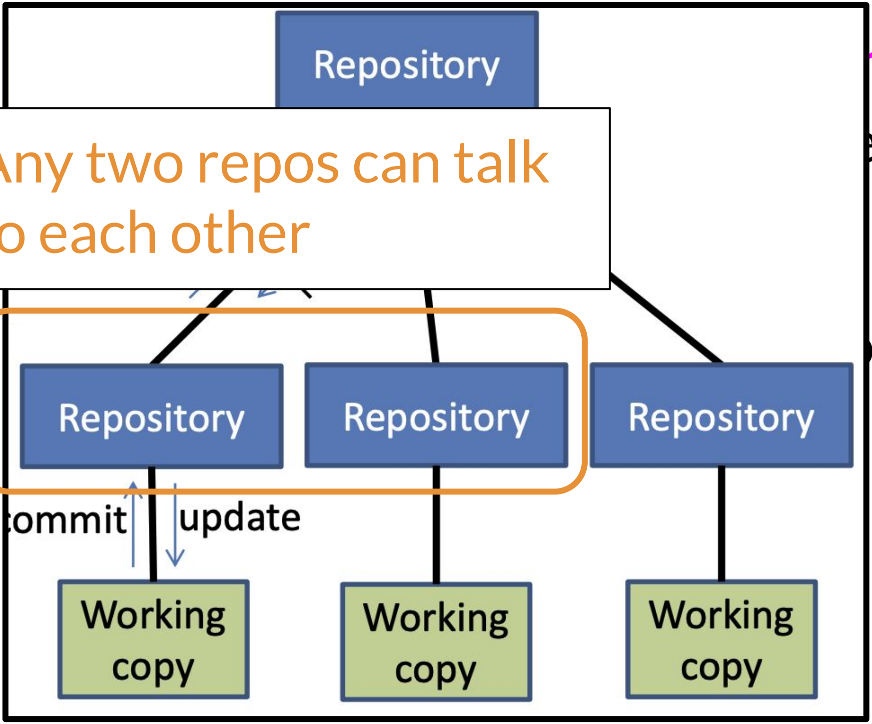

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typical setup: distributed VCS with a single, privileged main

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Distributed VCS is now the **industry standard** (e.g., git, hg). (Some organizations do still use centralized, though.)

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- Rationale:
  - Maintain more accurate, complete history
  - Keep all users in sync
  - Avoid painful conflicts
  - Avoid loss of work

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- If you have made changes in parallel, you must **merge**
  - Merge = create a new version incorporating all changes

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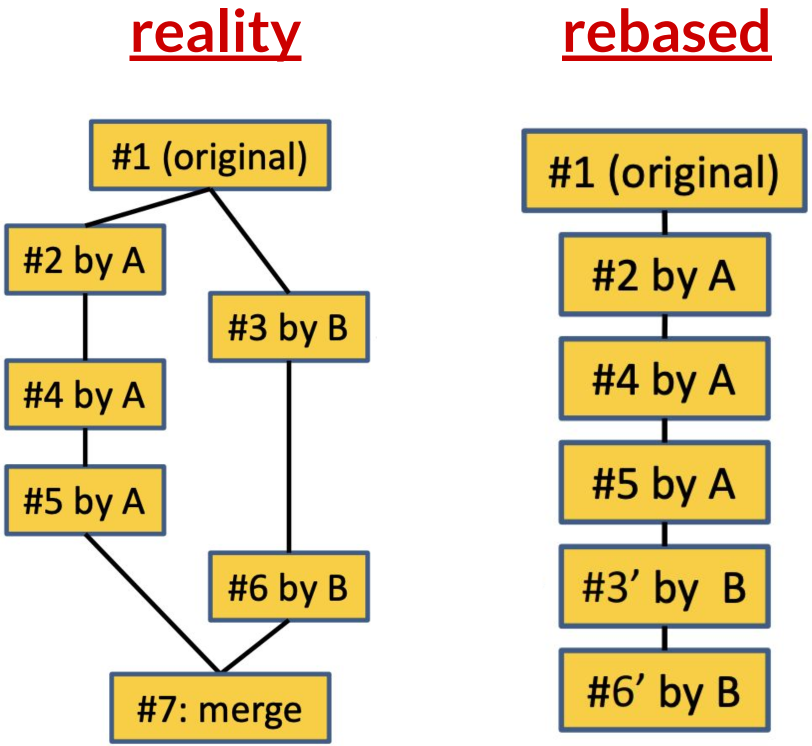

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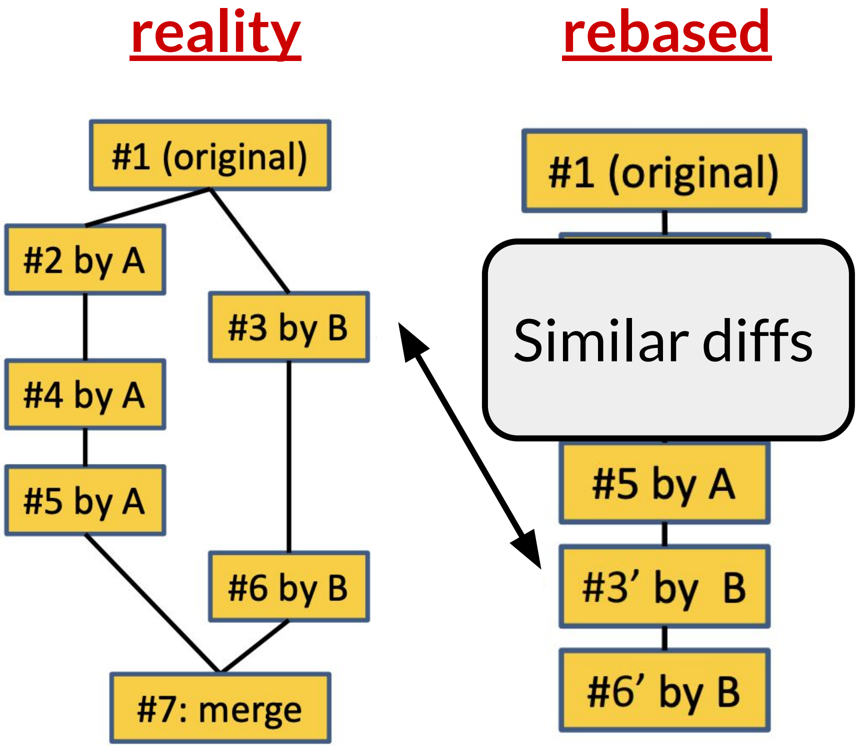

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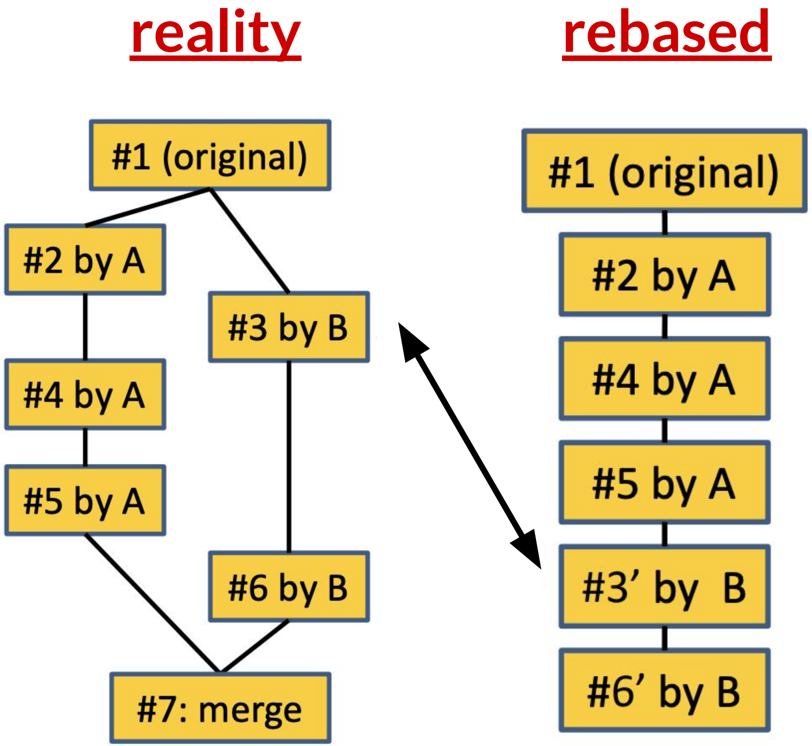

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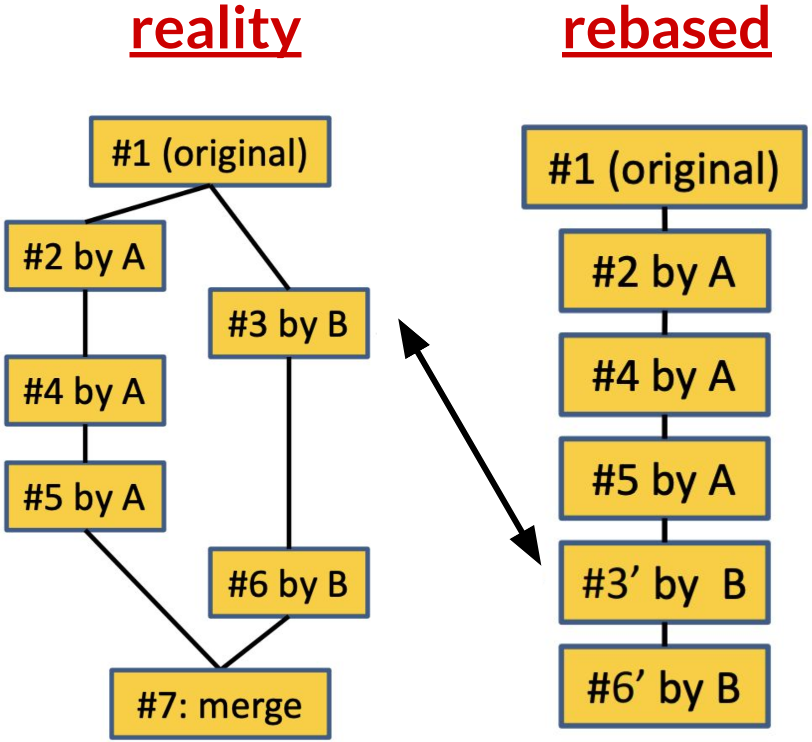

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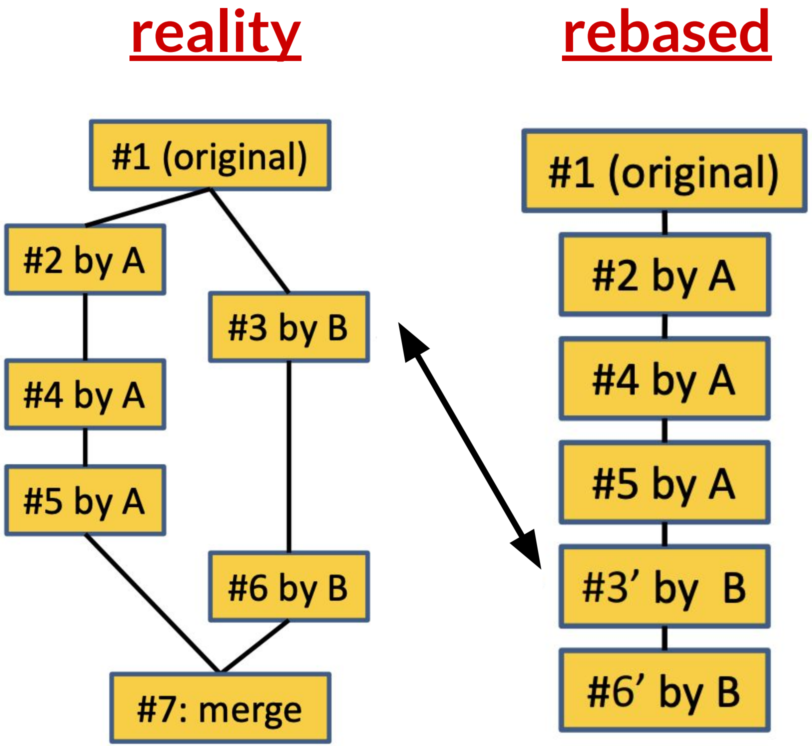
- Squash-and-merge is a safer form of rebasing



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- A heuristic about when to get the user involved
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Useful tool for thinking about anything that might warn us about a problem

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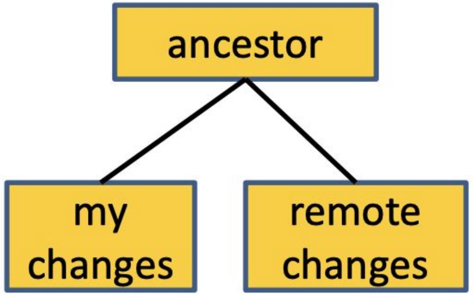

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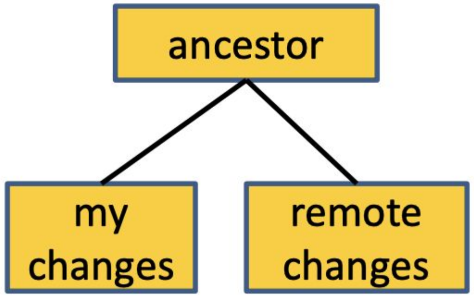

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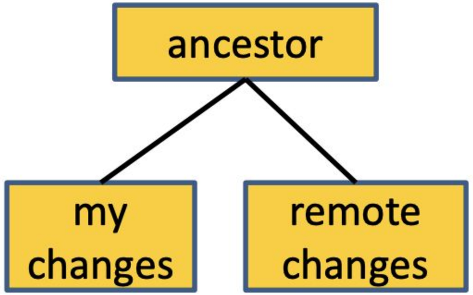
- **Don't panic!** Instead, think.
- **You can always** bail out of the merge and **start over**
  - You have the full local and remote history



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Version Control: advice and best practices

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    - Wastes space in repository
    - Causes merge conflicts

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- Pros:
  - features developed in isolation (less risk of main being broken)
  - encourages small PRs
- Cons:
  - large features can make integration difficult

Best practice: feature branch development

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Advice: use feature branch development model iff your team typically ships features quickly

Advice: synchronize with teammates often

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  - Avoid difficult and/or complex merges
- Push as often as practical
  - Don’t let your teammates get behind you!
  - Don’t destabilize the main build
  - Avoid long periods working on a branch
    - but do work in a feature branch - don’t work directly on main!

Advice: commit messages

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- Commit messages should be **descriptive**
- Don't write a novel: **summarize**. The code documentation in the commit should cover the rest.

Advice: commit messages: good or bad?

```
commit 763fe9cc335bb78ca45a608fa1f4c606713d5b44
Author: [redacted]
Date:

    Simplify `getImmediateSubcheckerClasses()` implementation (#5579)
```

Advice: commit messages: good or bad?

```
commit 763fe9cc335bb78ca45a608fa1f4c606713d5b44
Author:
Date:

    Simplify `getImmediateSubcheckerClasses()` implementation (#5579)
```

GOOD: short and to the point. Contains link to the PR it was merged in

Advice: commit messages: good or bad?

```
commit 123317b24a72215071a0f02e08635ee4b5b9669a
Author: [redacted]oreply.github.com>
Date:   [redacted]

    Update the code (#5)
```

Advice: commit messages: good or bad?

```
commit 123317b24a72215071a0f02e08635ee4b5b9669a
Author: [redacted] oreply.github.com>
Date: [redacted]

    Update the code (#5)
```

NOT SO GOOD:
description is vague
(looks auto-generated!)

Advice: commit messages: good or bad?

```
commit ddb6ab4df36a6bac3d4b118d40278f3428029f0c
Author: [redacted]@virginia.edu>
Date:   [redacted] 2014 -0500

    Comments? My code is self documenting.
```

Advice: commit messages: good or bad?

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commit ddb6ab4df36a6bac3d4b118d40278f3428029f0c
Author: [redacted]@virginia.edu>
Date:   [redacted] 2014 -0500

    Comments? My code is self documenting.
```

NOT SO GOOD: while the humor is nice, this message is content-free

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    - Error-prone
  - Create a branch for each simultaneous task
    - Need to keep track of all your branches, merge
    - Easier to share unfinished work with teammates

Advice: ways to avoid merge conflicts

- **Modularize** your work
  - Divide work so that individuals or subteams "**own**" a module
  - Other team members only need to understand its specification (abstractions!)
  - Requires good documentation and testing

Advice: ways to avoid merge conflicts

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Bonus: this kind of modularization improves **observability** for management: it's easier to see who is being productive

Advice: ways to avoid merge conflicts

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  - Other team members only need to understand its specification (abstractions!)
  - Requires good documentation and testing
- **Communicate** about changes that may conflict
  - Don't overwhelm the team with such messages

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  - backups
  - feature branches are still useful when working on multiple parts of a system in parallel
  - sharing work across multiple computers

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  - GitHub will give you free private repos because you're students

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I use **text-based formats** for many files so that I can version control them

Version Control

Today’s agenda:

- Reading Quiz
- How does a version control system work?
- How to use your VCS
- **GitHub workflows**

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- open PR against "**main**" repository from your fork's feature branch

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  - bonus points: email the full working copy, not just the diffs

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I've seen people make all of these mistakes (and more)!

Takeaways: version control

- Understand what your VCS is good for (storing text files, collaboration) and what it isn't good for (storing binaries!)
- Understand your VCS: don't just thoughtlessly use the GUI
- Follow best practices when using your VCS:
    - don't push straight to main
    - practice resolving merge conflicts
    - use process to try to avoid merge conflicts, if possible
    - commit early and often
    - pull as often as you can