Version Control

Martin Kellogg

Version Control

Today's agenda:

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

Reading Quiz: version control

Q1: **TRUE** or **FALSE**: if you try to run a push command (e.g., `git push`) but git rejects your updates, you should try to run `git push --force` instead

Q2: **TRUE** or **FALSE**: the reading suggests you commit everything in your local working copy every time you commit, including e.g., generated binary files

Q3: **TRUE** or **FALSE**: the reading suggests that you should run pull commands (e.g., `git pull`) frequently: at least once a day

Reading Quiz: version control

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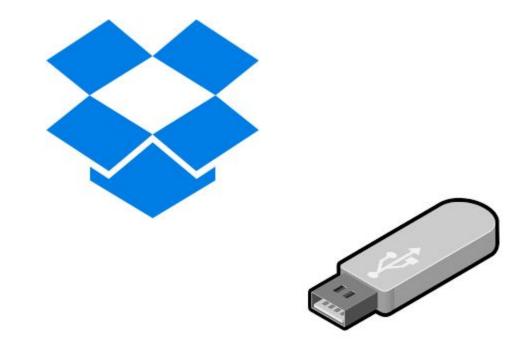
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Announcements:
- IP1 due on Thursday.
    - Don't overcomplicate it: implementations are (mostly) simple
    - Brief explanation of testing your tests
- Huzefa's OH changes:
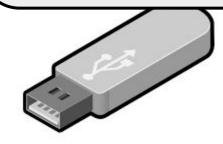   - Monday OH now 4:30-5:30
    - All OH in GITC 4234

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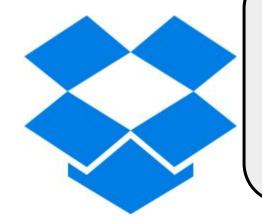- How to use your VCS
- GitHub workflows

Let's share a file

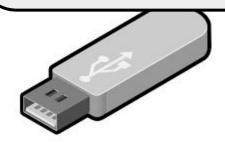# Let's share a file

Let's share a file

These systems are fine for "**binary blobs**": files that you don't intend to change once shared
- **but not for code**

Goals of version control

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- Keep a **history** of your work
  - Explain the purpose of each change
  - Checkpoint specific versions (known good state)
  - Recover specific state (fix bugs, test old versions)

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- Keep a **history** of your work
  - Explain the purpose of each change
  - Checkpoint specific versions (known good state)
  - Recover specific state (fix bugs, test old versions)
- **Coordinate**/merge work between team members
  - Or yourself, on multiple computers, or multiple features

What is version control

Definition: a *version control system* is a program that manages many versions of one or more text-based documents by storing diffs between them

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one main repository, many remotes with working copies

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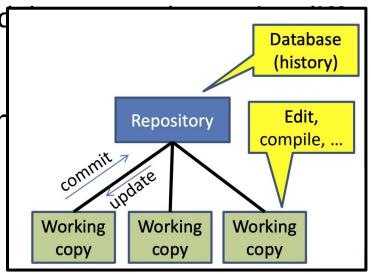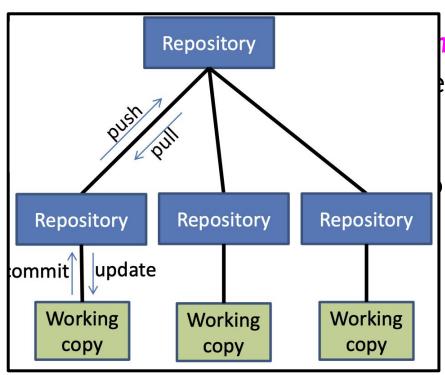
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many repositories, each repository has a working copy

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... or *distributed*

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What is version control

A *version control system* is a program that manages many ...ed documents by storing diffs

... or ***distributed***

many repositories, each repository has a working copy

Any two repos can talk to each other

Repository

Repository   Repository   Repository

commit | update

Working copy   Working copy   Working copy

What is version control

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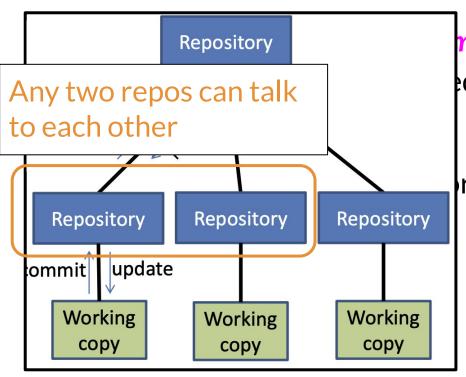one main repository, many remotes with working copies

many repositories, each repository has a working copy

typical setup: distributed VCS with a single, privileged main

Advantages of distributed VCS

- checkpoint work without publishing to teammates
- commit, examine history when not connected to the network
- more accurate history
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Less important in CS 490:

- share changes selectively with teammates
- flexibility in repository organization and workflow
- faster performance

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- commit, examine history when not connected to the network
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- more effective merging algorithms

Less important in CS 490:

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- flexibility in repository organization a
- faster performance

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

Distributed VCS prevents some operations

- No update if uncommitted changes exist: must commit first
- No push if not ahead of remote: must pull & merge first
- No partial update (e.g., updating just one directory)
  - update gets all changes in a changeset (= a commit)

Distributed VCS prevents some operations

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- No push if not ahead of remote: must pull & merge first
- No partial update (e.g., updating just one directory)
  - update gets all changes in a changeset (= a commit)
- Rationale:
  - Maintain more accurate, complete history
  - Keep all users in sync
  - Avoid painful conflicts
  - Avoid loss of work

Coordinating with others

- `pull` incorporates others' changes into your repository
  - (update brings changes into your working copy)
  - (N.b.: `git pull` does pull, merge, and update)

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  - Behind = your history is a **prefix** of master history
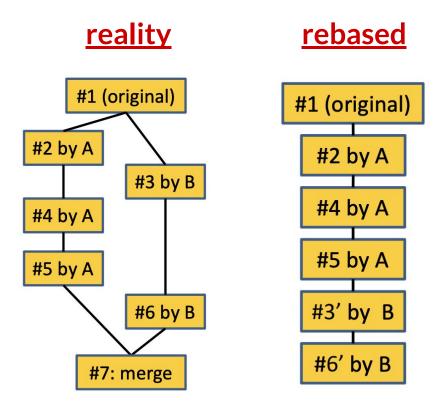
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  - Behind = your history is a **prefix** of master history
- If you have made changes in parallel, you must **merge**
  - Merge = create a new version incorporating all changes

Coordinating with others: rebasing

- `rebase` **rewrites** history

Coordinating with others: rebasing

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reality

rebased

#1 (original)

#2 by A

#3 by B

#4 by A

#5 by A

#6 by B

#7: merge

#1 (original)

#2 by A

#4 by A

#5 by A

#3' by B

#6' by B

Coordinating with others: rebasing

- `rebase` **rewrites** history

#1 (original)

#2 by A

#3 by B

#4 by A

#5 by A

#6 by B

#7: merge

#1 (original)

Similar diffs

#5 by A

#3' by B

#6' by B

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- **Cleaner** history, easier to read

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- Mixes commits #3 and #7
- Does not show context for change #3

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Coordinating with others: rebasing

- `rebase` **rewrites** history
- **Cleaner** history, easier to read
- Mixes commits #3 and #7
- Does not show context for change #3
- Squash-and-merge is a safer form of rebasing

reality

rebased

Coordinating with others: conflicts

Two changes can either be:

- **Conflict-free**:
- **Conflicting**:

Coordinating with others: conflicts

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- A heuristic about when to get the user involved
- Could yield compile errors or test failures

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Aside: false positives and false negatives

Can X **actually** happen?

<u>YES</u>   <u>NO</u>

Aside: false positives and false negatives

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Did a tool **warn** us about X?

	YES	NO
YES		
NO		

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	YES	NO
YES	True positive	False positive
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Useful tool for thinking about anything that might warn us about a problem

Coordinating with others: conflicts

Two changes can either be:

- **Conflict-free**: changes are to different lines of a file
- **Conflicting**:
  - Simultaneous changes to the same
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False positives,
false negatives,
both, or neither?

"Conflict-free" is a **textual**, **not semantic**, notion

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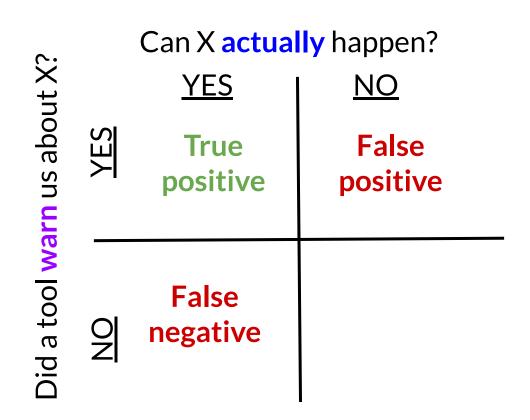- Could yield compile errors or test failures

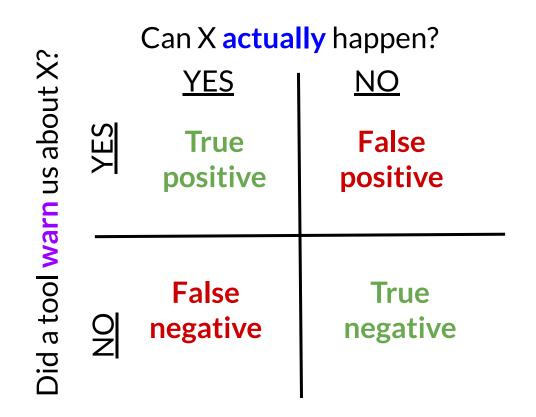# Coordinating with others: conflicts
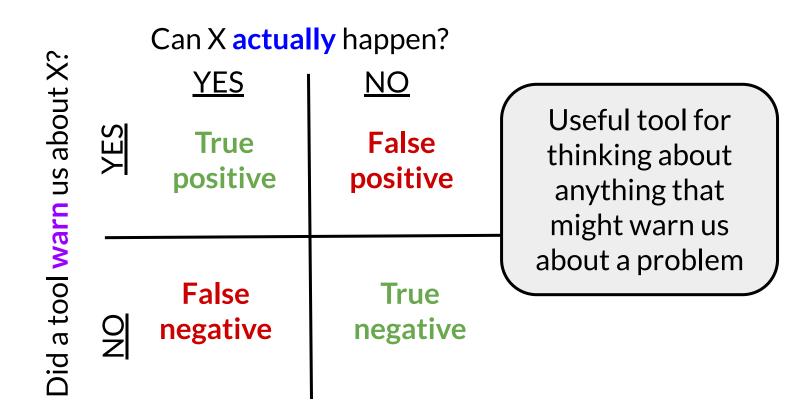
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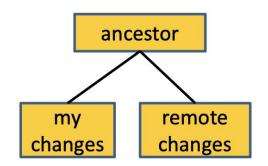   - Requires manual conflict resolut

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Coordinating with others: resolving conflicts

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Coordinating with others: resolving conflicts

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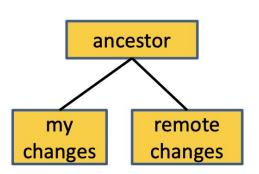 - **Practice** this ahead of time!

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- Many merge tools exist
- Configure your DVCS to use the merge tool that you prefer
  - **Practice** this ahead of time!
- **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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    - Binaries (e.g., .class files), etc.
    - IDE files (your teammates might use other tooling)

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    - IDE files (your teammates might use other tooling)
  - Wastes space in repository
  - Causes merge conflicts

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  - encourages small PRs
- Cons:
  - large features can make integration difficult

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

Advice: synchronize with teammates often

- Pull often

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  - Avoid difficult and/or complex merges

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Advice: synchronize with teammates often

- Pull often
  - **Avoid getting behind** the main repo or your teammates
  - 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

- **Always** write a commit message

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- Commit messages should be **descriptive**

Advice: commit messages

- **Always** write a commit message
- 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:
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:                                        noreply.github.com>
Date:

    Update the code (#5)
```

Advice: commit messages: good or bad?

```
commit 123317b24a72215071a0f02e08635ee4b5b9669a
Author:                                              noreply.github.com>
Date:

    Update the code (#5)
```

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

Advice: commit messages: good or bad?

```
commit ddb6ab4df36a6bac3d4b118d40278f3428029f0c
Author:                        ⟩@virginia.edu>
Date:                          ⟩ 2014 -0500

    Comments? My code is self documenting.
```

Advice: commit messages: good or bad?

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Author:                              @virginia.edu>
Date:                              2014 -0500

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NOT SO GOOD: I know writing jokes is fun, but try to keep commit messages serious

Advice: commit early and often

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- How to make many small commits:
  - Do only **one task at a time** and commit after each one

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  - Do only **one task at a time** and commit after each one
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    - Commit only a subset of files (use Git's staging area)
    - Error-prone

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  - Do multiple tasks in one working copy
    - Commit only a subset of files (use Git's staging area)
    - 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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  - Divide work so that individuals or subteams "**own**" a module
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  - 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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- Use **private repos** for things that should be private (e.g., your IP0/1/2 solutions…)
  - 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

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  - reminder: what were those? (see lecture 4)

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- **prepare** for code review: follow code review author's best practices
    - reminder: what were those? (see lecture 4)
- open PR against "main" repository from your fork's feature branch

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- **email** your changes to the maintainer of the original project

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- write code (if there are already tests, don't bother to run them)
- commit **all** of your code at once, when you're done
- **don't bother** to check if you've followed best practices
- **email** your changes to the maintainer of the original project
  - bonus points: email the full working copy, not just the diffs

How NOT to make a PR on GitHub

- start by creating a *hard fork* of the project
  - a new repository controlled by you, unconnected to the main
- do all of your work on the repository's **main** branch
- write code (if there are already tests, don't bother to run them)
- commit **all** of your code at once, whe
- **don't bother** to check if you've follo
- **email** your changes to the maintaine
  - bonus points: email the full worki

> 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