Leveraging version control to accelerate research

or Lessons learned in academic software engineering
or Don't make the mistakes I did!

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A note on terminology

Github $\subset$ git $\subset$ Version Tracking/Control $\subset$ Configuration Management

Introduction to version control

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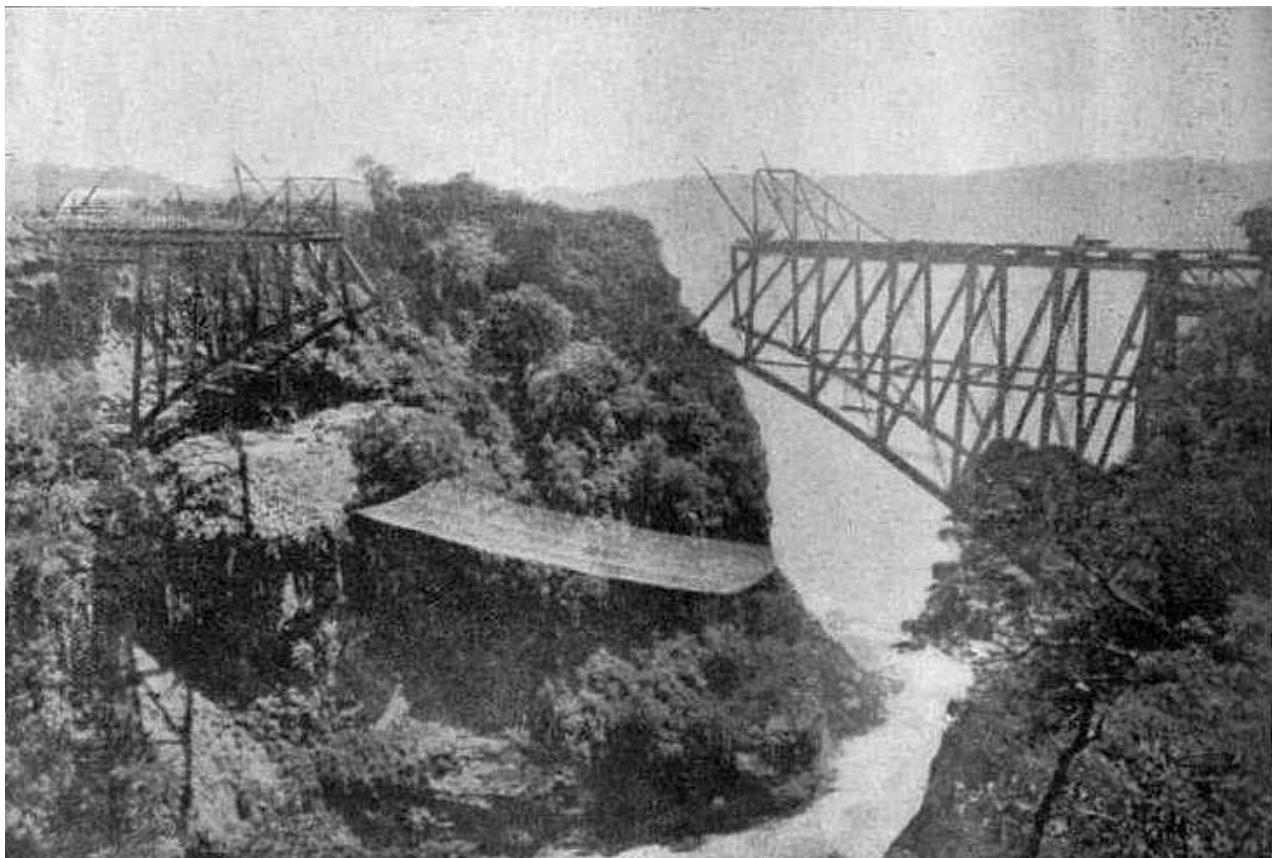
Version control manages changes to collections of information.

Introduction to version control

- Broadly, version control allows you to:
  - track, manage, and understand changes
  - collaborate effectively
  - store backups
  - create and build upon "known states"
- Version control is often seen as a safety net, which may be why it is often ignored.



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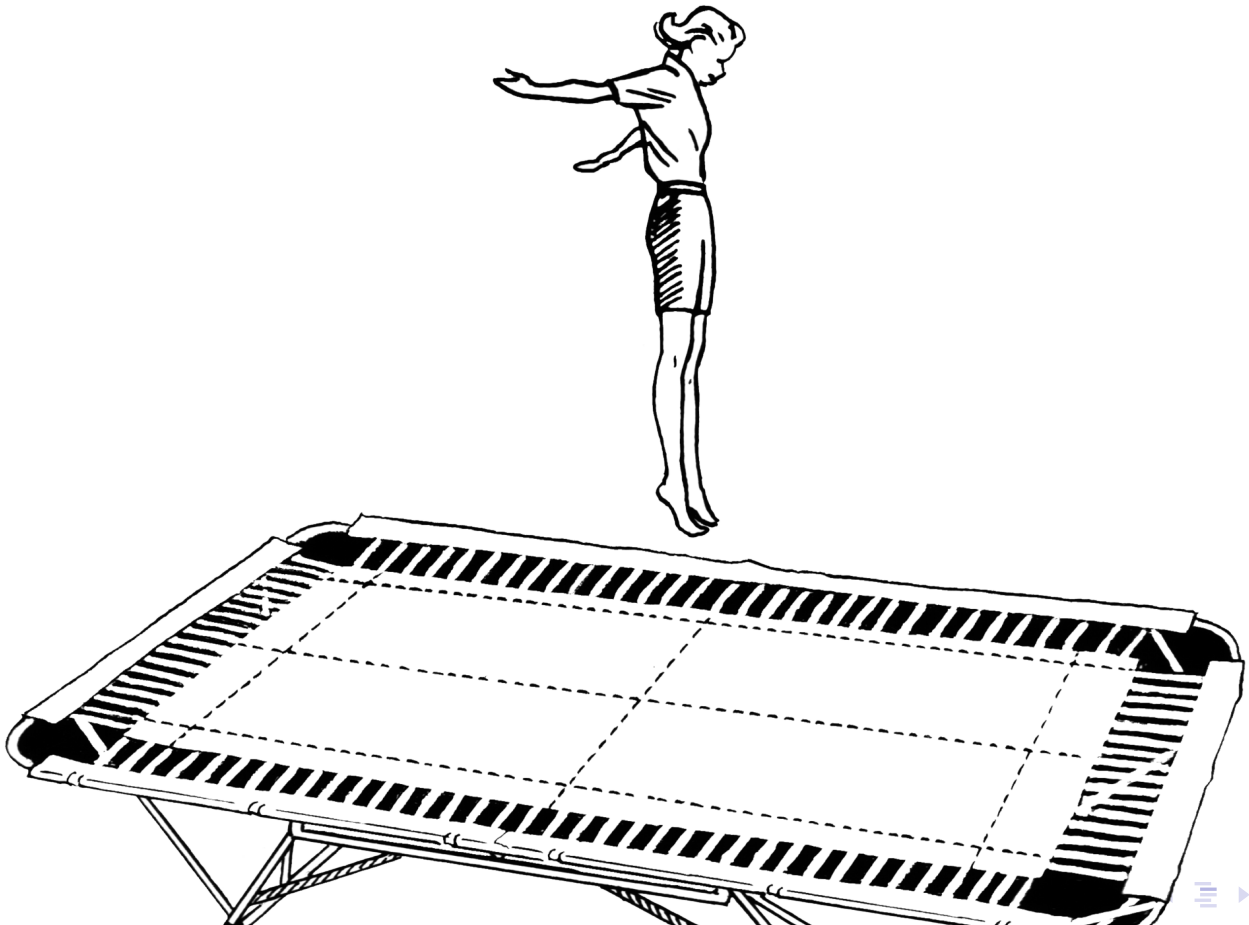
- But perhaps we should view it more as a trampoline!



Introduction to version control

However, version control can also accelerate progress!...Well, indirectly at least.
I will argue that effective utilization can

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  Standardized, automated, decentralized testing bakes in reproducibility, creates known states, and alerts you of unintentional changes.
- **Bake in tenants of Open Science from the start**
  Building a "product" that is incrementally constructed, continuously tested, serving a well-defined goal, reduces work at the end of a project and makes your work easier to understand and build on top of.

Introduction to git

- git was introduced in 2005 to manage development of the linux kernel.
- Extremely lightweight, pervasive, effectively manages projects of any size.
- There are plenty of ways to use git - I will show one that is probably sufficient.

Introduction to github

Github is:

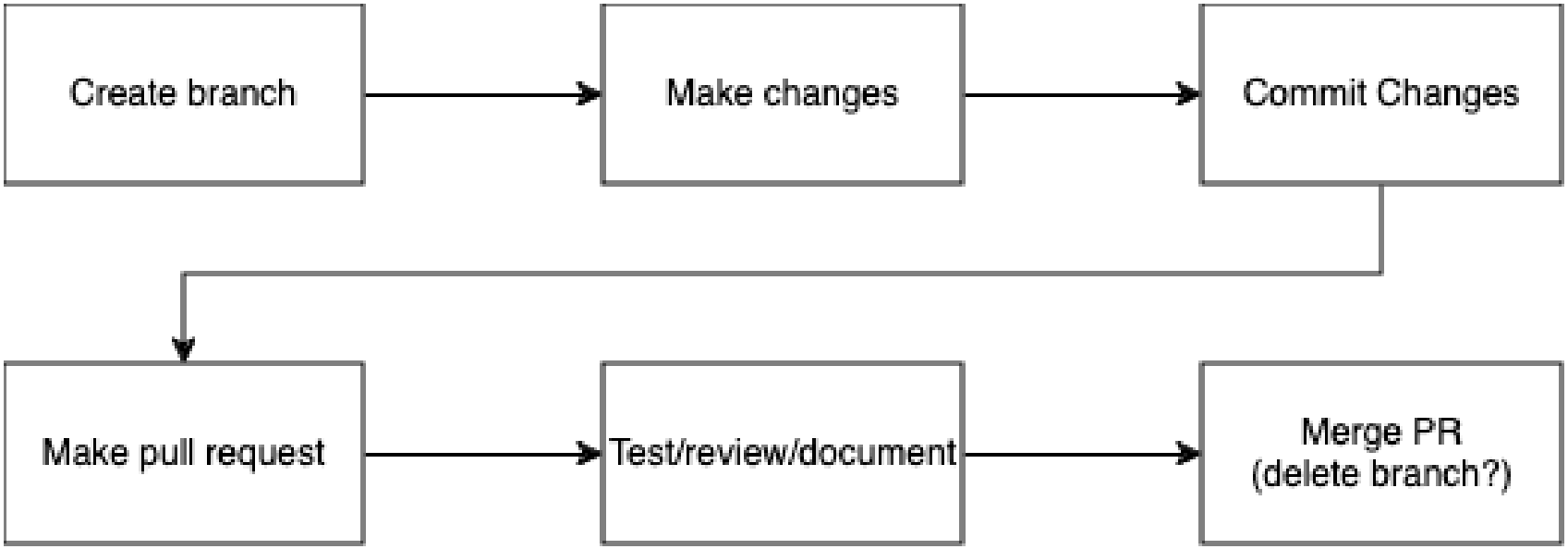
- Perfect in almost every way ✓
- ...owned by Microsoft ✗

Introduction to github

Github is a cloud-based service that

- **is free for students** (and many others)
- **synchronizes git repositories**
  Collaborate with others or yourself, and/or deploy to cloud computing and/or HPC
- **integrates with many toolchains** I alluded to earlier (continuous integration, documentation, project management, etc)
- Has a wonderful getting started tutorial

The git(hub) workflow & branches



- **Branch**: An isolated environment to make changes in, without effecting other branches
- **Commit**: A single batch of changes, usually quite small
- **Pull Request**: (PR) A formal request to merge two branches, usually consisting of peer review/tests/documentation of changes

Use cases

- **Branches**: topic branch, development branch, bug-fix, integration test

Use cases

- **Commits**: commits should happen frequently. Finish that function? Commit. Get another test to pass? Commit. Prove that theorem? Commit.

Use cases

- **Pull Requests**: PRs should happen when a coherent block of functionality is complete. Fix the bug you were hunting? Open a PR. Finish the task? Open a PR.

  Further, PRs are a great place to document the state of the work and handle review comments. Add figures, justify the approach taken, document any hang ups and review comments/follow ups.

Quick example

Github Actions

Github actions are configurable, automated scripts that

- run at pre-determined times (e.g., on PRs/merges)
- automate process like continuous integration (unit/integration testing), build and deploy documentation, codecoverage analysis, etc
- can post results in PRs upon completion

Example: You develop on your laptop and use github to sync to the HPC. Use github actions to ensure your code builds in a clean linux environment.

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Github actions are powerful

Github Actions

- Actions are defined via a *.yml file (YAML)
- Via the YAML file, you specify
  - triggers
  - platform to build on
  - build steps
  - run steps
  - post-run steps
- Look at established repositories for examples!!

Github Actions Examples

Version control as a springboard

- **Reduce cognitive overhead**
- **Deliver incremental success**
- **Reduce technical debt**
- **Bake in tenants of Open Science from the start**

Reduce cognitive overhead

- Trying to solve your problem in one step is admittedly hard, if not impossible
- We're often told to break the problem down into subproblems
- This is usually done informally, if at all.
- Further, when working on a subproblem, its easy to get distracted by an urgent request, or a sticky sub-subproblem.
- **Use issues, branches and PRs to enforce doing one thing at a time!** Not only will this improve the quality of your solutions, but it gives you a fighting chance to understand and document the effects of your solution to the subproblem.

Deliver incremental success

- What is a **known state**?
- Transitioning from a known state, to a known state:
  - ensures performance is understood
  - gives a posteriori clarity (*Why did we make that decision?*)
  - builds trust, and allows the next, next step.
  - enables test-driven development (or hypothesis-driven science)

Reduce (and quantify) technical debt

- Enforcing an automatic process against yourself is upfront work to stop technical debt accumulation!
- Post issues against your own code! What gets tracked gets managed!
- Test your code early and often - bonus points if its automated as part of your workflow

Bake in tenants of Open Science

These are all nice benefits for a worker, but as an advertiser, more rigorous process enforcement during research

- accelerates time to publication (less to clean up, fewer open questions, etc)
- makes sharing and collaborating *much* easier
- builds trust in the product from reviewers, colleagues $\rightarrow$ citations!

Templates!

- Julia template project:
  `https://github.com/cmhyett/JuliaTemplate`
  Runs tests, builds documentation, calculates code coverage, looks for any nasty compatibility issues, enforces standardized formatting, includes (what I think are) helpful templates for issues and PRs.
- Github project template for project launch:
  `https://github.com/users/cmhyett/projects/3`
  Enforce hypothesis-driven science! Scope your work, get to publication faster and (maybe) with a more defined contribution.

Conlusions

- In the middle of a project? That's fine - *Do no harm*
- The only way to learn your best practices are to do them! Try a workflow! Modify your workflow till you balance load and payoff.
- If you find you like this, try to get your team to buy in. Trying to do the process for a team, by yourself is exhausting, and likely duplicates your meetings.