Software Engineering Techniques for Collaborative Software Development

Princeton University Bootcamp 2018

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Outline

Git and GitHub for Collaborative Developments

Testing

Automatic Testing

Other Useful Tools For Collaborative Software Development

References and Getting Help

Conclusion

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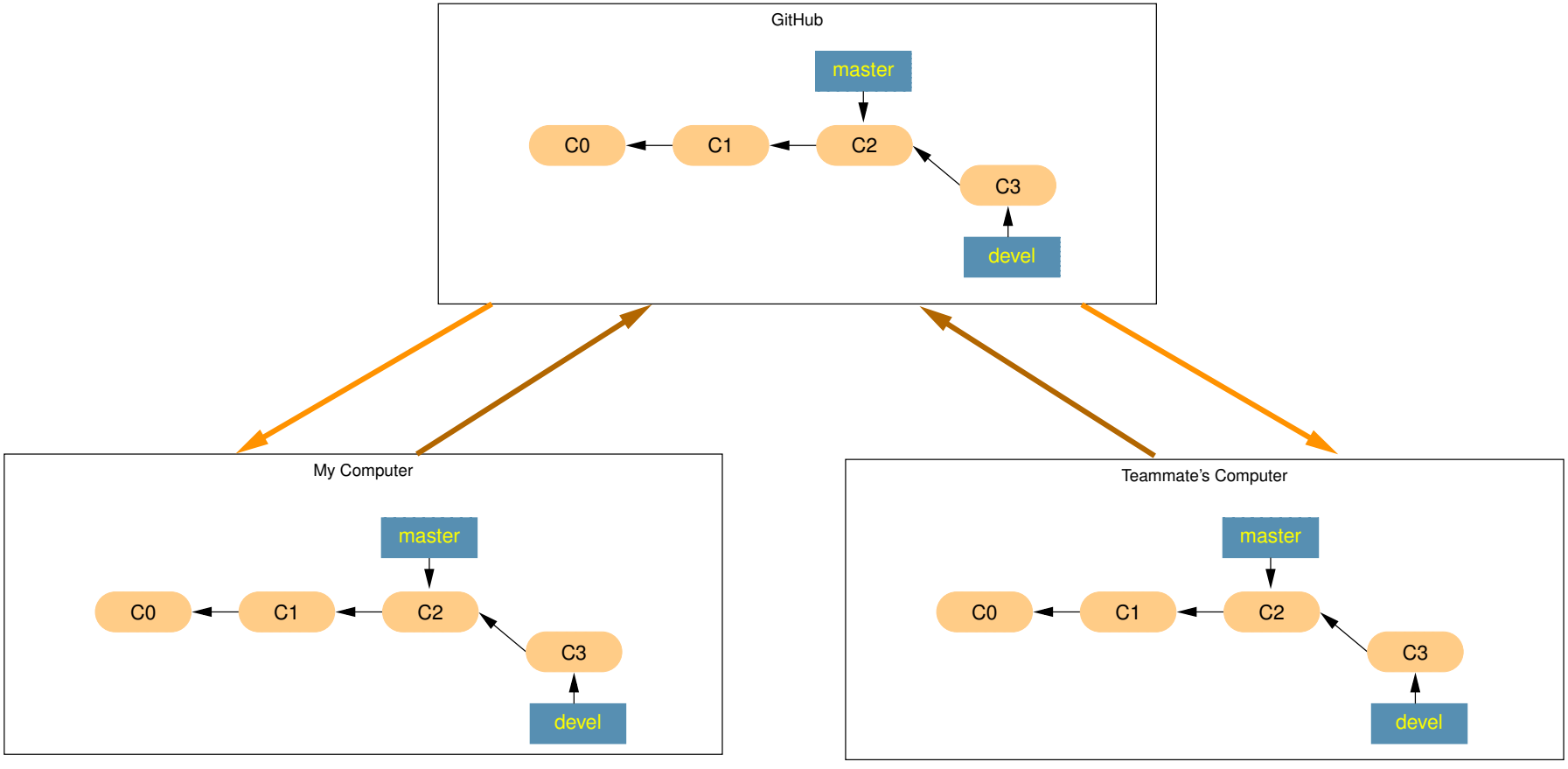
A Simple Collaborative Workflow

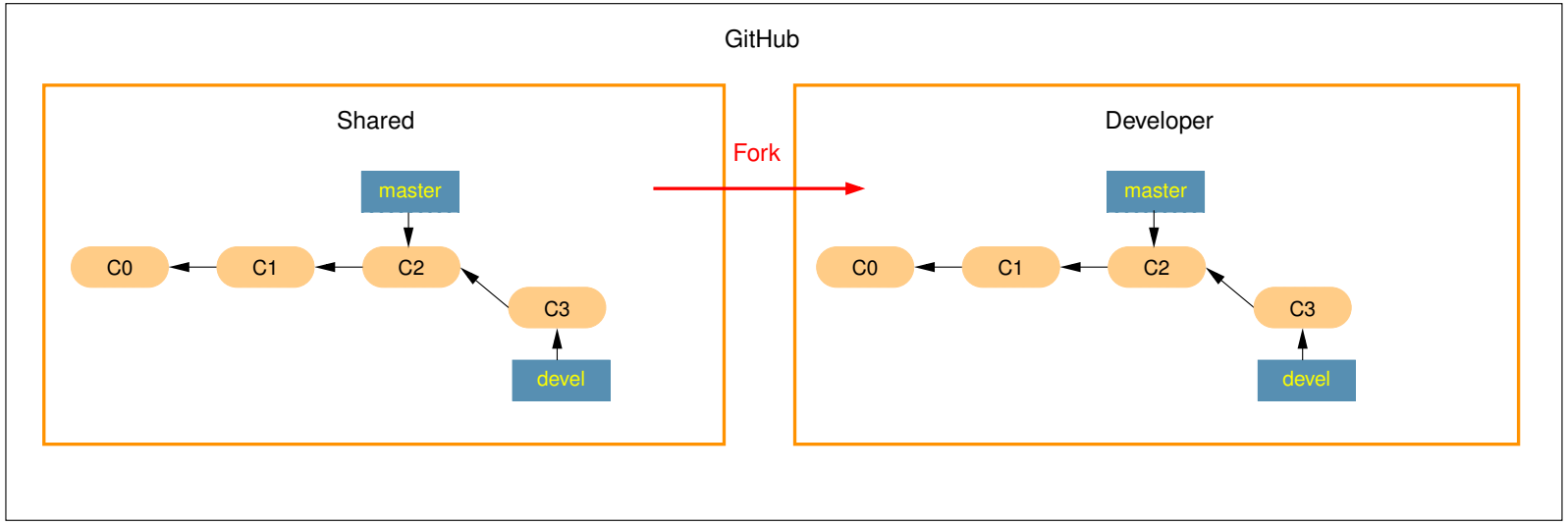


Remote Repository Permissions

- Problem with that simple workflow:
  - It's easy to push broken code to the shared repository.
  - when others pull the changes and start adding their development, it can create problem.
  - this does not work well with more than two developers.
- To solve this issue, we introduce two roles with different permissions on the shared repository:
  - code maintainers: push and pull permissions.
  - developers: only pull permission.

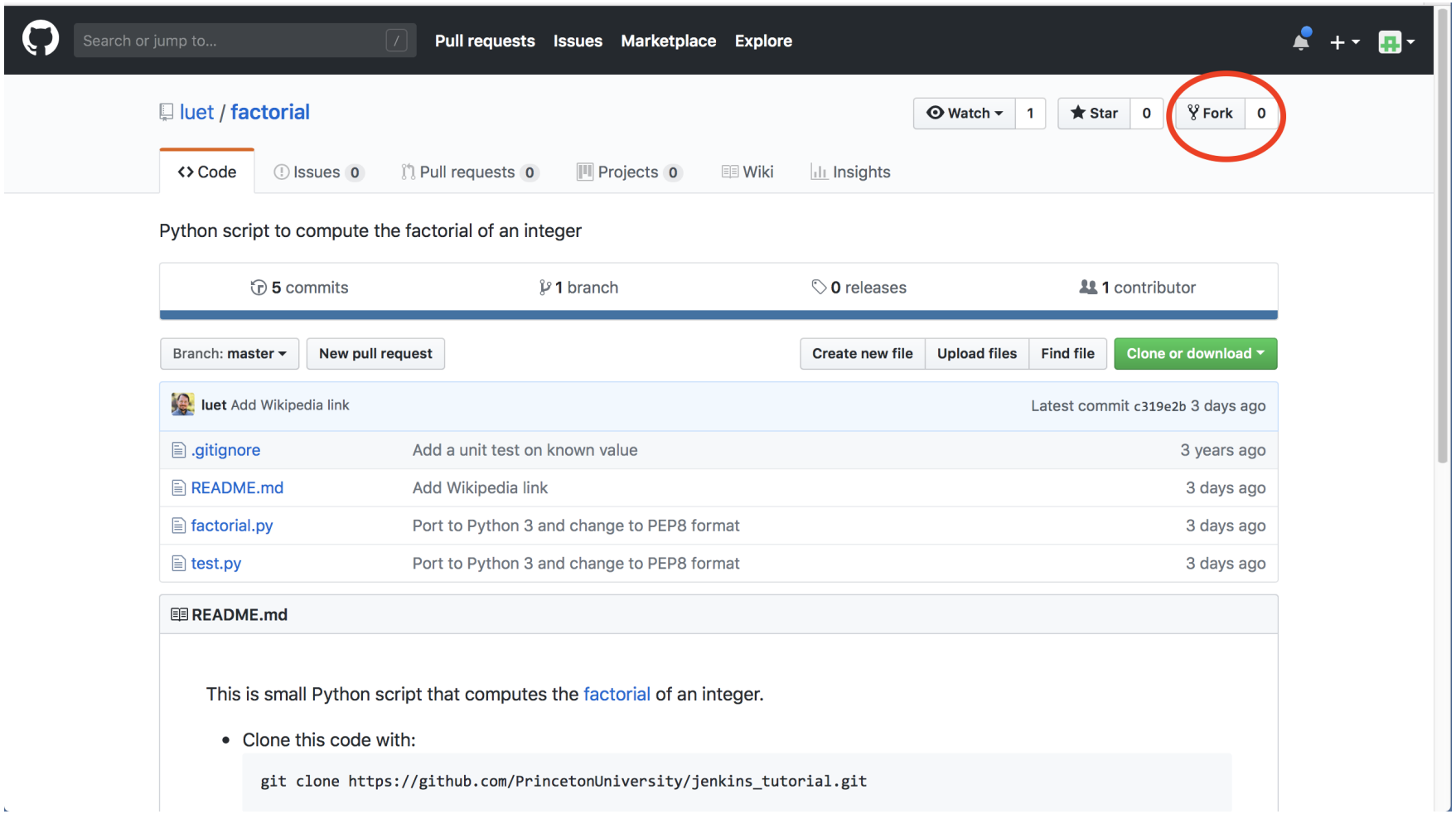
Forking a Repository on GitHub

Forks are basically a copy of a repo on GitHub.



Forking a Repository on GitHub

As the GitHub user `buildbot-princeton` I want to fork:
`https://github.com/luet/factorial`



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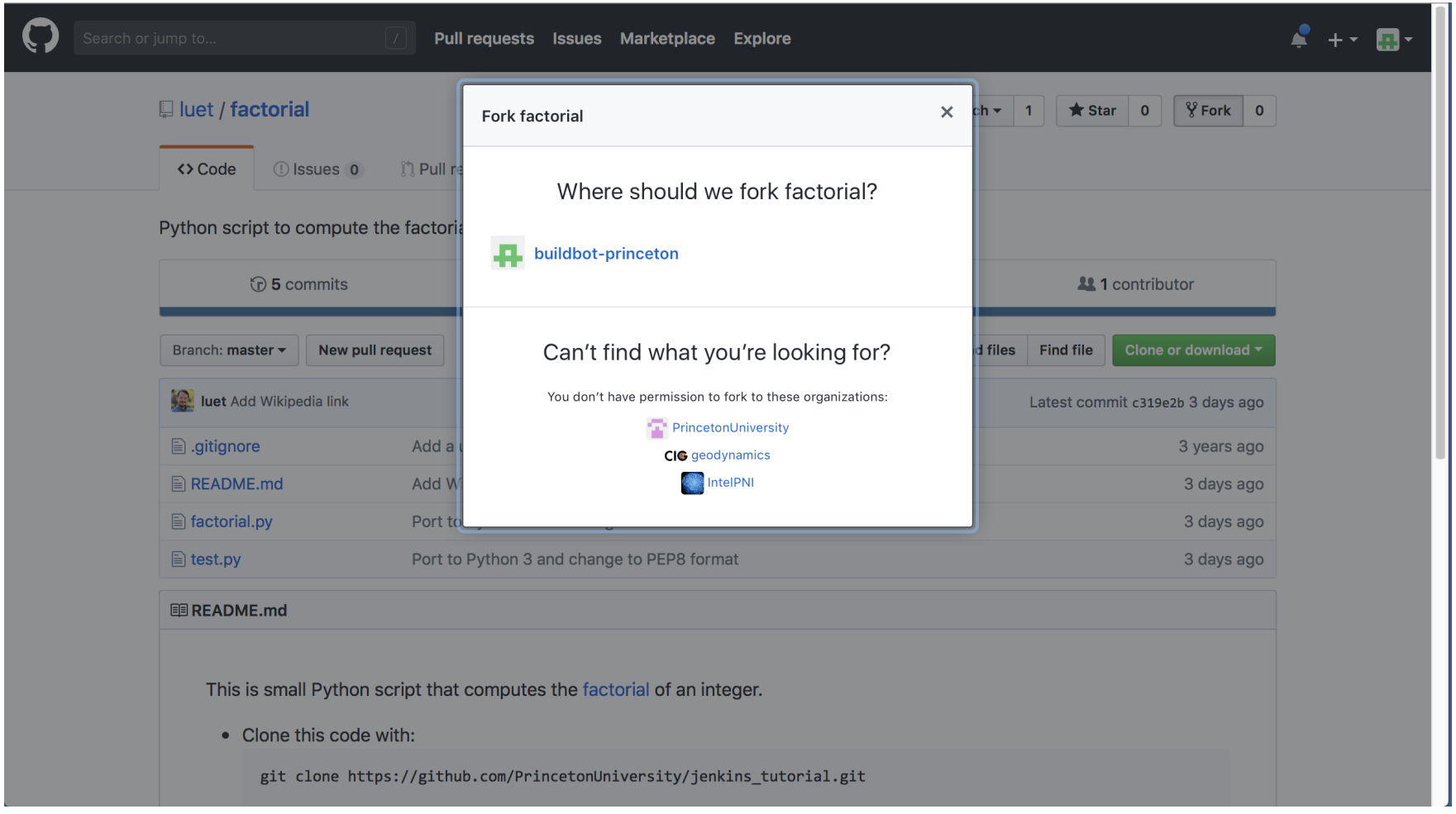

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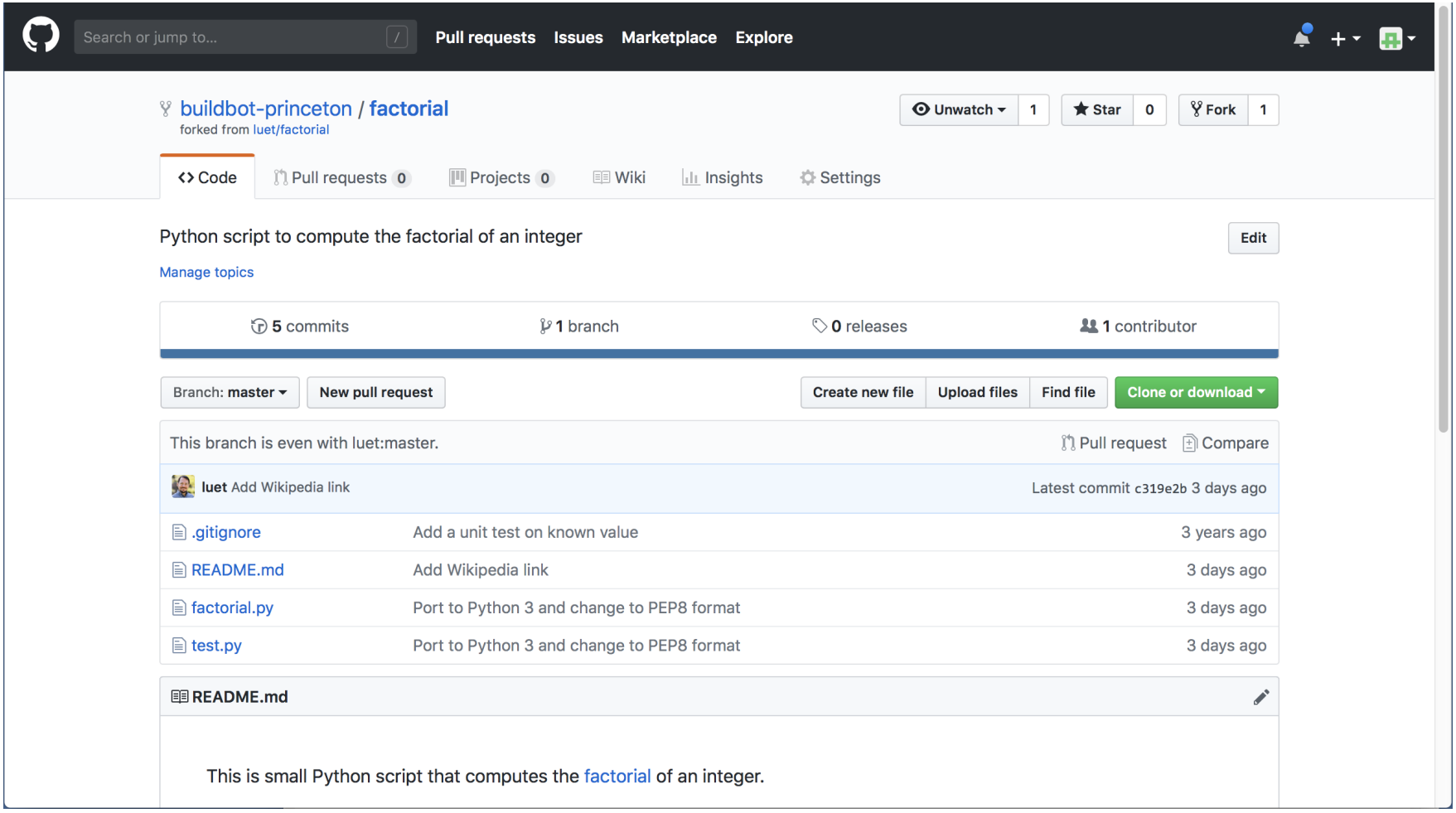
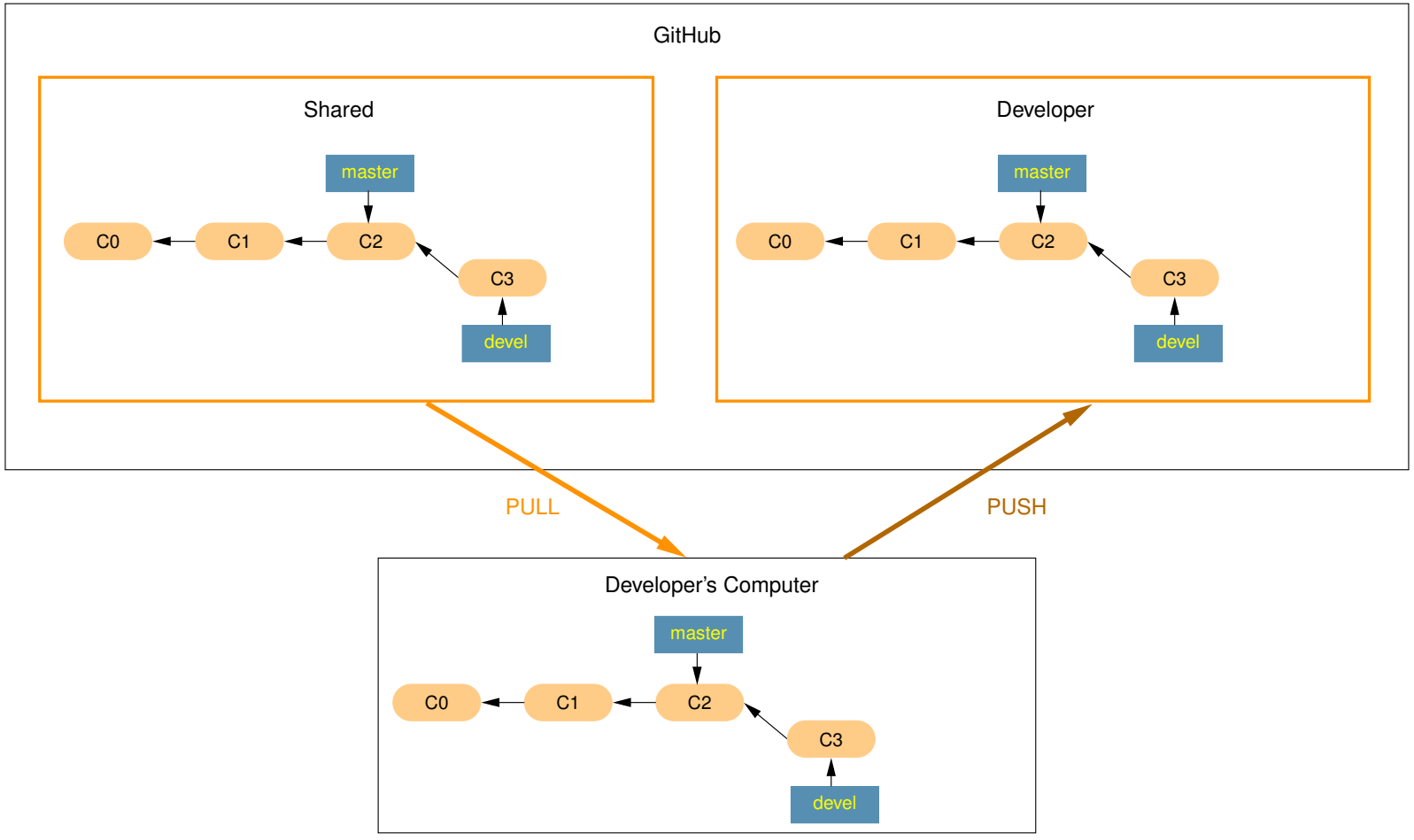
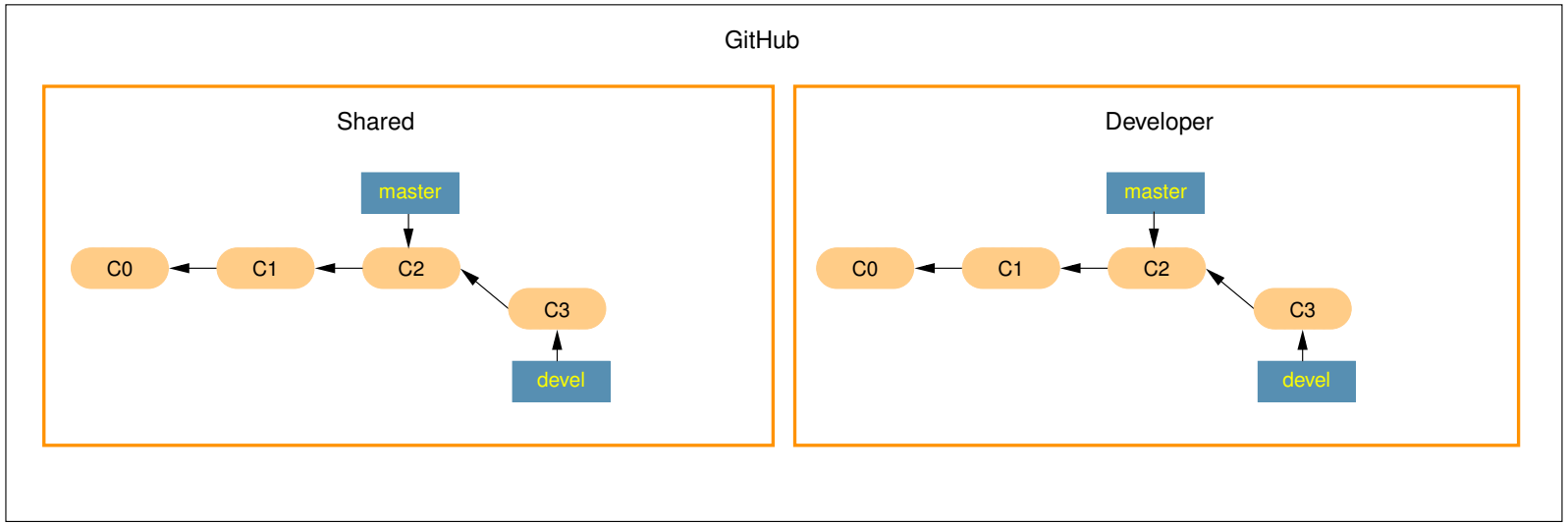
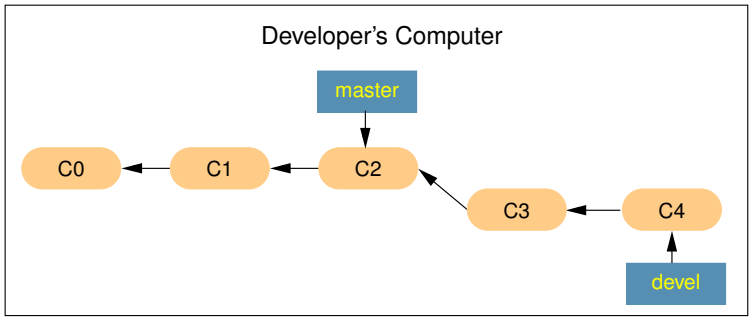


Pull-Request: the Different Repositories



Pull-Request Steps





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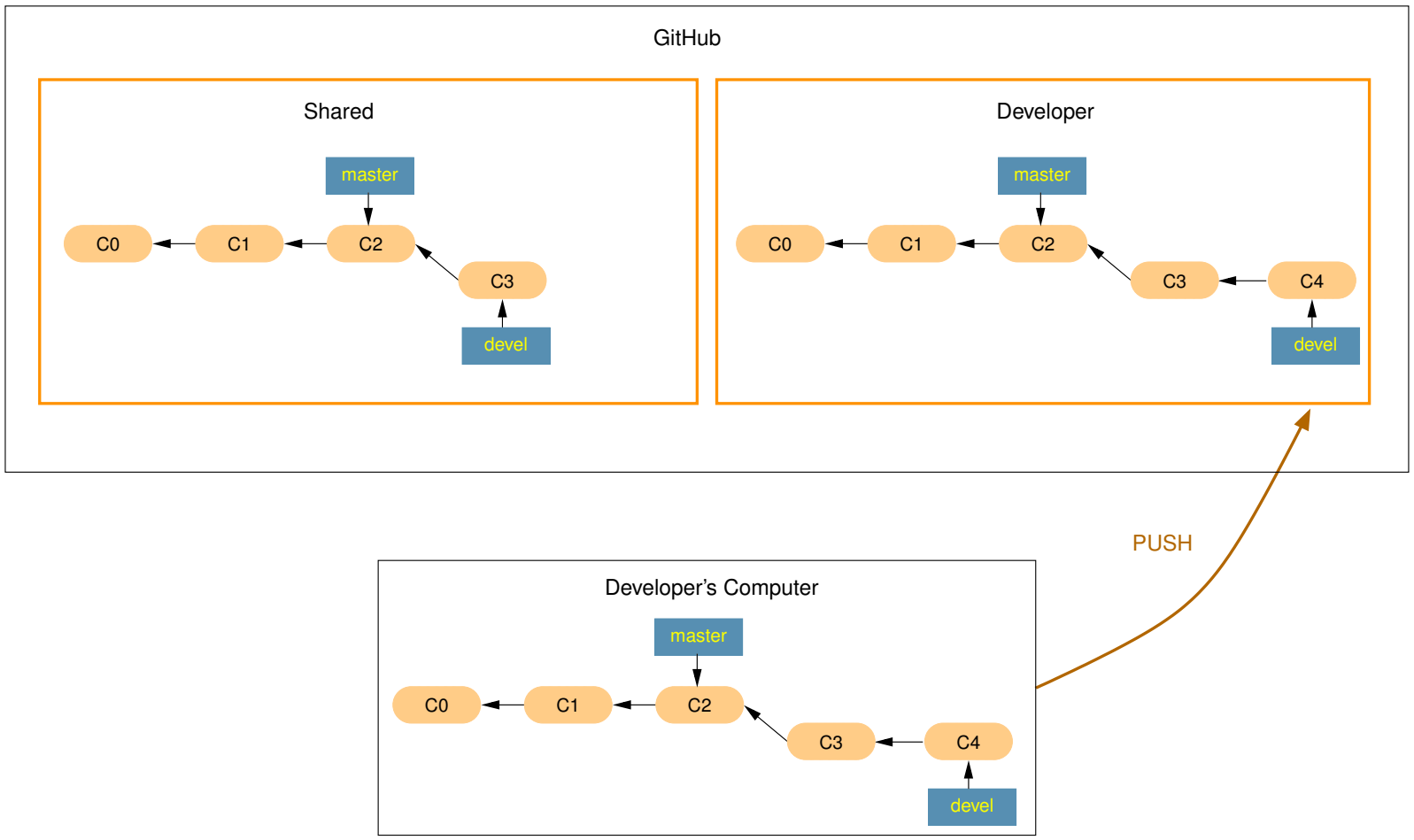

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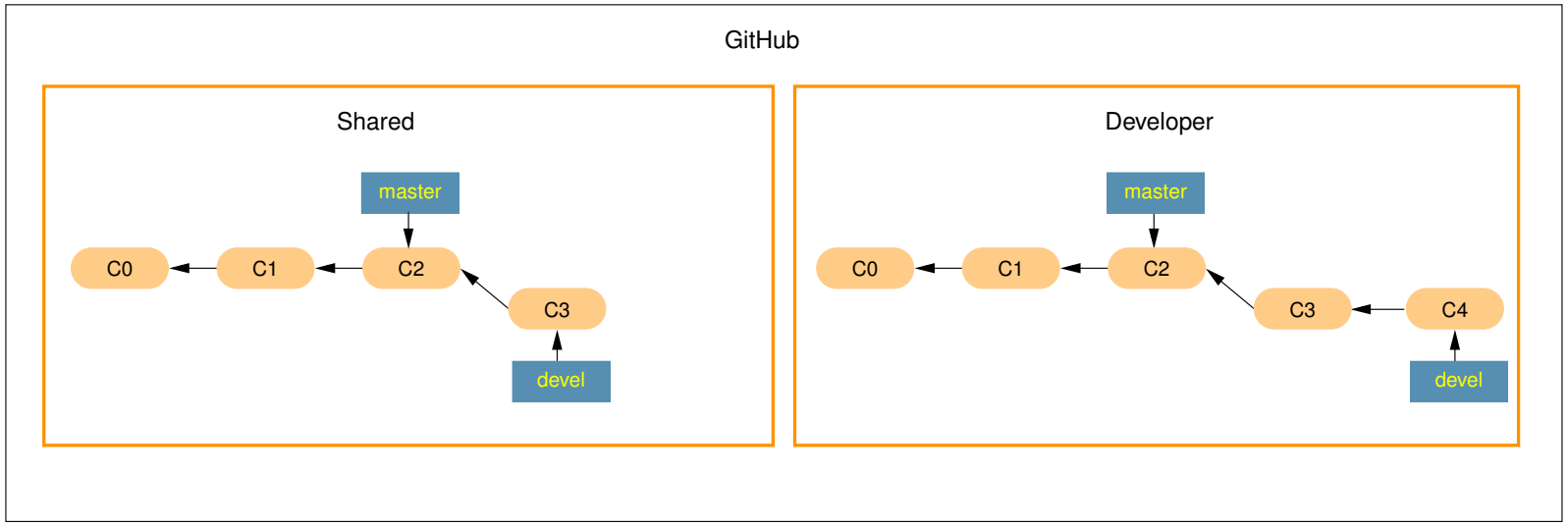

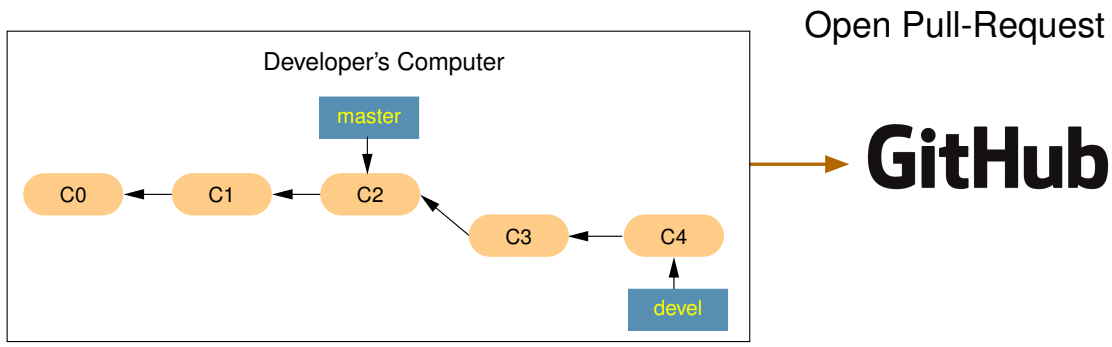

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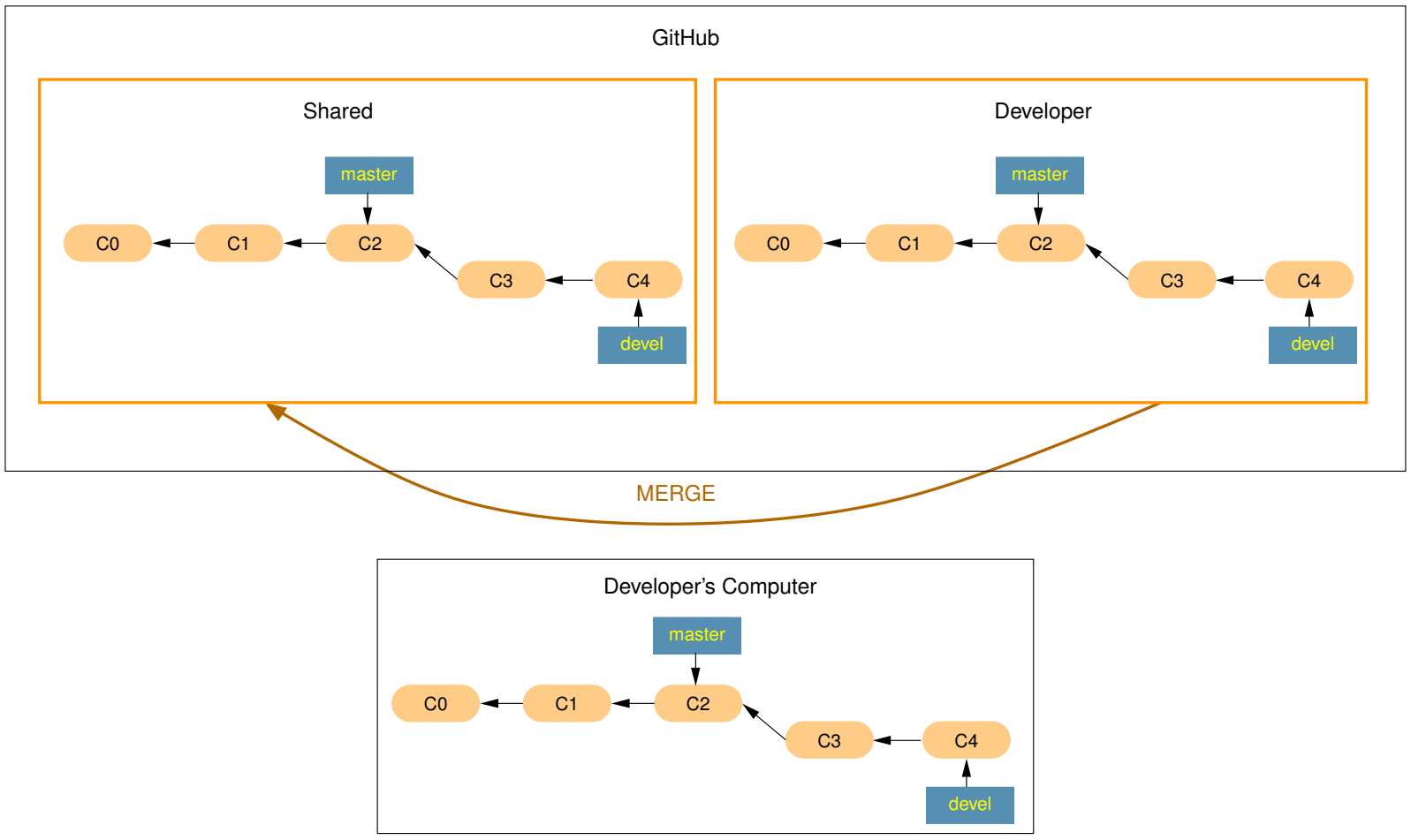

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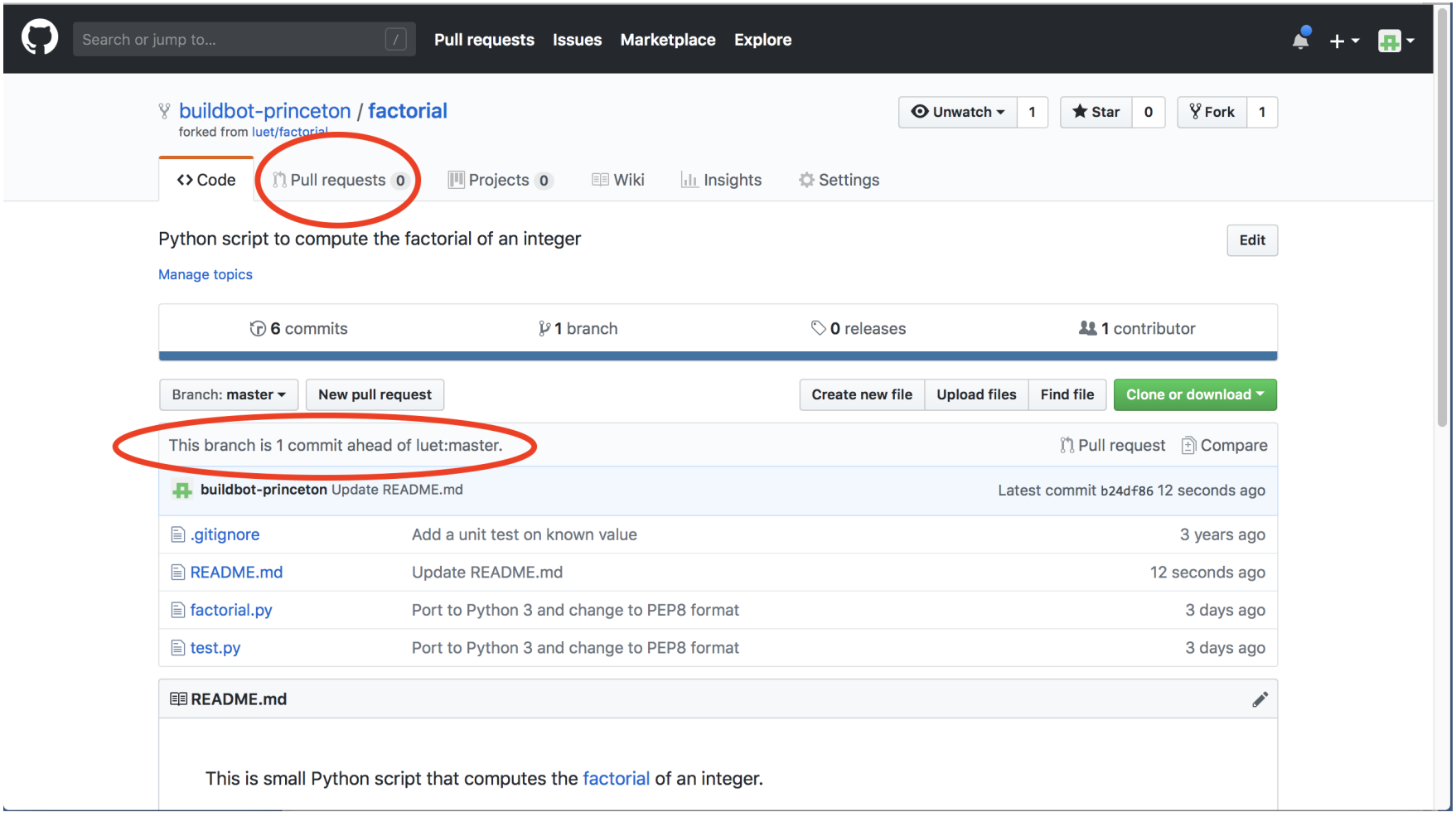

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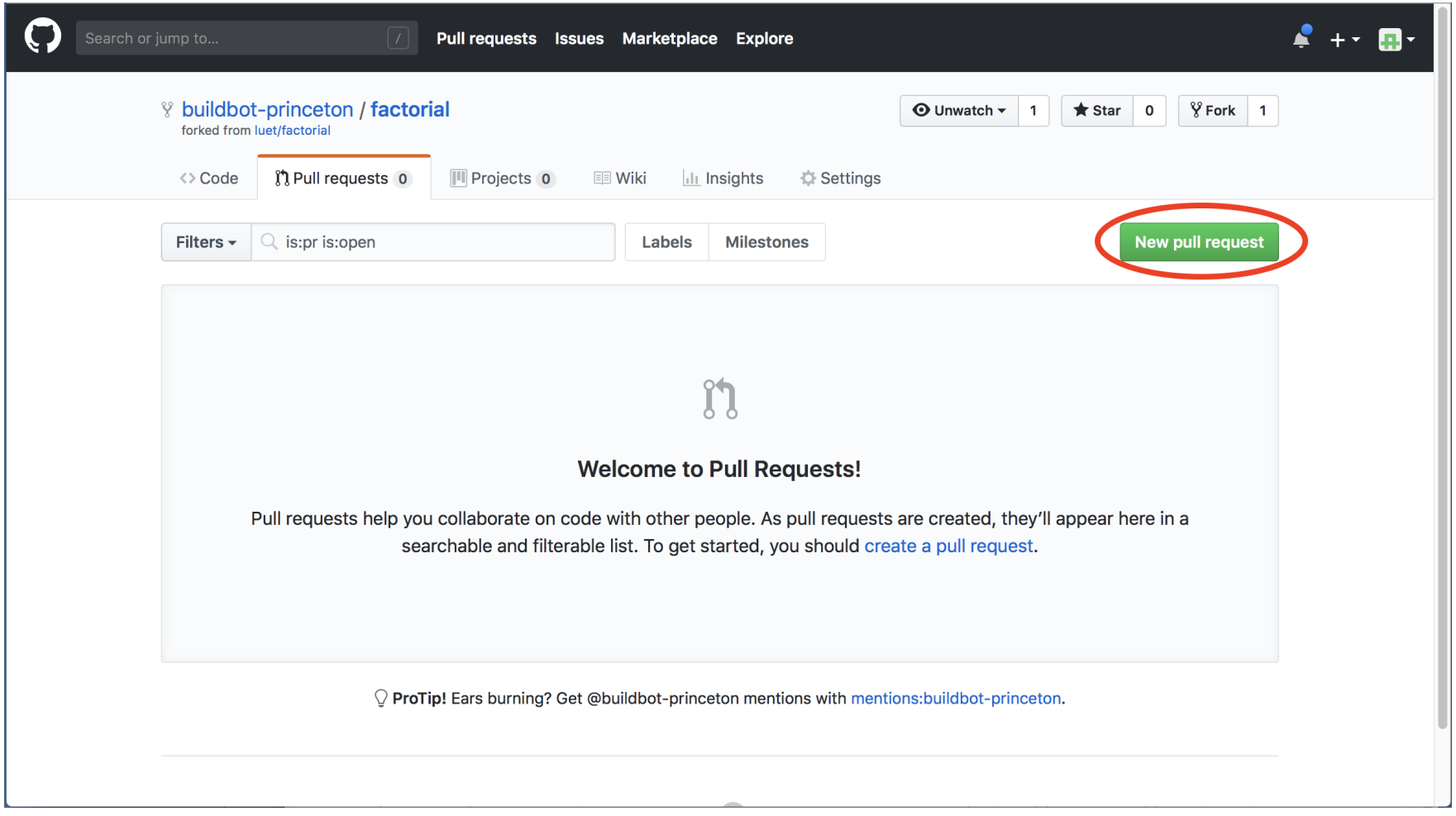

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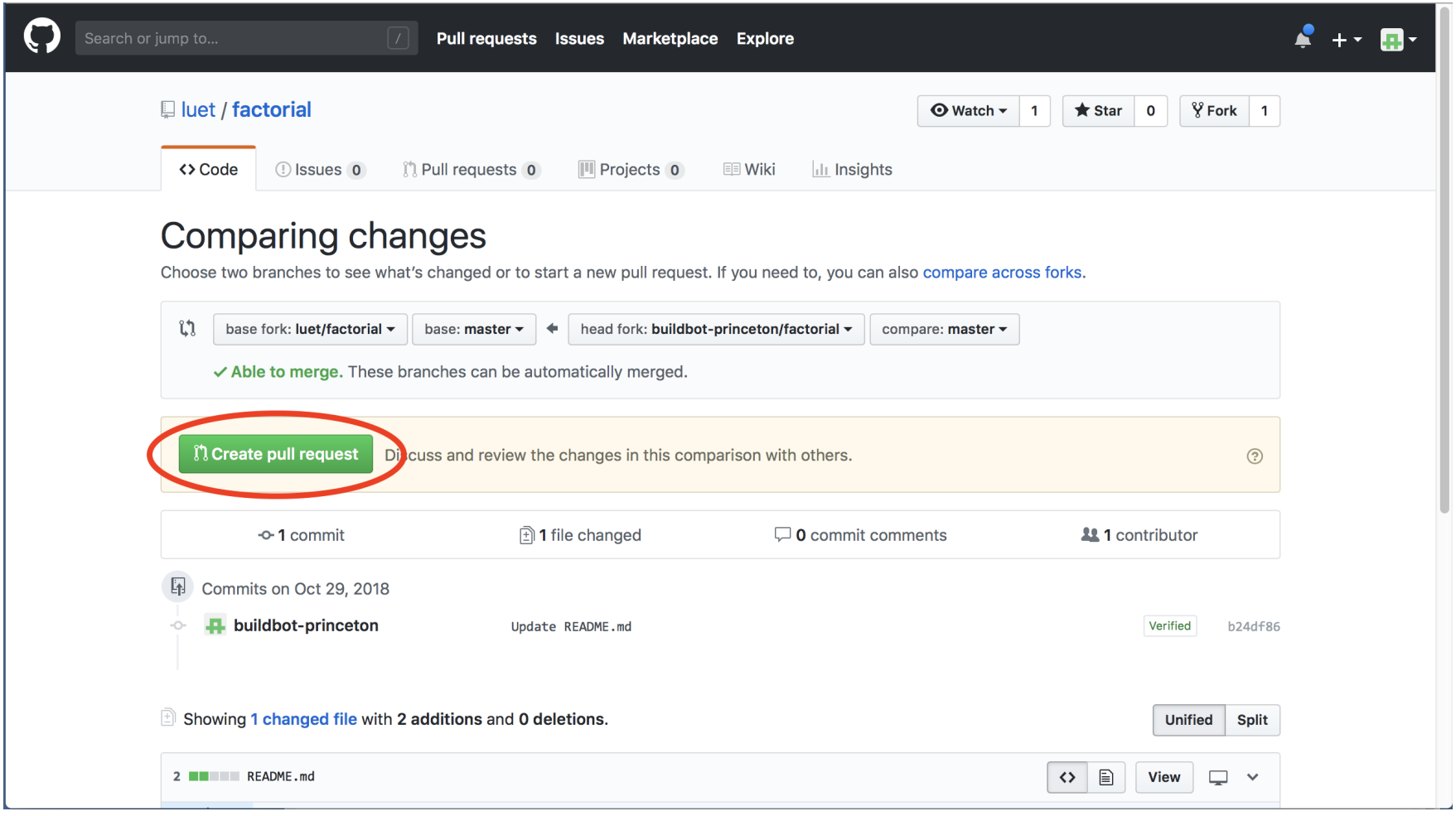

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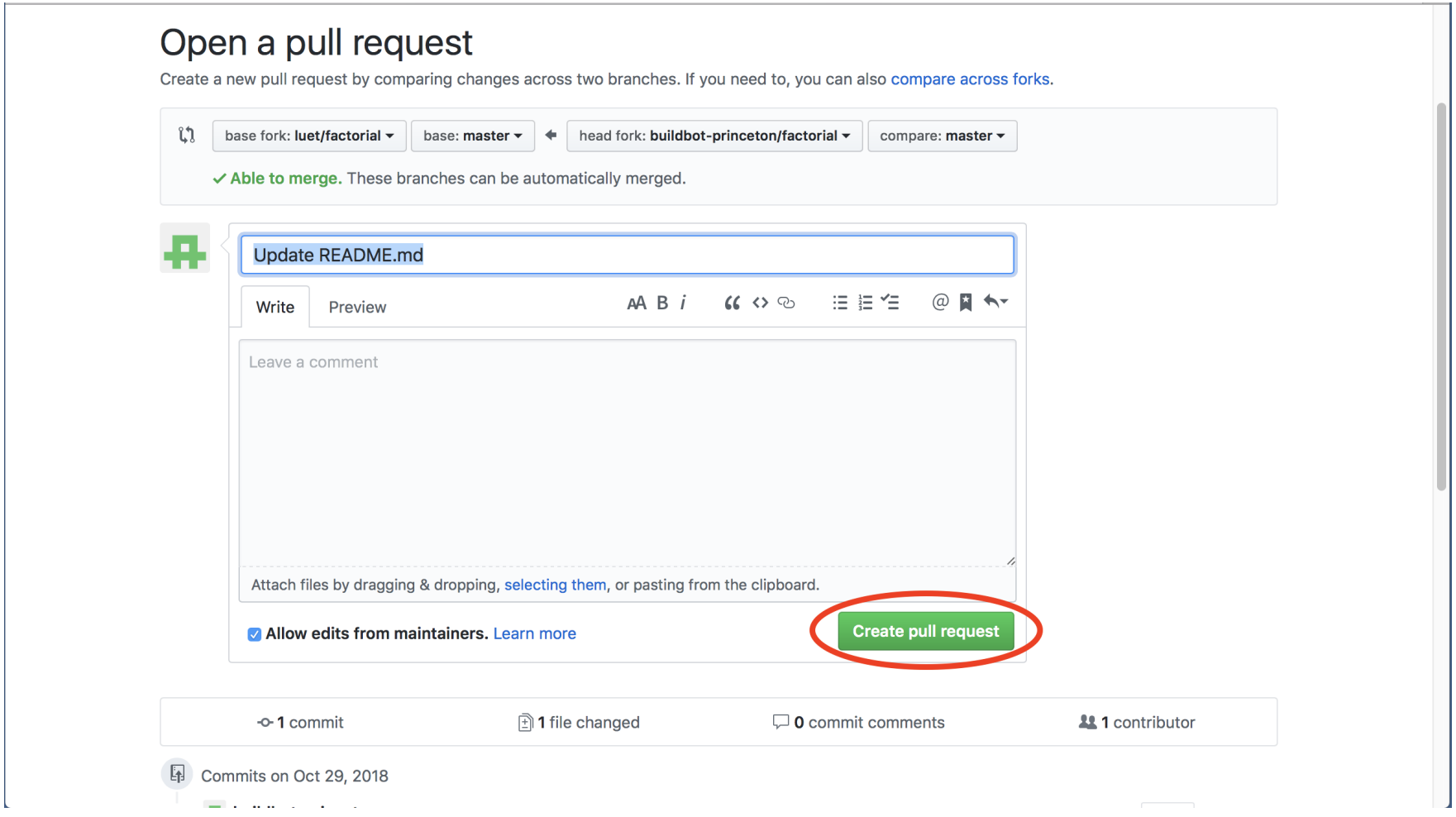

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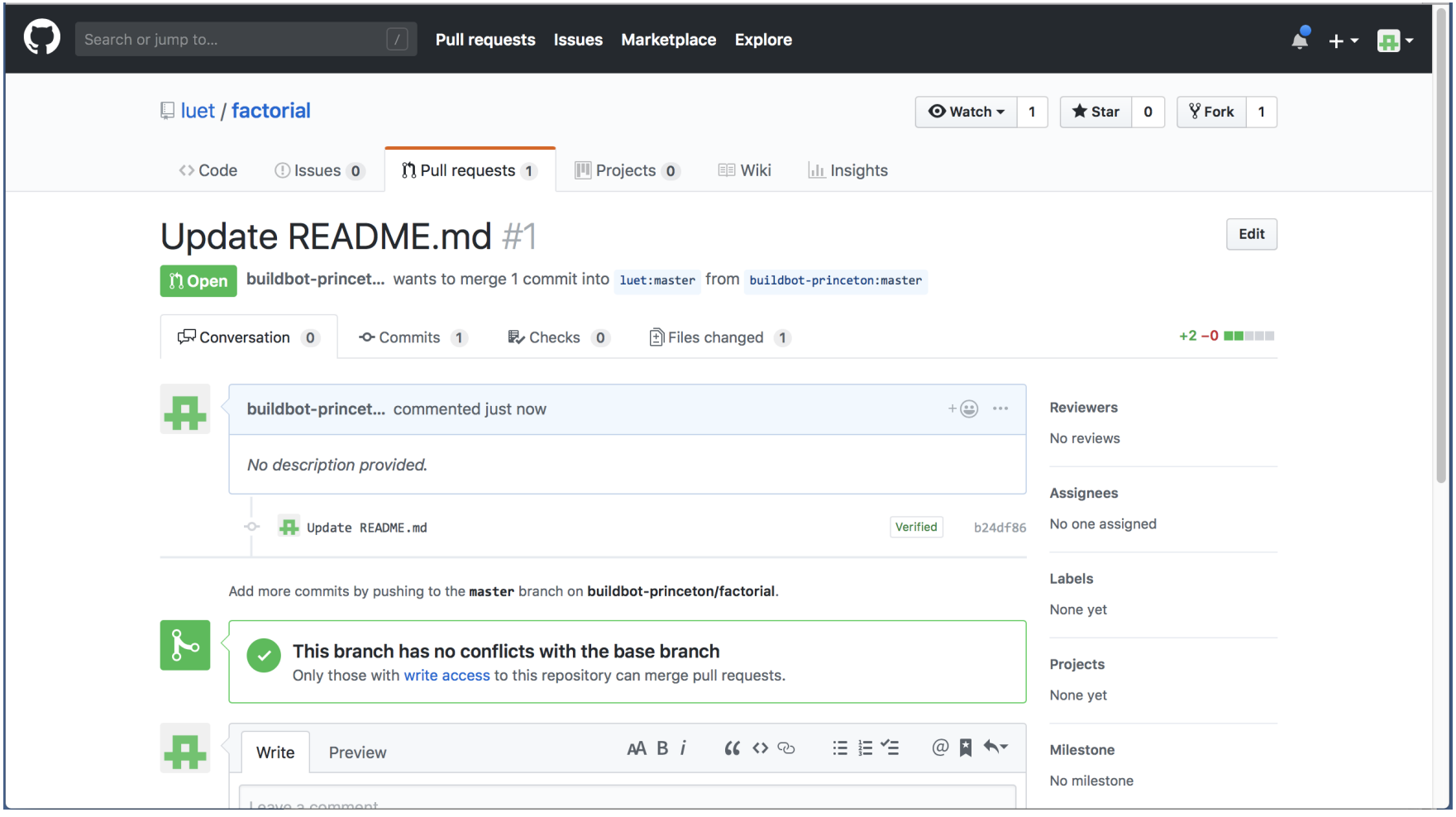

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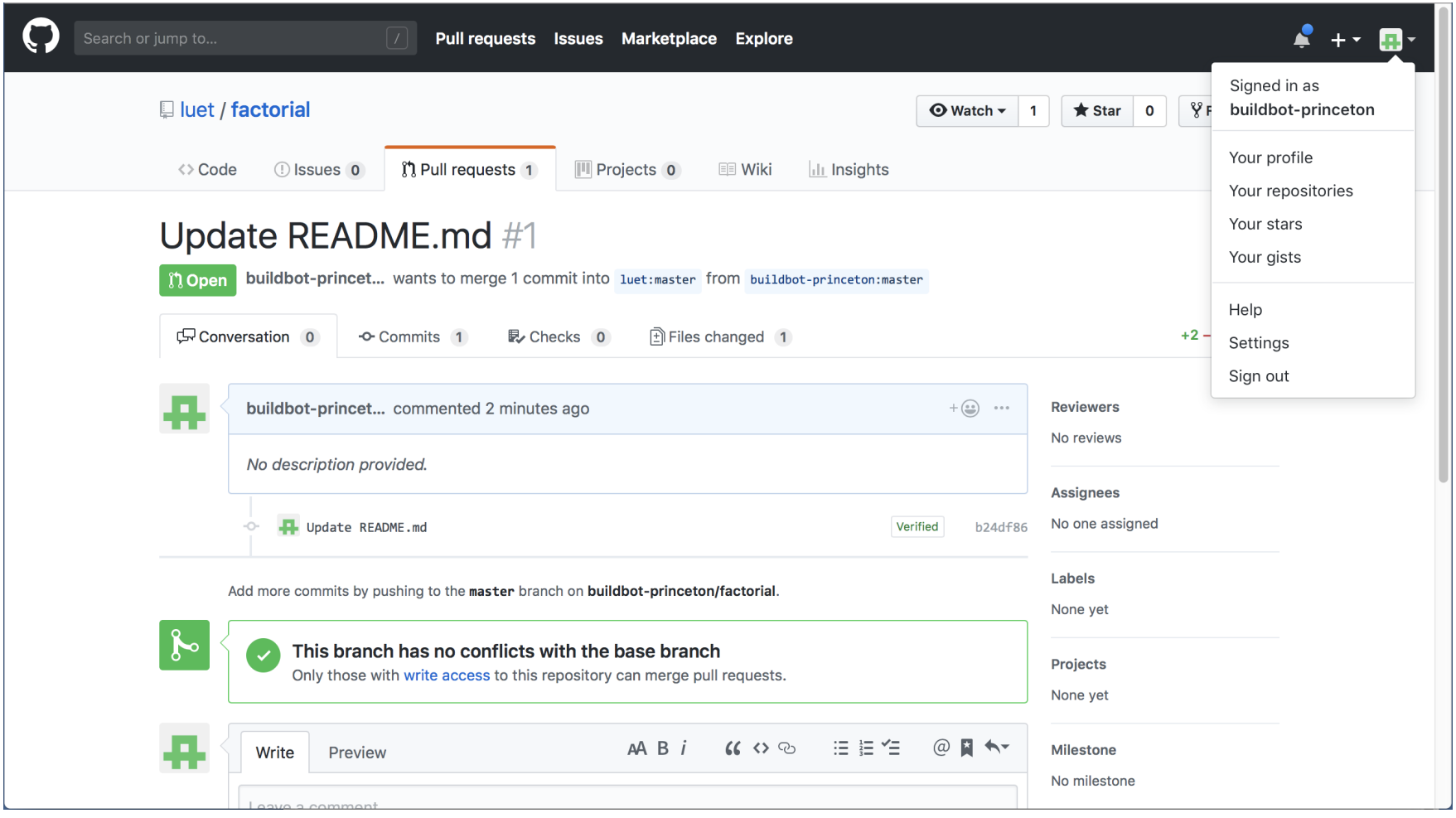

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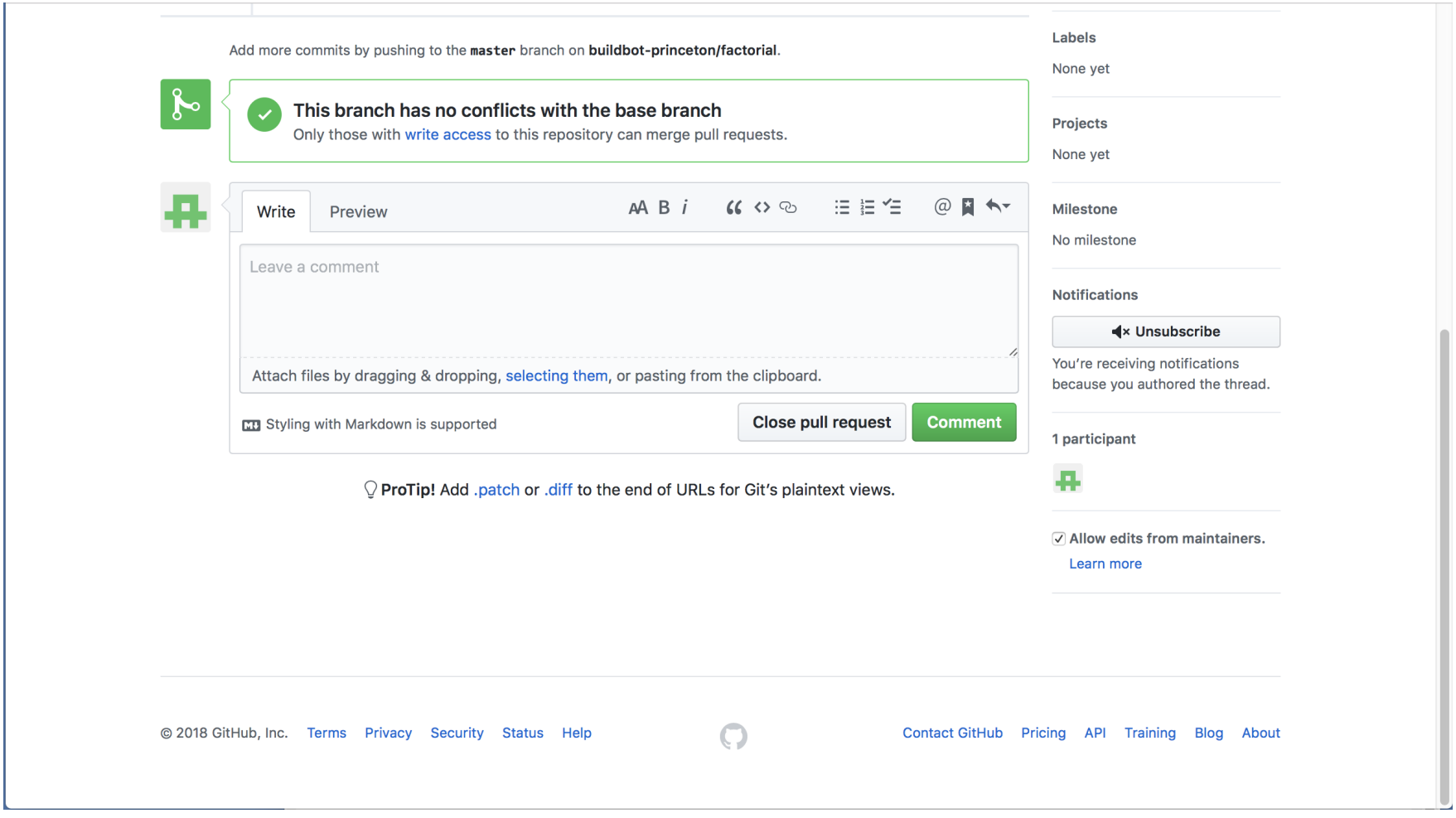

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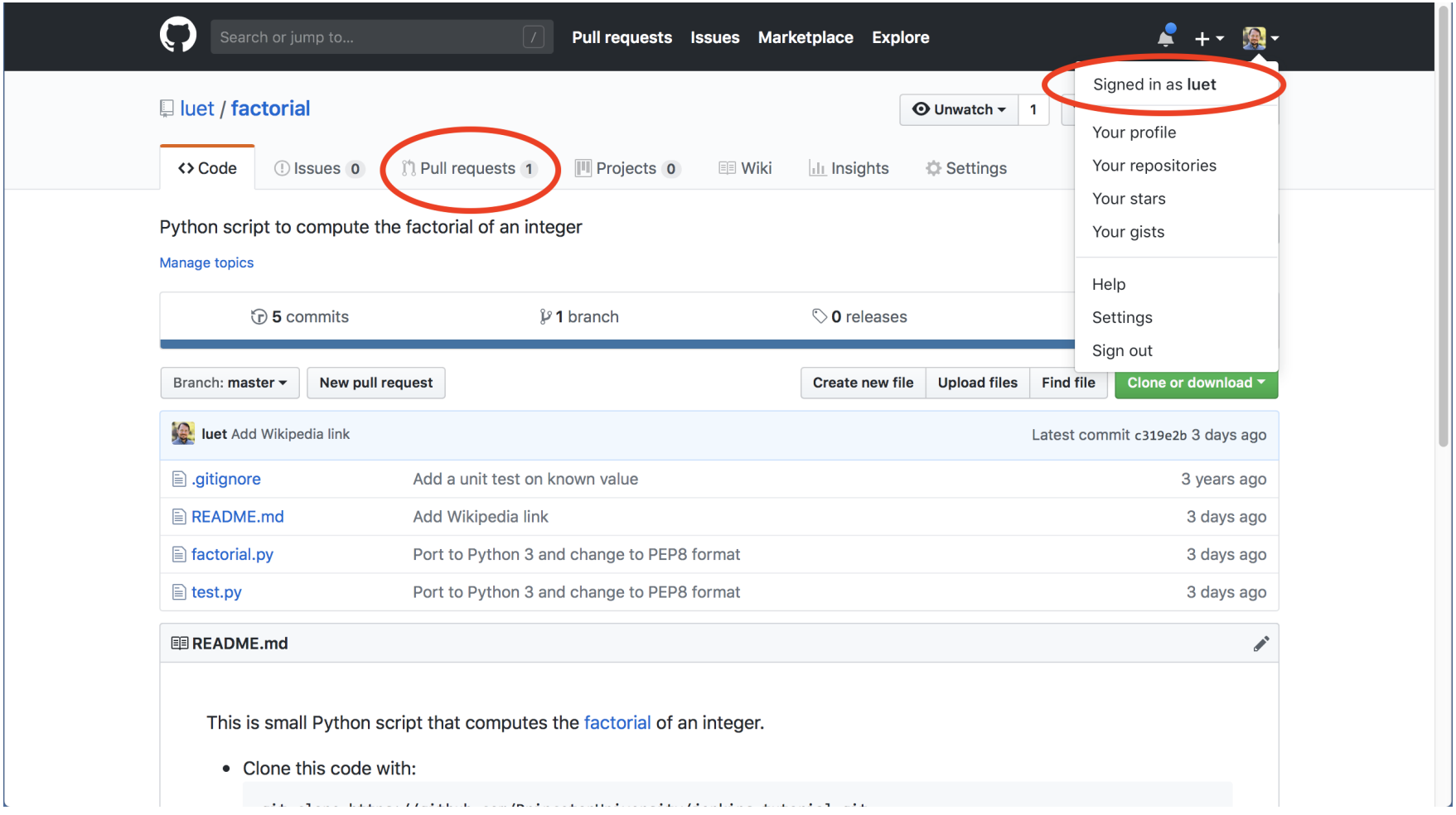

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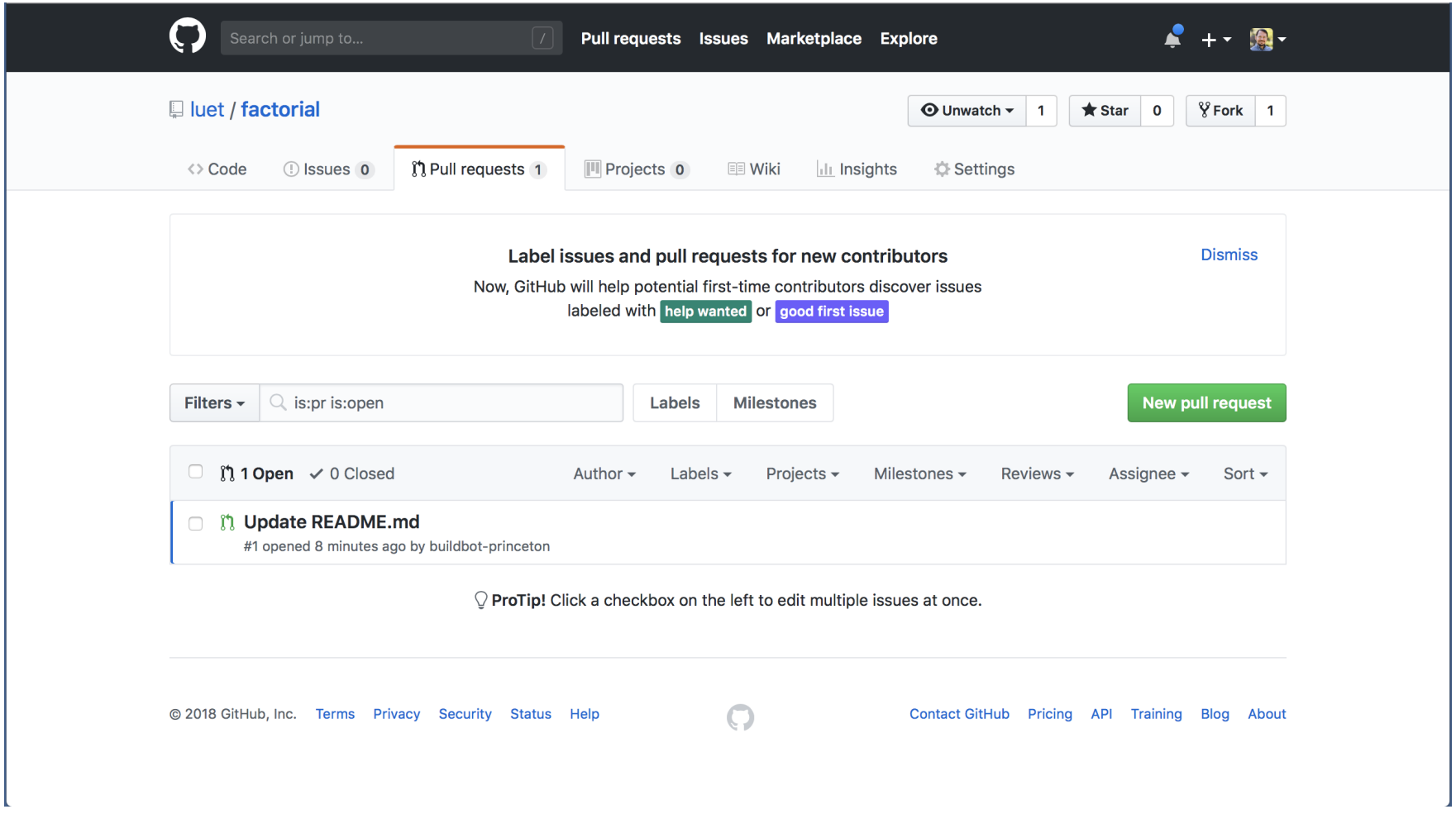

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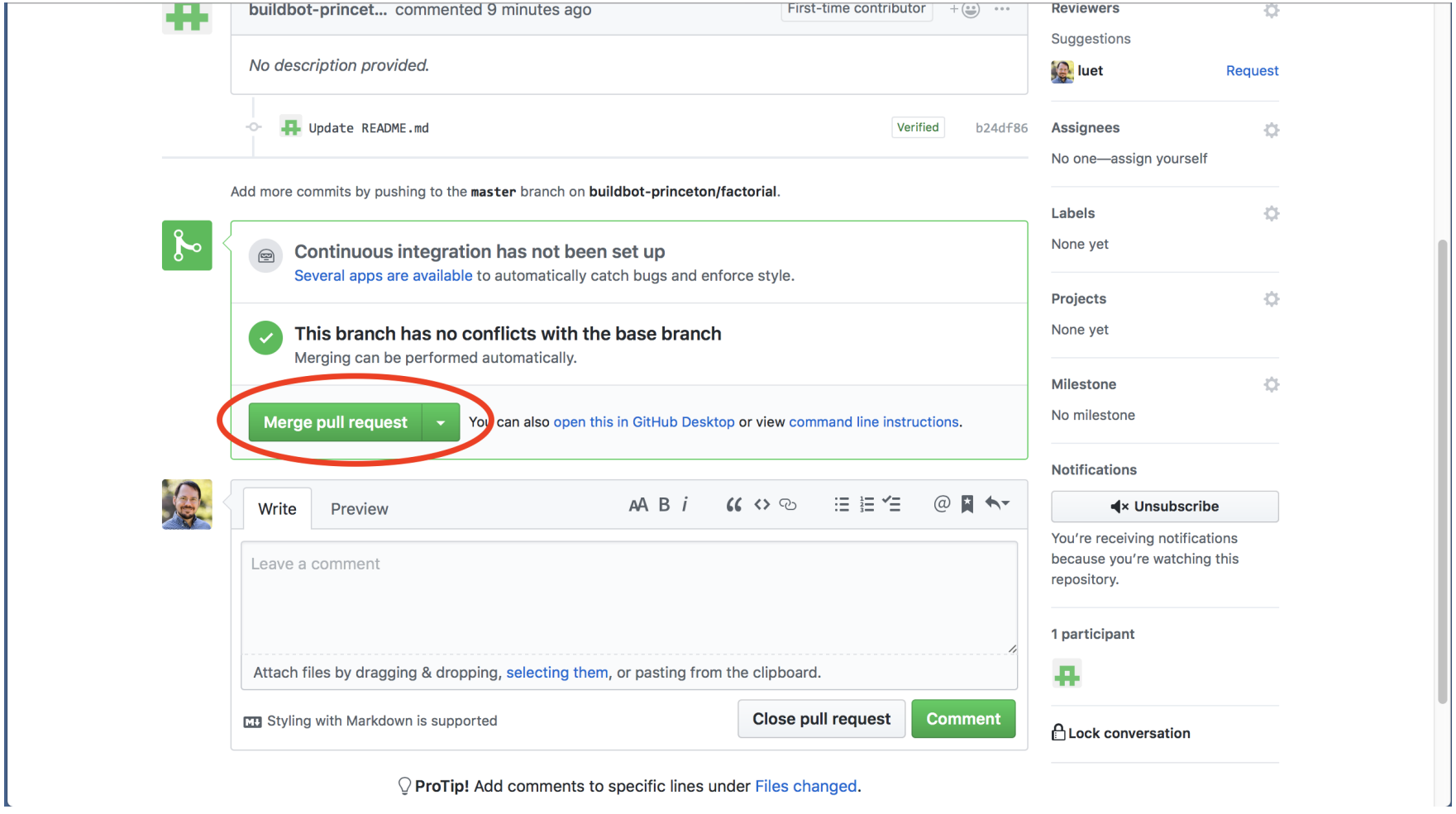

hands-on #1

http://luet.princeton.edu/cicd/

Advantages of Doing a Pull-Request?

- Gives us time to review and test the changes before committing them.
- So that no broken code gets committed to the shared repository.
- The problem with this simple workflow is that it can be hard for the code maintainers to know whether or not changes break the code.
- That's why we need to build some tests.

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Definition and Motivation

- Debugging is what you do when you know that a program is broken.
- Testing is a determined, systematic attempt to break a program that you think is working.
- Testing for Quality Assurance: make sure some changes didn't change the results compared to the last version.
- When you write code with testing in mind, you write better code because you write better interfaces.

When to Write the Tests

- Test while you are writing the code.
- Test incrementally:
  - write part of a program,
  - test it,
  - add some more code,
  - test that,
  - and so on.
- Some programming techniques (e.g. Extreme Programming) even instruct you to write the tests first.

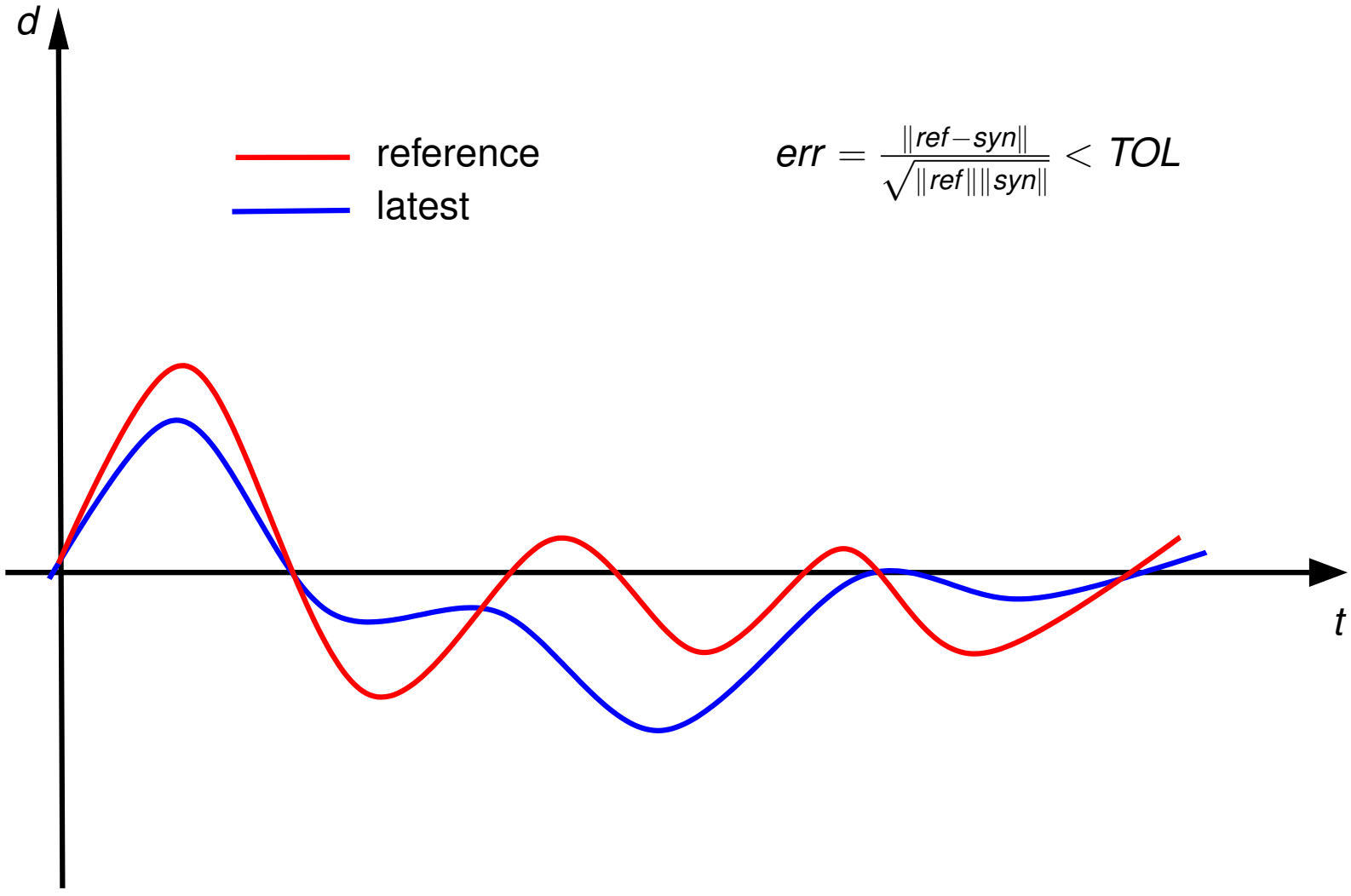
Testing for Functionality

- Unit testing: test one function.
- Test a set of functions or the entire code:
  - It can be hard to design a test that will exercise a certain portion of your code by running the entire code.
  - Use libraries and drivers to isolate functions or a group of functions.

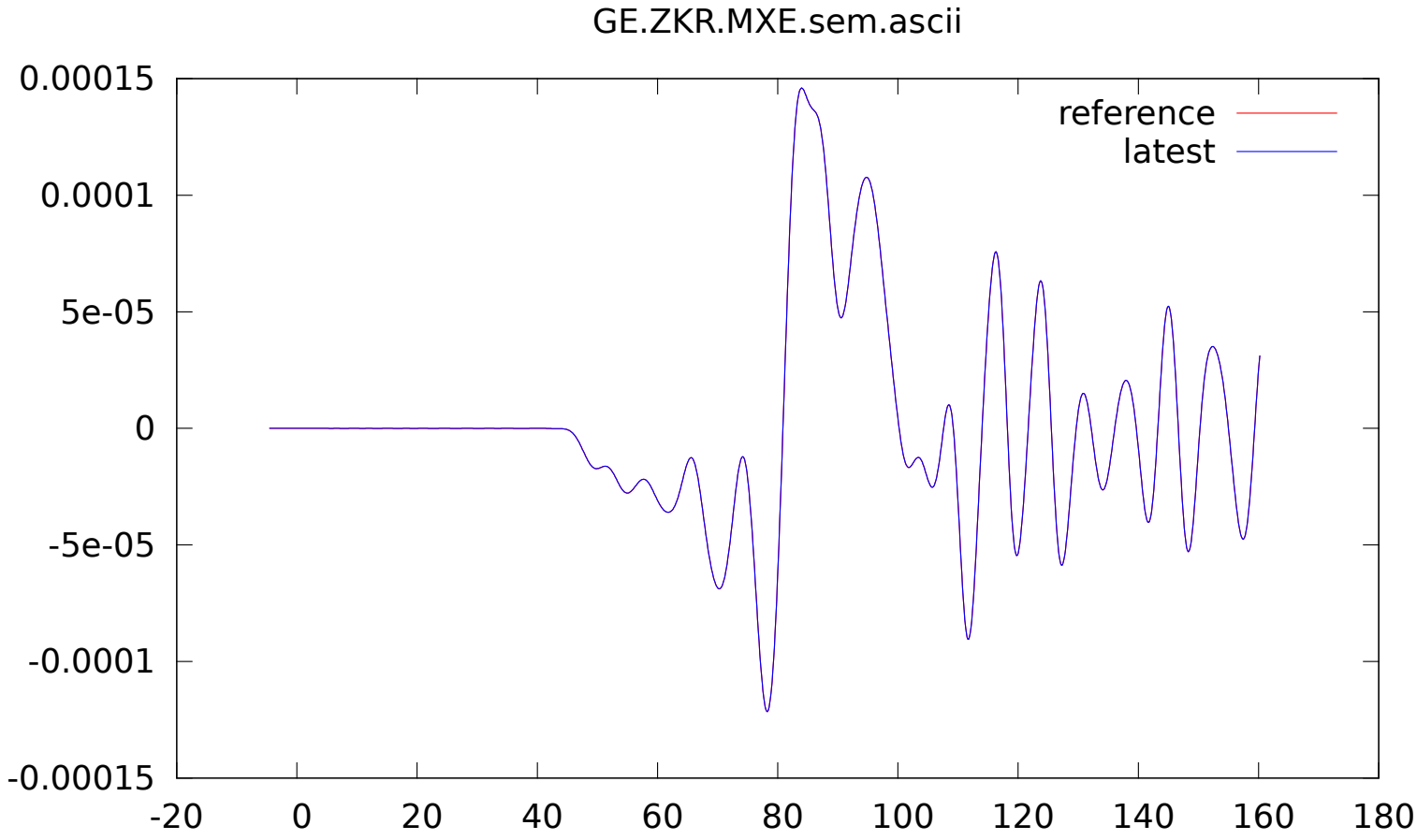
Regression Testing: An Example

- SPECFEM3D_GLOBE (Tromp et. al): simulates global and regional seismic wave propagation.
- This code produces seismograms, which are records of the ground motion in one direction at a measuring station as a function of time.

Regression Testing: Comparing Seismograms



An Actual Seismograms



Other Tests

- Use different compilers to:
  - check that it will compile.
  - find programming mistakes.
  - compare the results.
- Use different versions of scripting languages e.g. Python, Matlab.
- Run on different OS, hardware to make sure:
  - the code runs.
  - the code gives the same results.

Testing frameworks

- Google framework for C++: Google Test.
- Python: unittest
- Matlab

Testing Frameworks Example

- Look at my factorial calculation repository:
  https://github.com/luet/factorial/

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Why Run Test Automatically?

- The temptation when you develop code is to test only that part that you just wrote.
  - But there might be side effects to your changes.
  - So you want to run a your entire suite of tests every time you make a change.
  - you are less likely to do that if the tests have to be run manually.
- Not all the developers have access to all tools.
- Once it's set up you don't have to spend any time running your tests.

Test Automation with Travis

- An example: https://github.com/uvaaland/travis_tutorial
- You can get a free account at https://travis-ci.com/.
- When you can login with your GitHub credential.
- It's only really free for open source (public repositories).

Test Automation with Jenkins

- Service offered by Research Computing.
- Jenkins is a web-based application for automatic testing.
- Simple user interface: easy to configure.
- The advantage other Travis is that with Jenkins you have access to the Research Computing resources:
  - Large number of cores.
  - Compilers.
  - Licensed software e.g. Matlab.
- Email `cses@princeton.edu` to request an account.
- There is a tutorial at:
  `http://jenkins-doc.princeton.edu/tutorial.html`

A Workflow with Jenkins and GitHub

Typical workflow:

1. A Pull-Request is open on GitHub.
2. GitHub sends a signal to our Jenkins server (webhook).
3. Jenkins runs the tests suite.
4. Jenkins reports the results of the tests on the GitHub web site.
   - If the changes passed the test, the code maintainer can merge the changes.
   - If the changes failed the test, the developer needs to solve the problem and push the changes to Github.

Scheduled Tests

- A Pull-Request only triggers short (< 15 min) tests.
- We use Jenkins to schedule longer tests:
  - daily (< 1 hour).
  - weekly (> 1 hour).

Jenkins vs. Travis

- With Jenkins you can run on:
  - the Research Computing clusters.
  - any machine that you have `ssh` access to.
- Travis is good for small scripts, not parallel code.

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Code Documentation

- It's important to document your code when someone else will have to read it.
  - especially when this someone else can be you in a couple years.
- Doxygen:
  - Documentation is in the code.
  - Supports adding Latex to the documentation.
  - Build calling graph.
  - *show example*
- You can use Sphinx with Python.

Documenting outside the code: GitHub Wiki

- GitHub Wiki
  - It's easy to write in Markdown.
  - https://help.github.com/articles/about-github-wikis/
  - *show examples*
- Issues:
  - https://guides.github.com/features/issues/
  - Like a shared TODO list.
- Gists:
  - https://gist.github.com/
  - For sharing small codes.

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- The Practice of Programming, by Brian W. Kernighan and Rob Pike.
- Testing with Python:
  - The Hitchhiker's Guide to Python!: `http://docs.python-guide.org/en/latest/`
  - Testing your code: `http://docs.python-guide.org/en/latest/writing/tests/#testing-your-code`
- Agile development: Manifesto for Agile Software Development

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- I encourage you to, in order of urgency:
  - use a Version Control System.
  - design some tests.
  - run those tests automatically.
- In the long run, it will:
  - save you some time in debugging and troubleshooting.
  - let you modify your code with confidence that you are not breaking it.
  - generate a better organized and better written code.
- We are here to help.
  - You can e-mail us at: cses@princeton.edu.
  - Come to the help sessions Tuesdays (10-11 am) and Thursdays (2-3 pm), room 347 Lewis Library.
- Job opportunity for Graduate students.