Software Engineering Techniques for Collaborative Software Development
Princeton University Bootcamp 2018

David Luet
PICSciE, Research Computing/OIT, Department of Geosciences

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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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Conclusion
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
Forking a Repository on GitHub

This is a small Python script that computes the factorial of an integer.

- Clone this code with:
  
  ```
  git clone https://github.com/PrincetonUniversity/jenkins_tutorial.git
  ```
Forking a Repository on GitHub

Python script to compute the factorial of an integer

This is a small Python script that computes the factorial of an integer.
Pull-Request: the Different Repositories

GitHub

Shared

Developer

Developer's Computer

C0 -> C1 -> C2

C3

devel

master

C0 -> C1 -> C2

C3

devel

PUSH

PULL
Pull-Request Steps
Pull-Request Steps
Pull-Request Steps

GitHub

Shared

Developer

Developer's Computer

Open Pull-Request
Pull-Request Steps

GitHub

Shared

Developer

Developer's Computer

MERGE
Pull-Request Steps on GitHub

The user is working on the 'factorial' repository, which is a fork from the 'luet/factorial' repository. The user is about to create a pull request from the 'master' branch of the forked repository to the 'master' branch of the original repository.

The user is informed that this branch is 1 commit ahead of the original repository's 'master' branch.

The repository contains a Python script to compute the factorial of an integer. The script is located in the 'factorial.py' file and is described in the file itself as follows:

“This is small Python script that computes the factorial of an integer.”
Welcome to Pull Requests!

Pull requests help you collaborate on code with other people. As pull requests are created, they’ll appear here in a searchable and filterable list. To get started, you should create a pull request.

ProTip! Ears burning? Get @buildbot-princeton mentions with mentions:buildbot-princeton.
Pull-Request Steps on GitHub

Comparing changes
Choose two branches to see what's changed or to start a new pull request. If you need to, you can also compare across forks.

- base fork: luet/factorial
- base: master
- head fork: buildbot-princeton/factorial
- compare: master

✓ Able to merge. These branches can be automatically merged.

Create pull request
Discuss and review the changes in this comparison with others.

- 1 commit
- 1 file changed
- 0 commit comments
- 1 contributor

Commits on Oct 29, 2018
- buildbot-princeton
  Update README.md

Showing 1 changed file with 2 additions and 0 deletions.
Pull-Request Steps on GitHub

Open a pull request

Create a new pull request by comparing changes across two branches. If you need to, you can also compare across forks.

- base fork: luet/factorial
- base: master
- head fork: buildbot-princeton/factorial
- compare: master

Able to merge. These branches can be automatically merged.

Update README.md

Write Preview

Leave a comment

Attach files by dragging & dropping, selecting them, or pasting from the clipboard.

- Allow edits from maintainers. Learn more

Create pull request

Commits on Oct 29, 2018

- 1 commit
- 1 file changed
- 0 commit comments
- 1 contributor
Pull-Request Steps on GitHub
Pull-Request Steps on GitHub

Update README.md #1

buildbot-princeton... commented 2 minutes ago

No description provided.

Add more commits by pushing to the master branch on buildbot-princeton/factorial.

This branch has no conflicts with the base branch
Only those with write access to this repository can merge pull requests.
Pull-Request Steps on GitHub

This branch has no conflicts with the base branch
Only those with write access to this repository can merge pull requests.

Write

Leave a comment

Attach files by dragging & dropping, selecting them, or pasting from the clipboard.

Styling with Markdown is supported

ProTip! Add .patch or .diff to the end of URLs for Git’s plaintext views.
Pull-Request Steps on GitHub

Python script to compute the factorial of an integer

This is a small Python script that computes the factorial of an integer.

- Clone this code with:
Pull-Request Steps on GitHub
Pull-Request Steps on GitHub

Continuous integration has not been set up
Several apps are available to automatically catch bugs and enforce style.

This branch has no conflicts with the base branch
Merging can be performed automatically.

[Circle around Merge pull request button]

ProTip! Add comments to specific lines under Files changed.
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

\[ err = \frac{\| ref - syn \|}{\sqrt{\| ref \| \| syn \|}} < TOL \]
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 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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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/](https://help.github.com/articles/about-github-wikis/)
  - *show examples*

- Issues:
  - [https://guides.github.com/features/issues/](https://guides.github.com/features/issues/)
  - Like a shared TODO list.

- Gists:
  - [https://gist.github.com/](https://gist.github.com/)
  - For sharing small codes.
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References

- 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.