

Code Coverage and Continuous Integration

Presented at
Better Scientific Software tutorial
ISC18, Frankfurt, Germany

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Code Coverage

How do we determine what other tests are needed?

Code coverage tools

- Expose parts of the code that aren't being tested
- gcov
 - standard utility with the GNU compiler collection suite
 - compile with --coverage
 - counts the number of times each statement is executed
- lcov
 - a graphical front-end for gcov
 - available at <http://ltp.sourceforge.net/coverage/lcov.php>
- Hosted servers (e.g. coveralls, codecov)
 - graphical visualization of results
 - push results to server through continuous integration server

Code coverage output

Overall Analysis

SOURCE FILES ON BUILD 45					
LIST 2	CHANGED 0	SOURCE CHANGED 0	COVERAGE CHANGED 0		
▲ COVERAGE	Δ	FILE	LINES	RELEVANT	COVERED
74.39		src/functions/linear_fcn_class.f90	301	82	61
100.0		src/general/modulo_mod.f90	52	3	3

Detailed Analysis

```
265      ! Error distribution same for all x values
266      delta = S*Sxx - Sx*Sx
267      if (delta == 0.0_wp) then
268          ERRORMSG("Cannot do linear least-sqrs. Divide by zero.")
269          stop
270      end if
271      delta_inv = 1.0_wp / delta
```

Online tutorial - <https://github.com/adubey64/morph>

Other example - <https://github.com/irdoneal/infrastructure>

Code coverage is popular

- gcov also works for C and Fortran
- Other tools exist for other languages
 - Jcov for Java
 - Coverage.py for python
 - Devel::Cover for perl
 - profile for MATLAB
 - *etc.*

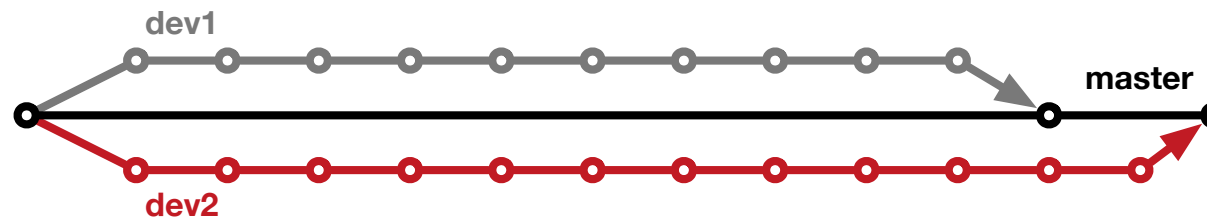


Continuous integration

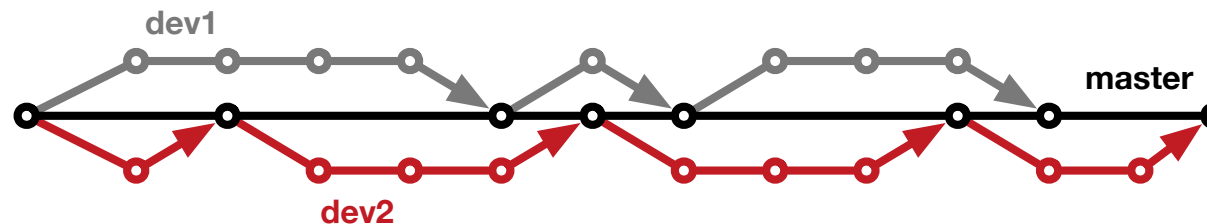
The Short & Sweet of Continuous Integration

A master branch that always works

- Develop workflow policies
 - Commit and merge often
 - Test on push & pull requests?
- Code changes trigger automated builds/tests on target environments



VS.



Continuous integration (CI)

- Has existed for some time and interest is growing
- Setup, maintenance, and monitoring required
- Prerequisites
 - A reasonably automated build system
 - An automated test system with significant test coverage & useful feedback
 - Ability to bundle subset of tests
 - Builds/tests must finish in reasonable amount of time

Cloud-based CI

- Linked to VCS hosts
 - GitHub & Travis CI
 - GitLab CI
 - BitBucket Pipelines
- Automated builds/tests triggered *via* pushes and pull requests
- Builds/tests can be run on cloud systems
- Test results are reported on the pull request page
- Can trigger code coverage analysis & documentation build
- Run tests on different environments

View of toy repository

<https://github.com/irdoneal/infrastructure>

Repository Root

documentation	Included proper location of folders
src	Convert line_t into a class and impr
.gitignore	Travis CI should now run code cover
.travis.yml	Convert line_t into a class and impr
Makefile	Dont delete html or html/.git as this
README.md	Update README.md
README.md	

Sample .travis.yml

```
1 language: cpp
2
3 os:
4   - linux
5   - osx
6
7 compiler:
8   - g++
9   - clang
10
11 script: make && ./runtests.pl
```

Status of Personal codebase

build passing coverage 75%

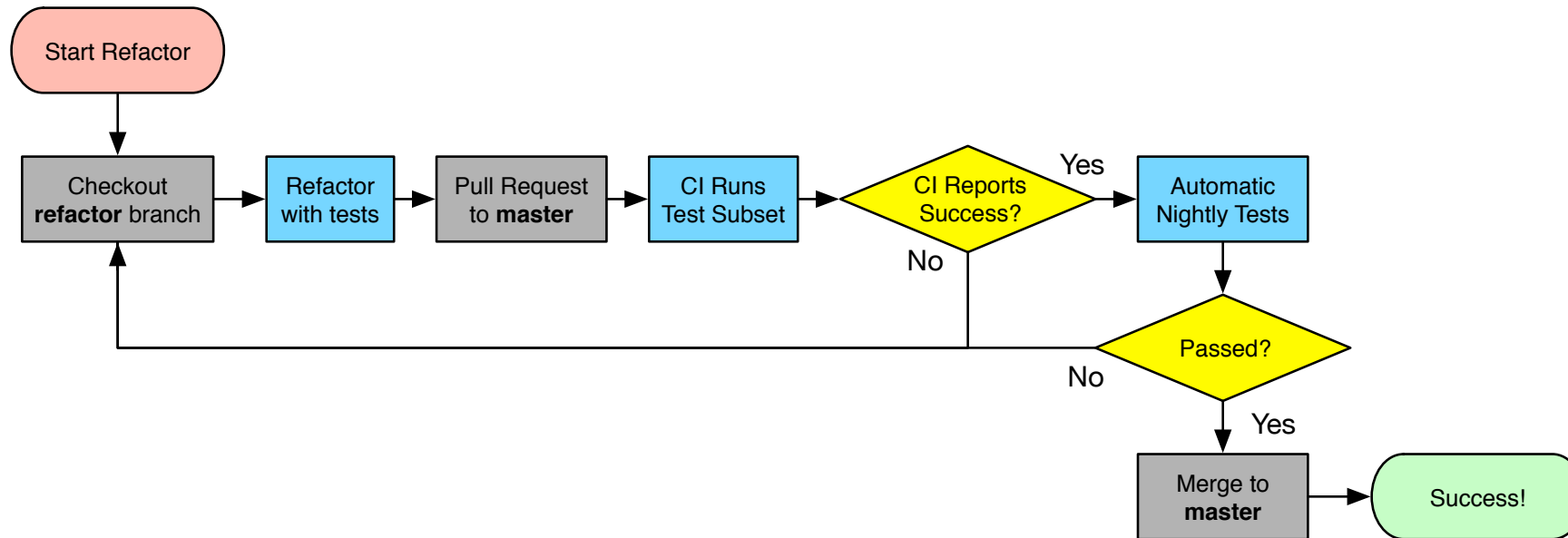
Updated automatically

Results of CI Actions

Default branch	
master Updated 16 days ago by jrdoneal ✓	All checks have passed 2 successful checks
Your branches	
gh-pages Updated 16 days ago by jrdoneal ✓	✓ continuous-integration/travis-ci/push — The Trav...
	✓ coverage/coveralls — Coverage remained the same...

Putting it all together

Toy CI Workflow



Other resources

Software testing levels and definitions:

http://www.tutorialspoint.com/software_testing/software_testing_levels.htm

Working Effectively with Legacy Code, Michael Feathers. The legacy software change algorithm described in this book is very straight-forward and powerful for anyone working on a code that has insufficient testing.

Code Complete, Steve McConnell. Includes testing advice.

Organization dedicated to software testing: <https://www.associationforsoftwaretesting.org/>

Software Carpentry: <http://katyhuff.github.io/python-testing/>

Tutorial from Udacity: <https://www.udacity.com/course/software-testing--cs258>

Papers on testing:

<http://www.sciencedirect.com/science/article/pii/S0950584914001232>

https://www.researchgate.net/publication/264697060_Ongoing_verification_of_a_multiphysics_community_code_FLASH

Resources for Trilinos testing:

Trilinos testing policy: <https://github.com/trilinos/Trilinos/wiki/Trilinos-Testing-Policy>

Trilinos test harness: <https://github.com/trilinos/Trilinos/wiki/Policies--%7C-Testing>

Agenda

Time	Topic	Speaker
2:00pm-2:30pm	Why Effective Software Practices are Essential for CSE Projects	Anshu Dubey, ANL
2:30pm-3:00pm	Introduction to Software Licensing	Michael A. Heroux, SNL
3:00am-3:30pm	Better (small) Scientific Software Teams	Michael A. Heroux, SNL
3:30am-4:00pm	Improving Reproducibility Through Better Software Practices	Michael A. Heroux, SNL
4:00pm-4:30pm	Break	
4:30pm-5:00pm	Testing HPC Scientific Software – Part 1	Anshu Dubey, ANL
5:00pm-5:30pm	Testing HPC Scientific Software – Part 2	Anshu Dubey, ANL
5:30pm-6:00pm	Code Coverage Hands-on and CI Demo	Anshu Dubey, ANL