Code Coverage and Continuous Integration

Better Scientific Software Tutorial

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Supercomputing 2018
Dallas, TX
November 12, 2018

U.S. DEPARTMENT OF ENERGY | Office of Science

National Nuclear Security Administration

License, citation, and acknowledgments

License and Citation

Acknowledgements

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/link with –coverage & turn off optimization
  - 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
```

https://github.com/jrdoneal/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

- DVCS workflow isolate master from integration environment
- Extend workflow to address difficulties of integrating
  – Minimize likelihood of merge conflict
  – Detect bugs immediately
  – Make debugging process quick and easy

Work Decomposition

Commit and integrate often

- Limit divergence between feature and master branches

- Decreased probability of conflict

- Conflict resolution is simpler and less risky

vs.
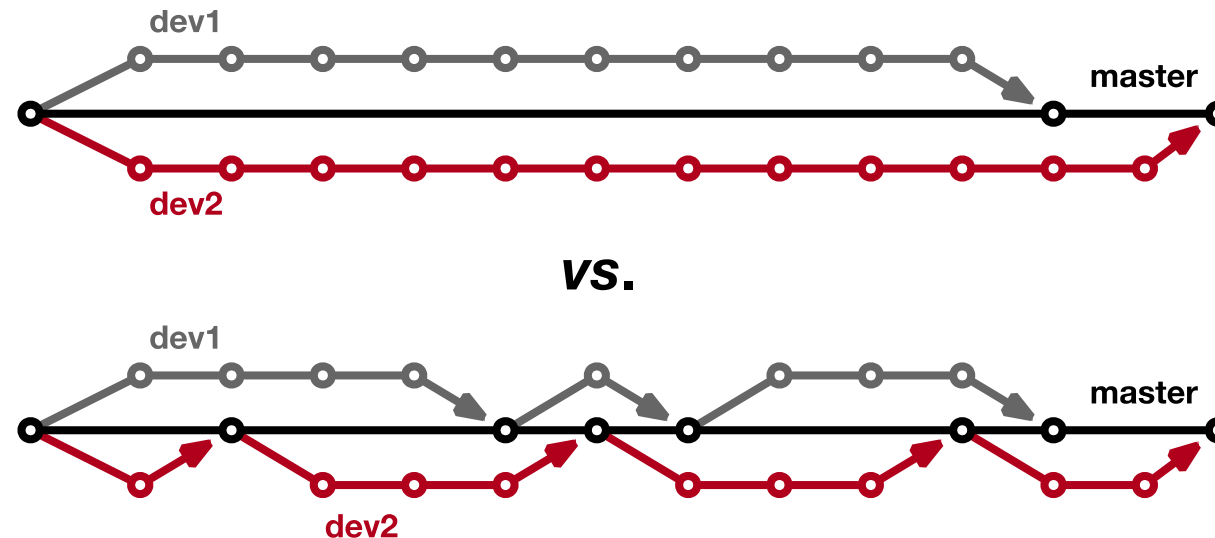
Error detection

Test at integration to identify failures immediately

- Control quality of code

- Isolate failure to few commits

- No context switching for programmer

We want a system that

- triggers automated builds/tests on target environments when code changes and

- ideally tests on proposed merge product without finalizing merge.

Test Servers

Servers that

• automate the execution of a test suite or a subset of a test suite,

• allow for running tests on different environments,

• host an interface for viewing results, and

• allows for configuring when the tests are run.

Examples

• CTest/CDash

• Jenkins

• Travis CI and GitLab CI

Cloud-based Test Servers

- Linked to VCS hosts
  - o GitHub & Travis CI
  - o GitLab CI
  - o BitBucket Pipelines
- Automated builds/tests triggered *via* pushes and pull requests
- Builds/tests can be run on cloud systems
- Test results are reported in repository's web interface
- Can trigger code coverage analysis & documentation build

Continuous integration (CI)

- Has existed for some time and interest is growing

- ECP working to adapt CI for HPC machines

- Setup, maintenance, and monitoring required

- Prerequisites
  - A reasonably automated build system
  - An automated test system with significant test coverage & useful feedback
  - Builds/tests must finish in reasonable about of time
  - Ability to bundle subset of tests

CI Hello World

https://github.com/jrdoneal/CI_HelloWorld

https://travis-ci.org/jrdoneal/CI_HelloWorld

GitHub Repository Page

https://github.com/jrdoneal/CI_HelloWorld

Travis CI Configuration File

.travis.yml

```yaml
env:
- TRAVIS_CI_ENV="Hello, World"

#before_install:
#- Put commands here to prepare for executing builds/installs
#- Examples would be using apt-get to install dependencies not
#  included in the Travis CI build environment by default.

#install:
#- Put build commands here
#- In each phase, you can execute multiple commands
#- Travis CI stops if any single command fails in this phase

before_script:
- echo $TRAVIS_CI_ENV

script:
- $TRAVIS_BUILD_DIR/hello_world.sh
#- Travis CI will run each command in this phase even if a previous command
#  terminated in failure

after_success:
- echo "You should see that Hello, World was printed by before_script"

after_failure:
- echo "Hello, World should not have been printed by before_script"
```

The Script Phase

hello_world.sh

```bash
#!/bin/bash

if   [ -z "${TRAVIS_CI_ENV}" ]; then
  echo "Please set the TRAVIS_CI_ENV environment variable"
  exit 1
elif [ "${TRAVIS_CI_ENV}" != "Hello, World" ]; then
  echo "TRAVIS_CI_ENV value is ill-suited for this tutorial"
  exit 2
fi
```

Connecting GitHub & Travis CI

MY ACCOUNT

jrdoneal

⟳ Sync account

ORGANIZATIONS
You are not currently a member of
any organization.

MISSING AN ORGANIZATION?
Review and add your authorized organizations.

jrdoneal
@jrdoneal

Repositories   Settings

We're only showing your public repositories. You can find your private projects on travis-ci.com.

Legacy Services Integration

⚏ Filter repositories

📖 CI_HelloWorld   ✓⬤   ⚙ Settings

📖 CI_Multiplatform   ✓⬤   ⚙ Settings

📖 infrastructure   ✓⬤   ⚙ Settings

Repository in Travis CI

https://travis-ci.org/jrdoneal/CI_HelloWorld

jrdoneal / CI_HelloWorld

Current   Branches   Build History   Pull Requests

More options

✓ **master** This change should lead to a correct build environment for the p...
tutorial. Travis CI builds should now be successful.

⊶ #3 passed

Restart build

Ran for 18 sec

a day ago

⊶ Commit `93a75c4`
Compare `ff52718..93a75c4`
Branch `master`

jrdoneal

</> Ruby
TRAVIS_CI_ENV="Hello, World"

Commit History

jrdoneal / **CI_HelloWorld**

`<>` Code   ⓘ Issues **0**   ᛘ Pull requests **0**   ▦ Projects **0**   ▤ Wiki   �📊 Insights

Branch: **master** ▾

Commits on Nov 3, 2018

This change should lead to a correct build environment for the purpos... ⋯
Developer D. Develop committed 2 days ago ✔

Update Travis CI configuration file so that it is a step closer to se... ⋯
Developer D. Develop committed 2 days ago ✕

.travis.yml added ⟶ **Add Travis CI configuration file. With the present content, the build** ⋯
Developer D. Develop committed 2 days ago ✕

Add the script that tests that the build environment is correctly con... ⋯
Developer D. Develop committed 2 days ago

Add README file to explain the intent and eventual content of this tu... ⋯
Developer D. Develop committed 2 days ago

Travis CI Build History

Add Travis CI configuration file. With the present content, the build ...

Developer D. Develop committed 2 days ago ✗

```
  ▶    1   Worker information                                                                          worker_info      ○
  ▶    6   Build system information                                                                    system_info
      413
      414
      415   Setting APT mirror in /etc/apt/sources.list: http://us-east-1.ec2.archive.ubuntu.com/ubuntu/
      416
  ▶  417   $ git clone --depth=50 --branch=master https://github.com/jrdoneal/CI_HelloWorld.git jrdoneal/CI_HelloWorld   git.checkout   0.54s
  ▶  427   $ rvm use default                                                                                    rvm       5.27s
  ▶  434   $ ruby --version                                                                             ruby.versions
      442   No Gemfile found, skipping bundle install
  ▼  443   $ echo $TRAVIS_CI_ENV                                                                       before_script    0.00s
      444
      445
      446   $ $TRAVIS_BUILD_DIR/hello_world.sh                                                                           0.00s
      447   Please set the TRAVIS_CI_ENV environment variable
      448
      449
      450   The command "$TRAVIS_BUILD_DIR/hello_world.sh" exited with 1.
  ▶  451   $ echo "Hello, World should not have been printed by before_script"                         after_failure    0.00s
      454
      455   Done. Your build exited with 1.
                                                                                                                Top ▲
```

IDE∆S productivity   ECP EXASCALE COMPUTING PROJECT

Travis CI Build History

Update Travis CI configuration file so that it is a step closer to se… …

Developer D. Develop committed 2 days ago ✕

```
  ▶     1  Worker information                                                                                    worker_info      ○
  ▶     6  Build system information                                                                              system_info
      413
      414
      415  Setting APT mirror in /etc/apt/sources.list: http://us-east-1.ec2.archive.ubuntu.com/ubuntu/
      416
  ▶   417  $ git clone --depth=50 --branch=master https://github.com/jrdoneal/CI_HelloWorld.git jrdoneal/CI_HelloWorld   git.checkout   0.52s
      427
      428  Setting environment variables from .travis.yml
      429  $ export TRAVIS_CI_ENV="This content will result in failure"
      430
  ▶   431  $ rvm use default                                                                                         rvm         4.53s
  ▶   438  $ ruby --version                                                                                    ruby.versions
      446  No Gemfile found, skipping bundle install
  ▼   447  $ echo $TRAVIS_CI_ENV                                                                               before_script   0.00s
      448  This content will result in failure
      449
      450  $ $TRAVIS_BUILD_DIR/hello_world.sh                                                                                0.00s
      451  TRAVIS_CI_ENV value is ill-suited for this tutorial
      452
      453
      454  The command "$TRAVIS_BUILD_DIR/hello_world.sh" exited with 2.
  ▶   455  $ echo "Hello, World should not have been printed by before_script"                                 after_failure   0.00s
      458
      459  Done. Your build exited with 1.
```

IDEAS productivity

ECP EXASCALE COMPUTING PROJECT

Travis CI Build History

This change should lead to a correct build environment for the purpos... ···

Developer D. Develop committed 2 days ago ✔

```
  ▶    1  Worker information                                                                          worker_info
  ▶    6  Build system information                                                                    system_info
     413
     414
     415  Setting APT mirror in /etc/apt/sources.list: http://us-east-1.ec2.archive.ubuntu.com/ubuntu/
     416
  ▶  417  $ git clone --depth=50 --branch=master https://github.com/jrdoneal/CI_HelloWorld.git jrdoneal/CI_HelloWorld    git.checkout    0.53s
     427
     428  Setting environment variables from .travis.yml
     429  $ export TRAVIS_CI_ENV="Hello, World"
     430
  ▶  431  $ rvm use default                                                                            rvm            4.69s
  ▶  438  $ ruby --version                                                                             ruby.versions
     446  No Gemfile found, skipping bundle install
  ▼  447  $ echo $TRAVIS_CI_ENV                                                                        before_script  0.00s
     448  Hello, World
     449
     450  $ $TRAVIS_BUILD_DIR/hello_world.sh                                                                          0.00s
     451
     452
     453  The command "$TRAVIS_BUILD_DIR/hello_world.sh" exited with 0.
  ▶  454  $ echo "You should see that Hello, World was printed by before_script"                       after_success  0.00s
     457
     458  Done. Your build exited with 0.
```

! ⟶ (pointing to line 448)