Unit testing in Python

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Outline

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  - Types of testing
- About unit testing
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  - Edge cases
  - Variable output
- When to test
- Nose tests
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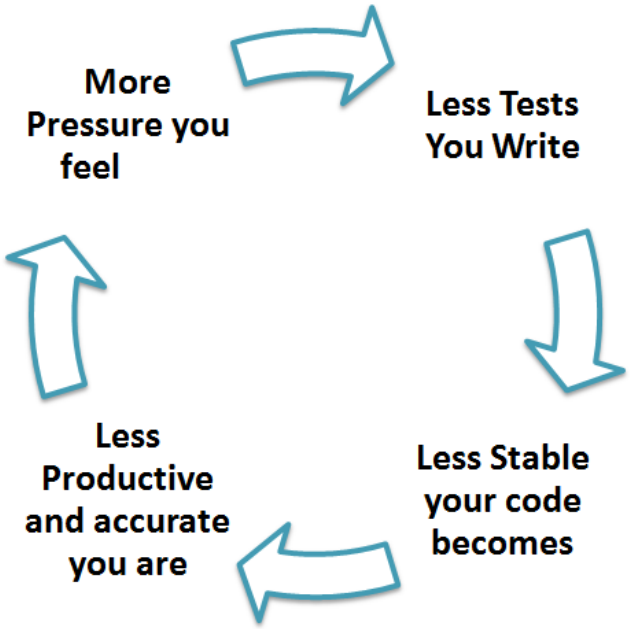
- Coverage testing
- Testing inside PyCharm
- Testing on GitHub with Travis CI (continuous integration)
  - With badges

What is testing?

- Find logical errors in your code
- The code runs, but …
  - It raises an error that you didn't anticipate
    - You calculate an average … and divide by zero
    - You calculate an average … and your user inputs text instead of numbers
  - Even worse: it produces the wrong result and you don’t notice
    - You divide two numbers and get integer (floor) division when you want a float, or vice versa
    - You compare text strings without attending to whitespace or Unicode normalization

Why people avoid testing



- It gets tested when I run it!
  - Only on the input you give it
  - Only at a high level
- My code is bullet-proof!
  - Er … no, it isn't …
- It takes too much time!
  - Not testing takes more time

Types of testing

- Unit testing
  - Smallest testable unit (function, method)
- Integration testing
  - I/O interaction between and among units
- System testing
  - Functionality as a whole
- Acceptance testing
  - End-user testing for suitability to task

What is unit testing?

- Smallest testable code component, in isolation
  - Function, method
- Isolate and test the unit independently of other code
  - Not dependent on filesystem, I/O, other processes, etc.
  - Tests are independent of one another
- If a unit test fails, you know where the error lies
- Tests are run as a suite
  - Framework, harness
  - The entire suite should complete, even if some individual tests fail
  - Testing may be run manually or automated
  - Testing has to be easy, or we won't do it

Digression: what is a pipeline?

```
grep -i 'horrible' review.json | cut -d, -f4 | sort | uniq -c | sort -nr
```

- `grep` find all lines that contain 'horrible' (case-insensitive)
- `cut` isolate part of the data
  - `-d,` means that the delimiter is a comma
  - `-f4` means fourth field
- `sort` sort only fourth field values
- `uniq -c` collect adjacent lines and put the count in front
- `sort` numeric sort from high to low
- Tada!

The pipeline

```
def transliterate(line: str) -> str:
    """
    Transliterate input line from Cyrillic XML to Roman string

    Keyword parameters:
    line (str): a line of verse as well-formed XML

    Returns:
    str: transliterated line
    """
    return functools.reduce(
        lambda value, function: function(value),
        (
            _flatten,
            _lexical,
            _ogo,
            _proclitics,
            _enclitics,
            _tsa,
            _palatalize,
            _jot,
            _romanize,
            _final_devoice,
            _regressive_devoice,
            _regressive_voice,
            _regressive_palatalization,
            _consonant_cleanup,
            _vowel_reduction
        ),
        line,
    )
```

What to test

- Functionality that can be isolated (functions, methods)
  - Create complex functions as piplines, not monoliths
- All possible types of input …
- … including edge cases

The Edge Case Saloon

- A developer walks into a bar and …
  - Orders a beer.
  - Orders 0 beers.
  - Orders 999999999 beers.
  - Orders a lizard.
  - Orders -1 beers.
  - Orders a sfdeljknesv.

Sample unit test

```
from nose.tools import *
from cyr2phon import cyr2phon

def test_ogo_moego():
    expected = "моевв0"
    assert_equal(cyr2phon._ogo("моег0"), expected)
```

Testing with variable output

- We can't use `assert_equal()` with, e.g., dictionary output because the order of dictionary entries is undefined
- So find another way

When to test?

- Test as you code
  - When you create code, add tests
  - When you fix a bug, add tests
- Test-driven development
  - Write the tests first, and then add code so that they pass
- Regression testing
  - Run the full test suite often

Nose tests

- Nose is a Python testing framework
  - There are others
- May be run from the command line, within an IDE, or in CI
- May be object oriented or not (mine is not)

Testing involves

- Discovering tests
  - Files or directories under the current working directory whose names include “test” or “Test” at a word boundary (like “test_this” or “functional_test” or “TestClass” but not “libtest”)
- Running tests
- Reporting results

Sample nose test

```
from nose.tools import *
from cyr2phon import cyr2phon

def test_ogo_moego():
     expected = "моевO"
     assert_equal(cyr2phon._ogo("моегO"), expected)
```

Test generator

```
def test_palatalize_front_vowel():
    for v in "яеиёюЯЕИЁЮ":
        fn = lambda: check_palatalize_front_vowel(v)
        fn.description =
"cyr2phon.tests.test_transliterate.test_palatalize_front_vowel with
{}".format(v)
        yield fn

def check_palatalize_front_vowel(v):
    assert_equal(cyr2phon._palatalize("б" + v), "Б" + v)
```

Fixtures

- Start-up
- Tear-down
- (I don’t use these)

Command line

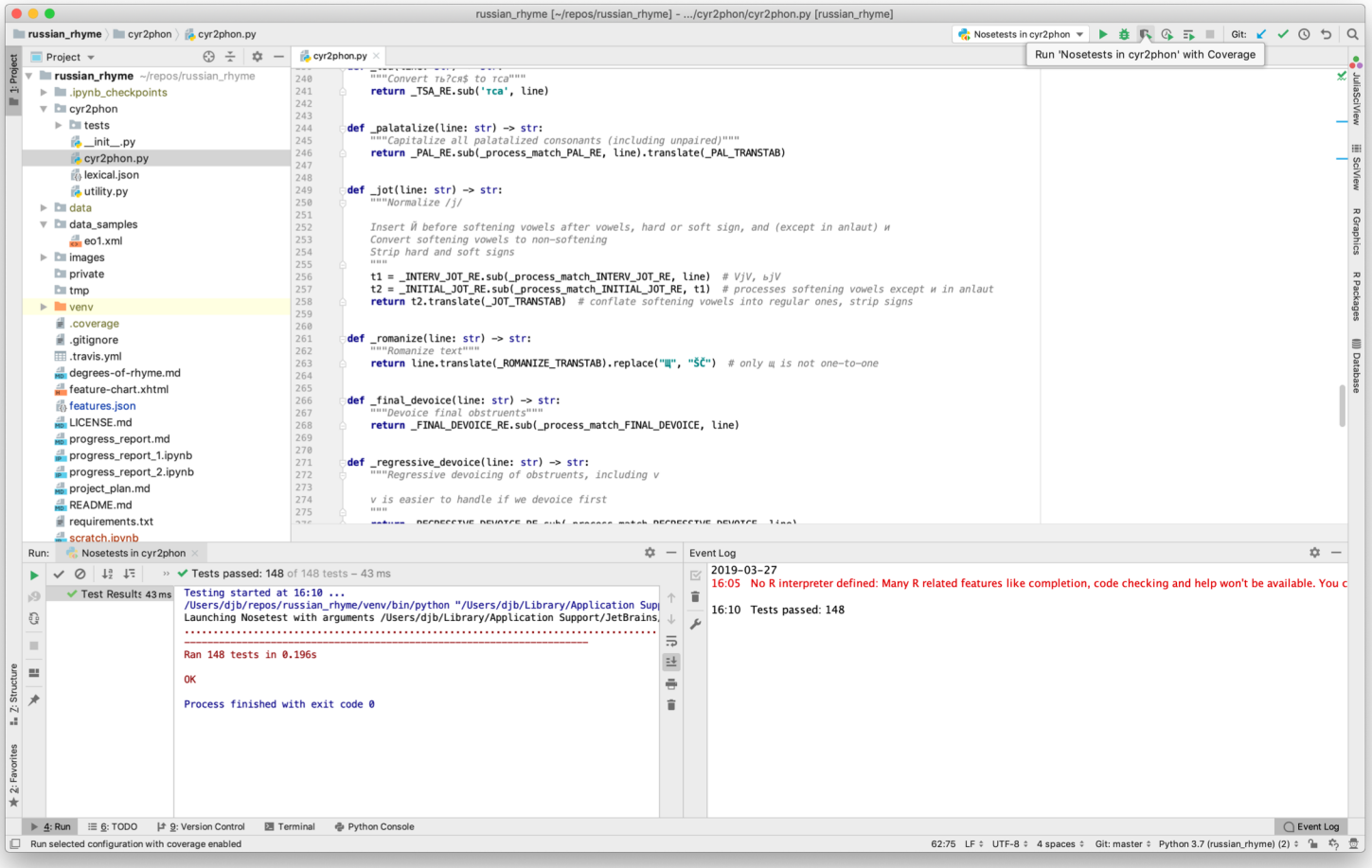
```
nosetests
      -v
      --with-coverage
      --cover-package=cyr2phon
      --cover-tests cyr2phon/tests/test_transliterate.py
      --cover-tests cyr2phon/tests/test_utility.py
```

Coverage testing

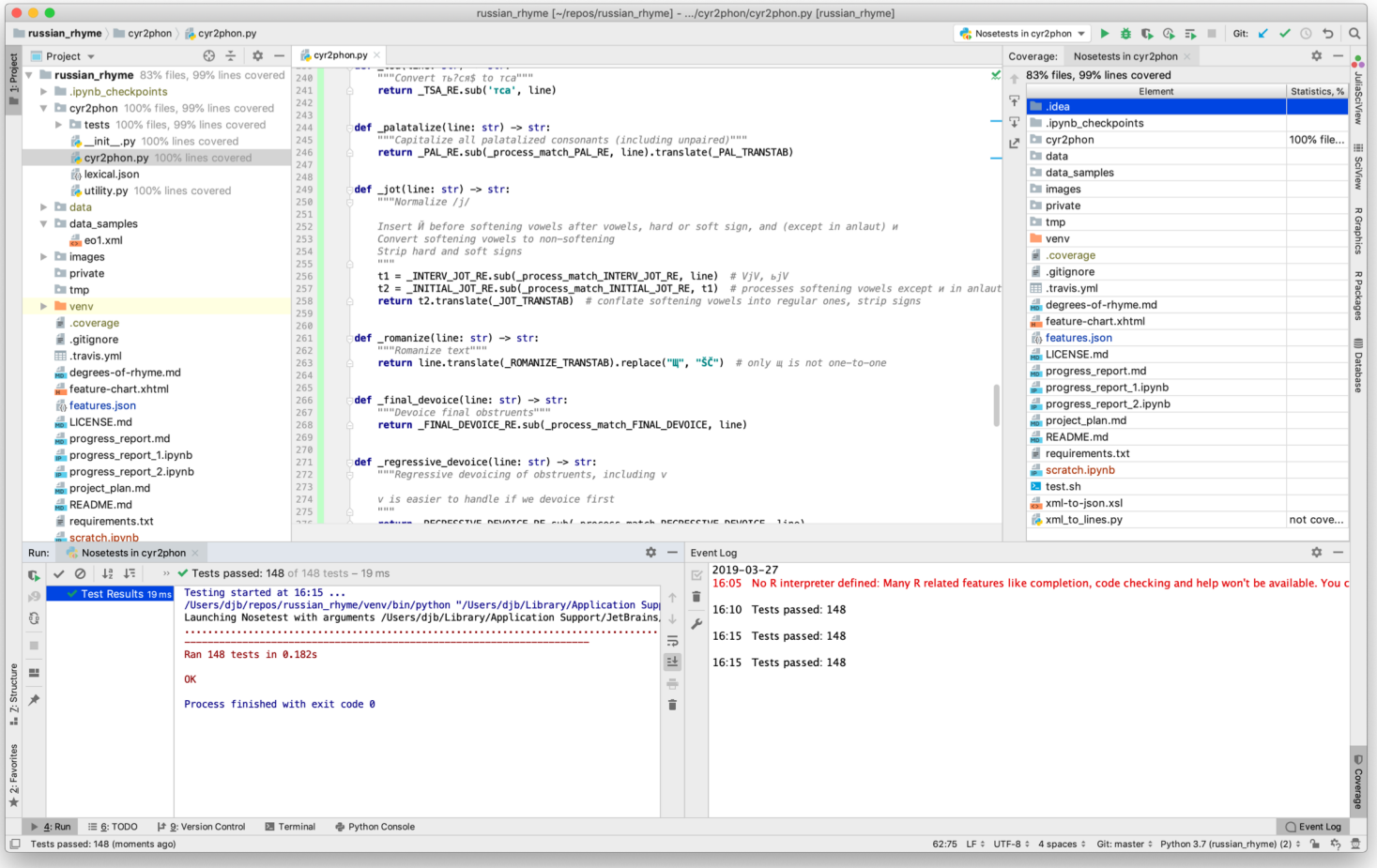
- Report about amount of the code base that is addressed by tests

```
Name                                    Stmts   Miss  Cover
-------------------------------------------------------------
cyr2phon/__init__.py                        6      0   100%
cyr2phon/cyr2phon.py                      112      0   100%
cyr2phon/tests/__init__.py                  0      0   100%
cyr2phon/tests/test_transliterate.py      172      0   100%
cyr2phon/tests/test_utility.py             24      0   100%
cyr2phon/utility.py                        32      0   100%
-------------------------------------------------------------
TOTAL                                     346      0   100%
```

Testing inside PyCharm



Testing inside PyCharm with coverage



Testing on GitHub with Travis CI

- Continuous integration
- Configure *.travis.yml* in repo
- List requirements in *requirements.txt*
- Project “builds” automatically on every push

Travis CI files

.travis.yml

```
language: python
python: 3.7
dist: xenial
sudo: true
script: "nosetests -v --with-coverage --cover-package=cyr2phon --cover-tests cyr2phon/tests/"
after_success: "codecov"
```

requirements.txt

```
numpy
pandas
nose
codecov
coverage
regex
```

GitHub badges

README.md

monotreme obdurodon | build passing | codecov 99%

Machine-assisted identification of rhyme in Russian verse

David J. Birnbaum

Files and directories

Code

Notebook

- Progress report 1 notebook

Library

- *cyr2phon.py*: Cyrillic to phonetic library; exposes `cyr2phon.transliterate()`
- *utility.py*: Utility functions; exposes `utility.syllabify()`

Development

- *test_transliterate*: Nose tests for transliteration code
- *test_utility*: Nose tests for utility code (syllabification)
- *.travis.yml* and *requirements.txt*: Configuration information for Travis CI

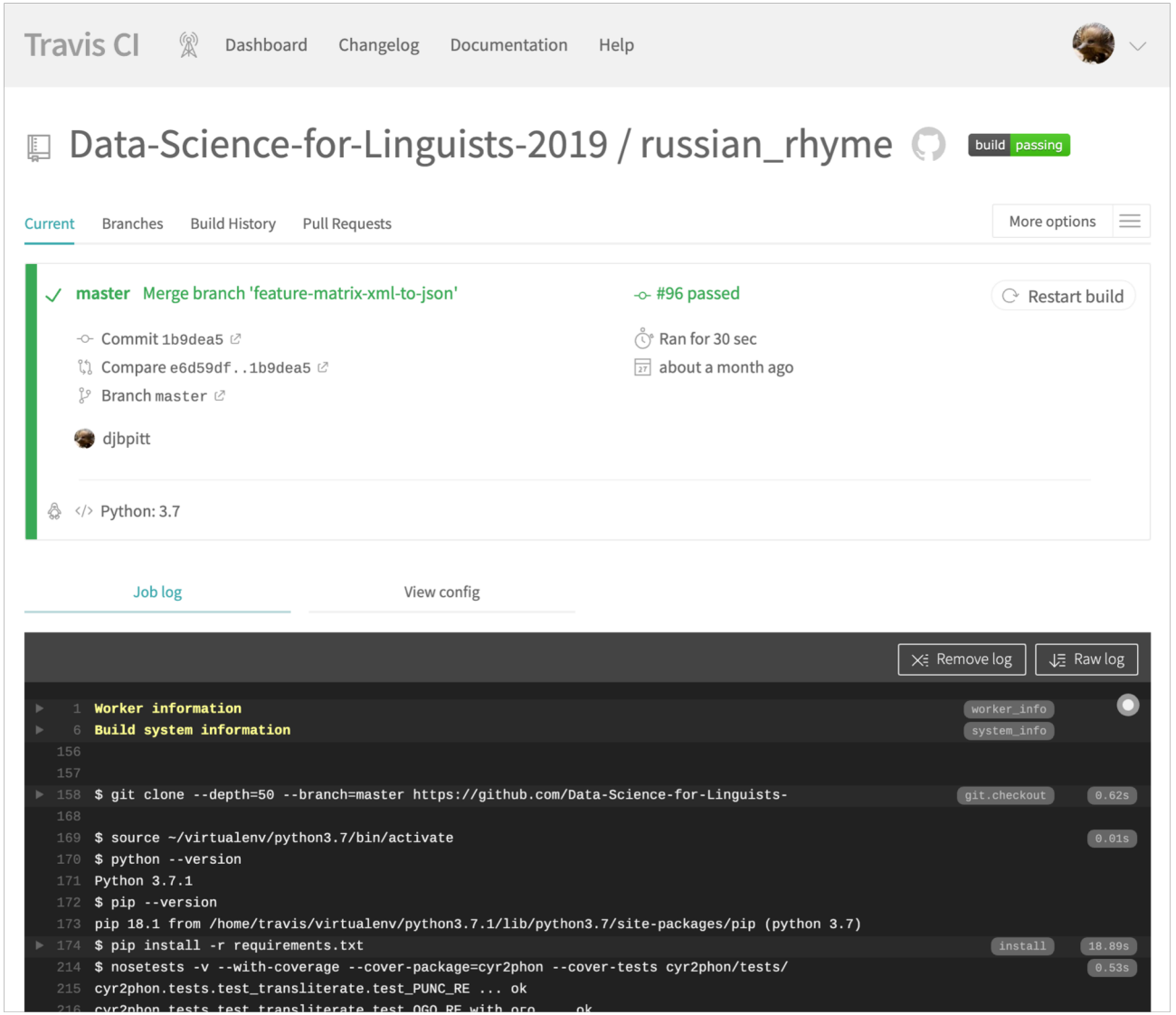
Badge code

- [![Obdurodon](images/monotreme-obdurodon-blue.svg)](http://www.obdurodon.org)
- [![Build Status](https://travis-ci.com/Data-Science-for-Linguists-2019/russian_rhyme.svg?branch=master)](https://travis-ci.com/Data-Science-for-Linguists-2019/russian_rhyme)
- [![Code Coverage](https://codecov.io/gh/Data-Science-for-Linguists-2019/russian_rhyme/branch/master/graph/badge.svg)](https://codecov.io/gh/Data-Science-for-Linguists-2019/russian_rhyme)

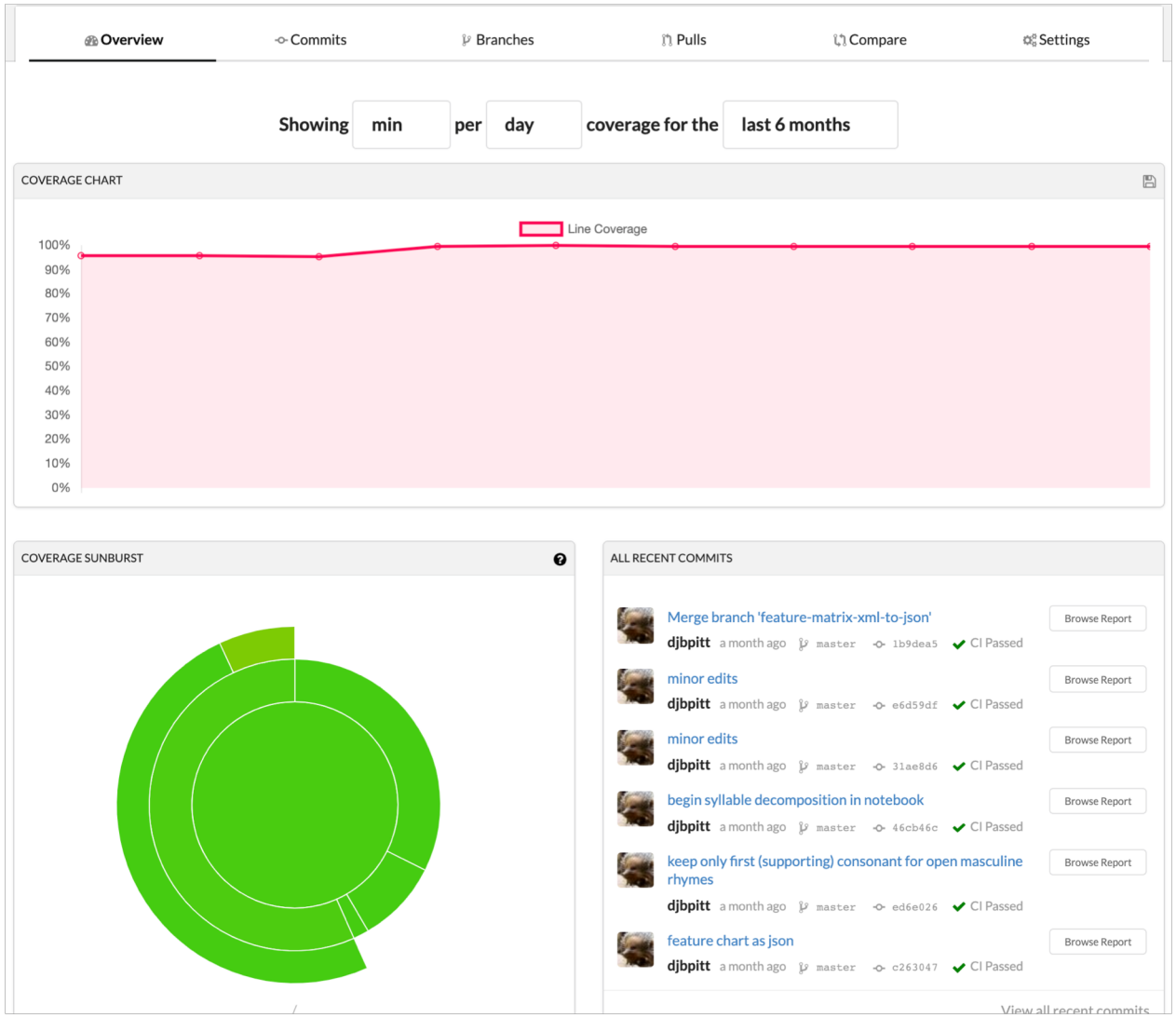
Your own badges

- Create an account at https://travis-ci.com
  - Connect to repo
- Create an account at https://codecov.io
  - Connect to repo
- Download images from https://shields.io/ or https://github.com/badges/shields
- Add links to README.md (see above)

Build report



Coverage report



Thank you

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For more information

- Install: https://pypi.org/project/nose/1.3.7/
- Documentation: https://nose.readthedocs.io/en/latest/index.html
- Tutorials
  - https://www.tutorialspoint.com/unittest_framework/nose_testing_framework.htm
  - http://pythontesting.net/framework/nose/nose-introduction/
  - http://ivory.idyll.org/articles/nose-intro.html