Test Driven Development

...if it's worth developing; it's worth testing

Instructor:

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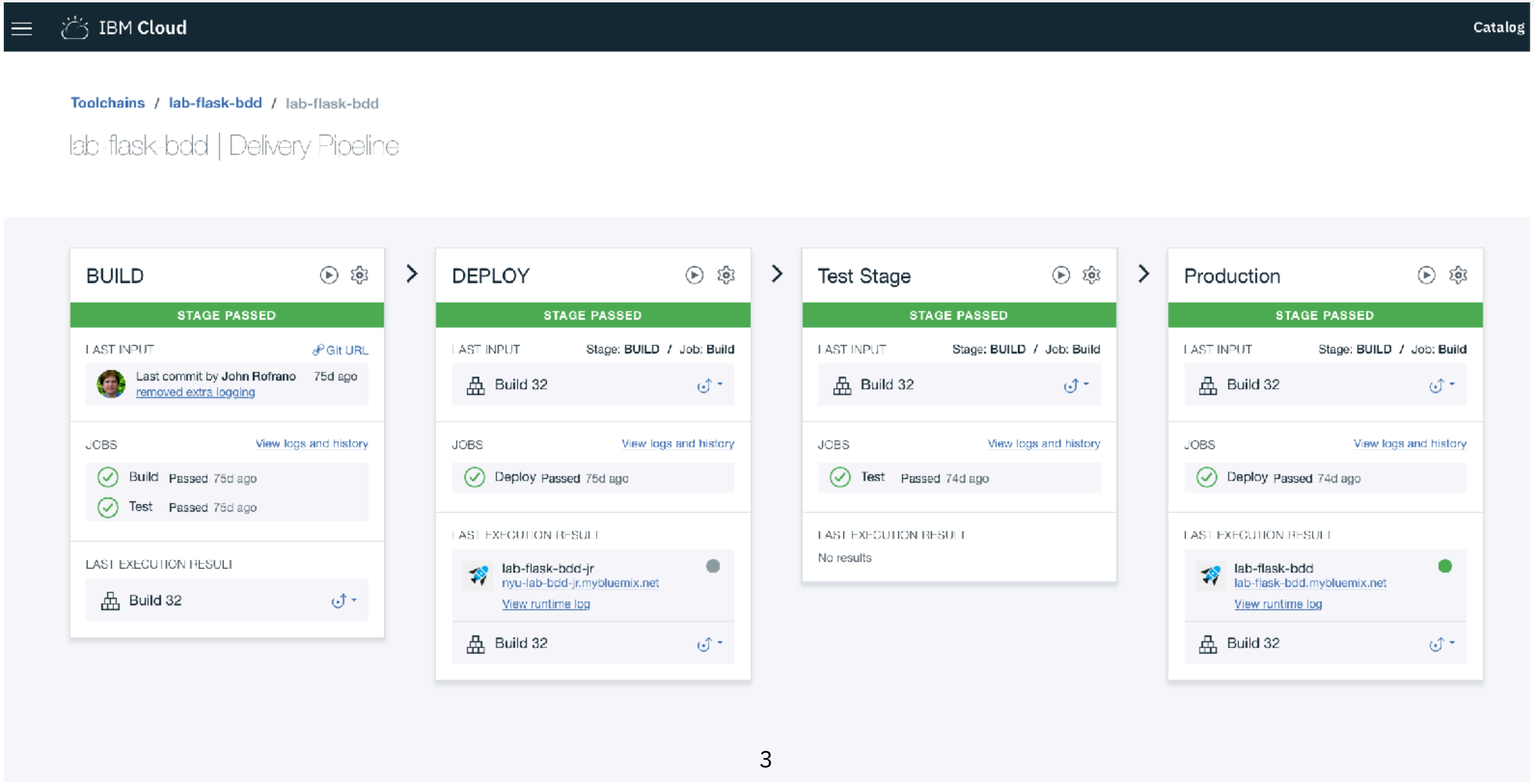
What Will You Learn?

- Why automated testing is important to DevOps
- How Test Driven Development makes you think about the requirements first
- How Test Driven Development can improve your code and save you time
- How to use Code Coverage to ensure all paths are tested

What is the Goal?



lab-flask-bdd | Delivery Pipeline

BUILD — STAGE PASSED
LAST INPUT — Git URL
Last commit by John Rofrano 75d ago — removed extra logging
JOBS — View logs and history
Build Passed 75d ago
Test Passed 75d ago
LAST EXECUTION RESULT
Build 32

DEPLOY — STAGE PASSED
LAST INPUT — Stage: BUILD / Job: Build
Build 32
JOBS — View logs and history
Deploy Passed 75d ago
LAST EXECUTION RESULT
lab-flask-bdd-jr
nyu-lab-bdd-jr.mybluemix.net
View runtime log
Build 32

Test Stage — STAGE PASSED
LAST INPUT — Stage: BUILD / Job: Build
Build 32
JOBS — View logs and history
Test Passed 74d ago
LAST EXECUTION RESULT
No results

Production — STAGE PASSED
LAST INPUT — Stage: BUILD / Job: Build
Build 32
JOBS — View logs and history
Deploy Passed 74d ago
LAST EXECUTION RESULT
lab-flask-bdd
lab-flask-bdd.mybluemix.net
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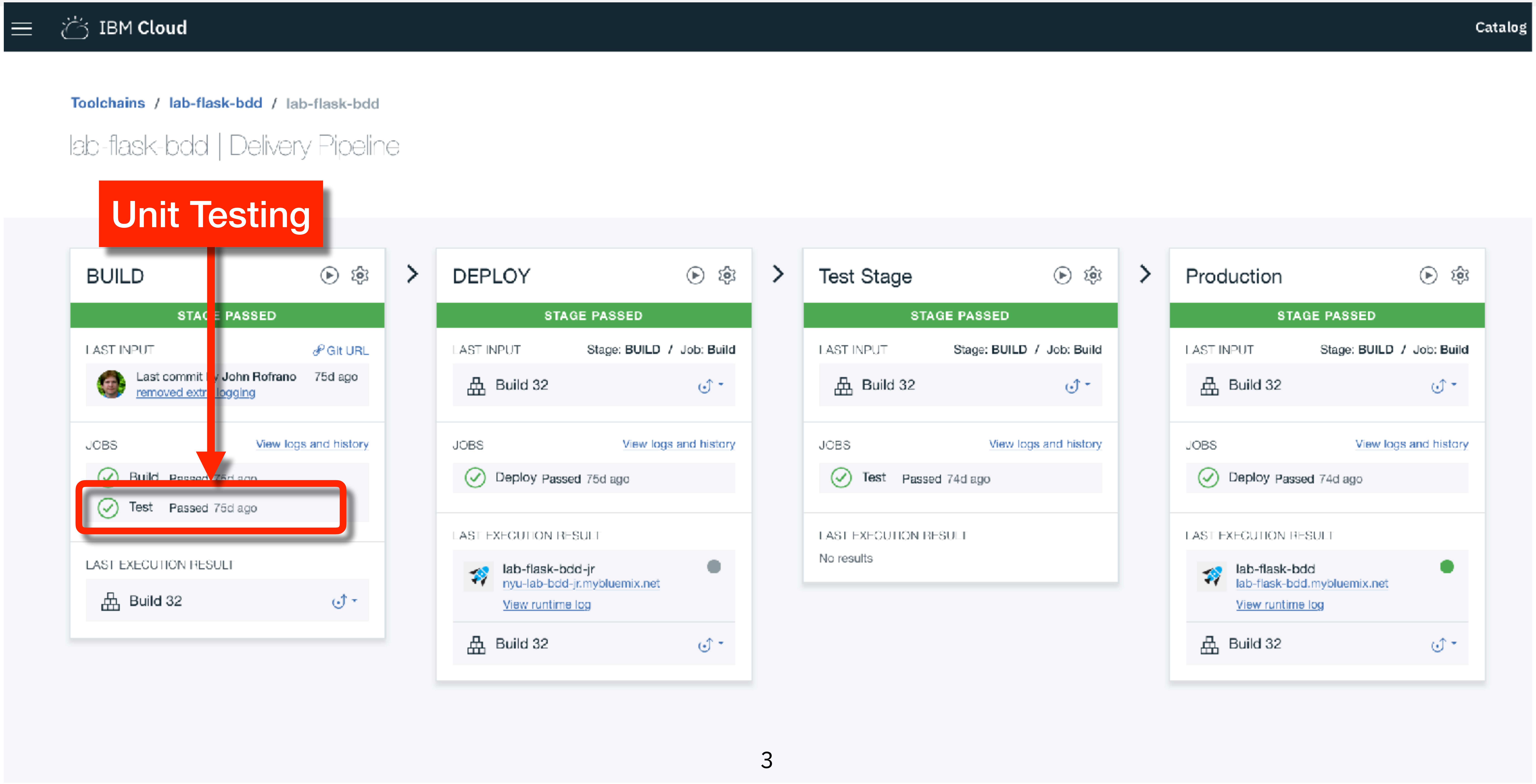

IBM Cloud

Catalog

Toolchains / lab-flask-bdd / lab-flask-bdd

lab-flask-bdd | Delivery Pipeline

Unit Testing

BUILD

STAGE PASSED

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LAST EXECUTION RESULT

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LAST EXECUTION RESULT

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View runtime log

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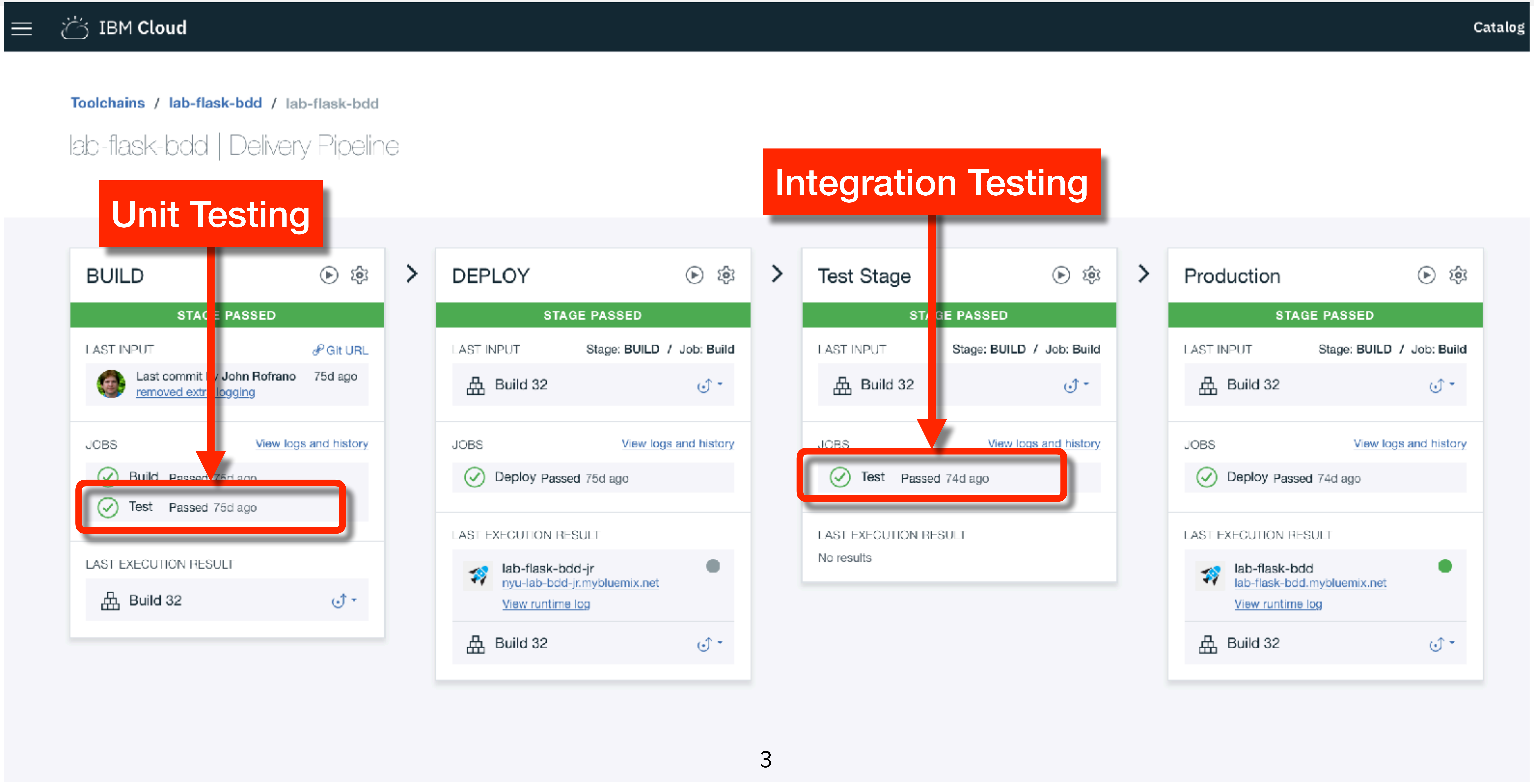
What is the Goal?



“If it's worth building, it's worth testing.
If it's not worth testing, why are you wasting your time working on it?”

–*agiledata.org*

Why Developers Don’t Test

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  - Others who work on your code in the future won’t know if they broke something

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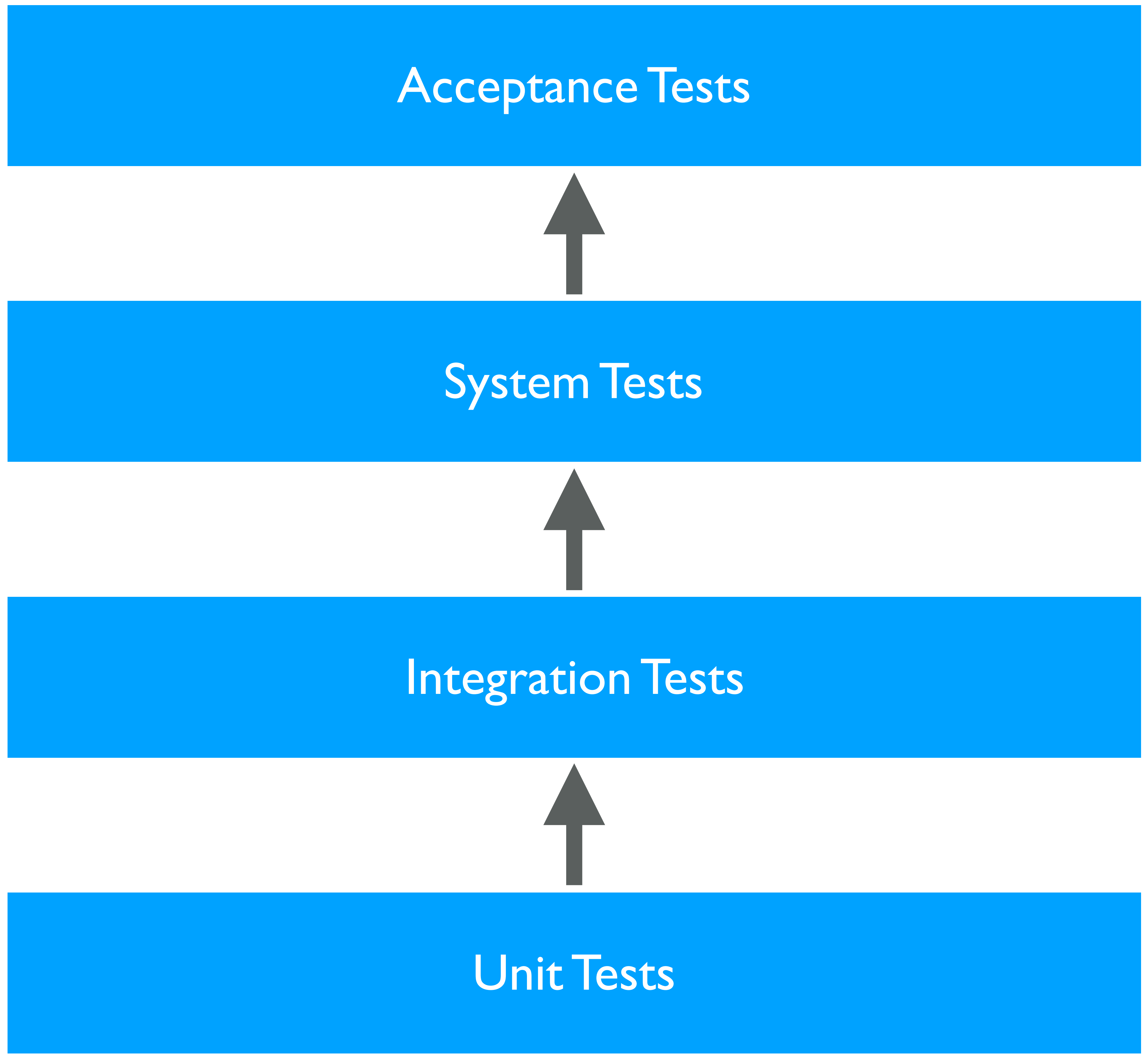
Why Developers Don’t Test

- I already know it works!
  - Others who work on your code in the future won’t know if they broke something
- I don’t write broken code!
  - Sometimes the environment changes and other future libraries read your code
- I have no time!
  - Testing actually saves you time (and stress) in the long run

Why Do We Need To Test?

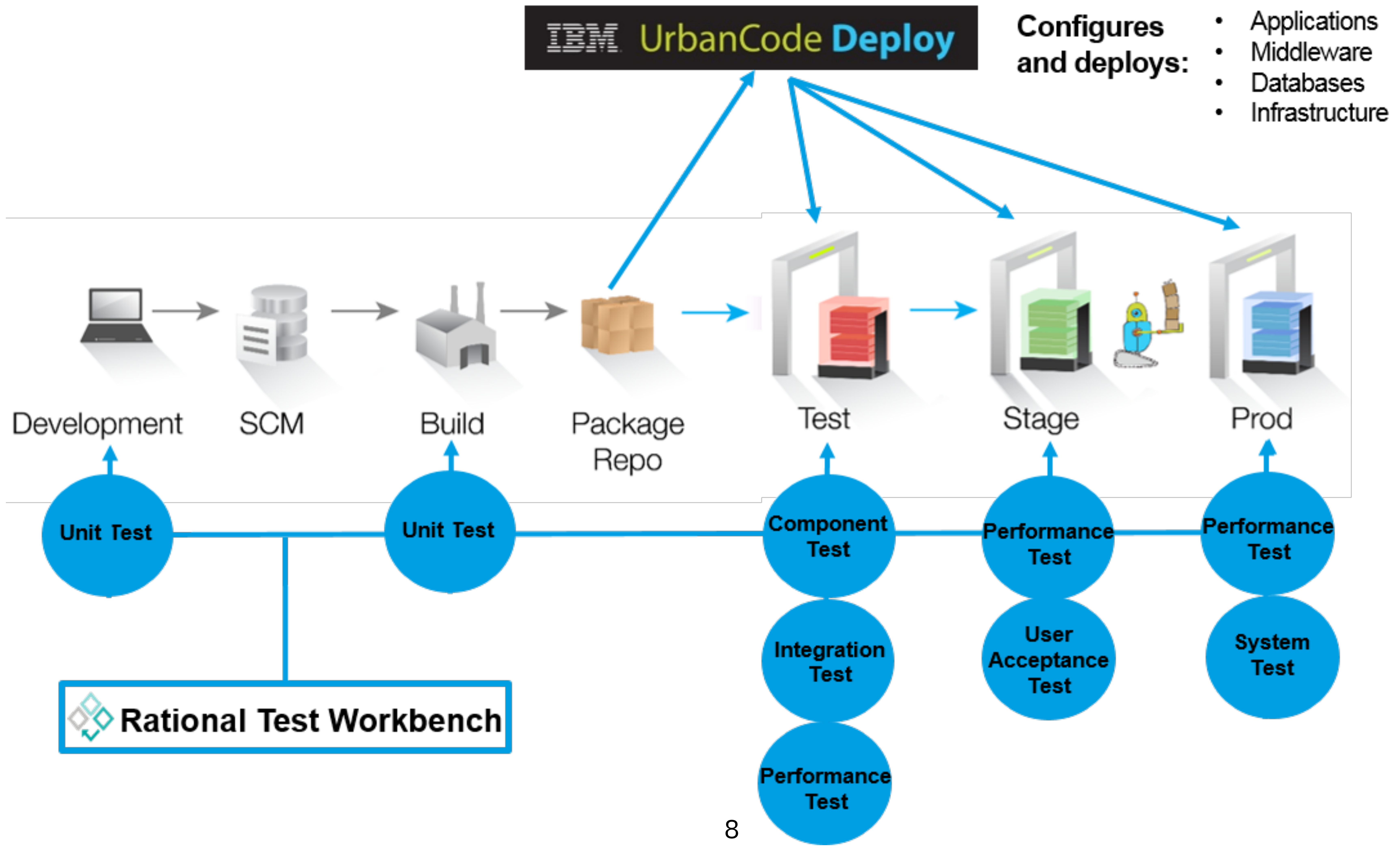
Software Testing Levels

Acceptance Testing	A level of the software testing process where a system is tested for acceptability. The purpose of this test is to evaluate the system's compliance with the business requirements and assess whether it is acceptable for delivery.
System Testing	A level of the software testing process where a complete, integrated system/software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements.
Integration Testing	A level of the software testing process where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units.
Unit Testing	A level of the software testing process where individual units/components of a software/system are tested. The purpose is to validate that each unit of the software performs as designed.



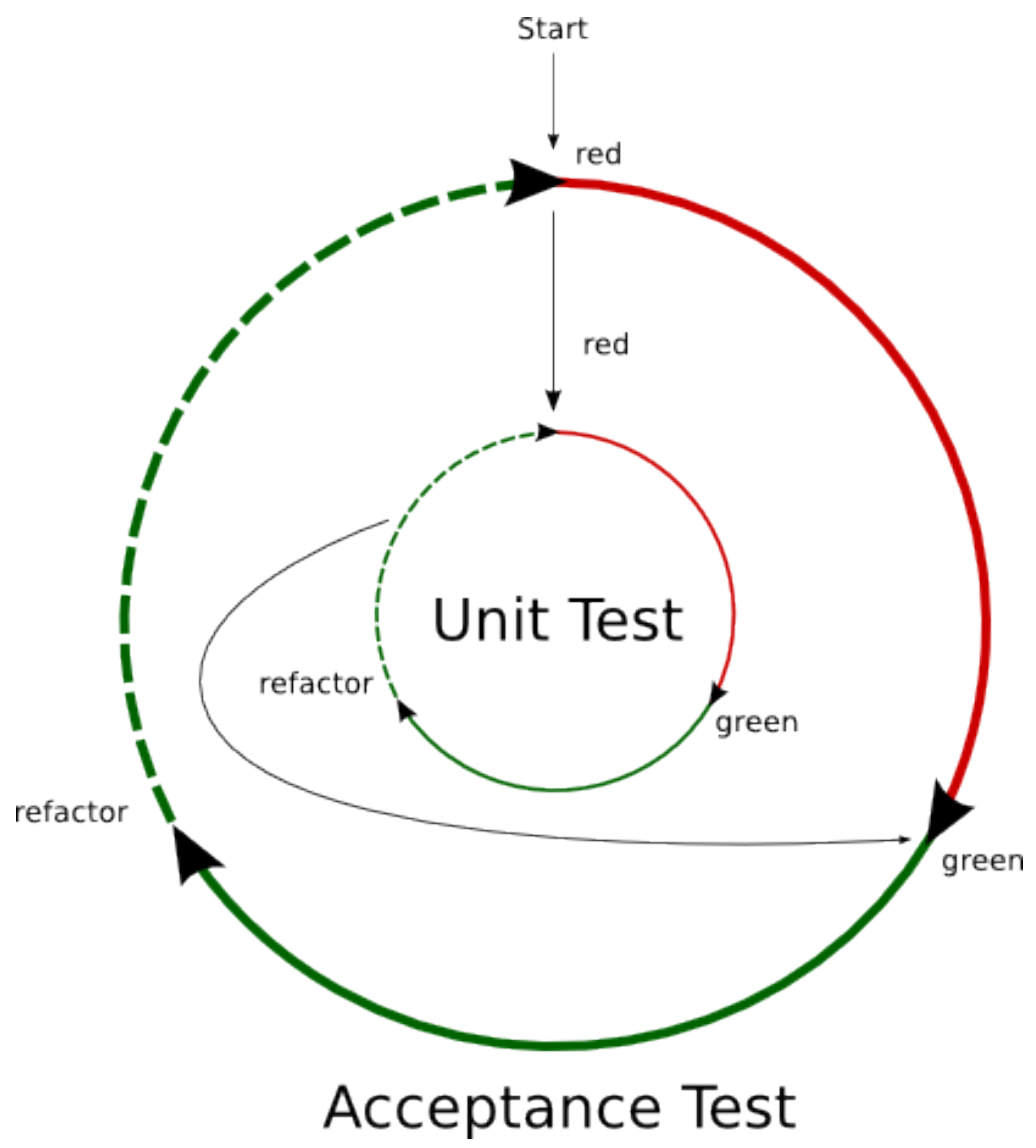
http://softwaretestingfundamentals.com/software-testing-lev

Traditional Release Cycle

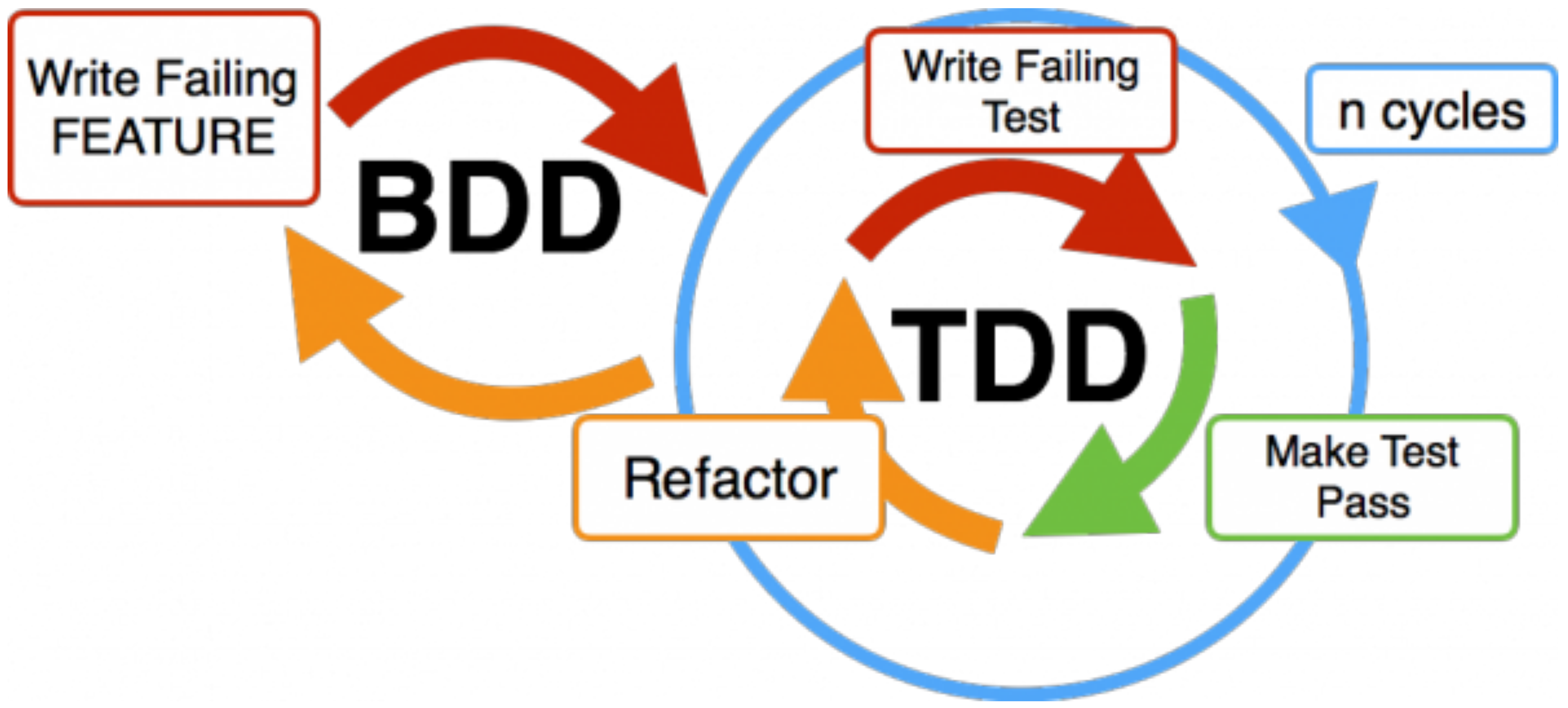


What is BDD & TDD

- Behavior-Driven Development (BDD)
  - Describes the behavior of the system from the outside in
  - Used for Integration / Acceptance Testing
- Test Driven Development (TDD)
  - Tests the functions of the system from the inside out
  - Used for unit testing



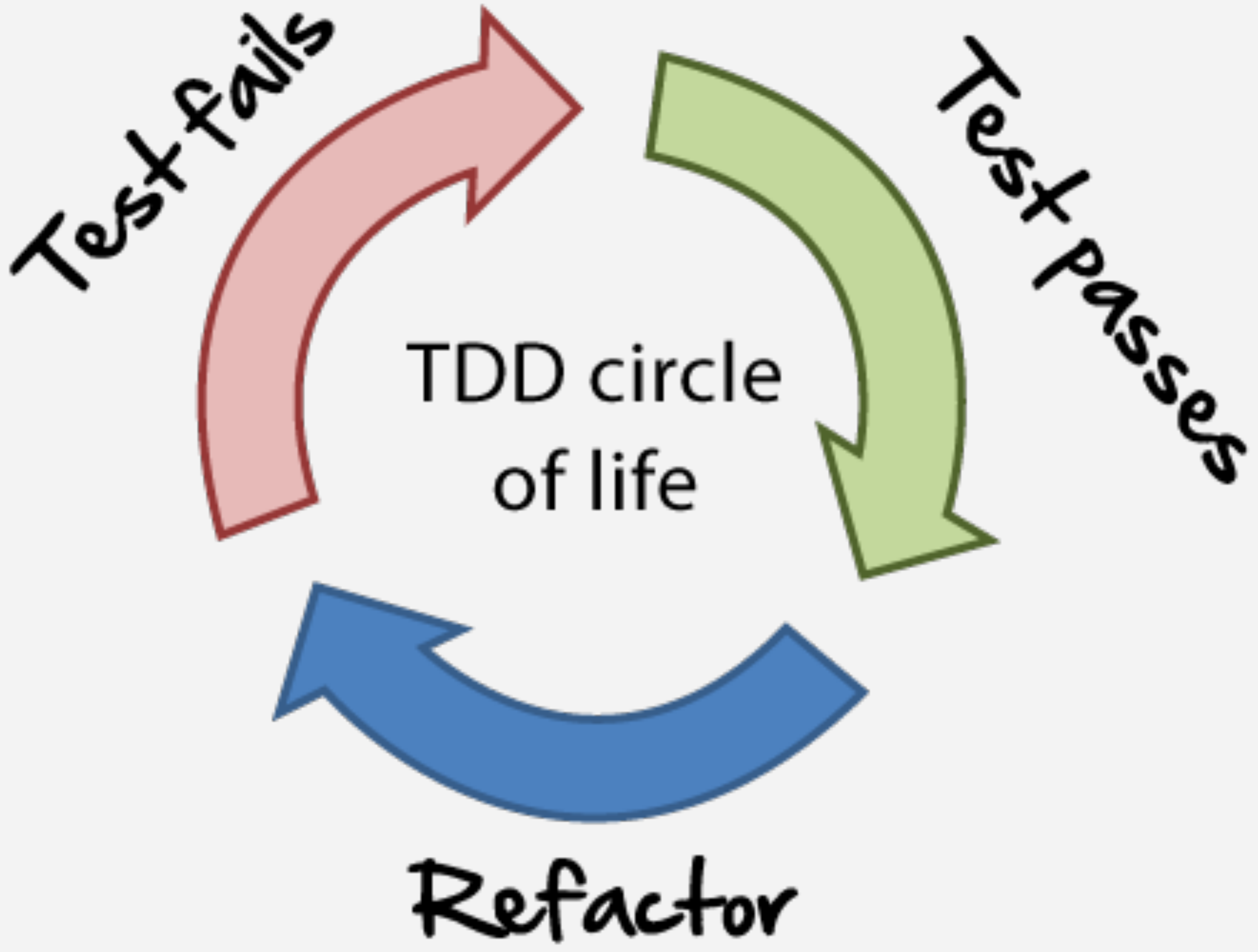
BDD & TDD Cycle



“BDD is building the *right thing*, and TDD is building the *thing right*.”

Test Driven Development

Using PyUnit



What is TDD?

- Test Driven Development means that your test cases drive the design and development of your code
- You write the tests first for the *code you wish you had*, then you write the code to make the test pass
- This keeps you focused on the purpose of the code (i.e., what is it supposed to do)

Why is automated Testing Important to DevOps?

- First and foremost it saves time when developing!
- It allows you to run faster because you are more confident
- It insures that your code is working as you expected
- It insures that future changes don’t break your code
- In order to use a DevOps Pipeline, all testing must be automated

I’m not a great programmer; I’m just a good programmer with great habits

— Kent Beck —

Get in the habit of testing early and often!

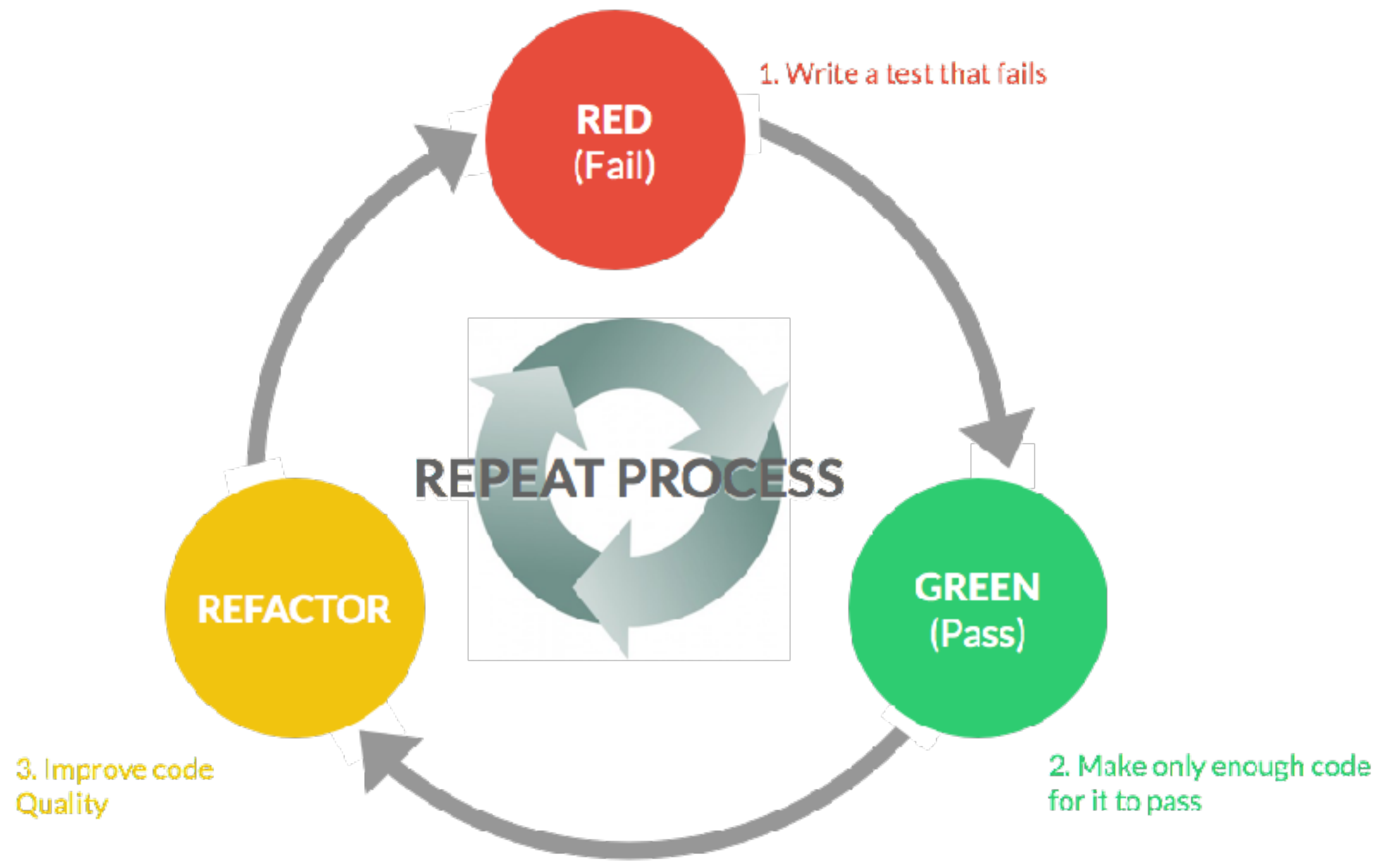
Kent Beck says Good Unit tests:

- Run fast (they have short setups, run times, and break downs).
- Run in isolation (you should be able to reorder them).
- Use data that makes them easy to read and to understand.
- Use real data (e.g. copies of production data) when they need to.
- Represent one step towards your overall goal.

The Basic TDD Workflow

- Write a failing unit test for the code you wish you had
- Write just enough code to make the unit test pass
- Refactor the code and repeat

Also know as: Red, Green, Refactor


RED
(Fail)
1. Write a test that fails
GREEN
(Pass)
2. Make only enough code for it to pass
REFACTOR
3. Improve code Quality
REPEAT PROCESS

Popular Python Test Tools

- **PyUnit:** This is what we will use. It is the standard unittest module like JUnit
- **Py.test:** Good for multiple levels of setup/ teardowns but may leads to highly unstructured and hard to read unit tests
- **Doctest:** is OK for simple things, but it's limiting and doesn't really scale for complex and highly interactive code
- **Nose:** isn't really a unit testing framework. It's a test runner and a great one at that. It can run tests created using unittest, py.test or doctest (we will also use it)

Anatomy of a Test Case

```
import unittest
from stack import Stack

class StackTestCase(unittest.TestCase):
    def setUp(self):
       self.stack = Stack()

    def tearDown(self):
       self.stack = None

    def test_push(self):
        self.stack.push(9)
        self.assertEqual(self.stack.peek(), 9)

    def test_pop(self):
        self.stack.push(9)
        self.assertEqual(self.stack.pop(), 9)
        self.assertTrue(self.stack.isEmpty())

if __name__ == '__main__':
    unittest.main()
```

Anatomy of a Test Case

import the unittest module and your code

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Anatomy of a Test Case

All tests are derived from `unitest.TestCase`

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Anatomy of a Test Case

Called before and after each test case method

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Any method that starts with '`test_`' is assumed to be a test case

Anatomy of a Test Case

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Runs the tests

Test fixtures

- A test fixture is a fixed state of a set of objects used as a baseline for running tests.
- The purpose of a test fixture is to ensure that there is a well known and fixed environment in which tests are run so that results are repeatable.
- Examples of fixtures:
  - Preparation of input data and setup/creation of fake or mock objects
  - Loading a database with a specific, known set of data
  - Copying a specific known set of files creating a test fixture will create a set of objects initialized to certain states.

Unittest Fixtures

```
def setUpModule():                  <- runs once before any tests

def tearDownModule():               <- runs once after all tests

class MyTestCases(TestCase):

    @classmethod
    def setUpClass(cls):            <- runs once before test class

    @classmethod
    def tearDownClass(cls):         <- runs once after test class

    def setUp(self):                <- runs before each tests

    def tearDown(self):             <- runs after each tests
```

Assertions for PyUnit

- **`assert`**: base assert allowing you to write your own assertions
- **`assertEqual(a, b)`**: check a and b are equal
- **`assertNotEqual(a, b)`**: check a and b are not equal
- **`assertIn(a, b)`**: check that a is in the item b
- **`assertNotIn(a, b)`**: check that a is not in the item b
- **`assertFalse(a)`**: check that the value of a is False
- **`assertTrue(a)`**: check the value of a is True
- **`assertIsInstance(a, TYPE)`**: check that a is of type "TYPE"
- **`assertRaises(ERROR, a, args)`**: check that when a is called with args that it raises ERROR

Tests Cases for Pet Demo

```
import unittest
import json
from server import app, db, Pet

class TestPetServer(unittest.TestCase):
   def setUp(self):
        # Set up the test database
        app.config['SQLALCHEMY_DATABASE_URI'] = 'sqlite:///db/test.db'
        db.drop_all()    # clean up the last tests
        db.create_all()  # make our sqlalchemy tables
        db.session.add(Pet(name='fido', category='dog'))
        db.session.add(Pet(name='kitty', category='cat'))
        db.session.commit()
        self.app = app.test_client()

    def tearDown(self):
        db.session.remove()
        db.drop_all()
```

Tests Cases for Pet Demo

```
def test_index(self):
    resp = self.app.get('/')
    self.assertEqual( resp.status_code, status.HTTP_200_OK )
    self.assertTrue ('Pet Demo REST API Service' in resp.data)

def test_get_pet_list(self):
    resp = self.app.get('/pets')
    self.assertEqual( resp.status_code, status.HTTP_200_OK )
    self.assertTrue( len(resp.data) > 0 )

def test_get_pet(self):
    resp = self.app.get('/pets/2')
    self.assertEqual( resp.status_code, status.HTTP_200_OK )
    data = resp.get_json()
    self.assertEqual (data['name'], 'kitty')

def test_get_pet_not_found(self):
    resp = self.app.get('/pets/0')
    self.assertEqual( resp.status_code, status.HTTP_404_NOT_FOUND )
```

Tests Cases for Pet Demo

```
def test_create_pet(self):
    # save the current number of pets for later comparison
    pet_count = self.get_pet_count()
    # add a new pet
    new_pet = {'name': 'sammy', 'category': 'snake'}
    resp = self.app.post('/pets', json=new_pet, content_type='application/json')
    self.assertEqual( resp.status_code, status.HTTP_201_CREATED )
    # Make sure location header is set
    location = resp.headers.get('Location', None)
    self.assertTrue( location != None)
    # Check the data is correct
    new_json = resp.get_json()
    self.assertEqual (new_json['name'], 'sammy')
    # check that count has gone up and includes sammy
    resp = self.app.get('/pets')
    data = resp.get_json()
    self.assertEqual( resp.status_code, status.HTTP_200_OK )
    self.assertEqual( len(data), pet_count + 1 )
    self.assertIn( new_json, data )
```

Install the Python Dependencies

- The Vagrantfile sets up a Python 3 virtual environment (so you don't have to)

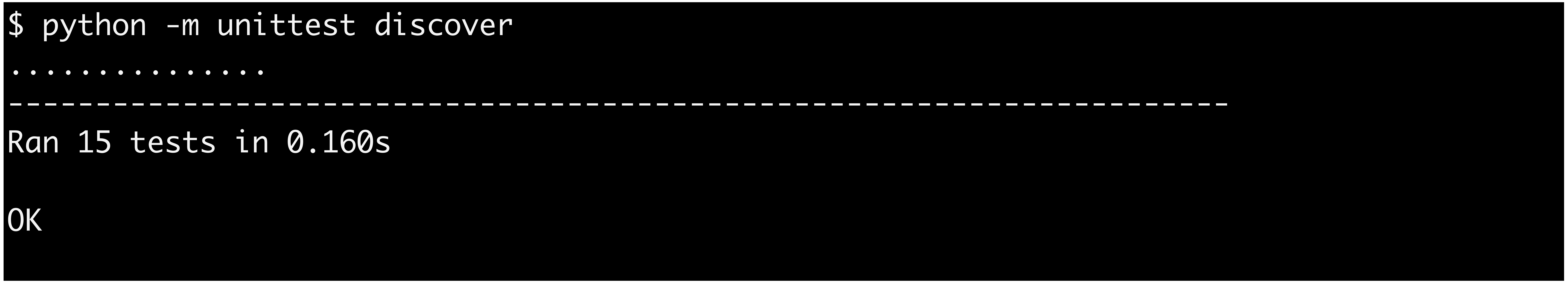
```
python3 -m venv ~/venv
```

- You just need to run pip to install the packages in requirements.txt

```
pip install -r requirements.txt
```

Run the Tests

- Normally you can run the tests using:
  `python -m unittest discover`

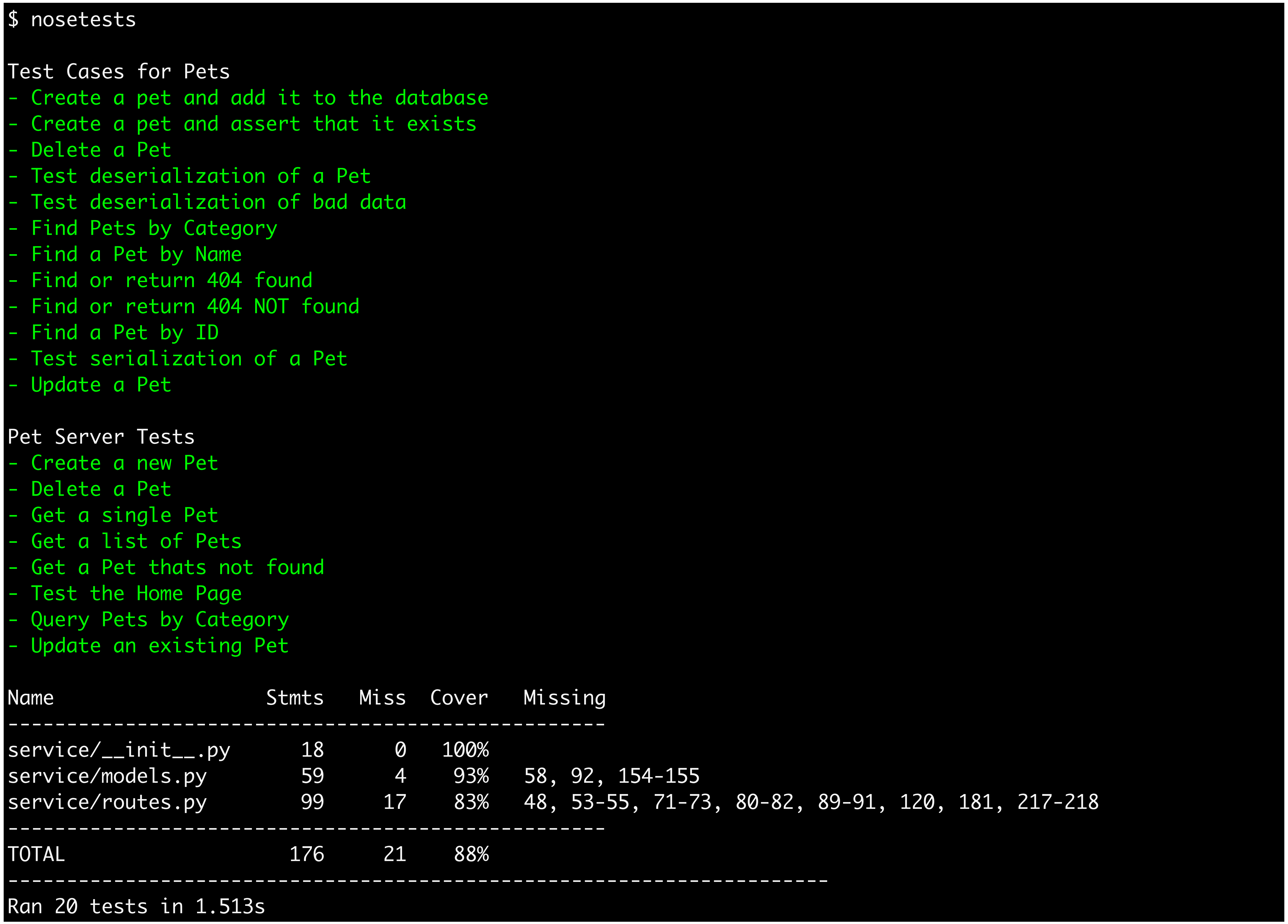


```
$ python -m unittest discover
...............
----------------------------------------------------------------------
Ran 15 tests in 0.160s

OK
```

- But we will use: `nosetests`

Run nosetests



```
$ nosetests

Test Cases for Pets
- Create a pet and add it to the database
- Create a pet and assert that it exists
- Delete a Pet
- Test deserialization of a Pet
- Test deserialization of bad data
- Find Pets by Category
- Find a Pet by Name
- Find or return 404 found
- Find or return 404 NOT found
- Find a Pet by ID
- Test serialization of a Pet
- Update a Pet

Pet Server Tests
- Create a new Pet
- Delete a Pet
- Get a single Pet
- Get a list of Pets
- Get a Pet thats not found
- Test the Home Page
- Query Pets by Category
- Update an existing Pet

Name                  Stmts   Miss  Cover   Missing
---------------------------------------------------
service/__init__.py      18      0   100%
service/models.py        59      4    93%   58, 92, 154-155
service/routes.py        99     17    83%   48, 53-55, 71-73, 80-82, 89-91, 120, 181, 217-218
---------------------------------------------------
TOTAL                   176     21    88%
----------------------------------------------------------------------
Ran 20 tests in 1.513s
```

@JohnRofrano

Windows Users Beware!

- Windows cannot handle execute bits so `nosetests` won’t run on a Windows share from within Linux without an additional parameter

```
$ nosetests --exe
```

This has been fixed in the Vagrantfile to force file permissions
But you still need to be aware of it happening

Nosetests Options

- Some useful command line options that you may wish to keep in mind include:
  - **-v:** gives more verbose output, including the names of the tests being executed.
  - **-s** or **-nocapture:** allows output of print statements, which are normally captured and hidden while executing tests. Useful for debugging.
  - **--nologcapture:** controls output of logging information.
  - **--rednose:** an optional plugin, which can be downloaded here, but provides colored output for the tests.
  - **--tags=TAGS:** allows you to place an @TAG above a specific test to only execute those, rather than the entire test suite

Use setup.cfg for Common Options

```
nosetests --verbosity 2 --with-spec --spec-color \
         --with-coverage --cover-erase --cover-package=service
```

```
[nosetests]
verbosity=2
with-spec=1
spec-color=1
with-coverage=1
cover-erase=1
cover-package=service
```

Test Coverage

- How do you know when you have written enough test cases?
- You use a tool like: `coverage`

```
$ pip install coverage

$ coverage run --omit "venv/*" test_server.py
$ coverage report -m --include= server.py
Name        Stmts   Miss  Cover   Missing
-----------------------------------------
server.py      81      5    94%   62, 66, 167-169
```

Test Coverage

- How do you know when you have written enough test cases?
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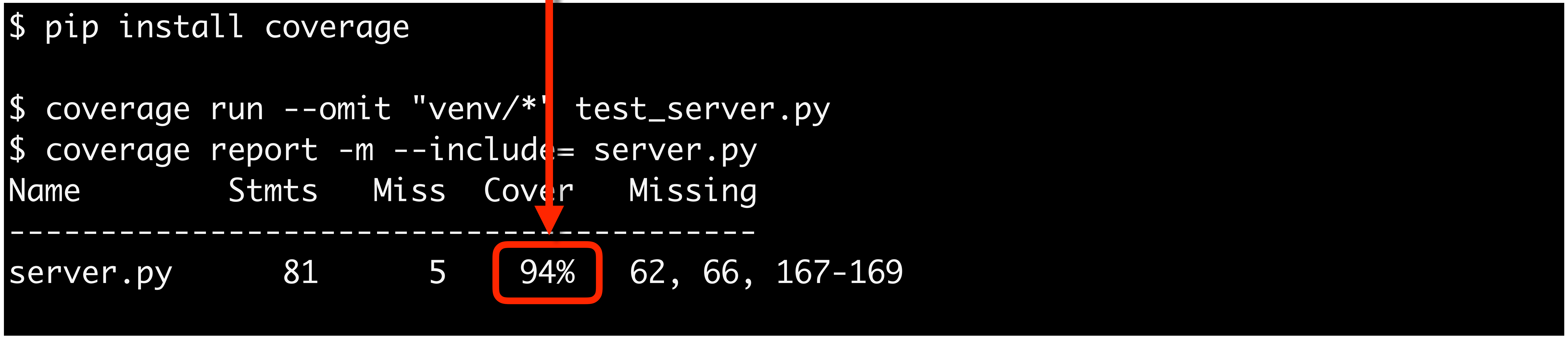
We have 94% code coverage



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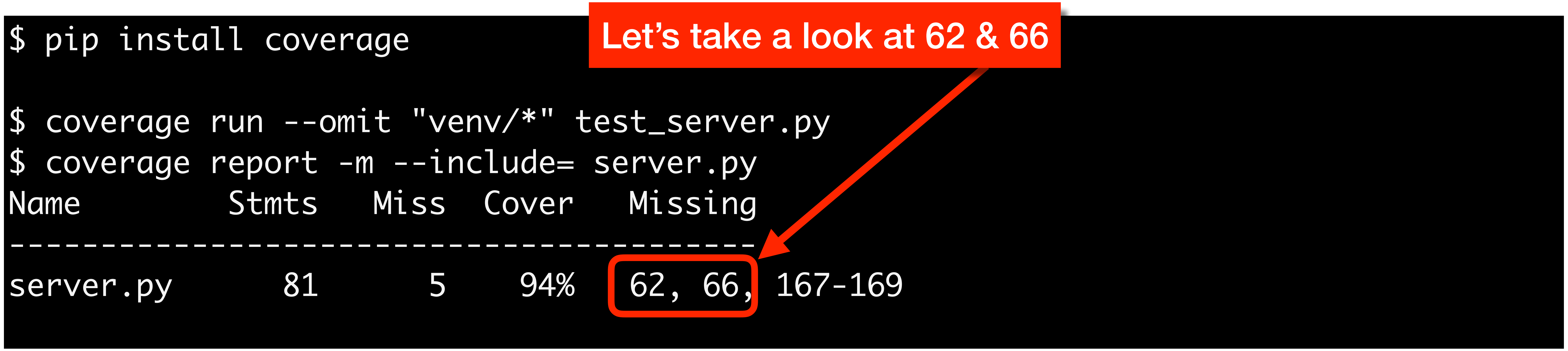

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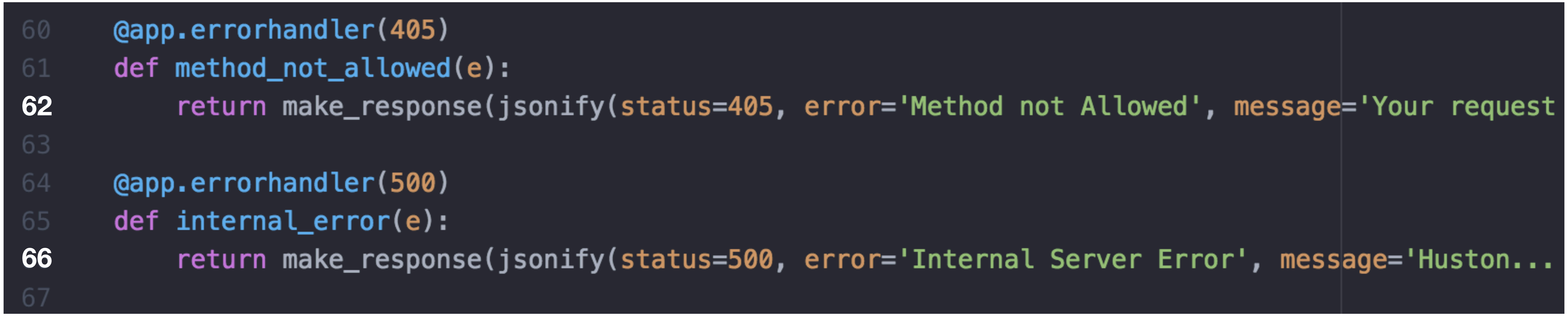
Missing Coverage

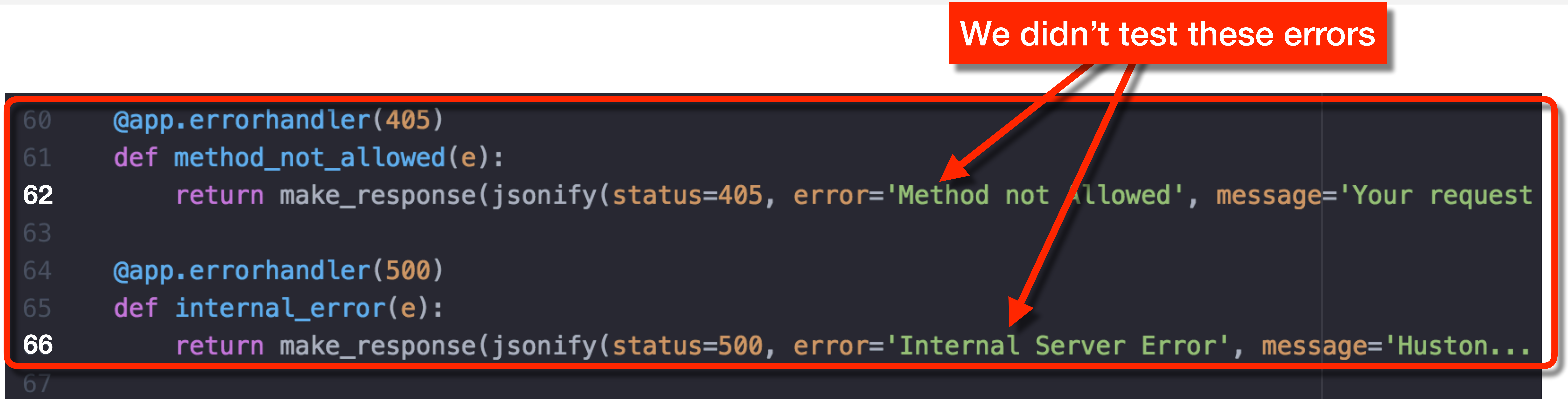


```
@app.errorhandler(405)
def method_not_allowed(e):
    return make_response(jsonify(status=405, error='Method not Allowed', message='Your request

@app.errorhandler(500)
def internal_error(e):
    return make_response(jsonify(status=500, error='Internal Server Error', message='Huston...

```

Missing Coverage



```
@app.errorhandler(405)
def method_not_allowed(e):
    return make_response(jsonify(status=405, error='Method not Allowed', message='Your request

@app.errorhandler(500)
def internal_error(e):
    return make_response(jsonify(status=500, error='Internal Server Error', message='Huston...
```

New test Case for 405

```
def test_method_not_allowed(self):
    resp = self.app.put('/pets')
    self.assertEqual(resp.status_code, status.HTTP_405_METHOD_NOT_ALLOWED)
```

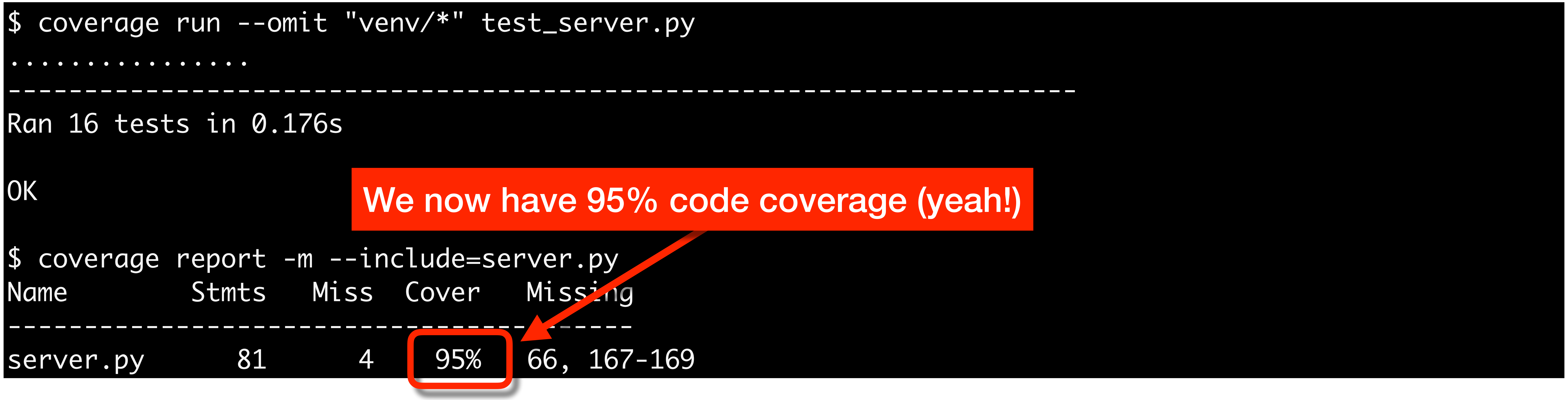
Re-run Coverage

```
$ coverage run --omit "venv/*" test_server.py
................
----------------------------------------------------------------------
Ran 16 tests in 0.176s

OK

$ coverage report -m --include=server.py
Name         Stmts   Miss  Cover   Missing
-----------------------------------------
server.py       81      4    95%   66, 167-169
```

Re-run Coverage



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Let's look at some Test Cases!