CI/CD Fundamentals

Introduction to Python Software Development on GitHub 2023

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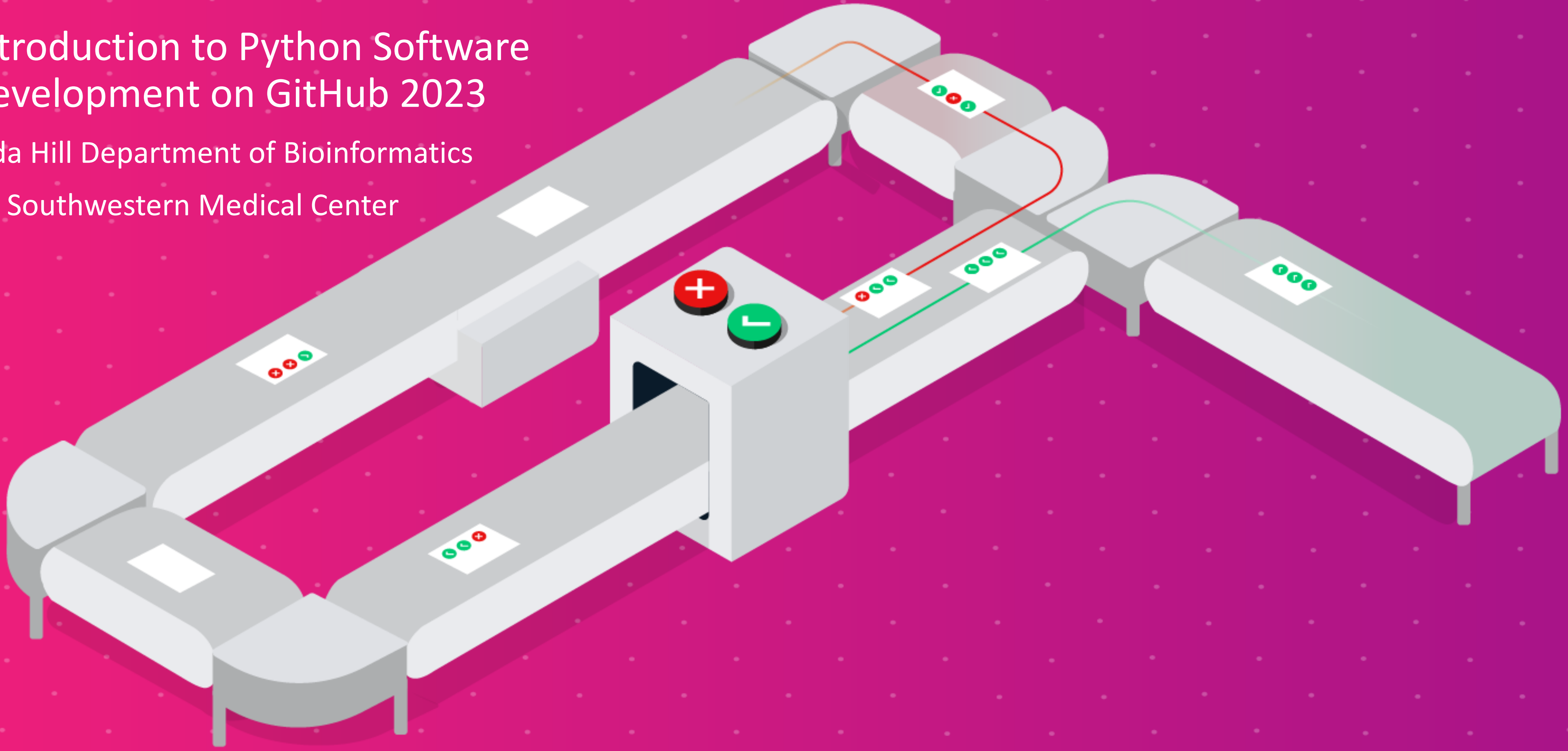

https://about.codecov.io/blog/common-steps-in-a-complete-continuous-integration-workflow/

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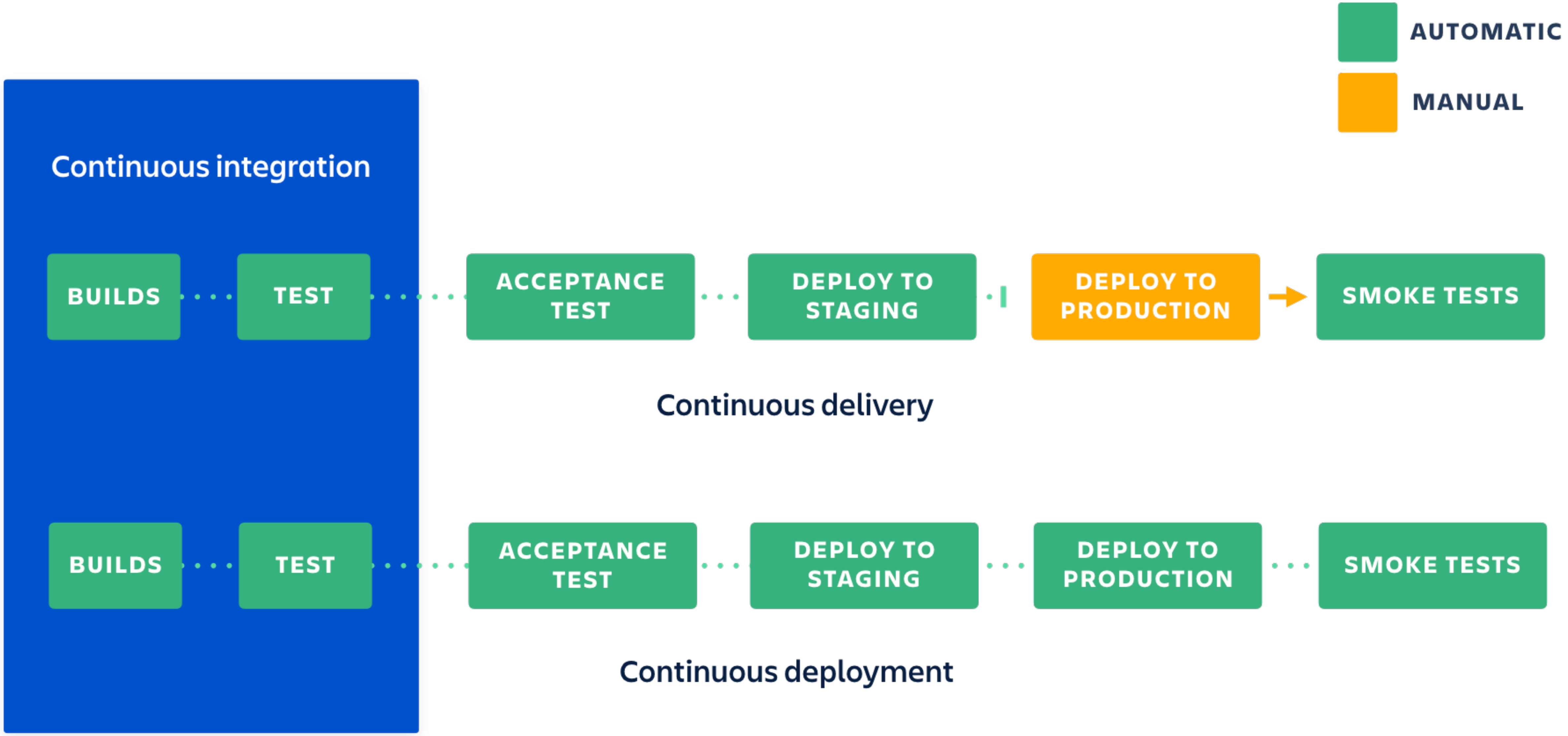
What does CI/CD stand for?

- **C**ontinuous **I**ntegration
- **C**ontinuous **D**elivery
- **C**ontinuous **D**eployment


AUTOMATIC
MANUAL
Continuous integration
BUILDS
TEST
ACCEPTANCE TEST
DEPLOY TO STAGING
DEPLOY TO PRODUCTION
SMOKE TESTS
Continuous delivery
BUILDS
TEST
ACCEPTANCE TEST
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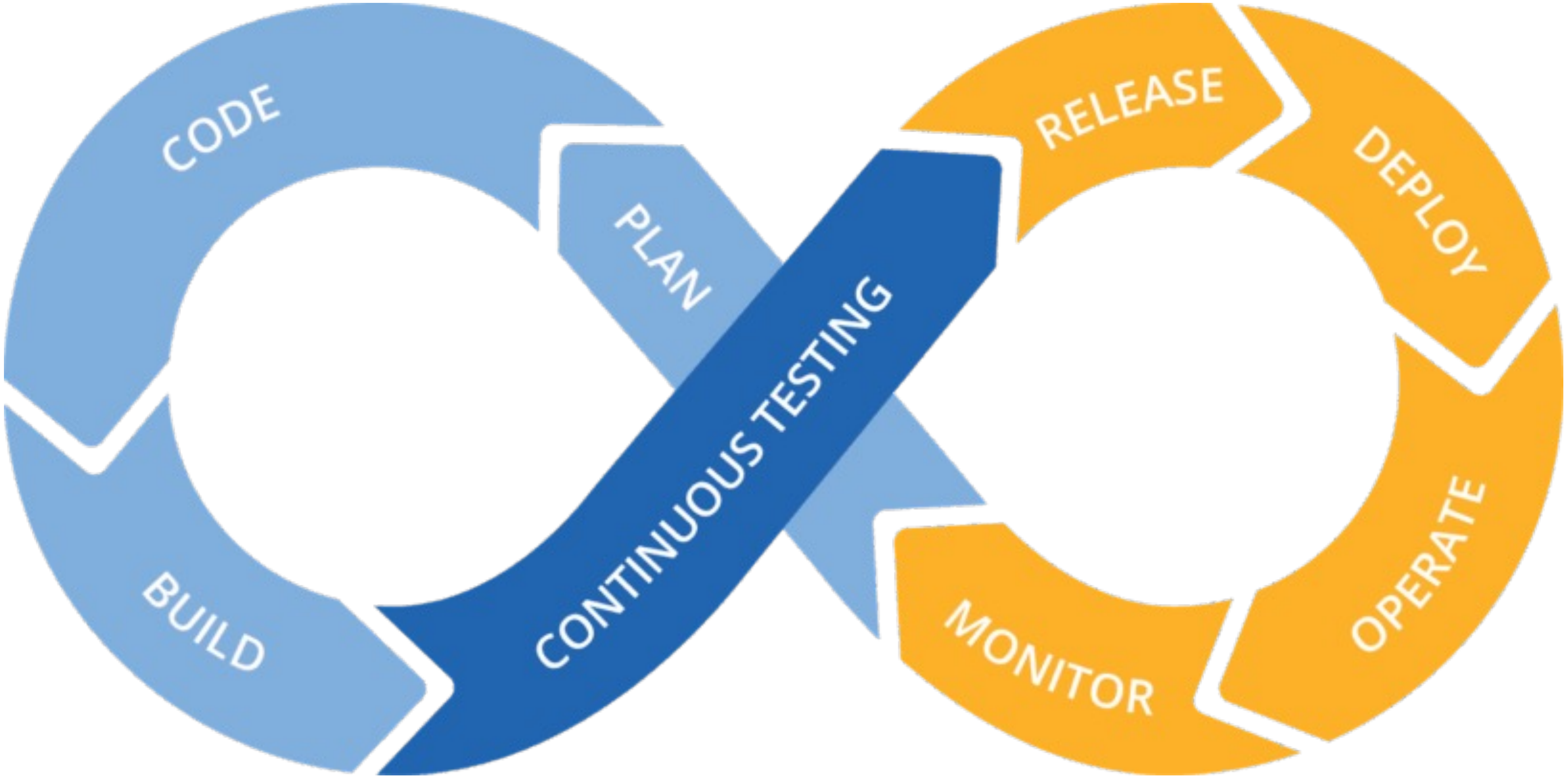
Continuous deployment



https://deploybot.com/blog/continuous-development

Vocabulary

- **Build**

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- **Test**

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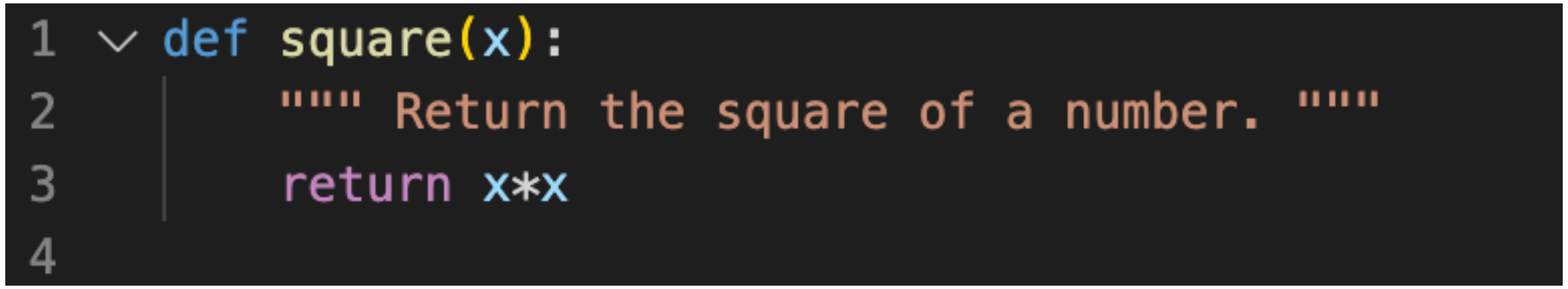
- **Test** – Evaluate and verify software can do what it is supposed to do.

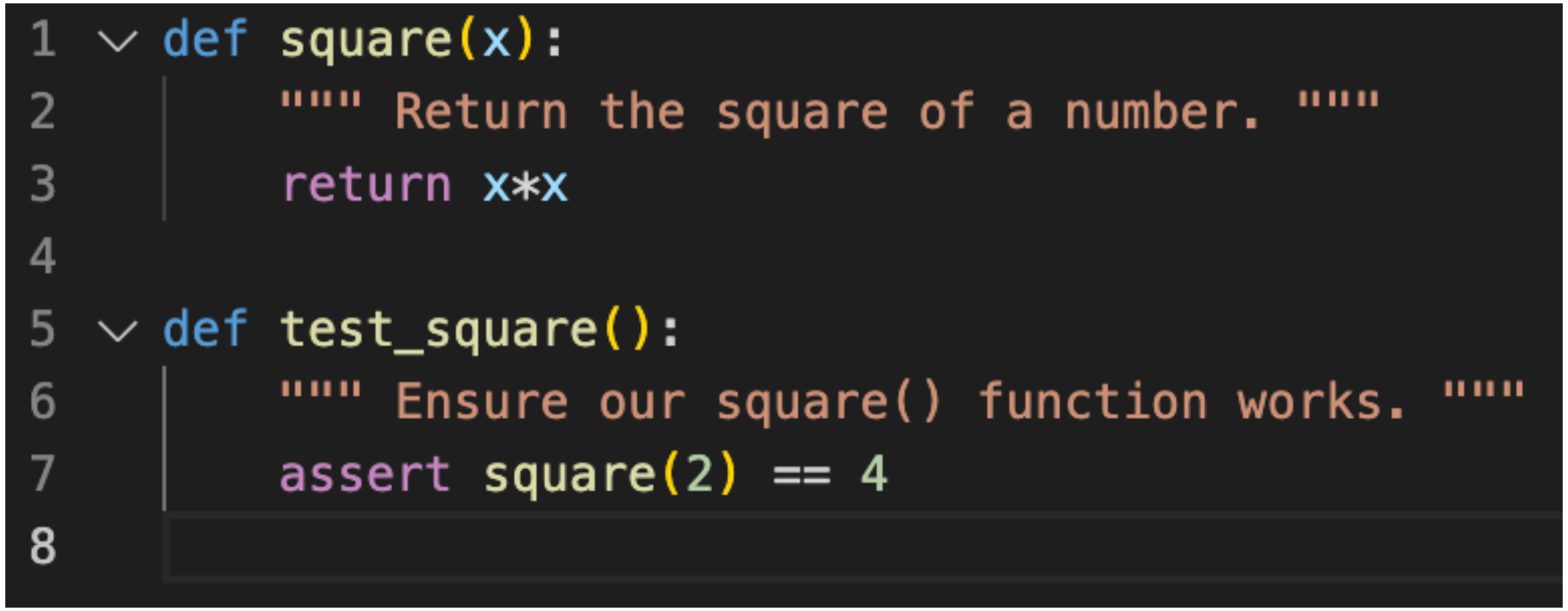
How do we know this function works?



```python
def square(x):
    """ Return the square of a number. """
    return x**x

```

We check it with a unit test



```python
def square(x):
    """ Return the square of a number. """
    return x**x

def test_square():
    """ Ensure our square() function works. """
    assert square(2) == 4

```

Test subgroups

- **Acceptance test** – A group of unit tests that ensure the software meets specifications e.g. of a contract.

- **Smoke test** – A group of unit tests that act as a sanity check for severe failures. If you run the software, does smoke come out of the computer?

Vocabulary

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Vocabulary

- **Build –** Convert source code files into a standalone software that anyone can run on their machine.
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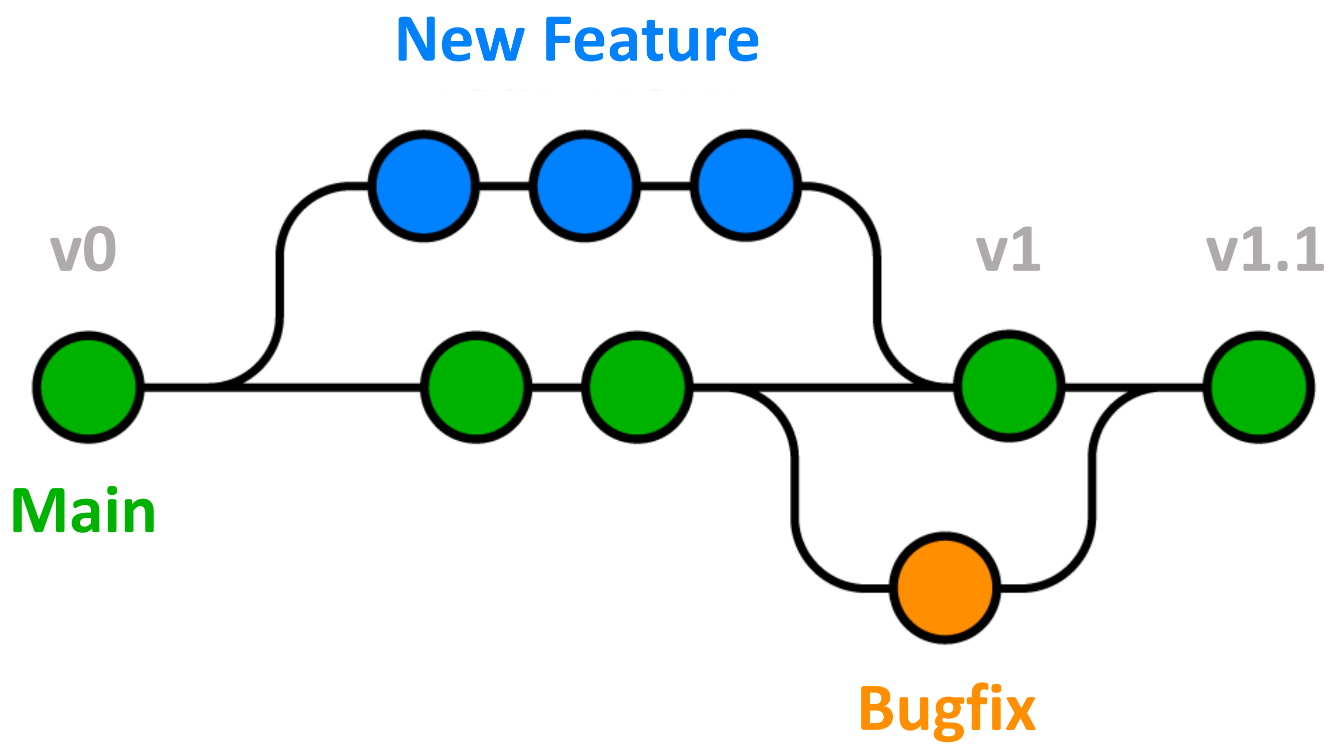
- **Deploy** – Make the software available for use.

The goal of CI/CD is to ensure developments do not stray far from the main branch



Why is CI/CD useful?

- Ensures disparate parts of the code base work together throughout development, preventing integration challenges.

- Protects against release of broken software.

- Allows for fast feedback from users and fast fixes from developers.

How do we implement CI/CD in practice?

- **Version control** (`git`)
- **Automatic testing** (`pytest`)
- **Automatic building** (`setuptools`, `pyproject.toml`)
- **Automatic deployment** (`twine`, `PyPI`)

Additional CI/CD tools in the workflow

- **Code quality** (linter such as `ruff`, code formatter such as `black`)
- **Test coverage check** (`codecov`)
- **Documentation** (`sphinx`, `numpydoc`)
- **Security checks** (`CodeQL`)

Local CI/CD workflows

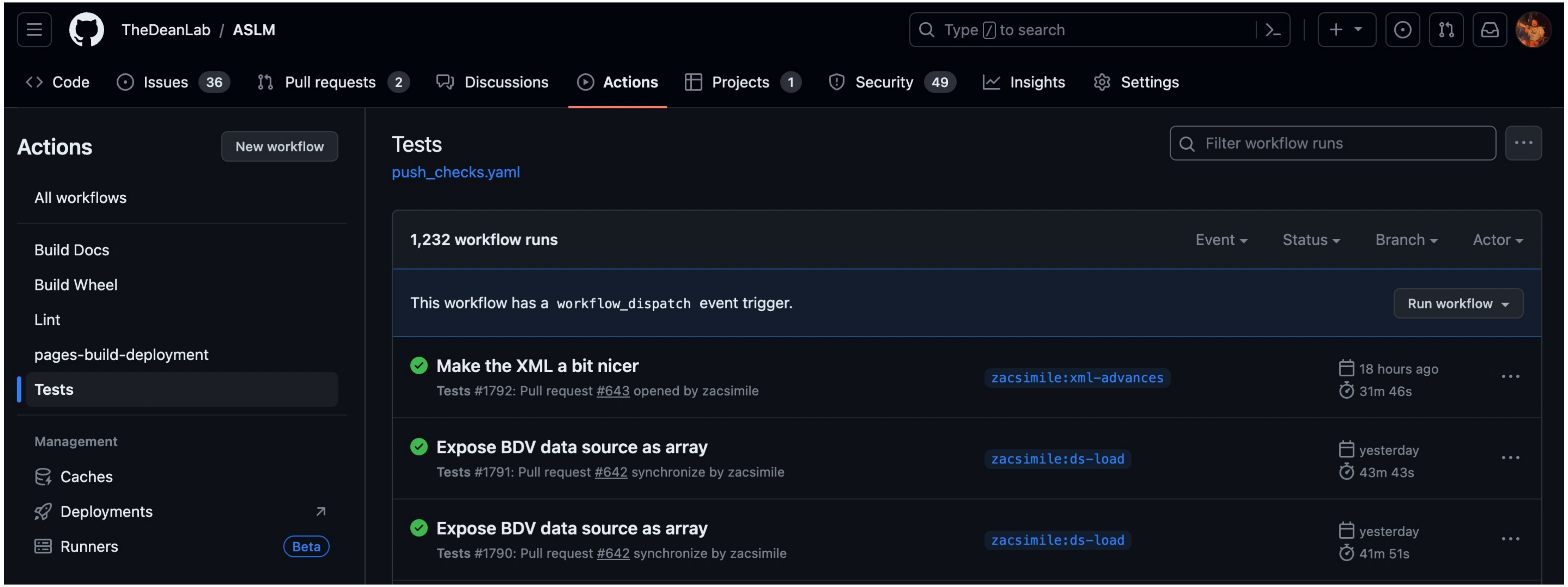
- Can run some tools, such as the linter and code formatter, before pushing code to the repository

- Can automatically run some actions using `pre-commit`

Running the CI/CD workflow

- Need a continuous integration tool
  - Bitbucket (https://bitbucket.org/product/features/pipelines)
  - Jenkins (https://jenkins.io)
  - AWS CodePipeline (https://aws.amazon.com/codepipeline)
  - CircleCI (https://circleci.com)
  - Azure (https://azure.microsoft.com/)
  - Gitlab (https://about.gitlab.com/)
  - GitHub (https://github.com/)
  - Etc.
- These tools use a YAML file (or similar) to describe a series of actions that make up a workflow.

GitHub Actions Dashboard



TheDeanLab / ASLM

Type / to search

Code | Issues 36 | Pull requests 2 | Discussions | Actions | Projects 1 | Security 49 | Insights | Settings

Actions — New workflow

- All workflows
- Build Docs
- Build Wheel
- Lint
- pages-build-deployment
- Tests

Management

- Caches
- Deployments
- Runners Beta

Tests
push_checks.yaml

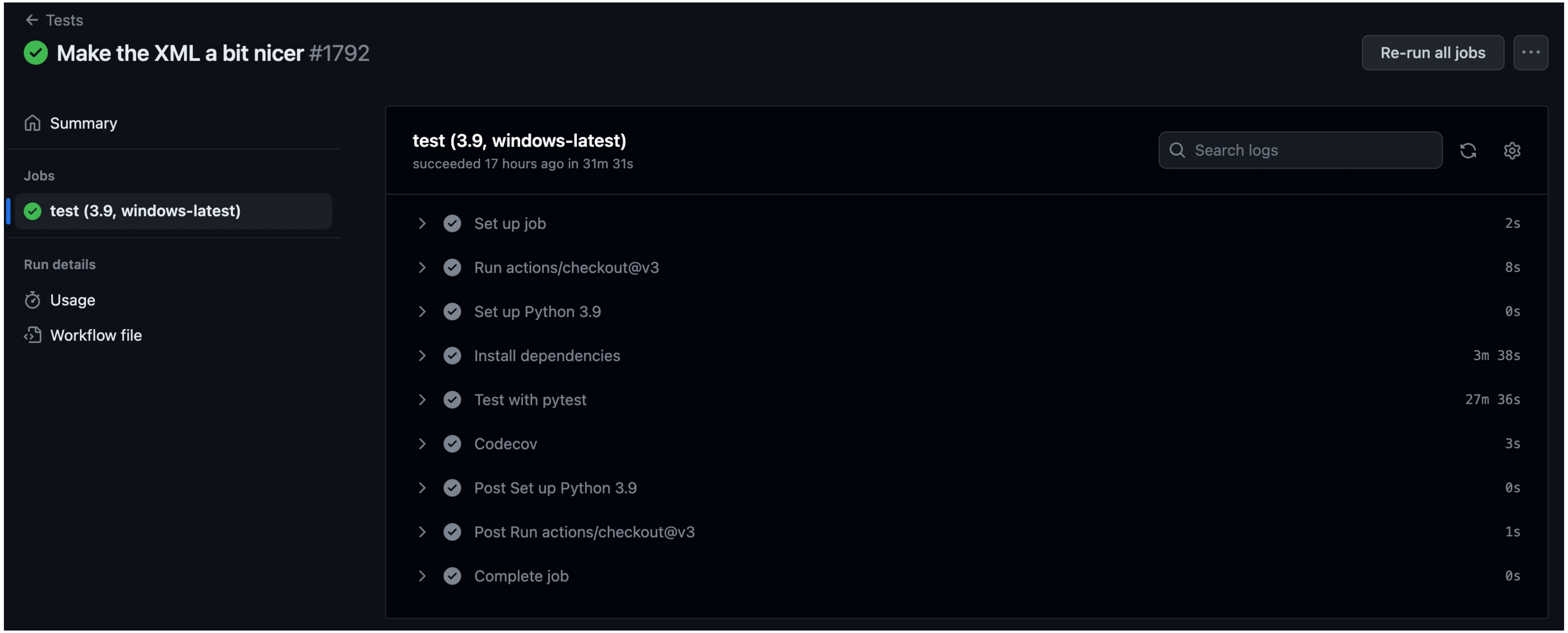
Filter workflow runs

1,232 workflow runs — Event, Status, Branch, Actor

This workflow has a `workflow_dispatch` event trigger. Run workflow

Run	Branch	When	Duration
Make the XML a bit nicer Tests #1792: Pull request #643 opened by zacsimile	zacsimile:xml-advances	18 hours ago	31m 46s
Expose BDV data source as array Tests #1791: Pull request #642 synchronize by zacsimile	zacsimile:ds-load	yesterday	43m 43s
Expose BDV data source as array Tests #1790: Pull request #642 synchronize by zacsimile	zacsimile:ds-load	yesterday	41m 51s

GitHub Actions Workflow Example



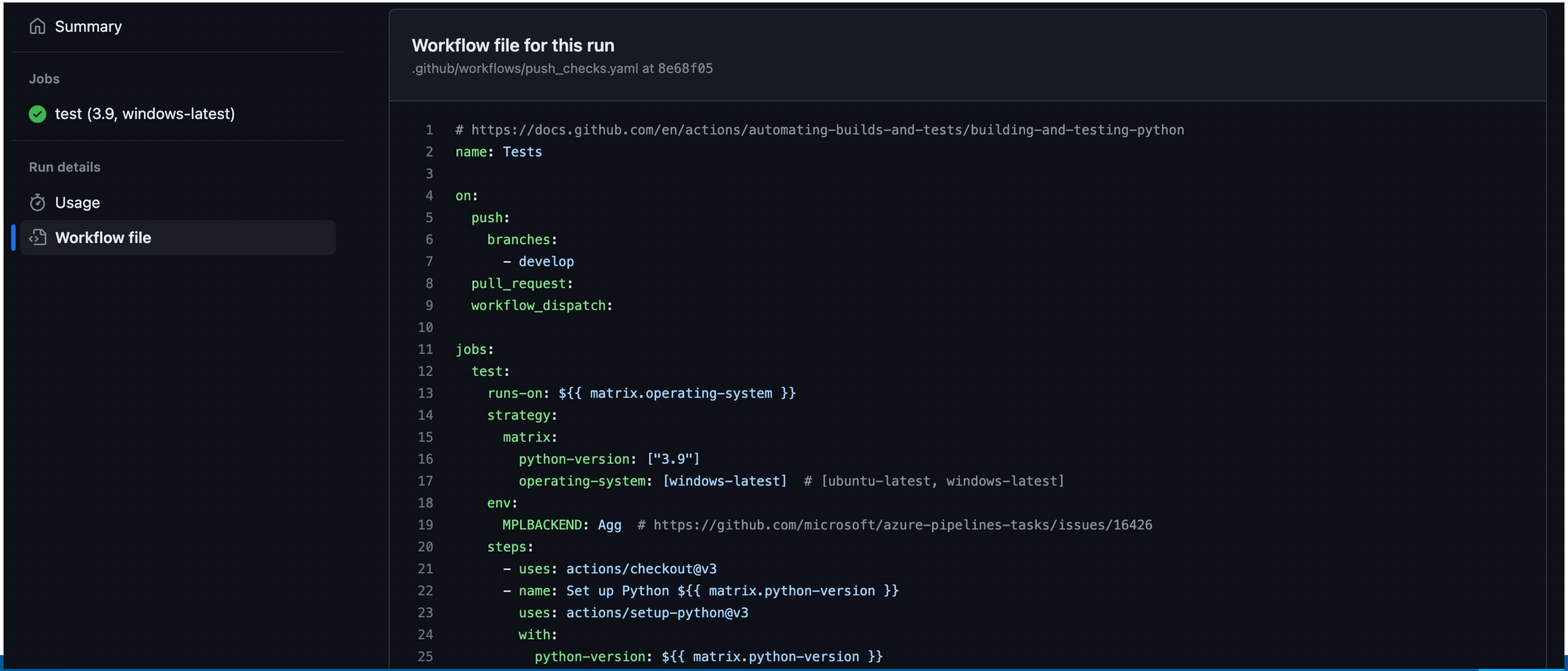
Make the XML a bit nicer #1792

test (3.9, windows-latest)

test (3.9, windows-latest)
succeeded 17 hours ago in 31m 31s

```
Set up job                          2s
Run actions/checkout@v3             8s
Set up Python 3.9                   0s
Install dependencies                3m 38s
Test with pytest                    27m 36s
Codecov                             3s
Post Set up Python 3.9              0s
Post Run actions/checkout@v3        1s
Complete job                        0s
```

GitHub Actions Workflow Example



Summary

Jobs

test (3.9, windows-latest)

Run details

Usage

Workflow file

Workflow file for this run

.github/workflows/push_checks.yaml at 8e68f05

```yaml
# https://docs.github.com/en/actions/automating-builds-and-tests/building-and-testing-python
name: Tests

on:
  push:
    branches:
      - develop
  pull_request:
  workflow_dispatch:

jobs:
  test:
    runs-on: ${{ matrix.operating-system }}
    strategy:
      matrix:
        python-version: ["3.9"]
        operating-system: [windows-latest]  # [ubuntu-latest, windows-latest]
    env:
      MPLBACKEND: Agg  # https://github.com/microsoft/azure-pipelines-tasks/issues/16426
    steps:
      - uses: actions/checkout@v3
      - name: Set up Python ${{ matrix.python-version }}
        uses: actions/setup-python@v3
        with:
          python-version: ${{ matrix.python-version }}
```