AST1501 - Introduction to Research

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Automating tasks

Why to automate tasks

Why to automate tasks

- There are a lot of things that we have to do

  - That are kind of annoying to do

  - So we put them off

  - And off

  - And off

  - And often we don't end up doing them for a long time

- If we can automate much of these tasks, we're much more likely to do them!

Tasks that can be automated

- Updating your personal website

- Testing your code

- Updating your code's documentation
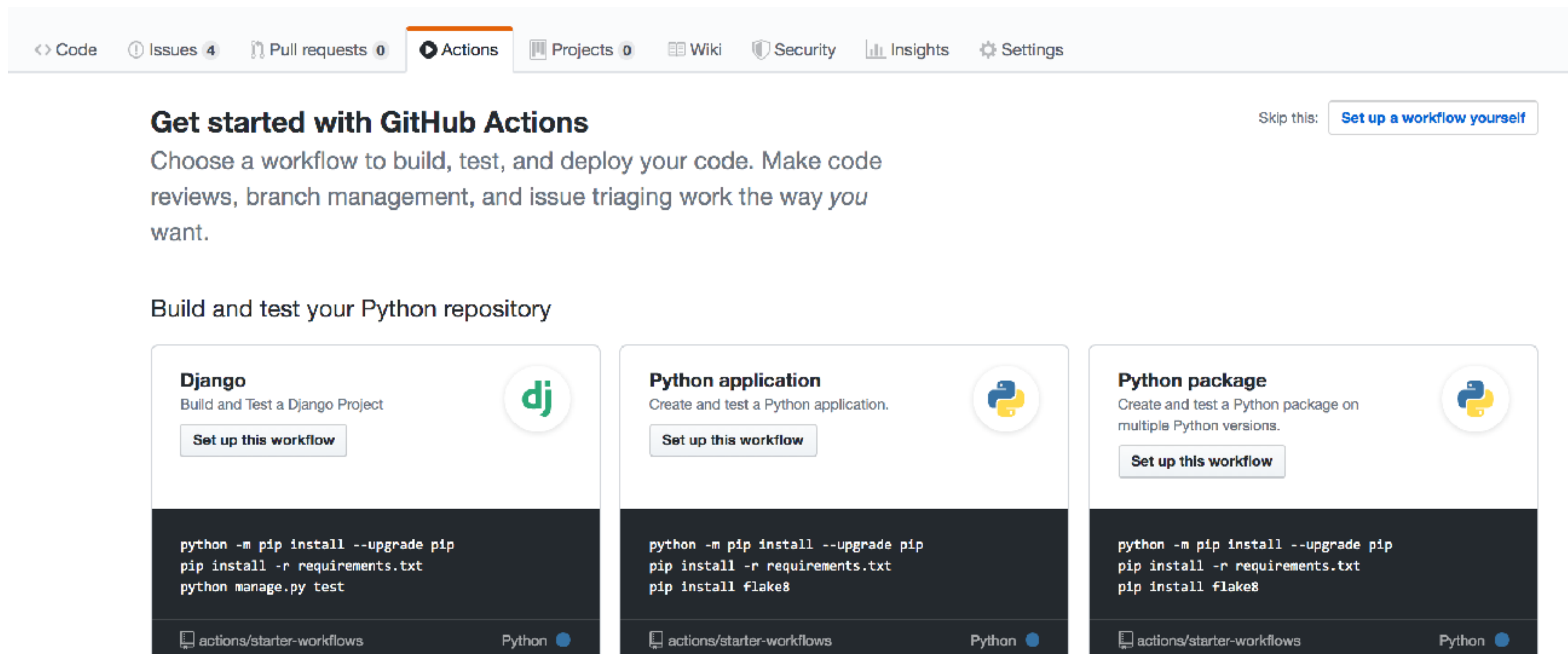
- Publishing your code

- …

GitHub Actions

GitHub Actions

- In 2019, GitHub released a CI/CD (continuous-integration/continuous-delivery) service that is automatically part of every GitHub repository
  —> `GitHub Actions`

- Configured with YAML files (`.yml`), `GitHub Actions` has some big advantages over other similar services:

  - Easily configure multiple different runs to do (CI tests, building documentation, building a website, responding to issues/pull requests, pushing to AWS S3, …)

  - Re-use atomic steps defined in other GitHub repositories (e.g., setup python, setup Miniconda, setup an SSH agent)

  - More free runners available (up to 20 Linux/Windows, 5 MacOS)

Setting up GitHub actions for your repository

Go to "Actions" tab

Setting up GitHub actions for your repository

or just add a `.yml` file under `.github/workflows`

```yaml
name: Test exampy

on: [push]

jobs:
  build:
    runs-on: ubuntu-latest
    strategy:
      matrix:
        python-version: [3.7, 3.8]
        numpy-version: [1.16,1.17,1.18]
        exclude:
          - python-version: 3.8
            numpy-version: 1.16
          - python-version: 3.8
            numpy-version: 1.17
    steps:
    - uses: actions/checkout@v2
    - name: Set up Python ${{ matrix.python-version }}
      uses: actions/setup-python@v1
      with:
        python-version: ${{ matrix.python-version }}
```

Note: action versions out of date on this slide

```yaml
    - name: Install dependencies
      run: |
        python -m pip install --upgrade pip
        pip install numpy==${{ matrix.numpy-version }}
    - name: Install package
      run: |
        pip install -e .
    - name: Test with pytest
      run: |
        pip install pytest
        pip install pytest-cov
        pip install scipy
        pytest -v tests/ --cov=exampy/
```

```yaml
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          - python-version: 3.8
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    steps:
    - uses: actions/checkout@v2
    - name: Set up Python ${{ matrix.python-version }}
      uses: actions/setup-python@v1
      with:
        python-version: ${{ matrix.python-version }}
    - name: Install dependencies
      run: |
        python -m pip install --upgrade pip
        pip install numpy==${{ matrix.numpy-version }}
    - name: Install package
      run: |
        pip install -e .
    - name: Test with pytest
      run: |
        pip install pytest
        pip install pytest-cov
        pip install scipy
        pytest -v tests/ --cov=exampy/
```

<— Informative name

<— When to run the workflow
(e.g., on: [push,pull request])
<— Job(s)
Each one runs independently
<— Operating system
(can be ubuntu, mac, windows)

<— Define a matrix of different builds,
(can't 'include', so exclude)

<— Arbitrary sequence of steps:
1) check out the repository
<— 2) setup Python
<— 3) install dependencies
with pip

<— 4) install package

<— 5) install test dependencies
and run tests

Note: action versions out of date on this slide

jobovy / exampy

Unwatch ▾ 1   ★ Star 1   Fork 0

<> Code   ⊙ Issues 0   ⑂ Pull requests 0   ▶ Actions   ⊞ Projects 0   ▥ Wiki   🛡 Security   Insights   ⚙ Settings

Workflows   New workflow

▶ All workflows

⊹ Test exampy

All workflows

🔍 Filter workflows

Event ▾   Status ▾   Branch ▾   Actor ▾

🟡 **Add GitHub action to test exampy**   master   📅 21 seconds ago   ...
Test exampy #1: Commit f850194 pushed by jobovy   🕐 14s

<> Code   ⓘ Issues 0   ⑂ Pull requests 0   ▶ Actions   ▦ Projects 0   ▤ Wiki   🛡 Security   �📊 Insights   ⚙ Settings

Fix exclusion syntax

master   🔲   ⟁ 93cf2da

▾ Test exampy
  on: push

✓ build (3.7, 1.16)	
✓ build (3.7, 1.17)	
✓ build (3.7, 1.18)	
✓ build (3.8, 1.18)	

Test exampy / build (3.7, 1.16)
succeeded 24 seconds ago in 21s

Search logs   ‹ › …

▶ ✓	Set up job	2s
▶ ✓	Run actions/checkout@v2	1s
▶ ✓	Set up Python 3.7	0s
▶ ✓	Install dependencies	8s
▶ ✓	Install package	1s
▶ ✓	Test with pytest	9s
▶ ✓	Post actions/checkout@v2	0s
▶ ✓	Complete job	0s

Easy to use multiple operating systems:

```yaml
name: Test exampy

on: [push]

jobs:
  build:
    runs-on: ${{ matrix.os }}
    strategy:
      matrix:
        os: [ubuntu-latest, windows-latest, macos-latest]
        python-version: [3.7, 3.8]
        numpy-version: [1.16,1.17,1.18]
        exclude:
          - os: ubuntu-latest
            python-version: 3.8
            numpy-version: 1.16
          - os: ubuntu-latest
            python-version: 3.8
            numpy-version: 1.17
          - os: windows-latest
            python-version: 3.8
            numpy-version: 1.16
          - os: windows-latest
            python-version: 3.8
            numpy-version: 1.17
          - os: macos-latest
            python-version: 3.8
            numpy-version: 1.16
          - os: macos-latest
            python-version: 3.8
            numpy-version: 1.17
    steps:
```

Unwatch ▾ 1   ★ Star 1   Fork 0

‹› Code   ⚠ Issues 0   ⁂ Pull requests 0   ▶ Actions   ▦ Projects 0   ▤ Wiki   ⛊ Security   ▥ Insights   ⚙ Settings

◯ Run integration tests on all three major OS using Act…
master   🖼   ⊶ 6c26f8e

▼ ⬡ **Test exampy**
   on: push

✓ build (ubuntu-latest, 3.7, …
✓ build (ubuntu-latest, 3.7, …
✓ build (ubuntu-latest, 3.7, …
✓ build (ubuntu-latest, 3.8, …
✓ build (windows-latest, 3….
✓ build (windows-latest, 3….
✓ build (windows-latest, 3….
✓ build (windows-latest, 3….
✓ build (macos-latest, 3.7, …
✓ build (macos-latest, 3.7, …
✓ build (macos-latest, 3.7, …
✓ build (macos-latest, 3.8, …

⬡ **Test exampy**

This run   Workflow file

Create status badge ▾

✓ **12 completed jobs** in 1m 34s

Artifacts

No artifacts were generated.

Annotations

Re-using other actions

- GitHub users can define their own 'actions' that you can re-use in your own workflows: e.g.,

  - `- uses: actions/checkout@v4`

  - ```
    - name: Set up Python ${{ matrix.python-version }}
      uses: actions/setup-python@v5
      with:
        python-version: ${{ matrix.python-version }}
    ```

- Take arguments in the `with:` section

- Make sure to

  - a) use a released version (e.g., `@v4`),

  - b) check that you can trust the action if you give it passwords or other permissions

Using secrets

- If as part of a workflow, you need to authenticate, you can add 'secrets' to your GitHub repository that can be used by actions (usernames, passwords, SSH keys, API keys, tokens, etc.)

- Use as `${{ secrets.SECRET_NAME }}`

- Not shared with forks, quite secure

- But always try to make secrets specific to GitHub, so can be easily revoked (e.g., set up special SSH key for GitHub use rather than using your normal one)

- SSH keys: set up special GitHub private key with *no passphrase*

jobovy / **exampy**

<> Code   ⓘ Issues 0   Pull requests 0   ▶ Actions   ▥ Projects 0   📖 Wiki   🛡 Security   📊 Insights   ⚙ Settings

Options

Manage access

Branches

Webhooks

Notifications

Integrations & services

Deploy keys

Autolink references

Secrets

Moderation

Interaction limits

Settings

Repository name

| exampy | **Rename** |

☐ **Template repository**

Template repositories let users generate new repositories with the same directory structure and files. Indicate if jobovy/exampy can be used as a template for creating other repositories.

Social preview

Upload an image to customize your repository's social media preview.

Images should be at least 640×320px (1280×640px for best display).

Download template

jobovy / **exampy**

⊙ Unwatch ▾ 1   ★ Star 2   ⑂ Fork 0

<> Code ⊙ Issues 0 ⑂ Pull requests 0 ▶ Actions ▥ Projects 0 ▦ Wiki ⛨ Security ⏲ Insights ⚙ Settings

Options

Manage access

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Integrations & services

Deploy keys

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Actions

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Secrets

Secrets are environment variables that are **encrypted** and only exposed to selected actions. Anyone with **collaborator** access to this repository can use these secrets in a workflow.

Secrets are not passed to workflows that are triggered by a pull request from a fork. Learn more.

Add a new secret

Once you hit 'Add secret',
you can never see the value again

Practical example: update your website on lepus

```
name: Update website

on: [push]

jobs:
  build_website:
    name: Build main website
    runs-on: ubuntu-latest
    if: "!contains(github.event.head_commit.message, 'ci skip')"
    steps:
    # check-out this repository
    - uses: actions/checkout@v4
    # Build main website
    - name: Build website
      run: |
          mkdir build
          make web ONLINEPATH=build
    # Setup SSH agent
    - uses: webfactory/ssh-agent@v0.9.0
      if: startsWith(github.ref,'refs/heads/main') && github.event_name != 'pull_request'
      with:
        ssh-private-key: ${{ secrets.SSH_PRIVATE_KEY }}
    # Upload to lepus, to quickly upload new website
    - name: Upload
      if: startsWith(github.ref,'refs/heads/main') && github.event_name != 'pull_request'
      working-directory: build
      run: rsync --rsh="ssh -o StrictHostKeyChecking=no -o UserKnownHostsFile=/dev/null -o HostkeyAlgorithms=+ssh-rsa -o PubkeyAcceptedAlgorithms=+ssh-rsa" -azv ./
bovy@lepus.astro.utoronto.ca:/home/bovy/web/
```

```yaml
build_cv:
  name: Build CV
  runs-on: ubuntu-latest
  if: "!contains(github.event.head_commit.message, 'ci skip')"
  steps:
  # check-out this repository
  - uses: actions/checkout@v4
  # Setup SSH agent
  - uses: webfactory/ssh-agent@v0.9.0
    if: startsWith(github.ref,'refs/heads/main') && github.event_name != 'pull_request'
    with:
      ssh-private-key: ${{ secrets.SSH_PRIVATE_KEY }}
  # Install LaTeX for CV building
  - name: Install LaTeX
    run: |
        sudo paperconfig -p letter
        sudo apt-get update
        sudo apt-get install -qq --no-install-recommends dvipng texlive-latex-base texlive-latex-extra texlive-fonts-recommended graphviz xzdec
  # Build CV
  - name: Build CV
    working-directory: CV
    run: |
        mkdir ../build
        make web ONLINEPATH=../build
  # Upload to lepus, including CV now
  - name: Upload
    if: startsWith(github.ref,'refs/heads/main') && github.event_name != 'pull_request'
    working-directory: build
    run: rsync -e"ssh -o StrictHostKeyChecking=no -o UserKnownHostsFile=/dev/null -o HostkeyAlgorithms=+ssh-rsa -o PubkeyAcceptedAlgorithms=+ssh-rsa" -azv ./
bovy@lepus.astro.utoronto.ca:/home/bovy/web/
```

Practical example: update your website on GitHub Pages

```
44        - name: Deploy 🚀|
45          if: github.event_name != 'pull_request'
46          uses: JamesIves/github-pages-deploy-action@v4
47          with:
48            folder: _site
```

Practical example: update your website on AWS/S3

```
24          # Push to Amazon S3
25        - name: Upload website
26          uses: jakejarvis/s3-sync-action@v0.5.1
27          with:
28            args: --acl public-read --follow-symlinks --delete
29          env:
30            AWS_S3_BUCKET: ${{ secrets.AWS_S3_BUCKET }}
31            AWS_ACCESS_KEY_ID: ${{ secrets.AWS_ACCESS_KEY_ID }}
32            AWS_SECRET_ACCESS_KEY: ${{ secrets.AWS_SECRET_ACCESS_KEY }}
33            AWS_REGION: 'us-east-2'
34            SOURCE_DIR: 'src'        # optional: defaults to entire repository
```

You can define multiple workflows

galpy / .github / workflows /

Add file ▾   ···

dependabot[bot] and jobovy   Bump the actions group with 1 update   ···   ✕   0937430 · last week   🕑 History

Name	Last commit message	Last commit date
📁 ..		
📄 build.yml	Bump the actions group with 1 update	last week
📄 build_pyodide_wheels.yml	Bump the actions group with 1 update	2 weeks ago
📄 build_windows.yml	Update test suite to Python 3.12 (#603)	last week
📄 stale.yml	Bump actions/stale from 8 to 9	2 months ago
📄 wheels.yml	Bump actions/upload-artifact and actions/download-artifact from 3 to 4 (	2 months ago

You can define multiple workflows

You can do almost anything!

- GitHub actions is extremely flexible and because you can re-use actions, someone else has almost certainly already figured out how to do what you want to do!

- Some non-trivial things I've used:

  - Set up an SSH agent

  - Caching data and code between runs —> actions/cache

  - Getting a list of files changed since the previous push to GitHub —> tj-actions/changed-files@v42

  - Using a job to create a matrix of other jobs to run

  - Only running a workflow when creating a tag (useful for automating releases)

Using Dependabot to keep your actions up-to-date

Using Dependabot to keep your actions up-to-date

- As we've seen, re-usable actions have a version that needs to be specified

- These are updated from time to time and it's hard to track when this happens

- Dependabot does this for you!

- How? Write a dependabot.yml file in your .github/ folder

```
.github > ! dependabot.yml
1   version: 2
2   updates:
3   - package-ecosystem: "github-actions"
4     directory: "/"
5     schedule:
6       interval: "weekly"
7     groups:
8       actions:
9         patterns:
10          - '*'
11
```

Using Dependabot to keep your actions up-to-date

Using Dependabot to keep your actions up-to-date