How to use GitHub Actions with security in mind

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What are GitHub workflows?

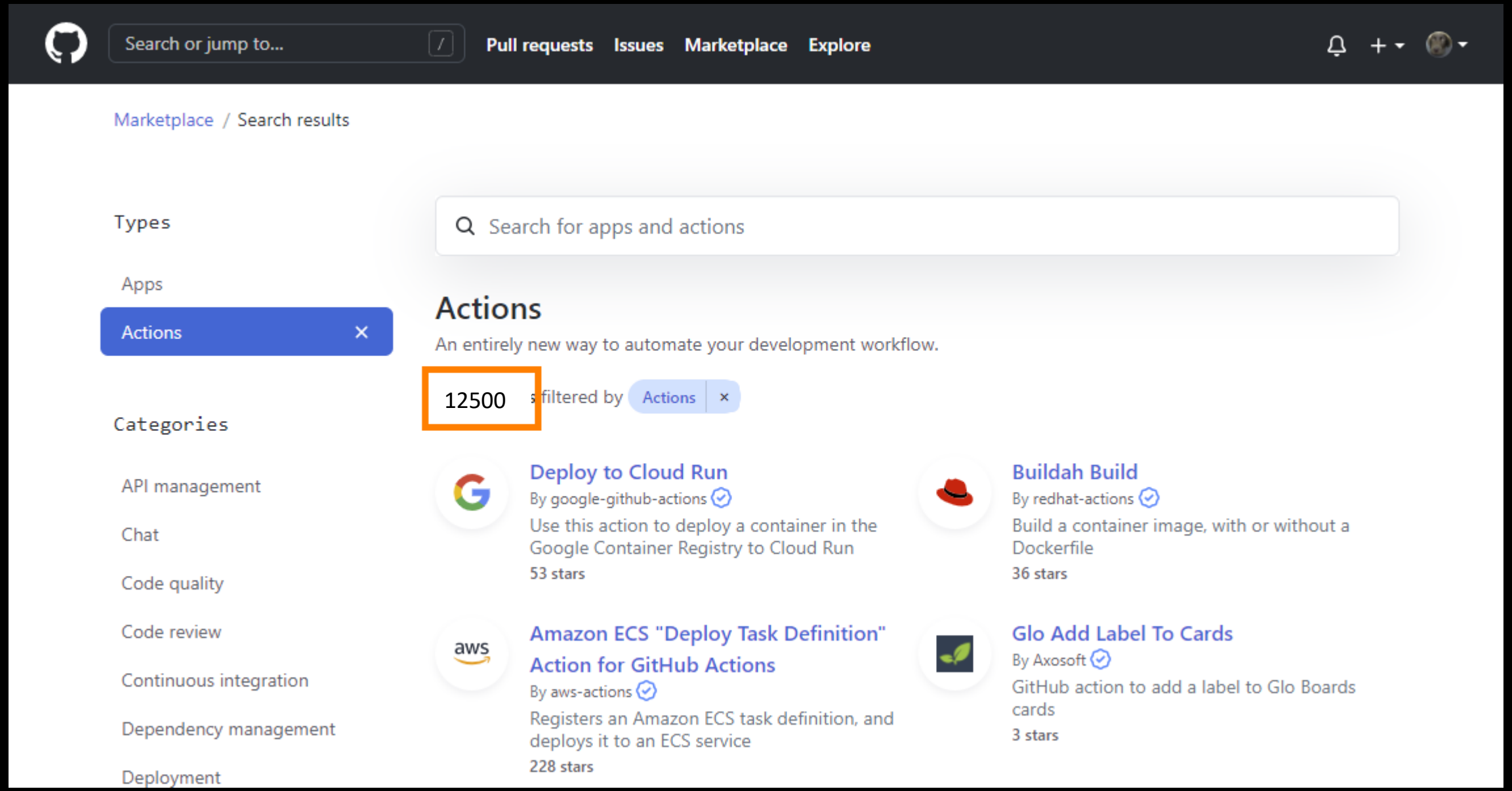
Execute one or more Actions

Workflows triggered by events:

- Push
- Comment
- Creating an Issue
- Release
- Etc.

What are GitHub Actions?

- Steps in the workflows
- Basis: Run a shell script
- Create your own
- Use an existing one from the marketplace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Workflow example

main

dotnetcore-webapp / .github / workflows / dotnetcore.yml

```yaml
name: .NET Core

on: [push]

jobs:
  build-and-deploy:
    environment: Production

    runs-on: ubuntu-latest

    steps:
    - uses: actions/checkout@v1
    - name: Setup .NET Core
      uses: actions/setup-dotnet@v1
      with:
        dotnet-version: 3.0.100

    # dotnet build
    - name: Build with dotnet
      run: |
        dotnet build --configuration Release ./dotnet-core-webapp/dotnetcore-webapp.csproj
```

GitHub Actions Security

- Repository security
- Runners and security
- Actions and security

- Forking actions
- Keeping up to date

Repository security

- Access to code
- Workflow secrets
- Your code

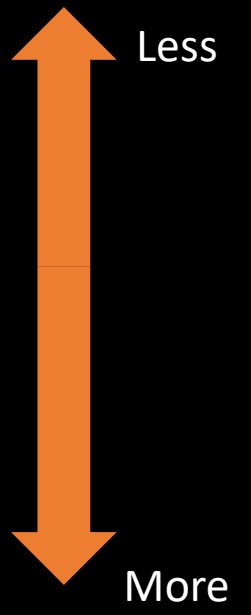
Code – Who has access?

Access levels can be set at:

- Repository
- Organization
- Enterprise

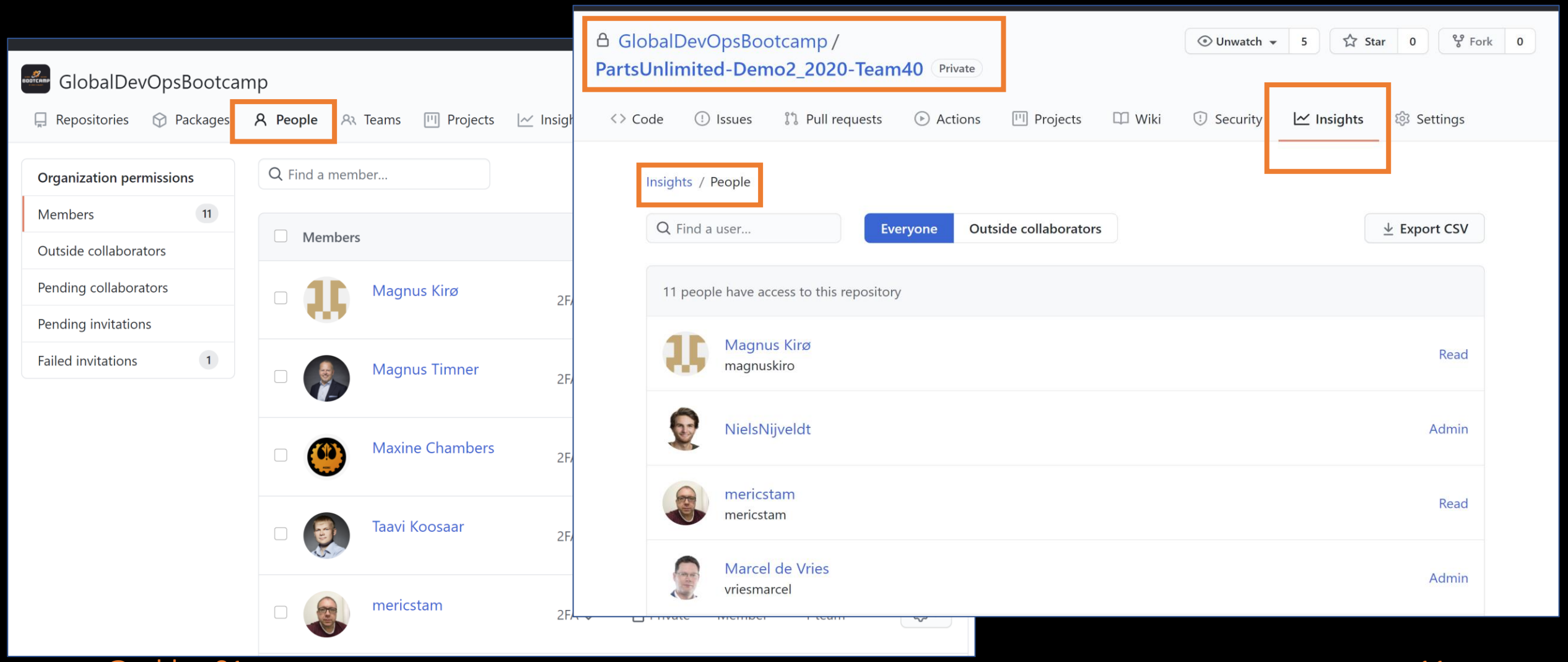
Code – Who has access?

Permission levels

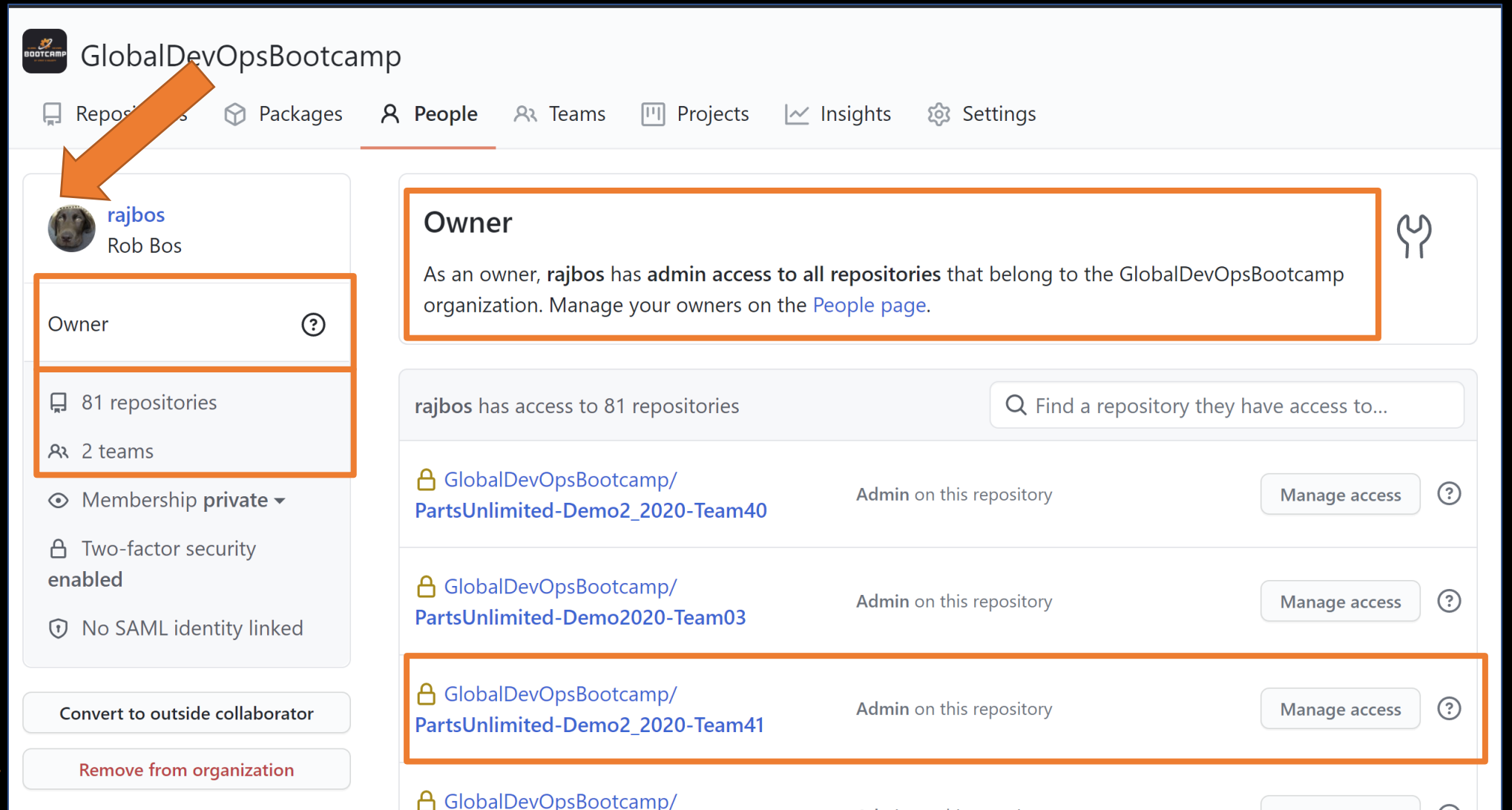


No access
Read only access
Triage: manage issues & pull requests
Write access
Maintain: No sensitive or destructive actions
Admin: full access

Configuring access



From the user



Repository security

- Access to code
- Workflow secrets
- Your code

Workflow secrets

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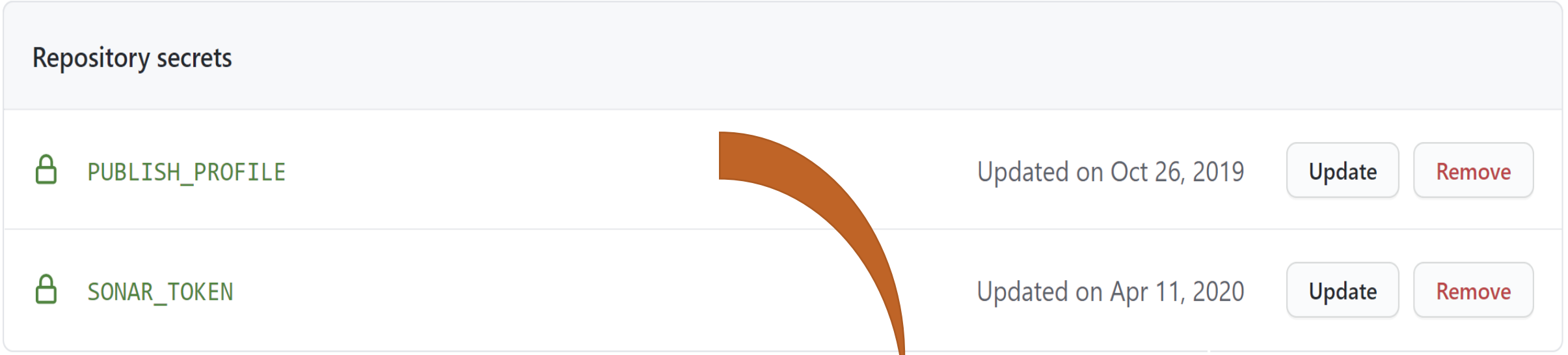



```
41
42      # publish to Azure App Service
43      - name: 'Run Azure webapp deploy action using publish profile cred ntials'
44        uses: azure/webapps-deploy@v2
45        with:
46          app-name: dotnetcorewebapp19 # Replace with your a
47          publish-profile: ${{ secrets.publish_profile }} #  ine secret variable in repository settings as per action documentation
48          package: './dotnetcorewebapp'
49
```

Workflow secrets

Encrypted client side before reaching GitHub:

- Encrypted with the public key for your org or repo (created and stored by GitHub)
- Used when using the UI
- Encrypt yourself before posting to the REST API

Secrets are not shared to forked repositories

Who has access to your secrets?

For creating at repo level: Repository Owner access

For creating at org level: Admin access to the org

Set an access policy for the secrets:

- All repositories
- Private repositories
- Only selected repositories

Who has access to your secrets?

Encrypted until used, then injected as:

- An environment variable
- Direct input

Will be redacted in logs

Don’t use structured data (like json): hard to redact

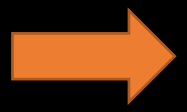
Who has access to your secrets?

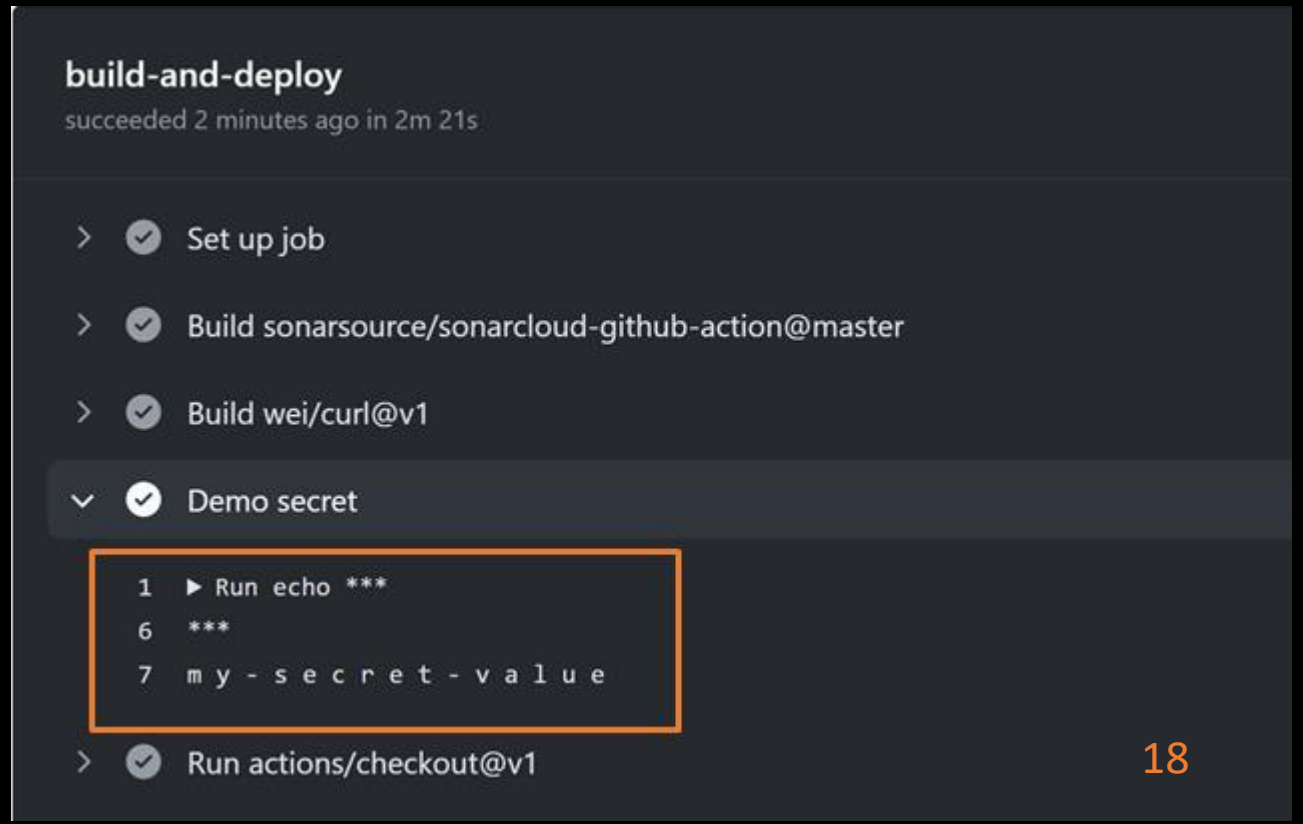
- Actions can do anything with them!
- Anyone with access to the Action Logs should be considered to have access to your secrets

```yaml
jobs:
  build-and-deploy:

    runs-on: ubuntu-latest

    steps:
    - name: Demo secret
      run: |
        echo ${{ secrets.DEMO_LOG }}
        echo ${{ secrets.DEMO_LOG }} | sed 's/./& /g'
```





Repository security

- Access to code
- Workflow secrets
- Your code/repo

Your code

Anything in your repository:

- Workflow files
- Shell scripts
- Your own code
- Dependencies:
  - Packages
  - Containers

Best practices:

- Static code analysis
  - Check your own code!
- Third party dependency scanning
  - 99% of your code, is not yours:
    - Scan for known vulnerabilities
  - Keep your dependencies up to date!

Your code – Best practices

Preventing changes by a single person → Pull Request

Protect your main branch

Branch protection rule:

- 1 approver (4 eyes / 2 person principle)
- Build validation

Your code/repo – trace changes

Who made changes:

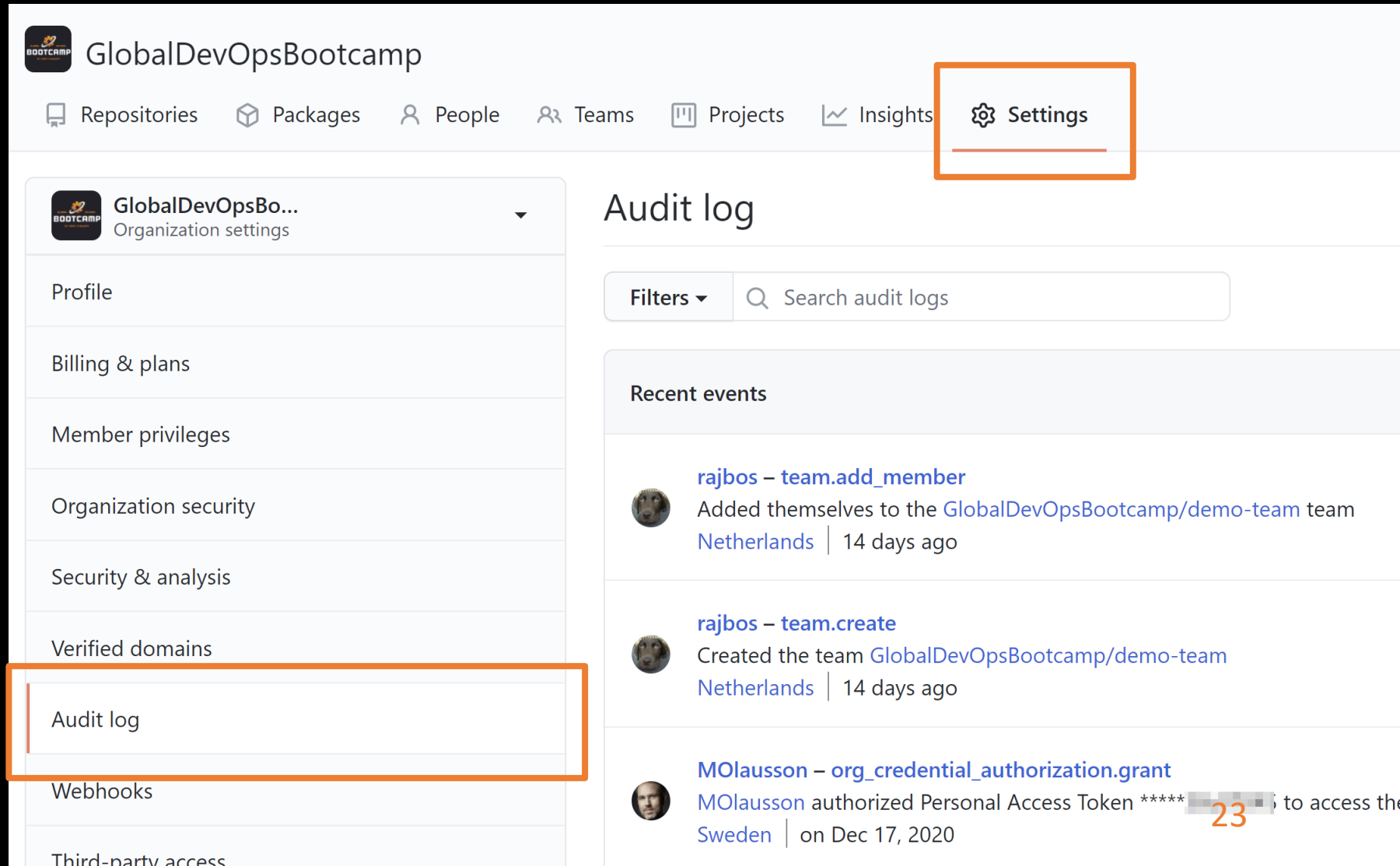
- Code: Git commit history

- Everything around your code is in the audit log

Your code/repo – trace changes (org level)

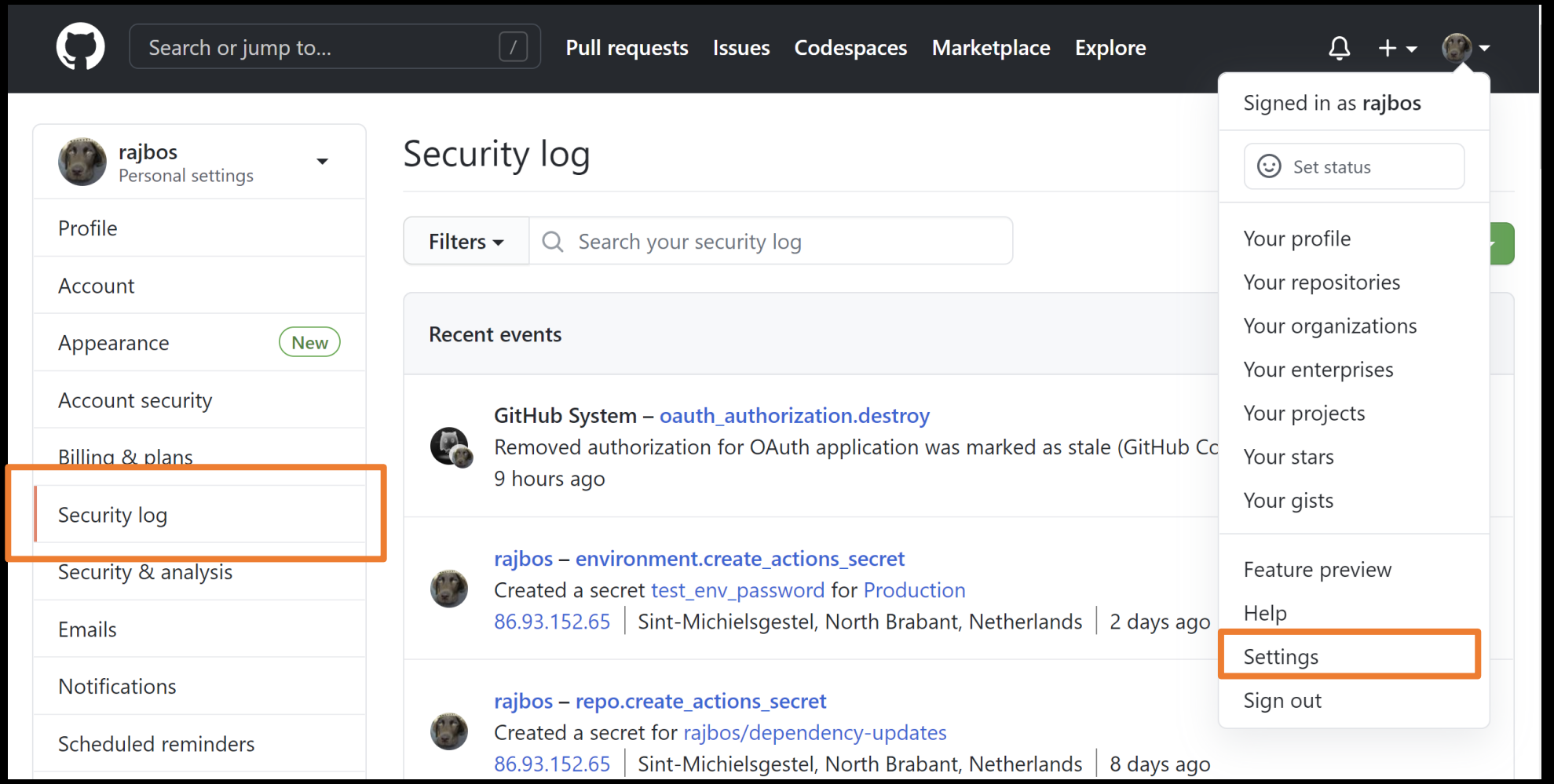
Audit log:

- Access
- Secrets
- Access Tokens
- OAuth grants
- Enabling features
- Etc.



Your code/repo – trace changes

Account level:



GitHub Actions Security

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- Forking actions
- Keeping up to date

Workflow Runners

Actions execute on runners

Self hosted

- Cloud / On premises hosted by yourself
- OS + Tools update = YOUR responsibility
- Enables specific environment setup
- No usage limits

GitHub hosted

- OS + Tools update = GitHub's responsibility
- Per minute rating applies after the free minutes
- Clean execution environment with every run

```yaml
name: .NET Core Deploy to IIS

on:
  push:
    branches:
      - "self-hosted"

jobs:
  build-and-deploy:

    runs-on: self-hosted

    steps:
    - uses: actions/checkout@v1
    - name: Setup .NET Core
      uses: actions/setup-dotnet@v1
      with:
        dotnet-version: 3.0.100
```

```yaml
name: .NET Core

on: [push]

jobs:
  build-and-deploy:

    runs-on: ubuntu-latest

    steps:
    - uses: actions/checkout@v1
    - name: Setup .NET Core
      uses: actions/setup-dotnet@v1
      with:
        dotnet-version: 3.0.100
```

Workflow Runners

Security

- Environment scope
  - Network
  - Shared state between runs
- User: limit its access!

Best practice: Run the action inside of a container

```yaml
jobs:
  my_first_job:
    steps:
      - name: My first step
        uses: docker://gcr.io/cloud-builders/gradle
```

```yaml
jobs:
  test-box:
    runs-on: ubuntu-latest
    container:
      image: azul/zulu-openjdk-alpine:8-jre
    steps:
    - uses: actions/checkout@v2
    - name: What OS is running
      run: uname -a
    - name: What java version do we have
      run: java -version
```

Workflow runners

Best practice: DO NOT EVER use self hosted runners for public repositories

Example:

- Your repo
- New fork
- Adds malicious code
- Create pull request to your repo
- Workflow is executed on your self hosted runner?

Persisting data between runs

Run 1:

- Download dependencies
- Build the code
- Somehow overwrite the dependency cache

Run 2:

- Use cached dependencies
- Build the code
- Malicious dependency in build artefact

Solarwind attack:
https://xpir.it/Solorigate

Workflow runners – Best practice

Don't share runners (and machines!) between repositories:

- Run 1 can influence Run 2

Risks:

- Malicious programs
- Escaping the runner sandbox
- Exposing access to the (network) environment
- Persisting unwanted or dangerous data

GitHub Actions Security

Repository security

Runners and security

Actions and security

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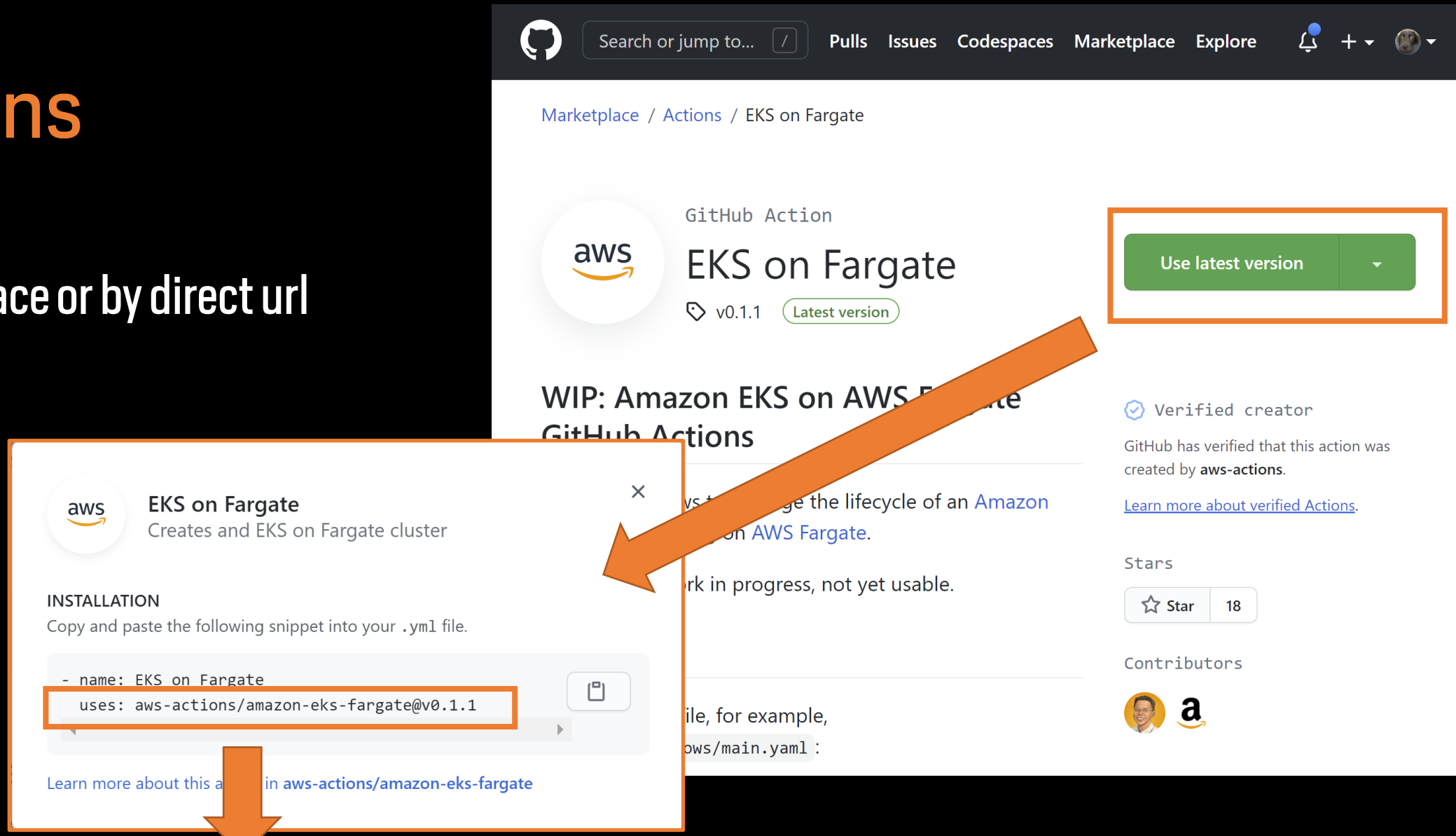
Actions

Marketplace or by direct url



https://github.com/aws-actions/amazon-eks-fargate

Actions and security

Are you running just any action from the internet?

Scary! Especially in an enterprise or on local runners

Attack vectors

1. **Data Theft**
2. **Data Integrity Breaches**
3. **Availability**

Protective measures

Manually:

1. Check the action repo code before use
2. Check its container images and dependencies before use

Protective measures

```yaml
uses: shprink/nonharmful-and-must-have-actions@v1
with:
  my-secret: ${{ secrets.MY_SECRET }}
```

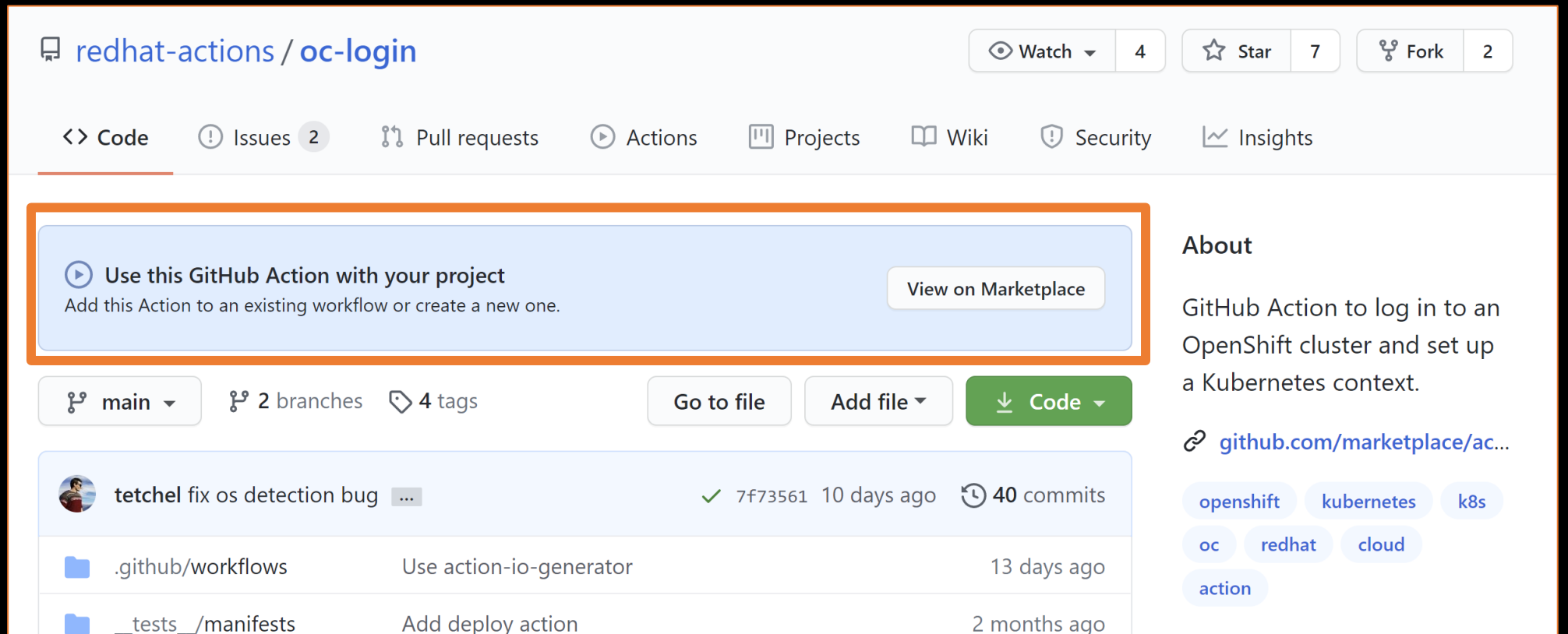
https://github.com/shprink/nonharmful-and-must-have-actions

If the repo has an action.yml, you can use it in your workflow

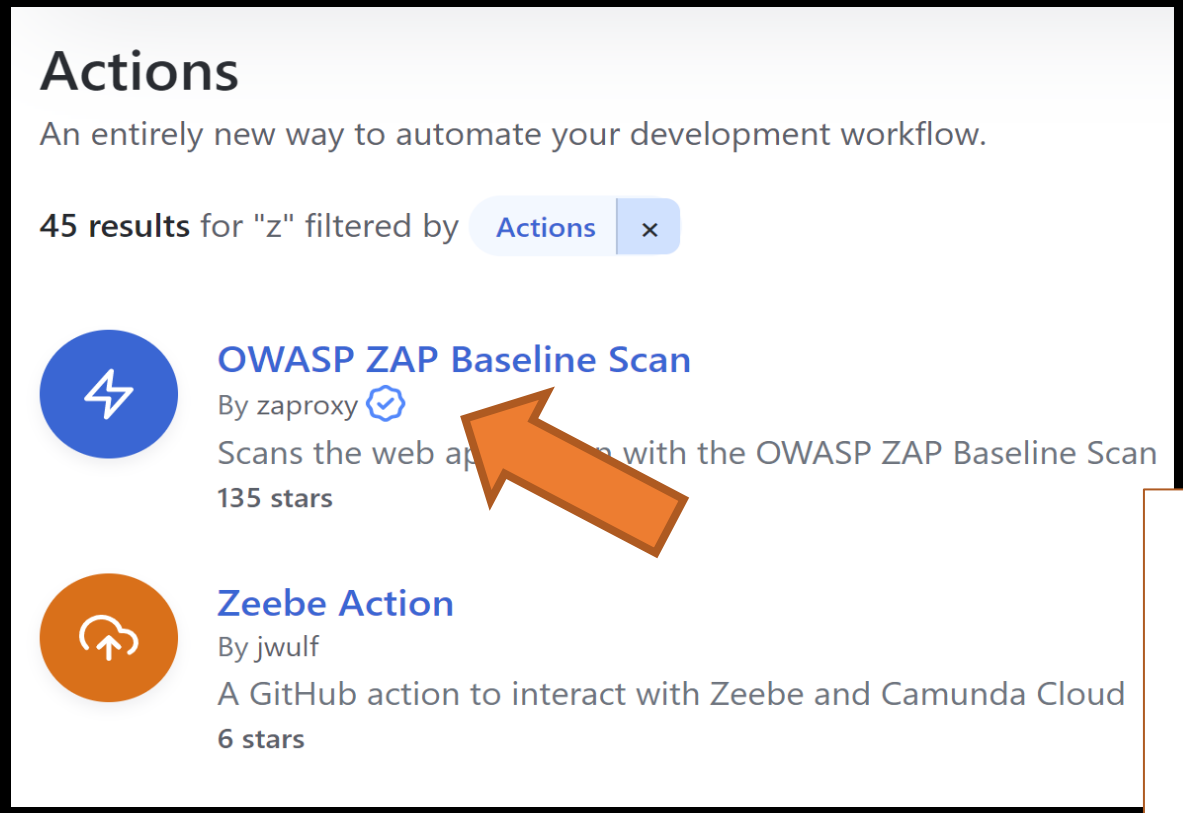
Protective measures

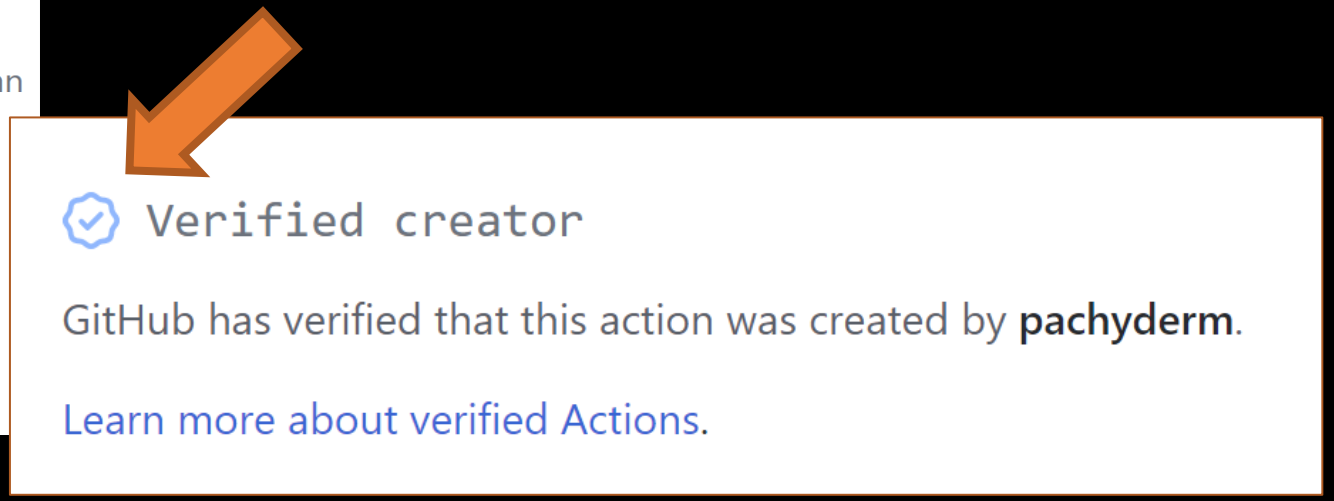
Only use actions listed in the marketplace?

- There is no real verification process for it ☹



Protective measures





Verified Creator

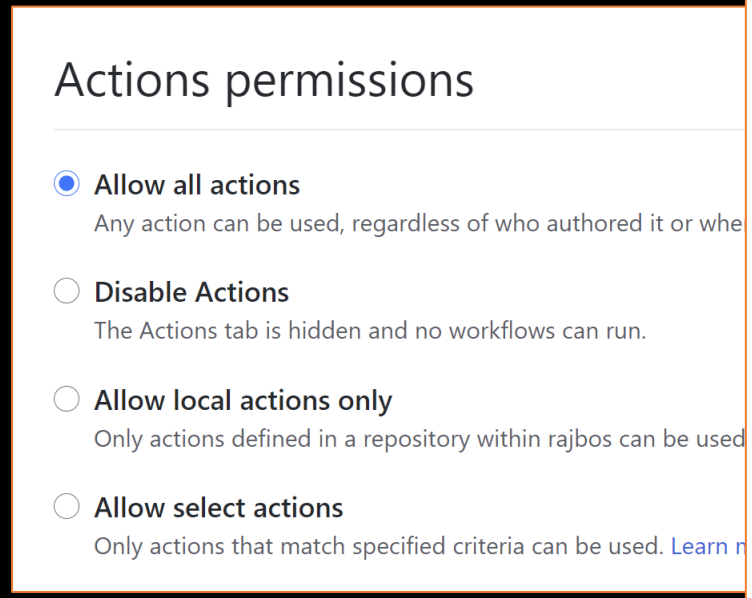
Verification process:

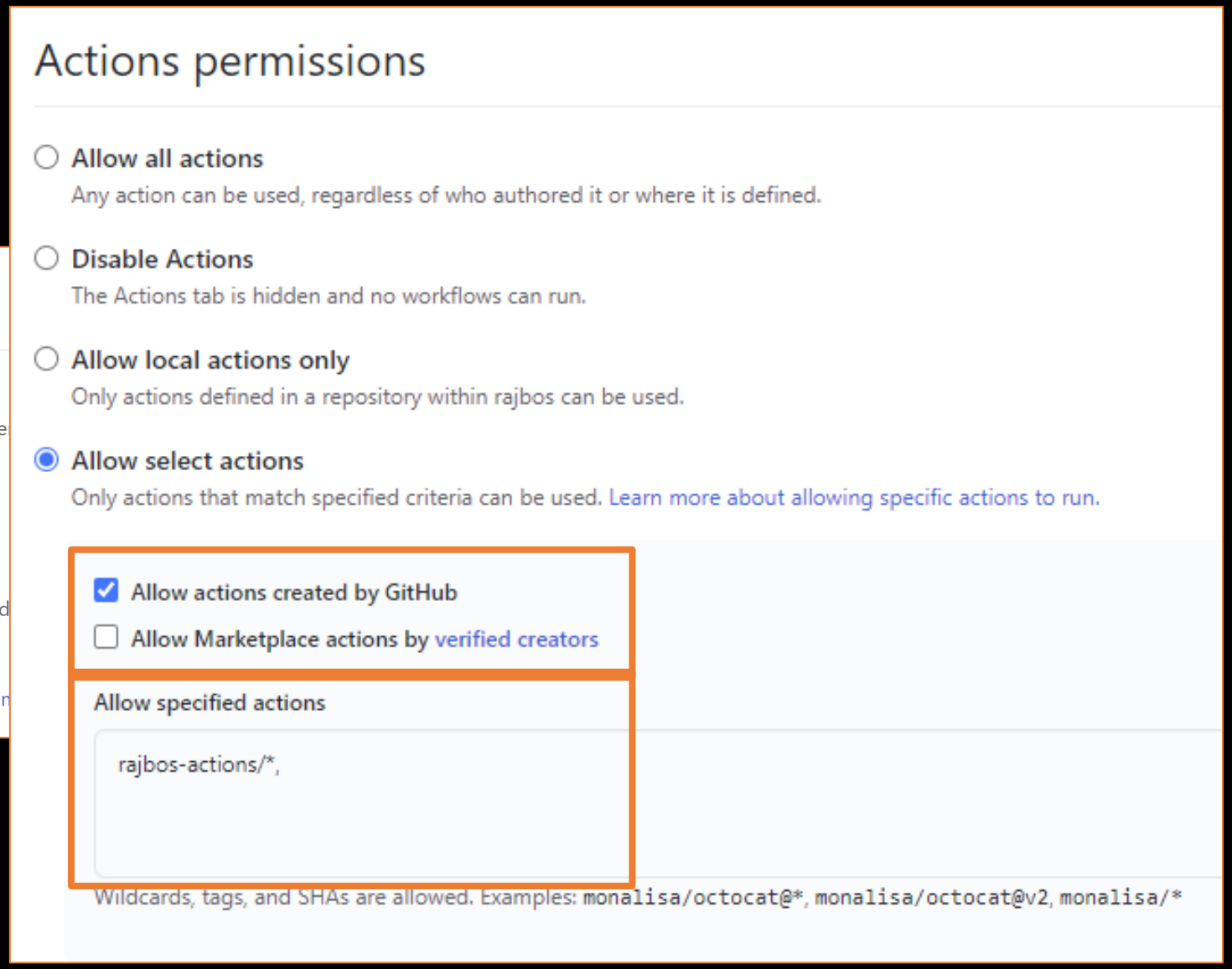
- GitHub Profile information is present and accurate
- Two factor authentication is on for the organization
- Domain verification through a txt record

See: https://xpir.it/verified-publisher

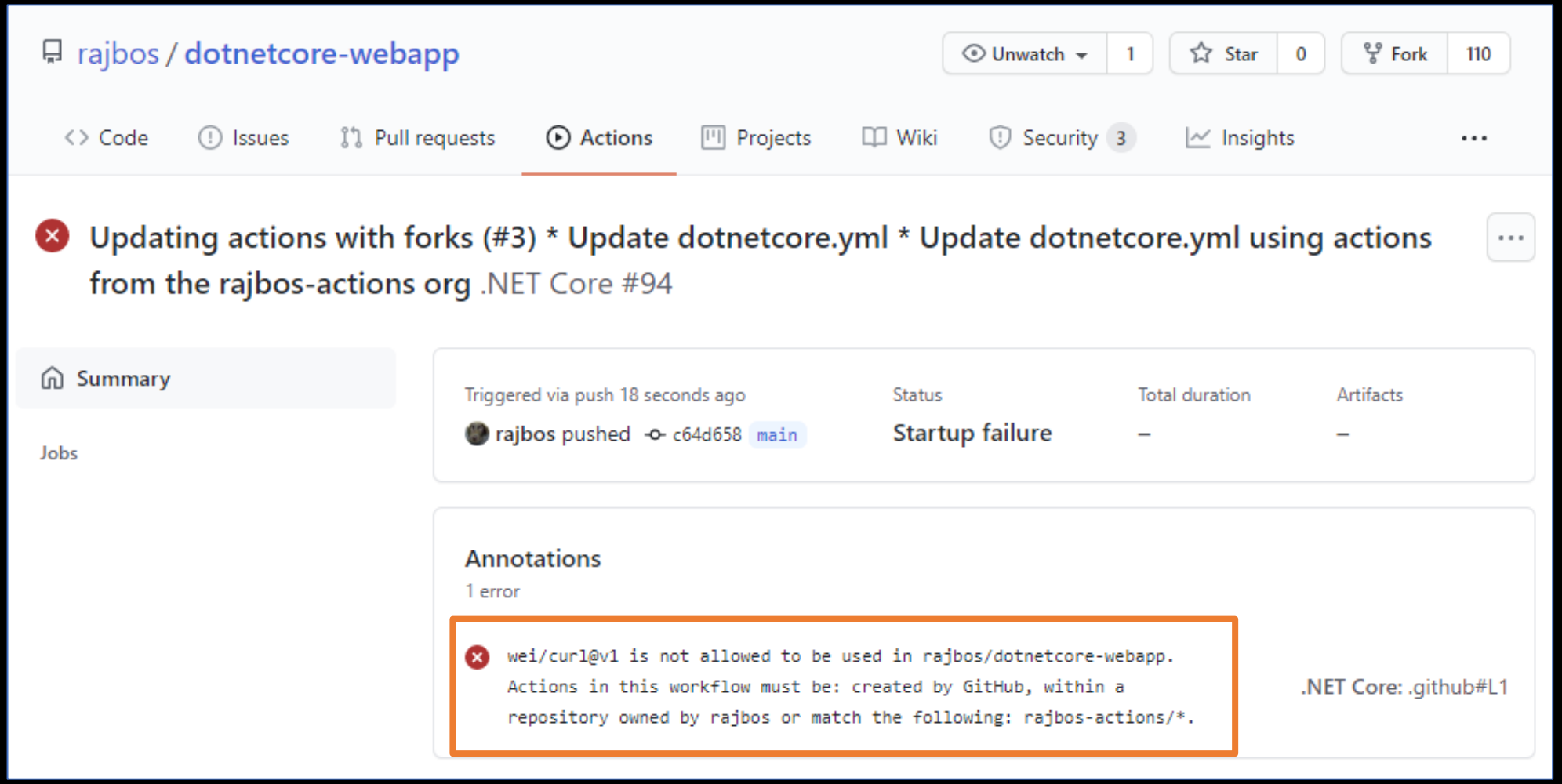
Protective measures

Limiting actions altogether





Protective measures



Protective measures

Pin the action version:

uses: gaurav-nelson/github-action-markdown-link-check@v1
uses: gaurav-nelson/github-action-markdown-link-check@v1.0.1

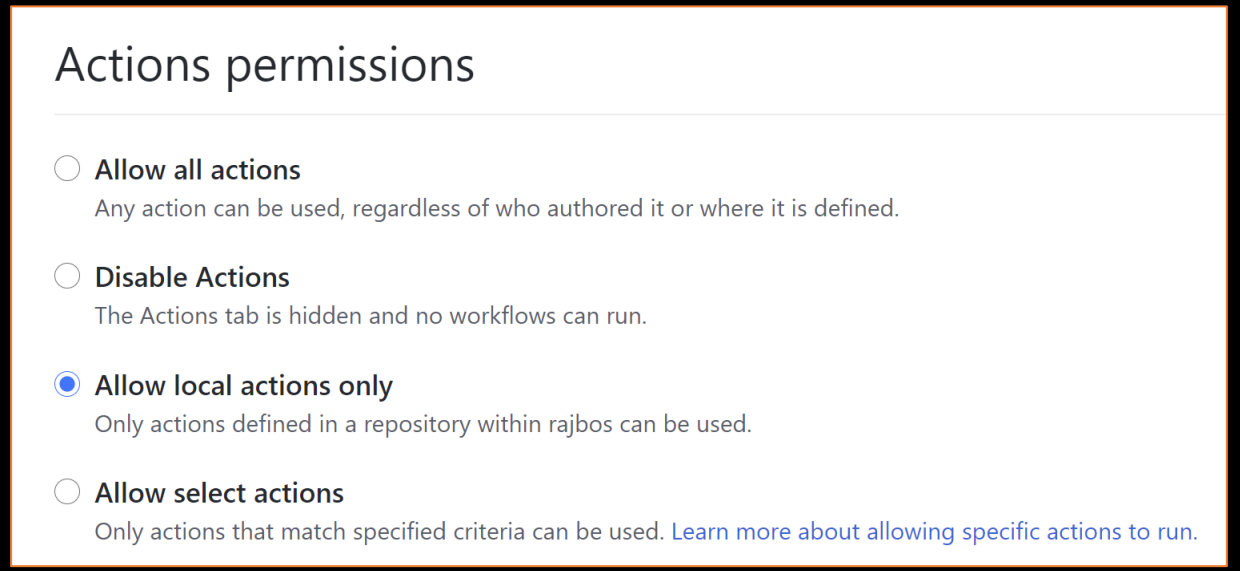
Best practice: Pin the Action's commit SHA:

uses: gaurav-nelson/github-action-markdown-link-check@44a942b2f7ed0dc101d556f281e906fb79f1f478

Recommendation

- Best practice: Limit to local actions and fork action repositories

- Create a separate org to test actions in
  - Enable DevOps teams to own the actions



Workflow attack vectors

- Forks of public repos
- Common fields

Forks of public repos

```
3   on:
4     - push
5     - pull_request
6     - pull_request_target
7
8   jobs:
9     build-and-deploy:
10      environment: PullRequestEnvironment
11
12      runs-on: ubuntu-latest
13
14      steps:
15      - uses: actions/checkout@v1
```

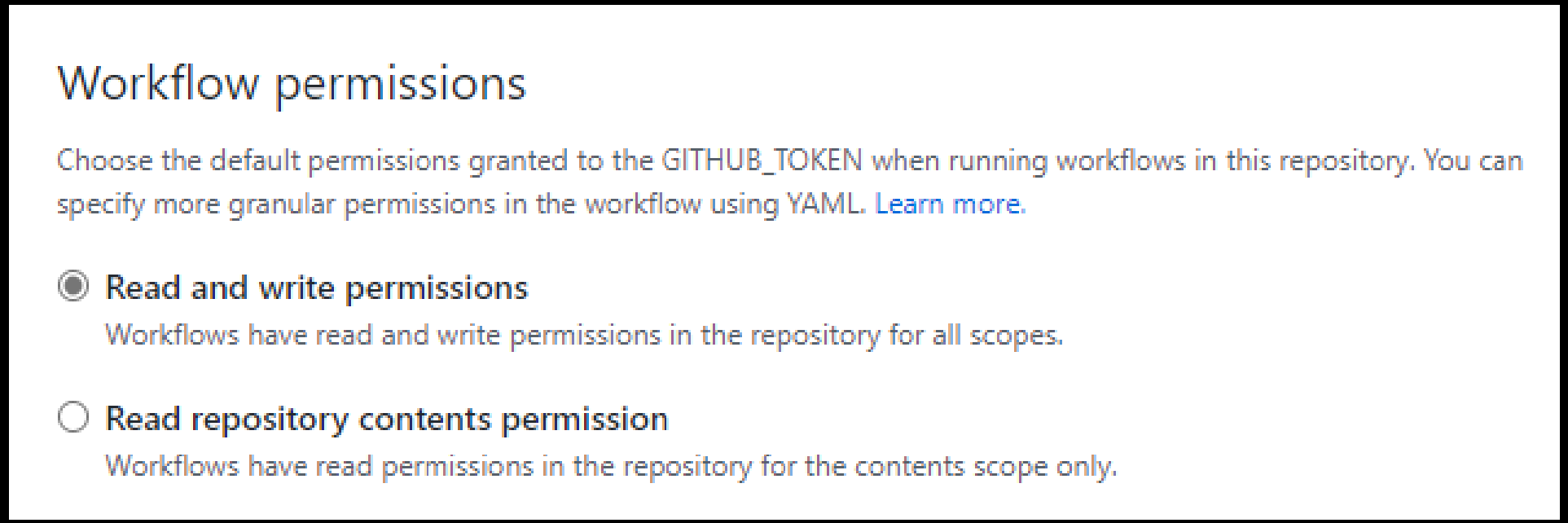
Safe, runs on merge commit, read only access

High risks! Runs on the target, has read + write access and can access secrets

https://xpir.it/gh-pwn-request

Pull Requests

${{ secrets.GITHUB_TOKEN }}



Pull Requests

${{ secrets.GITHUB_TOKEN }}

```yaml
name: Pull request labeler

on: [ pull_request_target ]

permissions:
  contents: read
  pull-requests: write

jobs:
  triage:
    runs-on: ubuntu-latest
    steps:
      - uses: actions/labeler@v2
        with:
          repo-token: ${{ secrets.GITHUB_TOKEN }}
```

Common fields

```
github.event.issue.title
github.event.issue.body
github.event.pull_request.title
github.event.pull_request.body
github.event.comment.body
github.event.review.body
github.event.review_comment.body
github.event.pages.*.page_name
github.event.commits.*.message
github.event.head_commit.message
github.event.head_commit.author.email
github.event.head_commit.author.name
github.event.commits.*.author.email
github.event.commits.*.author.name
github.event.pull_request.head.ref
github.event.pull_request.head.label
github.event.pull_request.head.repo.default_branch
github.head_ref
```

Common fields

```
- name: Check title
  run: |
    title="${{ github.event.issue.title }}"
    if [[ ! $title =~ ^.*:\ .*$ ]]; then
      echo "Bad issue title"
      exit 1
    fi
```

Payload: `a"; echo test`

Remediation

```
- name: print title
  env:
    TITLE: ${{ github.event.issue.title }}
  run: echo ‘$TITLE’
```

https://xpir.it/actions-untrusted-input

GitHub Actions Security

Repository security

Runners and security

Actions and security

Forking actions

Keeping up to date

Forking actions

Pros:

- More secure
- Backup of actions that can be deleted or moved to a different org/repo

Cons:

- More maintenance work
  - Fork needs to be created
  - Kept up to date
- Limits the usage of new actions in your org, as someone create the new action (and by that take responsibility for enabling its use)

GitHub Actions Security

Repository security

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Forking actions

Keeping up to date

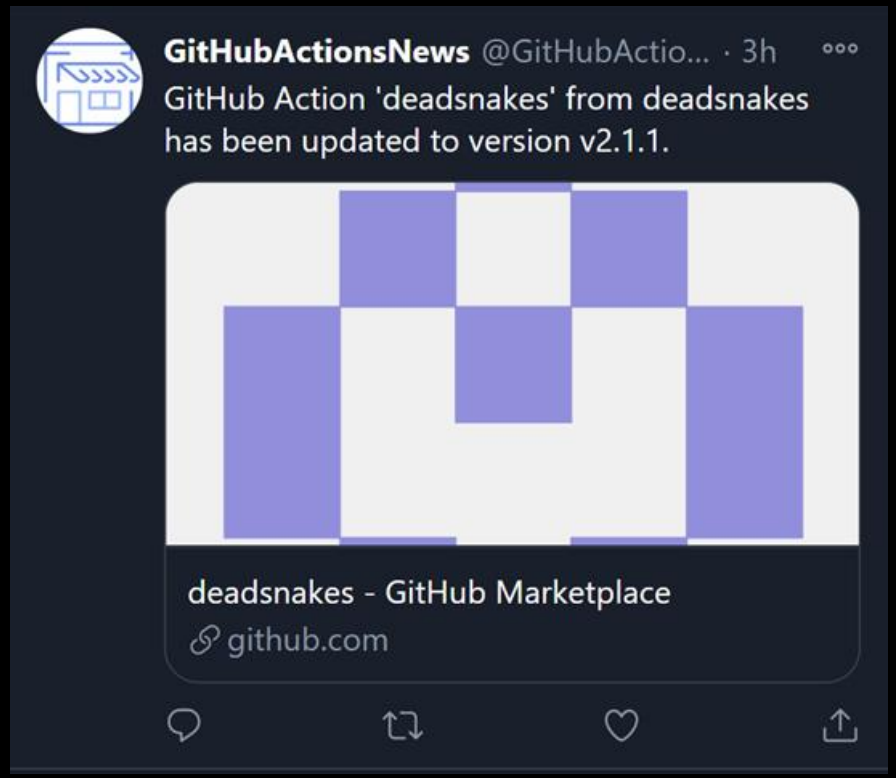
Updates

- Actions are updated regularly
- Wait for a deprecation message?
- How do you stay up to date?

- Auto update with a PR?
- Read the changes in the source repo

Staying up to date

Follow @githubactions on Twitter!



Update action versions

1. Review the Action
   Use Actions + Commit SHA + Dependabot

---

2. Review the Action
   Fork the Actions repo, update your forks and use Dependabot

Option 1: Use SHA + Dependabot

Best practice: Pin the Action's commit SHA:

uses: gaurav-nelson/github-action-markdown-link-check@44a942b2f7ed0dc101d556f281e906fb79f1f478

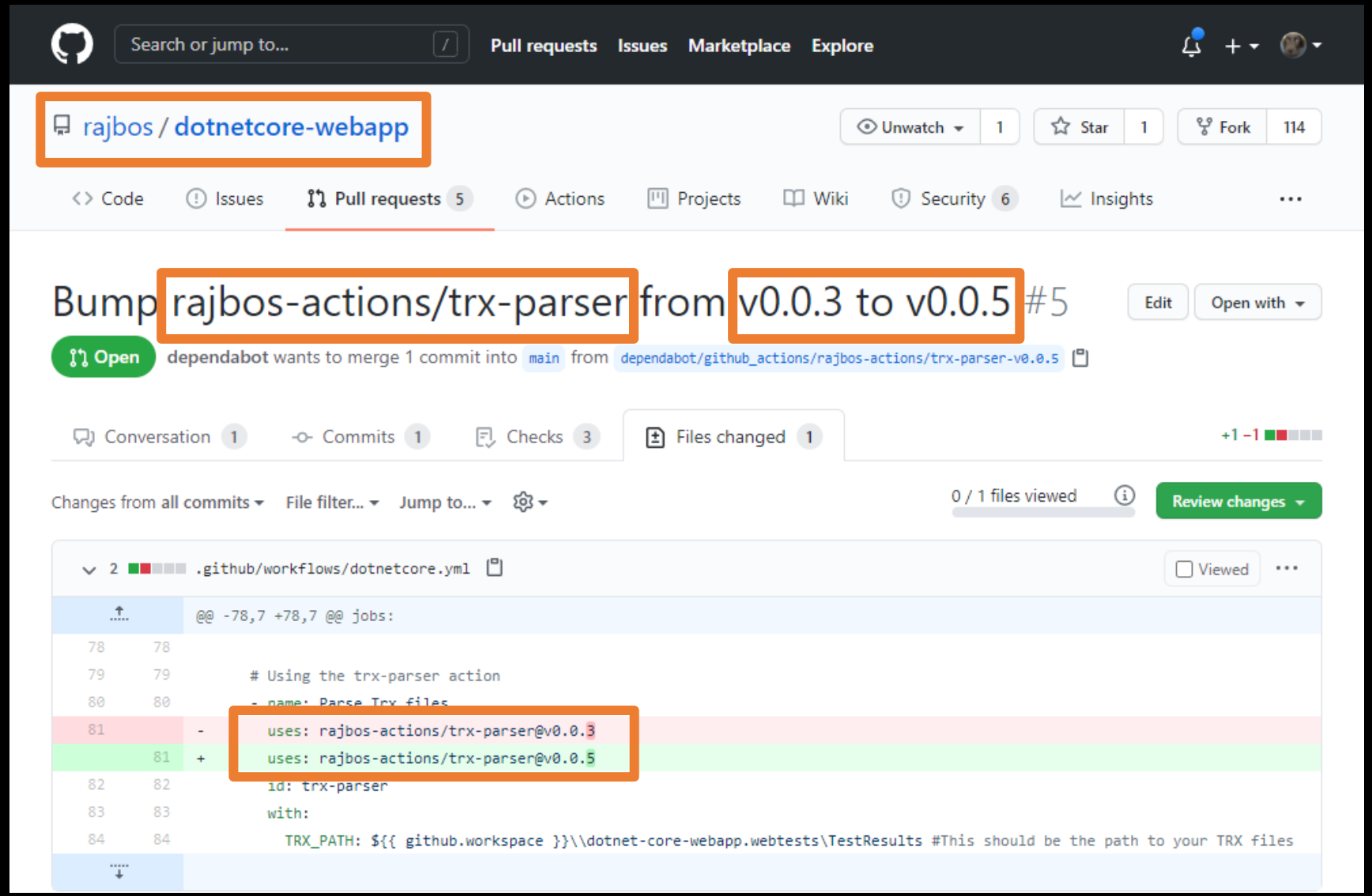
Add .github/dependabot.yml to the repo

```yaml
#Dependabot will check the dependencies in this repo for updates

version: 2
updates:
  - package-ecosystem: "github-actions"
    directory: "/"
    schedule:
      # Check for updates to GitHub Actions every weekday
      interval: "daily"


  - package-ecosystem: "nuget"
    directory: "/"
    schedule:
      # Check for updates to on nuget packages every weekday
      interval: "daily"
```

Use Dependabot



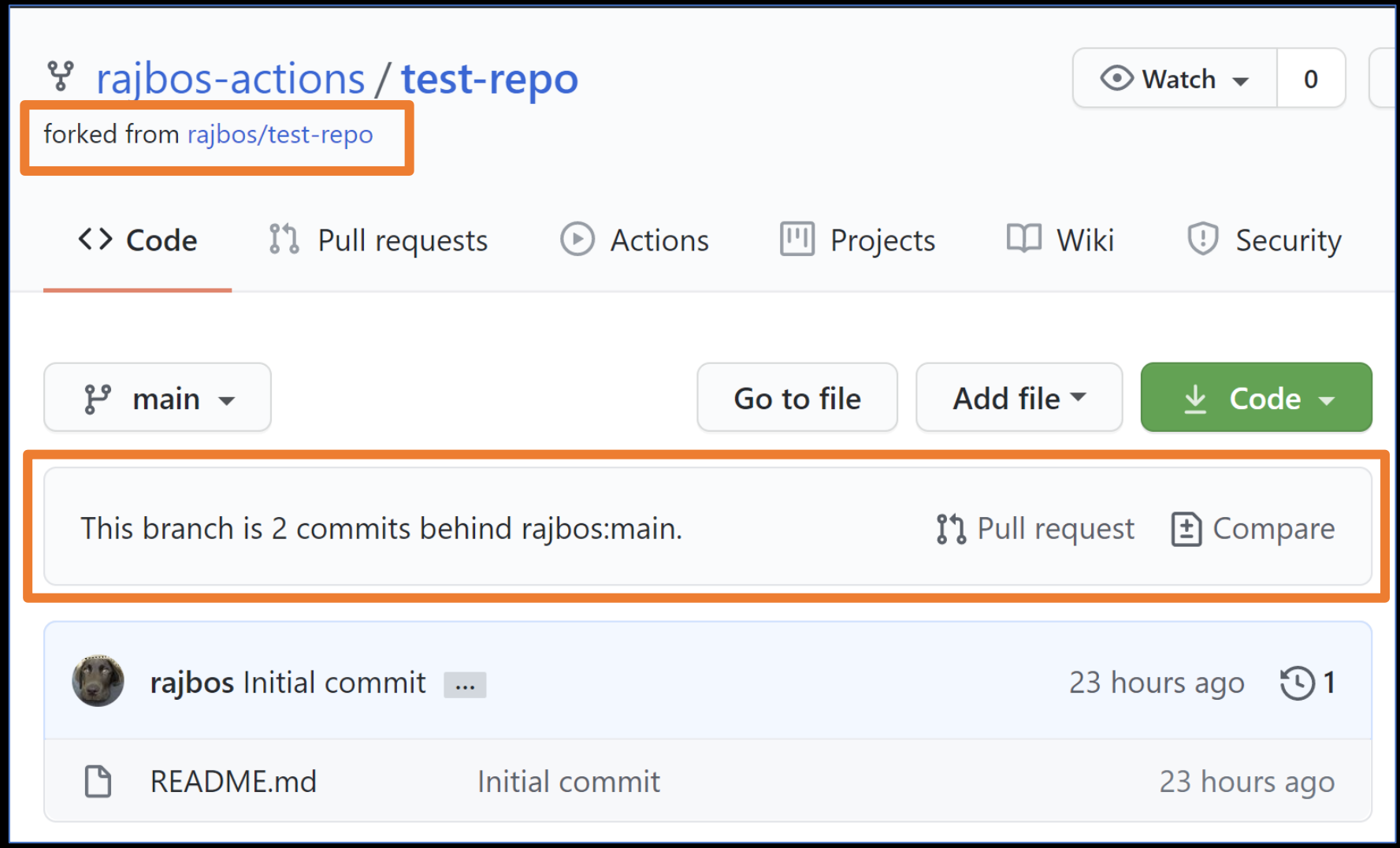
Update action versions

1. Review the Action
   Use Actions + Commit SHA + Dependabot

---

2. Review the Action
   Fork the Actions repo, update your forks and use Dependabot

Keep you forked action up to date



Keep your forked action up to date

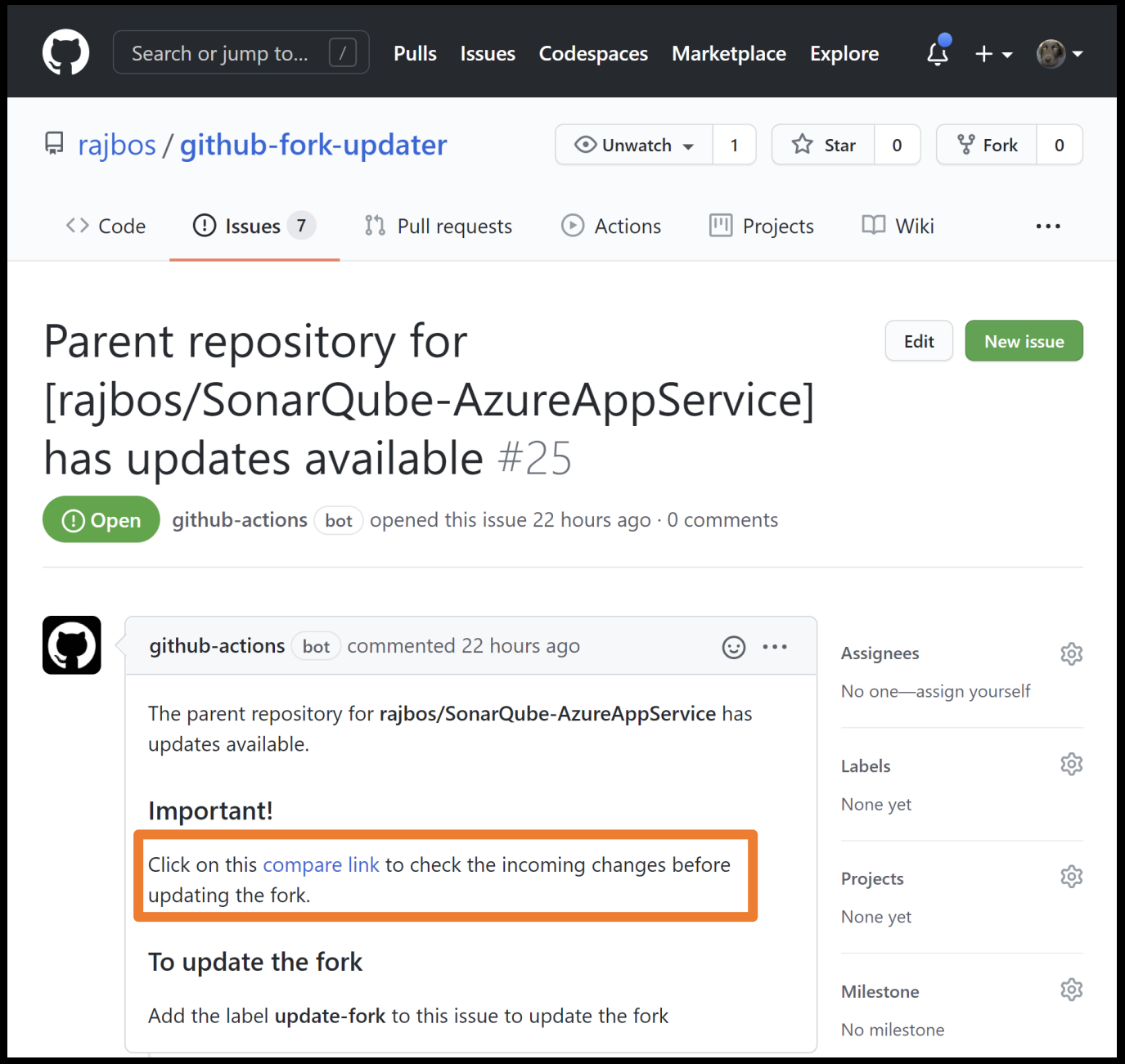
Fork a repo and automate it!

https://github.com/rajbos/github-fork-updater

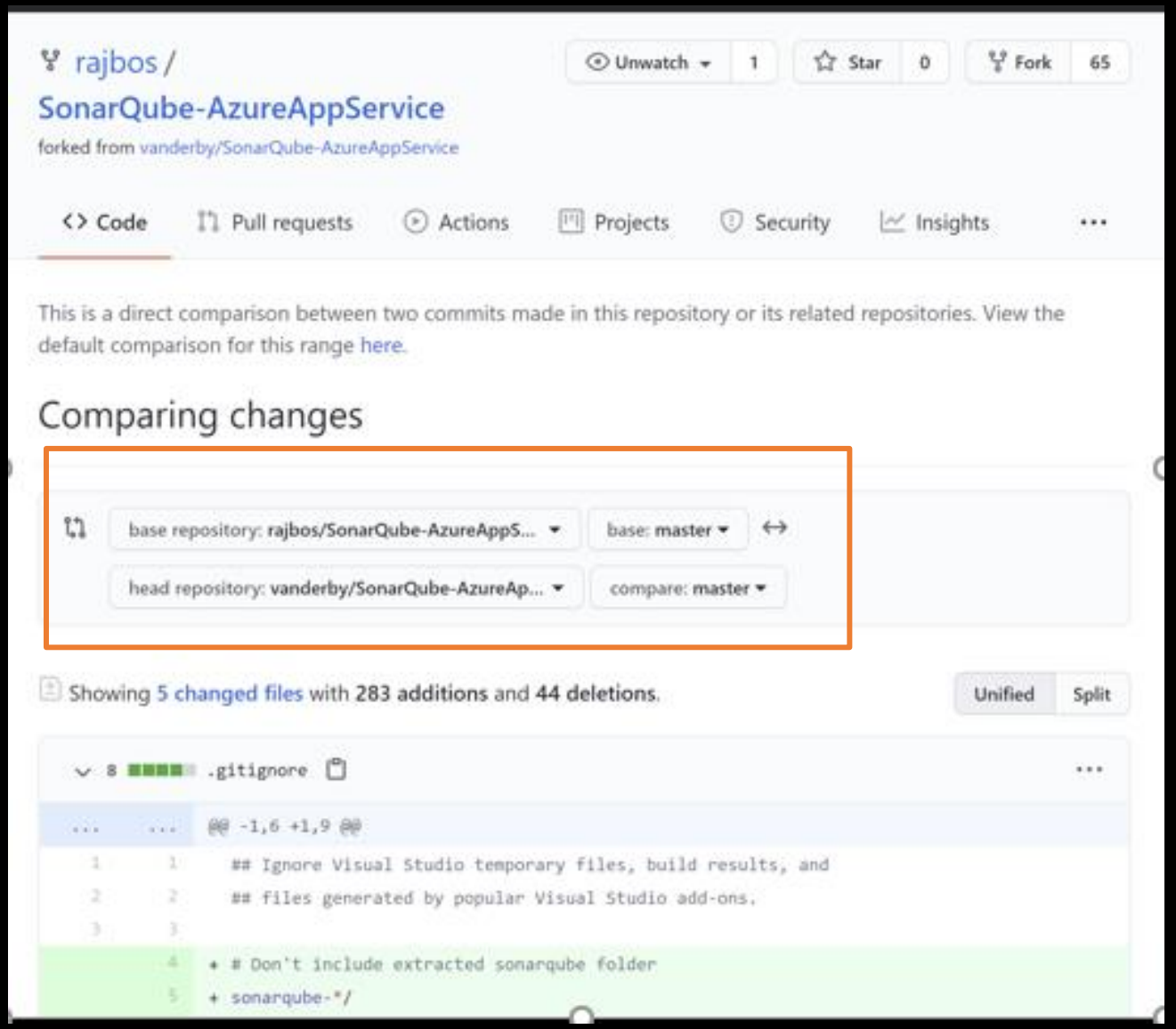
Contains:

- Scheduled workflow
- Creates an issue
- Review the changes
- Label the issue
- Pull in changes

Creates issues

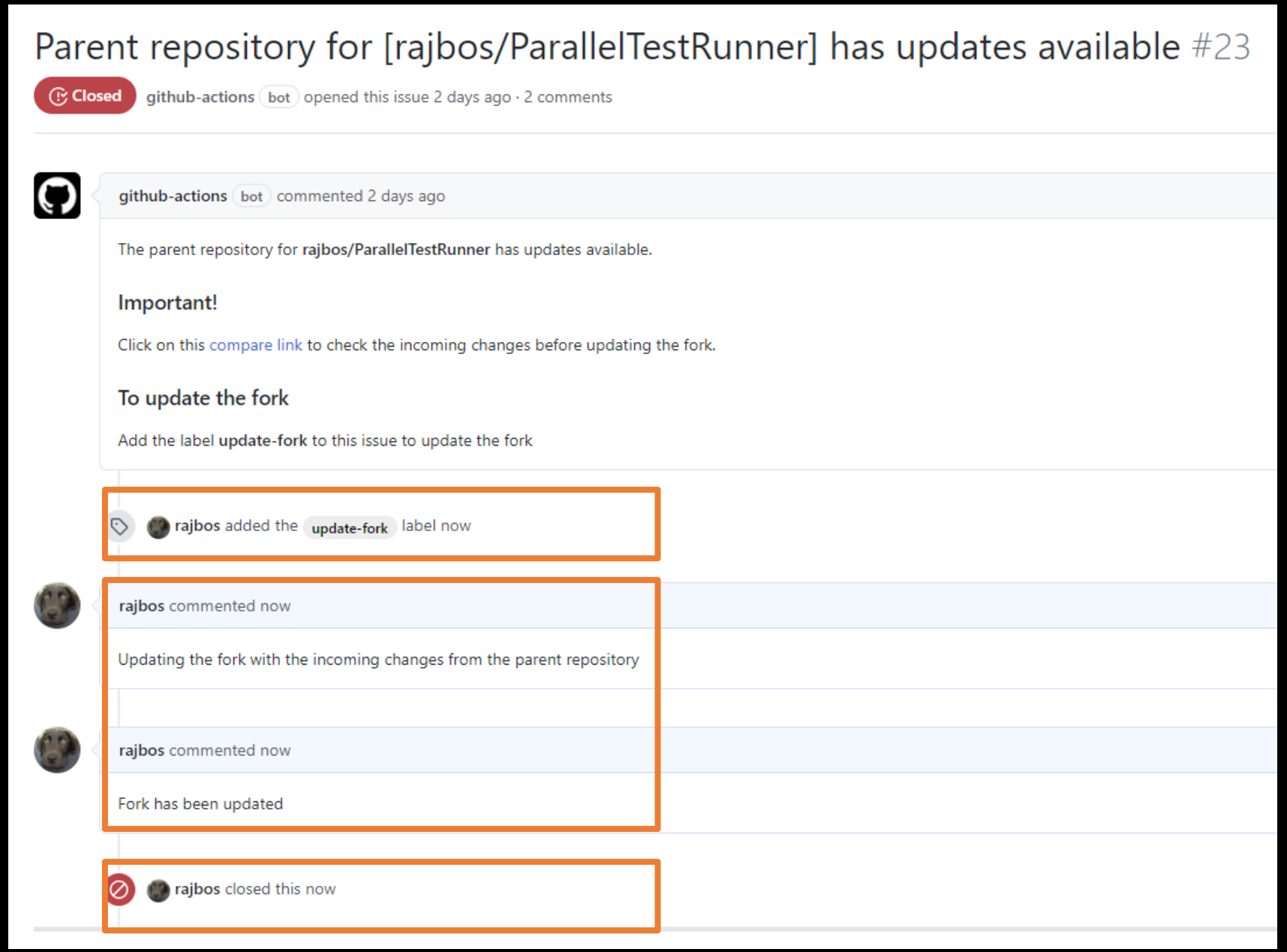


Review before merging



Automation

- Add a label
- Fork gets updated
- Issue gets closed



Pros of forking

- Backup of the action
- Full control over updates
- Pull in updates with validation centrally
- Only allow actions from your actions organization

- Skip commit SHA lookup and updating in every workflow
- Skip adding Dependabot in every repository

https://xpir.it/actions-best-practices

GitHub Actions Security

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Actions and security

Forking actions
Keeping up to date

Best practices summarized

- Treat workflow secrets very carefully: best to think of them as public
- Review actions' source code
- Pin actions to commit SHA
- Don't trust incoming Pull Requests on public repos
- Fork the action repo and limit actions to local actions only
- Have an organization setup to test with
- Keep your forked actions up to date

How to use GitHub Actions with security in mind

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