

GitHub Actions Advanced Features

Building Powerful CI/CD Pipelines

55 Minutes • 5 Topics • 10 Demos

Agenda

- **Matrix Builds** (10 min) - Parallelize across versions & platforms
- **Reusable Workflows** (10 min) - DRY principle for workflows
- **Composite Actions** (10 min) - Build custom actions
- **Environment Protection Rules** (10 min) - Control deployments
- **Caching & Artifacts** (10 min) - Speed up workflows
- **Q&A** (5 min)

1. Matrix Builds

What are Matrix Builds?

- Run jobs across multiple versions, platforms, or configurations
- Automatically creates job for each combination
- Perfect for testing compatibility
- Reduces workflow duplication

Matrix Builds: Simple Demo

DEMO 1: Basic Matrix

```
strategy:  
  matrix:  
    os: [ubuntu-latest, windows-latest, macos-latest]  
    node: [16, 18, 20]  
  
  runs-on: ${{ matrix.os }}  
  steps:  
    - uses: actions/setup-node@v3  
      with:  
        node-version: ${{ matrix.node }}
```

Result: Creates 9 jobs (3 OS × 3 Node versions)

Matrix Builds: Advanced Demo

DEMO 2: Matrix with Include/Exclude

```
strategy:  
  matrix:  
    os: [ubuntu-latest, windows-latest]  
    node: [16, 18, 20]  
    include:  
      - os: ubuntu-latest  
        node: 20  
        experimental: true  
    exclude:  
      - os: windows-latest  
        node: 16
```

Advanced Features: `include` adds extra jobs, `exclude` removes combinations

2. Reusable Workflows

Why Reusable Workflows?

- Eliminate workflow duplication across repositories
- Centralize CI/CD logic in one place
- Pass inputs and secrets to workflows
- Return outputs from workflows
- Easier maintenance and updates

Reusable Workflows: Simple Demo

DEMO 3: Basic Reusable Workflow

Called Workflow:

```
on:  
  workflow_call:  
jobs:  
  build:  
    runs-on: ubuntu-latest  
    steps:  
      - run: echo "Reusable workflow!"
```

Caller Workflow:

```
jobs:  
  call-workflow:  
    uses: ./github/workflows/reusable-simple.yml
```

Reusable Workflows: Advanced Demo

DEMO 4: Workflow with Inputs & Outputs

```
on:
  workflow_call:
    inputs:
      environment:
        required: true
        type: string
    outputs:
      build-id:
        value: ${{ jobs.build.outputs.id }}
    secrets:
      deploy-token:
        required: true
```

3. Composite Actions

What are Composite Actions?

- Bundle multiple steps into a single reusable action
- Defined with `action.yml` file
- Can use other actions within them
- Support inputs, outputs, and environment variables
- Different from reusable workflows (actions vs workflows)

Composite Actions: Simple Demo

DEMO 5: Basic Composite Action

action.yml:

```
name: 'Setup Node with Cache'
description: 'Install Node and cache dependencies'
runs:
  using: 'composite'
  steps:
    - uses: actions/setup-node@v3
    - run: npm ci
      shell: bash
```

Usage:

```
- uses: ./github/actions/setup-node
```

Reusable Workflows vs Composite Actions

1. Where they live & how you invoke them

- **Composite Action:** Defined in `action.yml`, invoked as a *step* inside a job (`uses: ./path/to/action`)
- **Reusable Workflow:** Normal workflow YAML file, invoked at the *job level* (`uses: .github/workflows/file.yml` with `workflow_call`)

2. Scope: steps vs jobs

- **Composite Action = steps only:** Packages steps into one reusable component; runs on the same runner as the caller job
- **Reusable Workflow = full workflow with jobs:** A complete workflow you can run from other workflows;

defines multiple jobs with their own runners and dependencies

Reusable Workflows vs Composite Actions (cont.)

3. Inputs & secrets

- **Reusable Workflow:** Inputs + secrets defined on `workflow_call`; callers pass them via `with:` and `secrets:`
- **Composite Action:** Inputs/outputs in `action.yml`; secrets must be passed explicitly from caller
- **Limitation:** Environment secrets must be configured in the reusable workflow's environment; they cannot be passed from the caller via `workflow_call`

4. Orchestration & features

- **Reusable Workflow:** Defines the entire job; can enforce runner labels; supports full workflow features

- **Composite Action:** Defines a list of steps; gives flexibility to run before/after other steps

Choosing Between Them

Use a Composite Action when...

- You need **reusable step sequences** (setup toolchain, cache, install, standard logging wrapper)
- The logic fits naturally inside one job and should share the caller job's environment and runner

Use a Reusable Workflow when...

- You need to **standardize an entire pipeline pattern** across repos (build+test → security scanning → deploy jobs)
- You need strongly typed inputs and secrets, and want to keep workflows centrally maintained
- You need **job-level structure** (multiple jobs, job dependencies, distinct runners)

Composite Actions: Advanced Demo

DEMO 6: Action with Inputs & Outputs

```
inputs:
  node-version:
    description: 'Node version'
    required: true
    default: '18'
outputs:
  cache-hit:
    description: 'Whether cache was hit'
    value: ${{ steps.cache.outputs.cache-hit }}
runs:
  using: 'composite'
  steps:
    - id: cache
      uses: actions/cache@v3
```

4. Environment Protection Rules

Why Environment Protection?

- Control deployments to sensitive environments
- Require manual approvals before deployment
- Restrict which branches can deploy
- Set wait timers before deployment
- Limit deployment reviewers

Environment Protection: Simple Demo

DEMO 7: Basic Environment

```
jobs:
  deploy-staging:
    runs-on: ubuntu-latest
    environment:
      name: staging
      url: https://staging.example.com
    steps:
      - run: echo "Deploying to staging"
```

Environment configuration: Set up in Settings → Environments → New environment

Environment Protection: Advanced Demo

DEMO 8: Production with Approvals

```
jobs:  
  deploy-production:  
    runs-on: ubuntu-latest  
    environment:  
      name: production  
    steps:  
      - run: echo "Deploying to production"
```

Protection rules (configured in Settings):

- ✓ Required reviewers (up to 6 reviewers)
- ✓ Wait timer (0-43,200 minutes)
- ✓ Deployment branches (selected branches only)

5. Caching & Artifacts

Caching vs Artifacts

Caching

- Speed up workflow runs
- Store dependencies
- Shared across workflow runs
- Automatically evicted after 7 days

Artifacts

- Share data between jobs
- Store build outputs
- Available for download
- Retained for 90 days (default)

Caching & Artifacts: Simple Demo

DEMO 9: Basic Caching

```
- uses: actions/cache@v3
  with:
    path: ~/.npm
    key: ${{ runner.os }}-node-${{ hashFiles('**/package-lock.json') }}
    restore-keys: |
      ${{ runner.os }}-node-
```

Key generation: Include dependencies in key to invalidate when changed

Caching & Artifacts: Advanced Demo

DEMO 10: Multi-stage with Artifacts

```
jobs:
  build:
    steps:
      - uses: actions/cache@v3
        # ... cache setup
      - run: npm run build
      - uses: actions/upload-artifact@v3
        with:
          name: build-output
          path: dist/
  deploy:
    needs: build
    steps:
      - uses: actions/download-artifact@v3
        with:
          name: build-output
```

Best Practices

- **Matrix Builds:** Use fail-fast: false for CI, max-parallel to control costs
- **Reusable Workflows:** Version them, document inputs/outputs thoroughly
- **Composite Actions:** Keep them focused and single-purpose
- **Environments:** Always use for production, consider for staging
- **Caching:** Include dependency lock files in cache key
- **Artifacts:** Set appropriate retention periods to manage storage

Questions & Answers

Thank you!

All demos are in the repository:

github.com/seandorsett/github-actions-advanced-features

Additional Resources

- GitHub Actions Documentation: docs.github.com/actions
- Actions Marketplace: [github.com/marketplace?](https://github.com/marketplace?type=actions)
`type=actions`
- GitHub Actions Community: github.community
- This Repository: All demos runnable and documented

Next Steps: Try combining these features in your own projects. Start small, iterate, and build powerful CI/CD pipelines!

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