Introduction to Continuous Integration/Continuous Delivery for Machine Learning

CI/CD FOR MACHINE LEARNING

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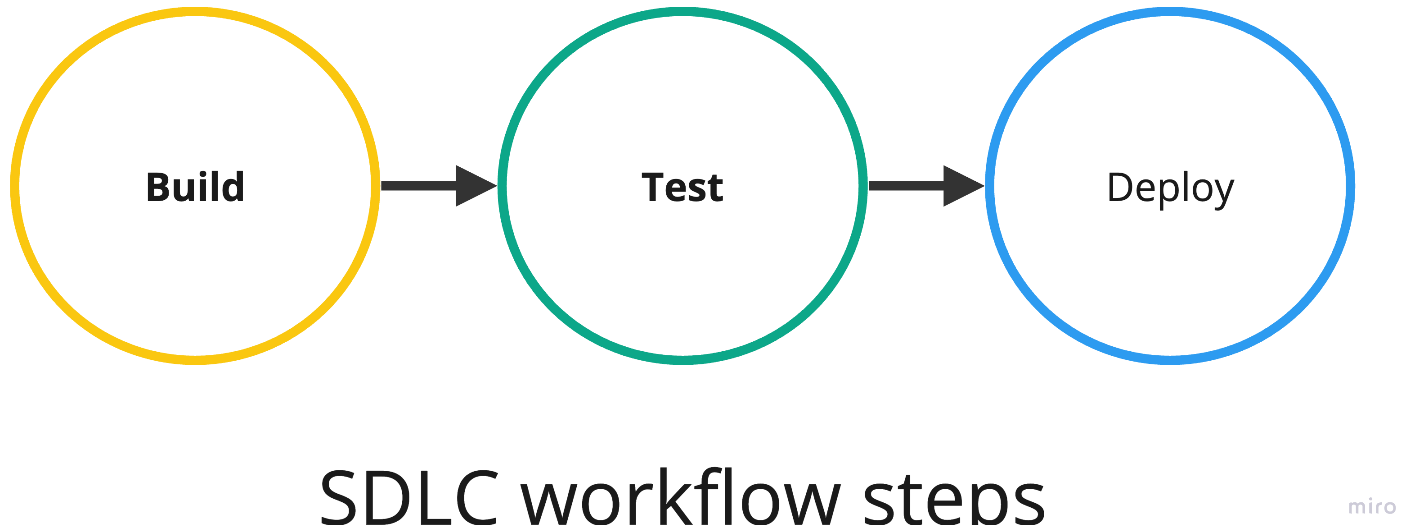
SDLC Overview

- **SDLC**: **S**oftware **D**evelopment **L**ife **C**ycle
- Systematic approach covering software development from start to finish
- **SDLC workflow** refers to the sequence of steps followed to achieve specific goals:
  - **Build**: compiling and/or packaging code, resolving dependencies
  - **Test**: used to ensure codebase functionality, quality, and reliability
  - **Deploy**: process of making the software available for use in a specific environment



SDLC workflow steps

SDLC in machine learning

- Machine learning development can be complex and time-consuming
  - Model is an algorithm that evolves dynamically
  - Data engineering is important
- Continuous Integration/Continuous Delivery reduces errors and ensures faster delivery of high-quality ML software
- Essential for efficient machine learning and experimentation

[1] https://cloud.google.com/blog/products/ai-machine-learning/making-the-machine-the-machine-learning-lifecycle

What is CI/CD?

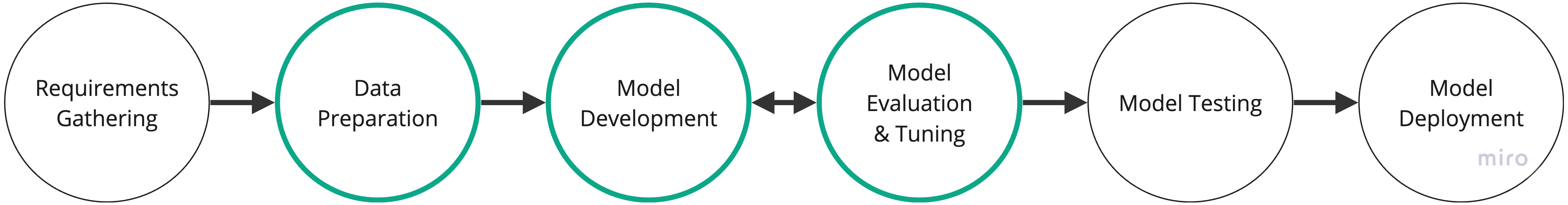
- **Continuous Integration (CI):** The practice of frequently building, testing, and merging code changes into a shared repository
- Allows developers to detect integration issues early and maintain a consistent codebase

- **Continuous Delivery (CD):** Ensures that code changes can be deployed to production at any time but requires manual approval
- **Continuous Deployment (CD):** Automatically deploys code changes to production without manual intervention

CI/CD in machine learning

- **Data Dependency:** Data versioning and management strategies
- **Experimentation:** Automating hyperparameter tuning
- **Model Versioning:** Improving collaboration
- **Testing Paradigm:** Goes beyond traditional functional and unit testing
- **Continuous Deployment Challenges:** Complexities in model serving, monitoring, and updates

Scope of this course



Summary

- Software Development Life Cycle workflow involves building, testing, and deploying code
- Continuous Integration (CI) ensures frequent code merging and early issue detection
- Continuous Delivery (CD) allows code changes to be deployed with manual approval
- Continuous Deployment (CD) automates code deployment without manual intervention
- CI/CD in Machine Learning enables
  - Data versioning
  - Building models and model versioning
  - Automating experiments
  - Testing
  - Deployment

Let's practice!

Introduction to YAML

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What is YAML?

- YAML: YAML Ain't Markup Language
- Used in configuration files, data exchange, and structured data representation
- A data formatting language similar to JSON and XML
- Allows a standard format to transfer data between languages or applications
- Simple and clean format
- Valid file extensions: `.yaml` or `.yml`
- Used to write configuration for variety of CI/CD tools:
  - GitHub Actions
  - Data Version Control (DVC)

YAML Syntax

- YAML has a hierarchical structure
  - Indentation is meaningful
- **Tabs are not allowed**
- YAML validators (https://www.yamllint.com/)
- Comments start with `#`

```yaml
name: Ravi
occupation: Instructor
# This is a valid comment
programming_languages: # and this one too
  python: Advanced
  go: Intermediate
  scala: Beginner
```

YAML Scalars

- Numbers: Integers or floating-point numbers
- Booleans: `true` or `false`
- Null: keyword `null` or `~`
- Strings: Represented as plain text or enclosed in `''` or `""`

```yaml
# Integer
42
# Floating point
3.14
```

```yaml
# Boolean
true
```

```yaml
# Null values
null
```

```yaml
# String value
a: "A string in YAML"
b: 'A string in YAML'
c: A string in YAML
```

YAML Collections

Sequences

- Also called lists, arrays, or vectors
- Written in two styles:
  - Block style

```
- first
- second
- third
```

  - Flow style

```
[first, second, third]
```

Mappings

- Also called dictionary, key-value pairs, hashes, or objects
- Unique keys, any valid data as values
- Keys and values are separated by `:`

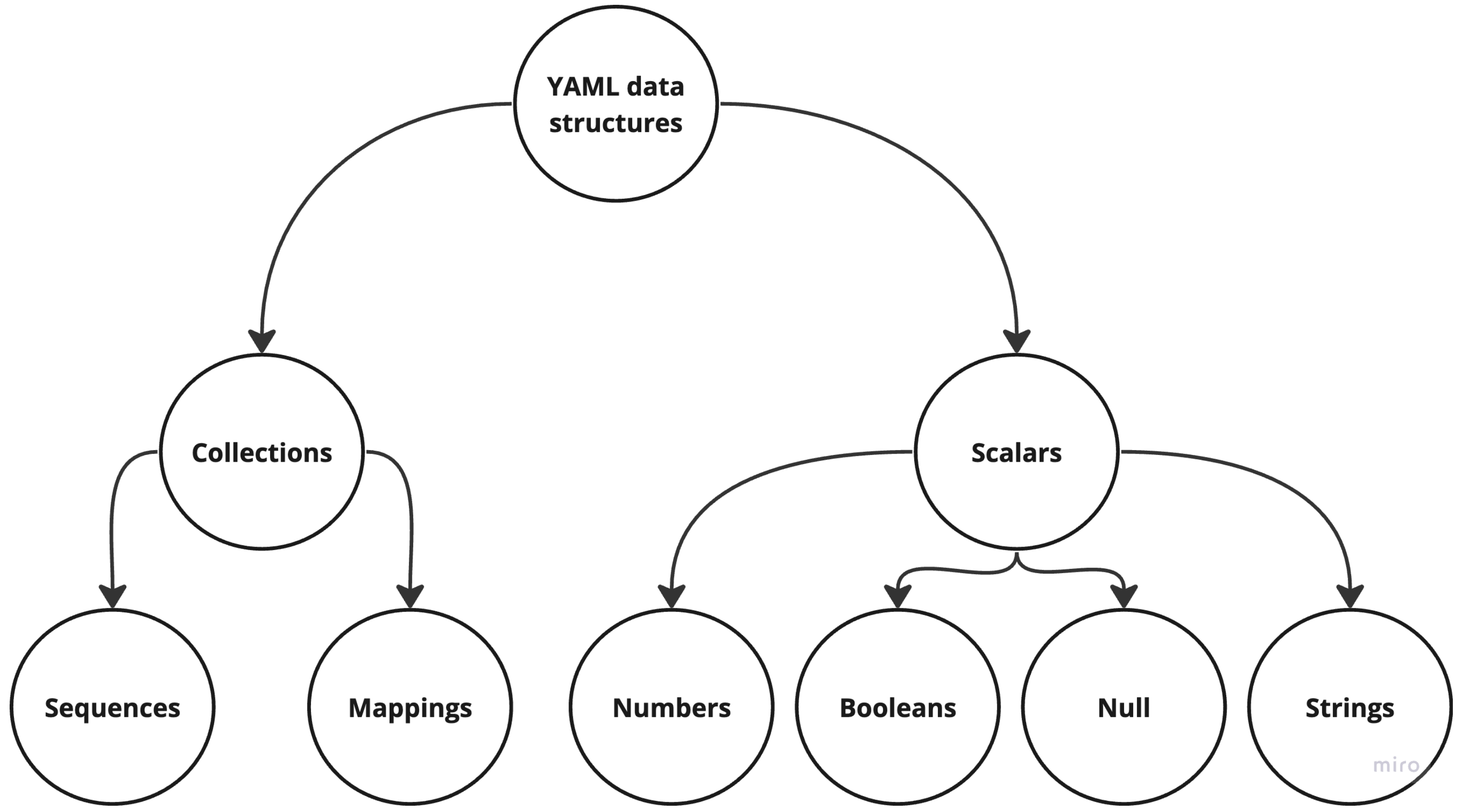
```
key1: value1
```

```
blocklist:
  - first
  - second
```

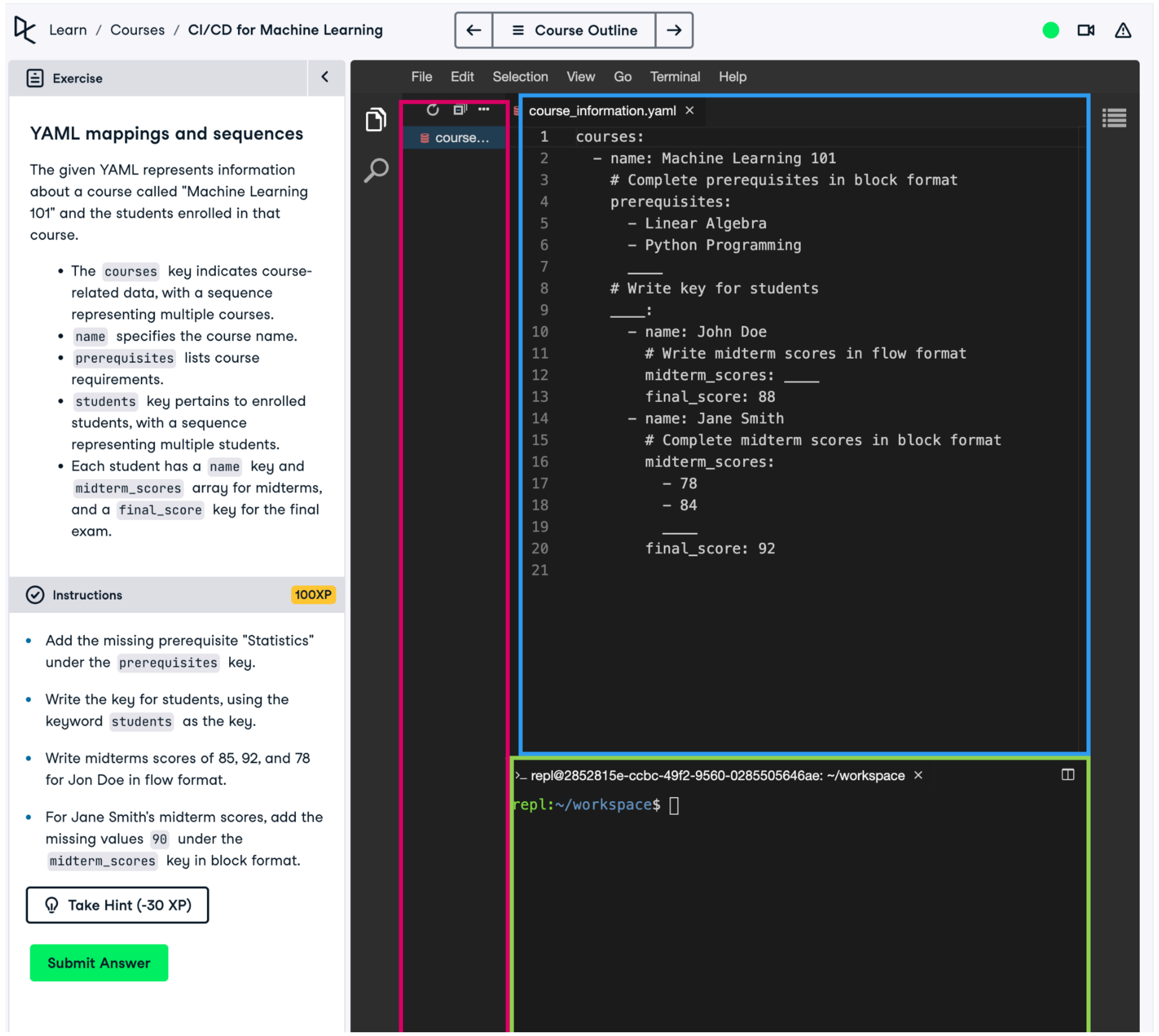
```
flowlist: [1.2, 2, "fifty", true]
```

Summary

- YAML is a data formatting language
- Useful in writing CI/CD configurations
- Indentation is very important
  - **Tabs are not allowed**
- Mappings, sequences, and scalars are building blocks of YAML



Editor Exercises Layout


Learn / Courses / CI/CD for Machine Learning
Course Outline
Exercise
File Edit Selection View Go Terminal Help
course...
course_information.yaml

YAML mappings and sequences

The given YAML represents information about a course called "Machine Learning 101" and the students enrolled in that course.

- The `courses` key indicates course-related data, with a sequence representing multiple courses.
- `name` specifies the course name.
- `prerequisites` lists course requirements.
- `students` key pertains to enrolled students, with a sequence representing multiple students.
- Each student has a `name` key and `midterm_scores` array for midterms, and a `final_score` key for the final exam.

Instructions 100XP

- Add the missing prerequisite "Statistics" under the `prerequisites` key.
- Write the key for students, using the keyword `students` as the key.
- Write midterms scores of 85, 92, and 78 for Jon Doe in flow format.
- For Jane Smith's midterm scores, add the missing values `90` under the `midterm_scores` key in block format.

Take Hint (-30 XP)

Submit Answer

```yaml
courses:
  - name: Machine Learning 101
    # Complete prerequisites in block format
    prerequisites:
      - Linear Algebra
      - Python Programming
      ____
    # Write key for students
    ____:
      - name: John Doe
        # Write midterm scores in flow format
        midterm_scores: ____
        final_score: 88
      - name: Jane Smith
        # Complete midterm scores in block format
        midterm_scores:
          - 78
          - 84
          ____
        final_score: 92

```

```
>_ repl@2852815e-ccbc-49f2-9560-0285505646ae: ~/workspace
repl:~/workspace$ 
```

Let's practice!

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Introduction to GitHub Actions

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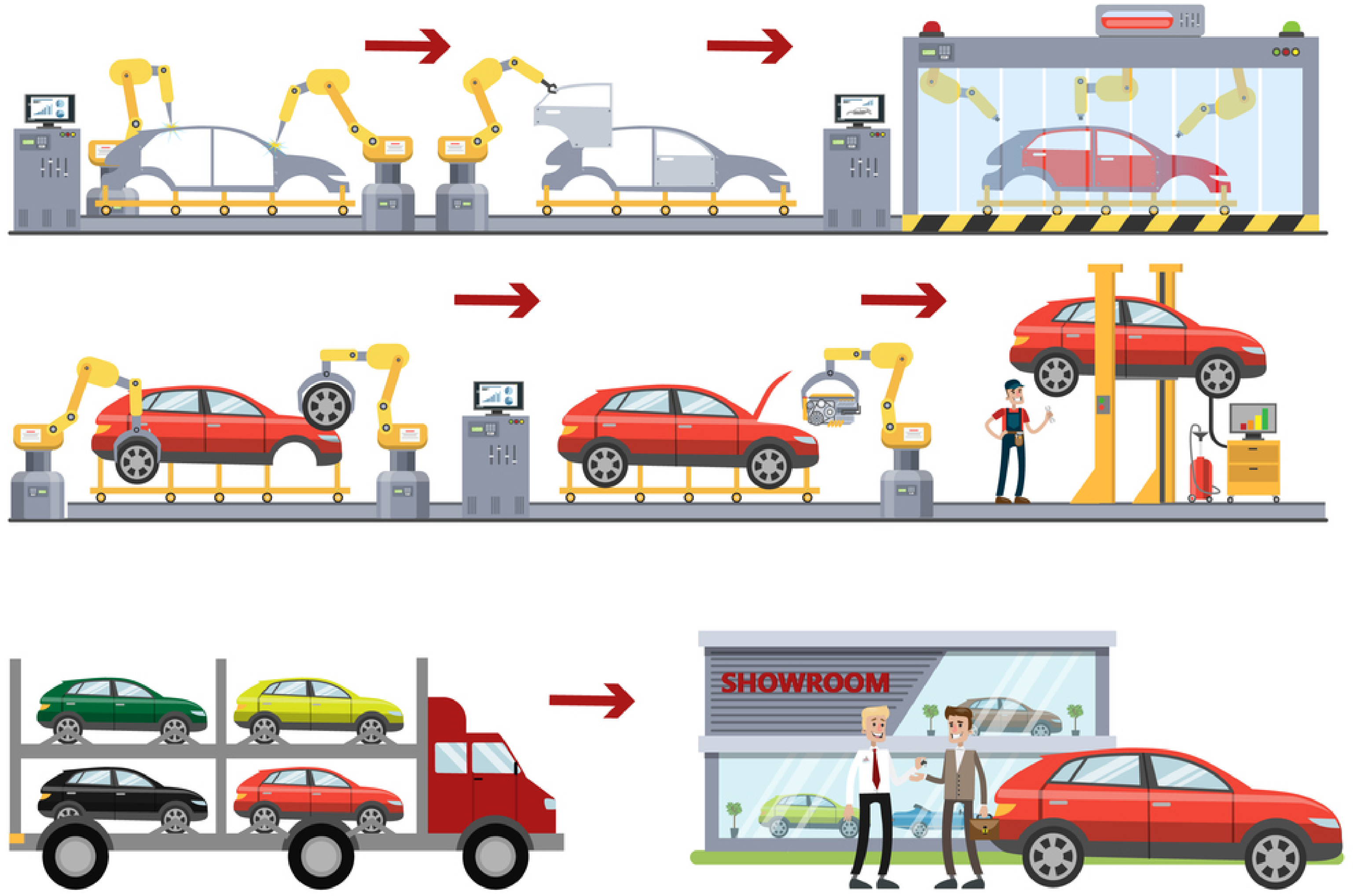
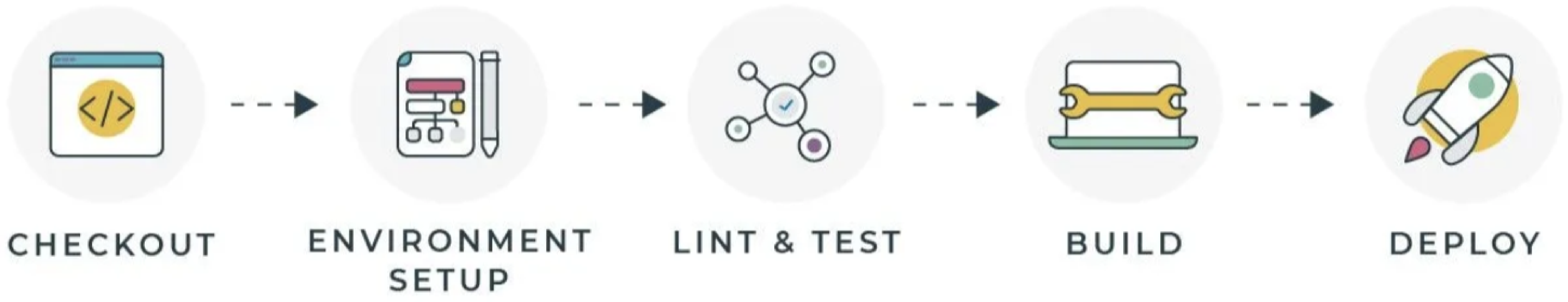
What is GitHub Actions?

- **GitHub Actions (GHA):** CI/CD platform to automate *pipelines*
- **Pipeline:** a sequence of steps that represent the flow of work and data

What is GitHub Actions?



What is GitHub Actions?



[1] https://medium.com/empathyco/applying-ci-cd-using-github-actions-for-android-1231e40cc52f

GHA Components: Event

- **Event:** is a specific activity in a repository that triggers a workflow run
  - Push
  - Pull Request
  - Opening an issue

GHA Components: Workflow

- **Workflow:** automated process that will run one or more jobs
  - Defined in YAML files
  - Triggered automatically by **event**
    - Manual run possible
  - Housed in `.github/workflows` directory in the repository
  - Multiple workflows can be defined

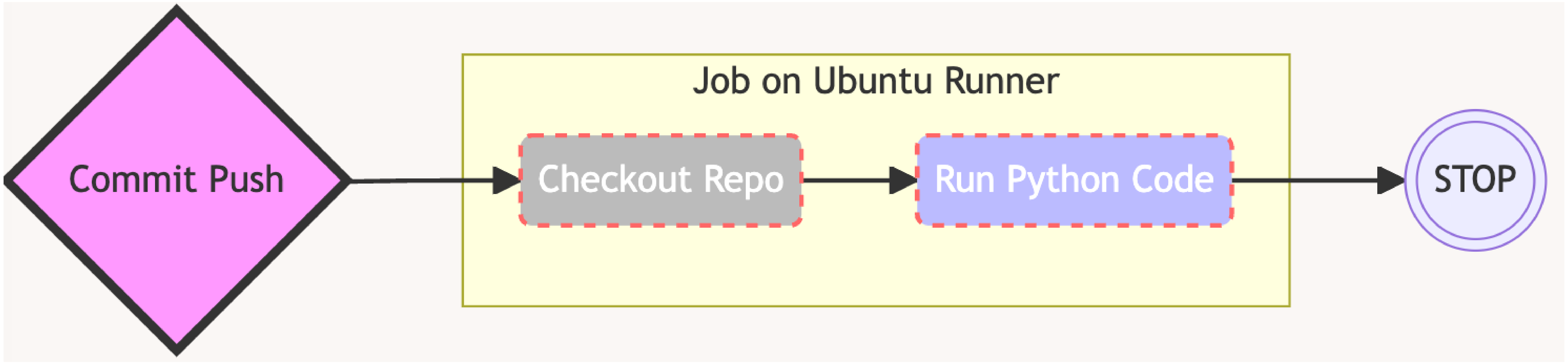
GHA Components: Steps and Actions

- **Steps**: individual units of work
  - Executed in order, depends on previous step
  - Run on the same machine, so data can be shared
  - Unit of work examples
    - Compiled code application, shell script
    - **Action**: GHA platform specific application
      - E.g. checkout repo, comment on PR

GHA Components: Jobs and Runners

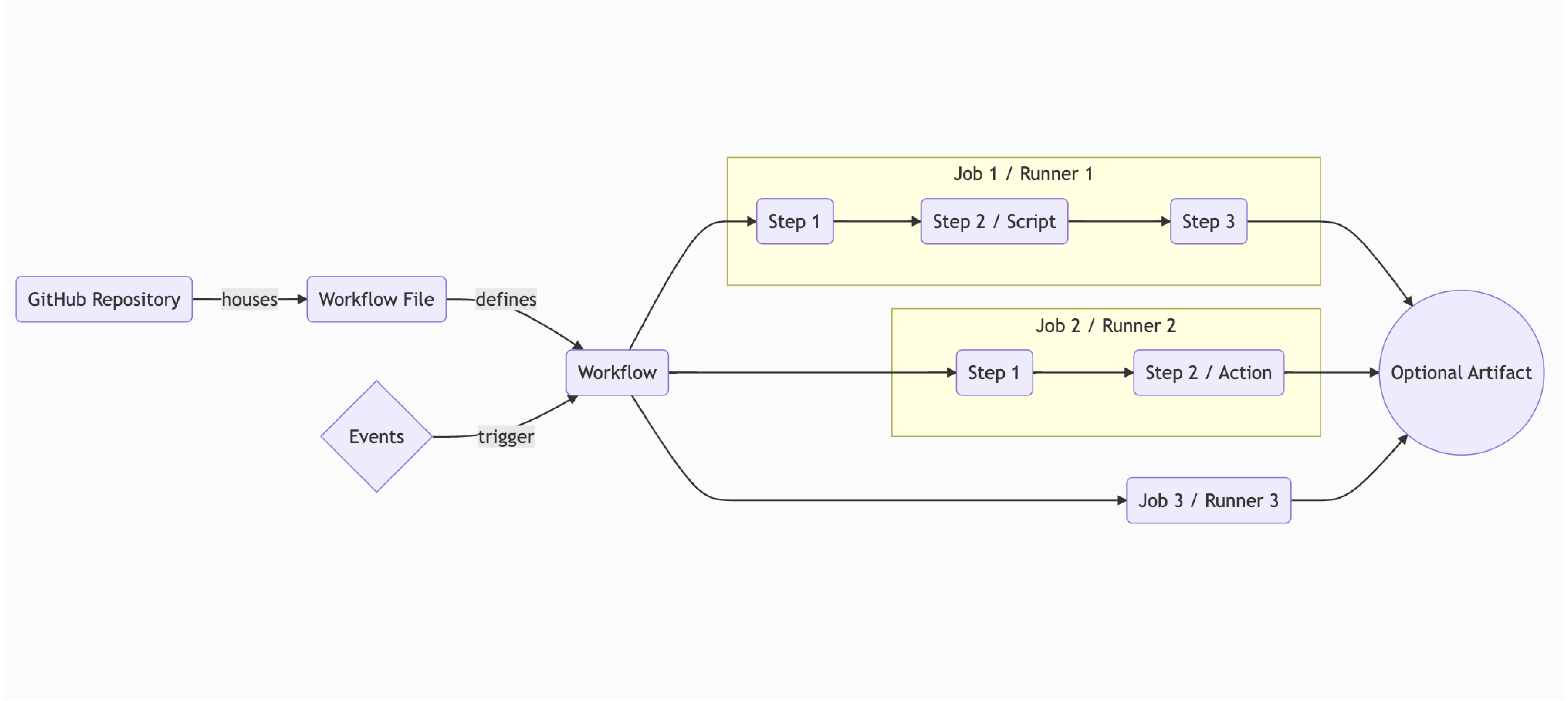
- **Job:** set of *steps*
  - Each job is independent
  - Parallel execution is possible
  - Executed on the compute machine called **runners**

A simple GHA workflow



- **Event:** Push
- **Job:** runs on *Ubuntu* **runner**, has two **steps**
  - **Action:** Checkout Repo
  - Run Python Code

Putting it all together



Let's practice!

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