# Introduction to Continuous Integration/Continuous Delivery for Machine Learning

CI/CD FOR MACHINE LEARNING

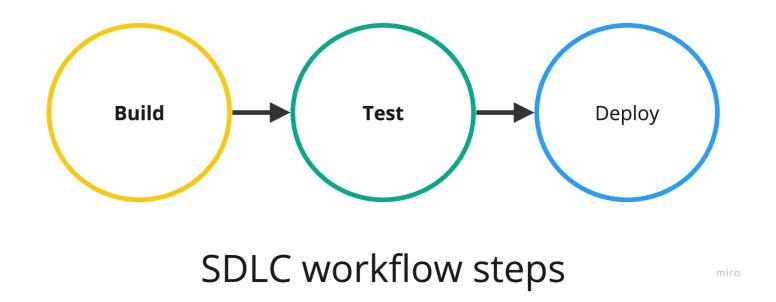
Ravi Bhadauria Machine Learning Engineer





#### **SDLC Overview**

- SDLC: Software Development Life Cycle
- 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 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

<sup>&</sup>lt;sup>1</sup> https://cloud.google.com/blog/products/ai-machine-learning/making-the-machine-the-machine-learning-lifecycle



#### What is CI/CD?

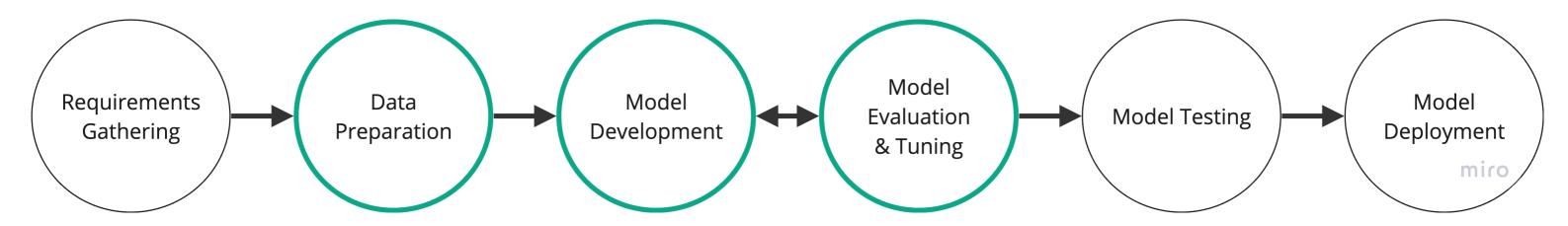
- Continuous Integration (CI): The practice of frequently building, testing, and merging code changes into a shared repository
- Allows developers to detect integration issues early and maintain a consistent codebase

- 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!

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# Introduction to YAML

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Ravi Bhadauria Machine Learning Engineer



#### 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 #

```
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 ""

```
# Integer
42
# Floating point
3.14
# Boolean
true
# Null values
null
# 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
```

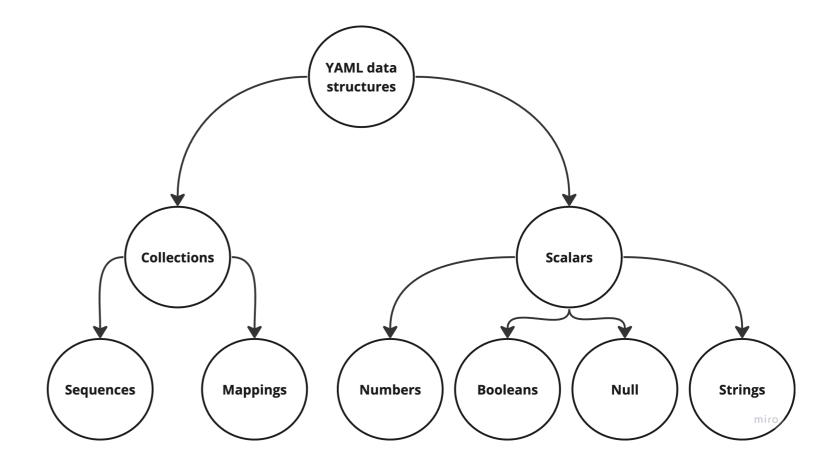
#### blocklist:

- first
- second

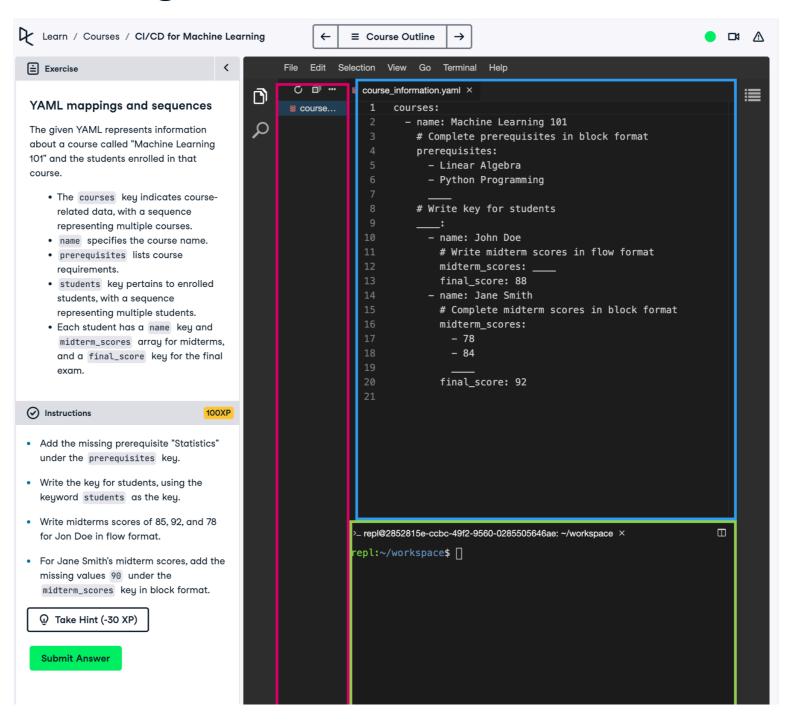
```
flowlist: [1.2, 2, "fifty", true]
```

#### 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**





## Let's practice!

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# Introduction to GitHub Actions

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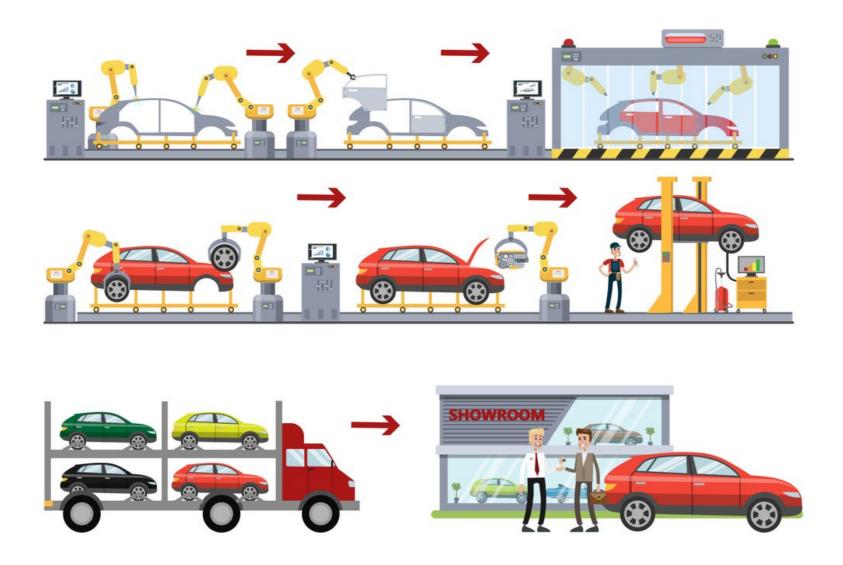
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#### What is GitHub Actions?

- 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?



<sup>&</sup>lt;sup>1</sup> 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

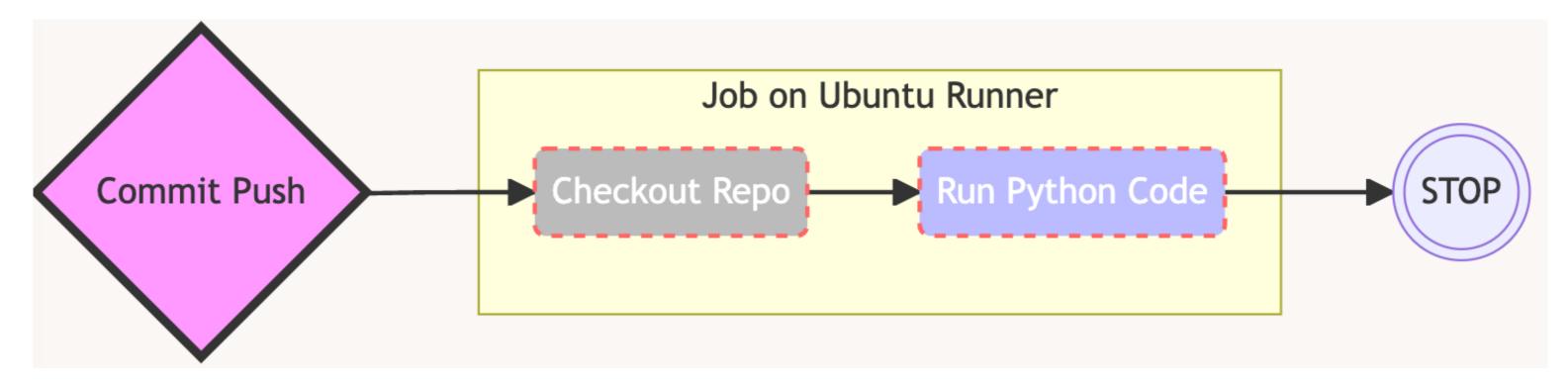
#### GHA Components: Steps and Actions

- 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

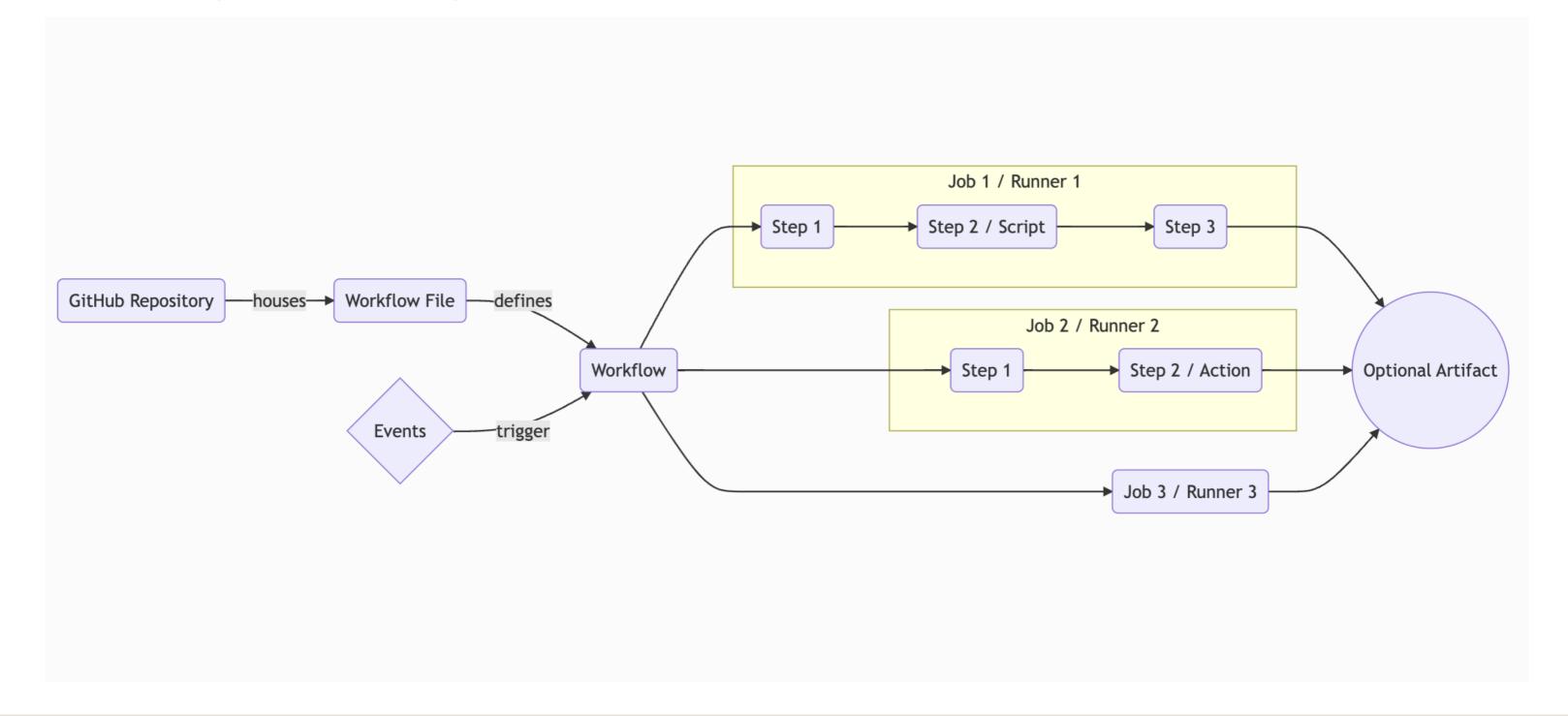
- Job: set of *steps* 
  - Each job is independent
  - Parallel execution is possible
  - Executed on the compute machine called runners

#### 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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