Learning Session Series

Topic: MLOps for AI Engineer and Data Scientist

Sub-topic: Containers for ML Deployment

Speaker: Joseph Itopa Abubakar

December 08th, 2021

Learning section objective:

- Gain an introductory knowledge about Web APIs.
- Understand Basic Concept of Docker and how to containerize a simple Flask/Fast Api.
- To have fundamental knowledge of kubernertes
- To learn the concept of continuous delivery in MLOps.

Agenda

- Introduction to WebApi
- Introduction to Docker
- Introduction to Kubernetes
- Containerize web apps using docker
- An introduction to automating ML deployment workflow

Introduction to Web APIs

✓ **What is Web Api?**

Web Api is a type of Apis that was derived from the concept of web development, to aid functionality for http clients or web browsers.

✓ **Features of Web Api**

- Web Apis are client-side oriented.
- Most times access is via URI using http requests.
- Web Api uses REST for it interactions.

Reference: https://en.wikipedia.org/wiki/Web_API

Introduction to Web APIs

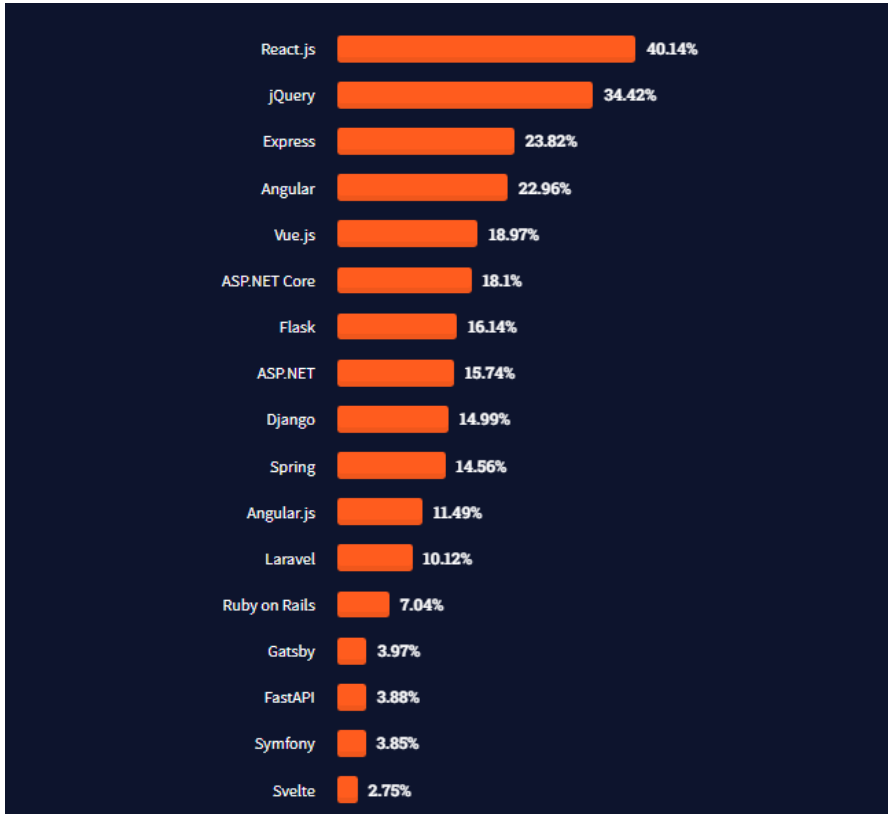


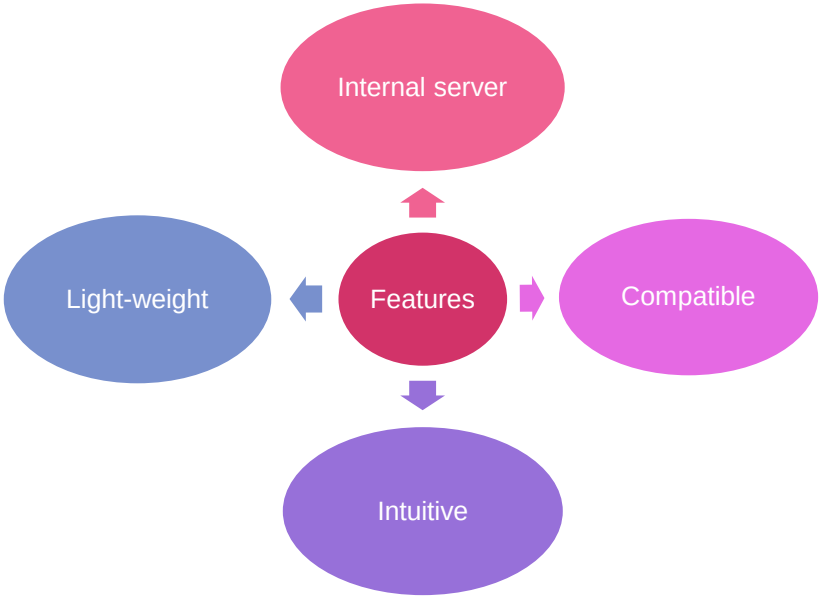
Figure 1: 2021 Survey on web frameworks popularity [StackOverflow]

Reference: https://insights.stackoverflow.com/survey/2021/

Introduction to Web APIs

What is FlaskApi?

- According to wikipedia, Flask is a *"micro web framework written in python for developing APIs".*

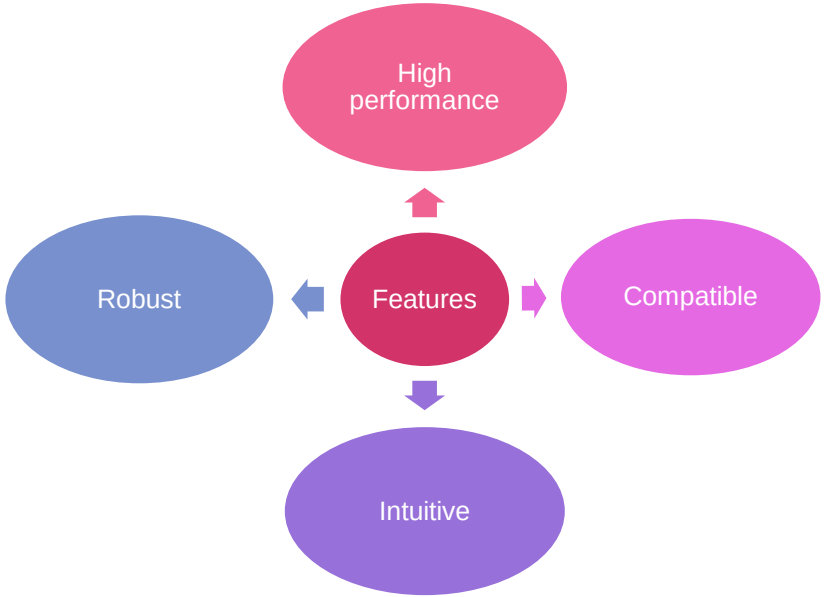


Reference: https://www.dreamstime.com/components-machine-learning-lifecycle-components-machine-learning-lifecycle-image200203062

Introduction to Web APIs

What is FastApi?

- According to FastApi documentation, FastApi is a *"modern high-performance web framework for building APIs with Python 3.6 and above."*



Reference: https://www.dreamstime.com/components-machine-learning-lifecycle-components-machine-learning-lifecycle-image200203062

Flask API vs Fast API

- No data validation
- Does not support Async
- Has larger community

- Possess data validation
- Async code(async/wait) support
- Has a small community

Reference: https://www.dreamstime.com/components-machine-learning-lifecycle-components-machine-learning-lifecycle-image200203062

Introduction to Web APIs

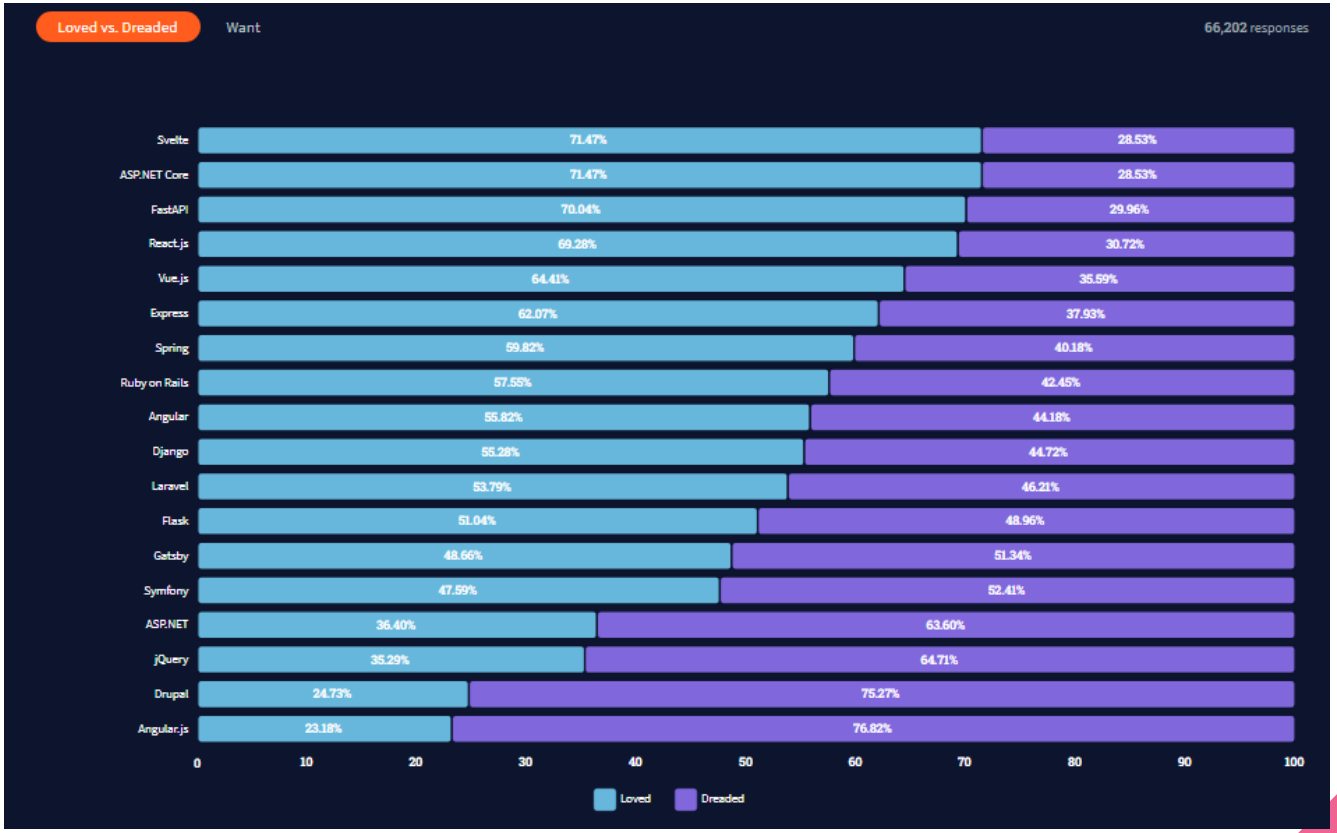


Figure 2: 2021 survey on Loved vs Dreaded Web frameworks [Stackoverflow]

Reference: https://insights.stackoverflow.com/survey/2021/

Tea Break | Quiz

1) Which of the following is a way of accessing REST api?

a) URI using http requests; b) command prompt; c) others

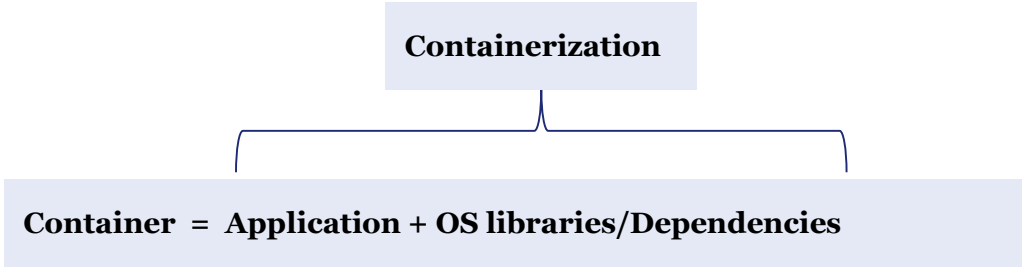
2) Which of the web api frameworks below handles data validation

a) Fast api b) Flask api c) All of the above

Introduction to Docker

✓ **What is containerization?**

According to IBM, “Containerization is the packaging of software code with just the operating system (OS) libraries and dependencies required to run the code to create a single lightweight executable—called a container—that runs consistently on **any** infrastructure.”



Reference:
https://www.ibm.com/cloud/learn/containerization#toc-what-is-co-r25Smlqq

Introduction to Docker

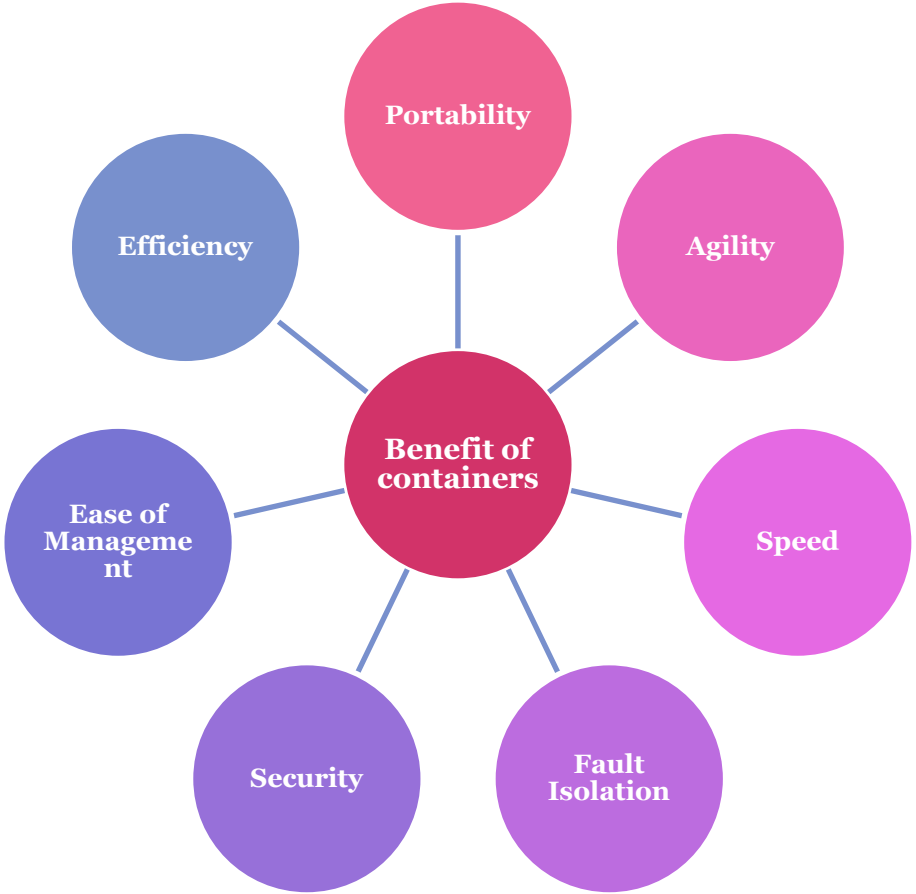


Figure 3: Benefit of containers

Reference:
https://www.ibm.com/cloud/learn/containerization#toc-what-is-co-r25Smlqq

Introduction to Docker

- ✓ What is containerization?
- ✓ **Containerization vs Virtualization**

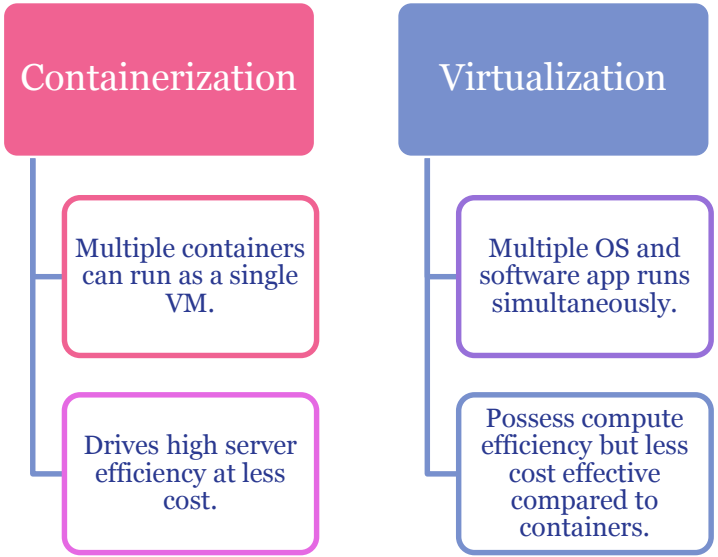


Figure 4: Comparism of container vs virtualization

Reference:
https://www.ibm.com/cloud/learn/containerization#toc-what-is-co-r25Smlqq

Introduction to Docker

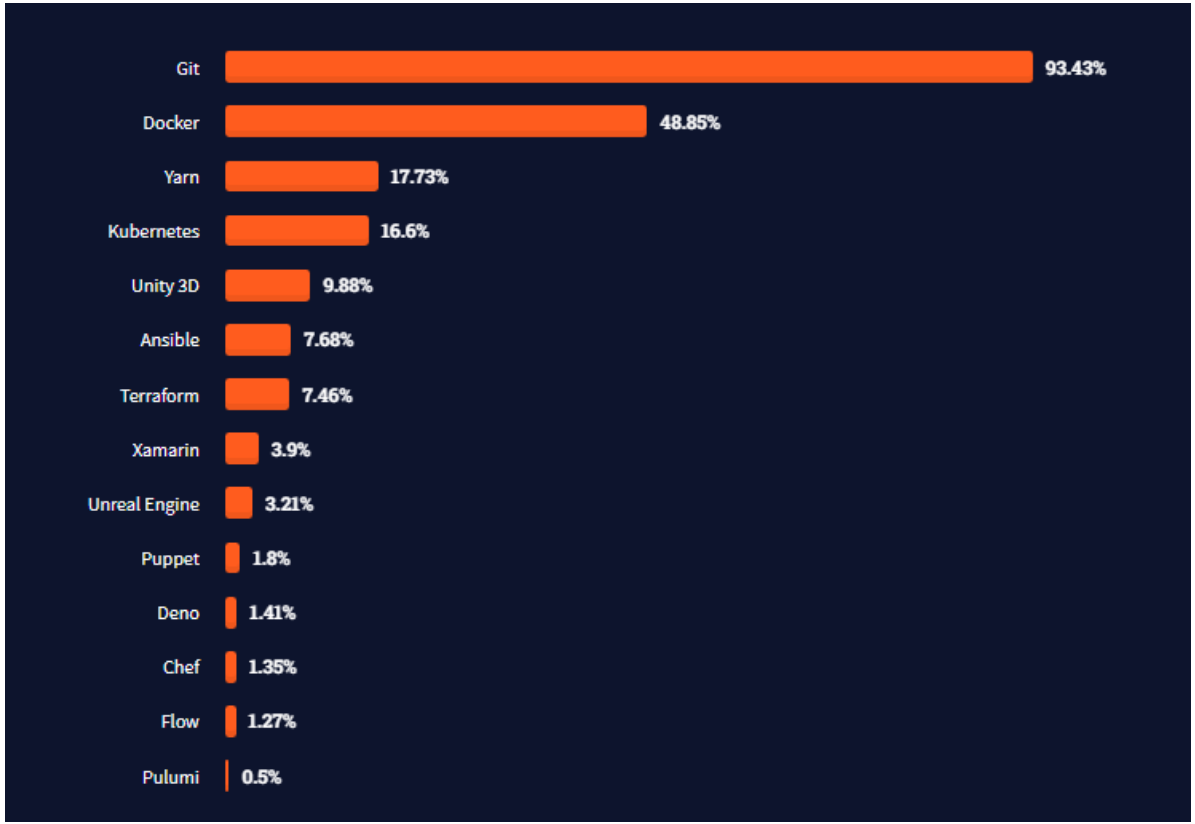


Figure 5: 2021 Survey result on 'Other' tools used by developers [StackOverflow]

What is Docker?

According to docker documentation, "Docker is an open platform for developing, shipping, and running applications."

Reference: https://insights.stackoverflow.com/survey/2021/
https://docs.docker.com/get-started/overview/

Architecture & component of docker

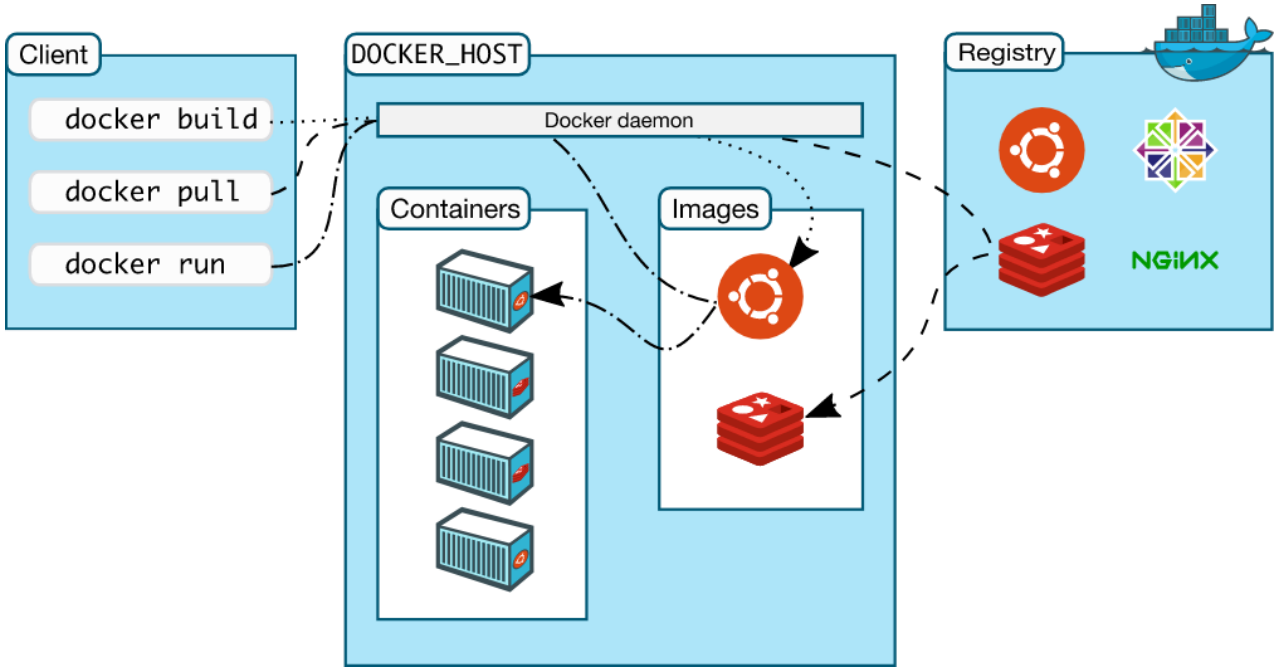


Figure 6: An architectural diagram of docker

Reference: https://docs.docker.com/get-started/overview/

Architecture & component of docker

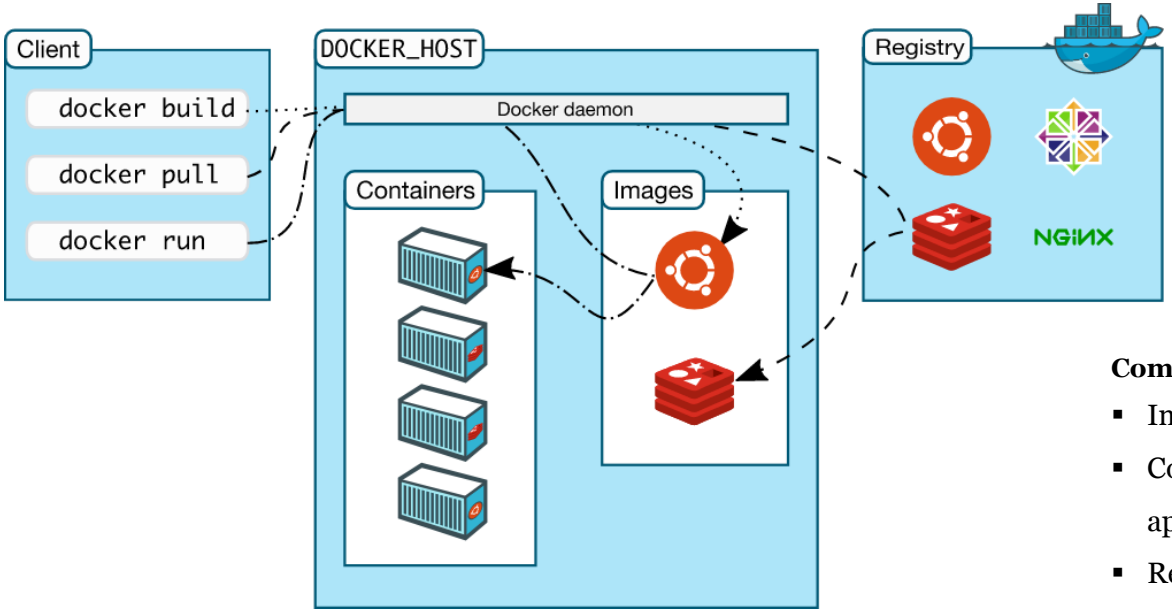


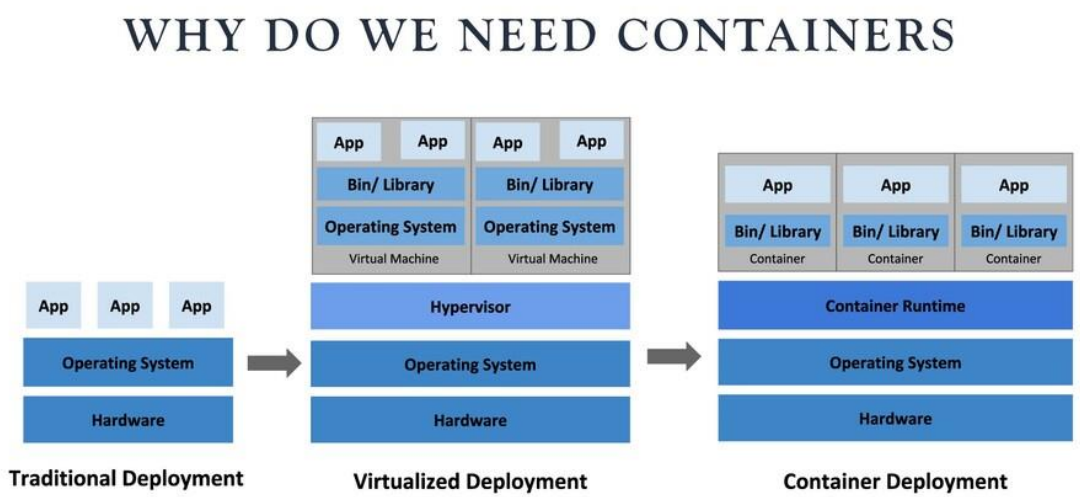
Figure 5: An architectural diagram of docker

Components of Docker

- Images:- the template for creating containers.
- Containers:- Live instance of images that allows app to run.
- Registries:- repositories for docker images.
- Docker Engine:- Daemon, Client, and REST API

Reference: https://docs.docker.com/get-started/overview/
https://www.bmc.com/blogs/docker-101-introduction/

Architecture & component of docker



https://kubernetes.io/docs/concepts/overview/what-is-kubernetes/

Figure 6: Traditional deployment vs Virtualized Deployment vs Container Deployment

Reference: https://speakerdeck.com/helayoty/kubernetes-101-for-java-developers

First Encounter with Docker

Playing with Docker images:

- How to list/remove images
- How build images
- How to tag images
- How to understand image layers
- How to develop executable images
- Sharing images online

- docker image ls/ docker image rm --tag <image repo>:<image tag>
- docker image build -t <image repo>:<image tag>
- docker image rm --tag <image repo>:<image tag> .
- docker image history <image repo>:<image tag>)
- ?????
- docker login

- docker –version
- docker-compose --version

Playing with Docker containers:

- Docker Installation
- How to remove containers
- How to list containers
- How to stop/kill containers
- How to re(start) containers
- How to create containers

- pip install docker
- docker container rm <identifier(id)>
- docker ls (–-all)
- docker container stop/kill <identifier(id)>
- docker container re(start) <identifier(id)>
- docker container create –-publish 8080:80 <directory/script>

Reference: https://insights.stackoverflow.com/survey/2021/
https://docs.docker.com/get-started/overview/

First Encounter with Docker

How to write a docker file.

- Create a doker file: $ touch Dockerfile

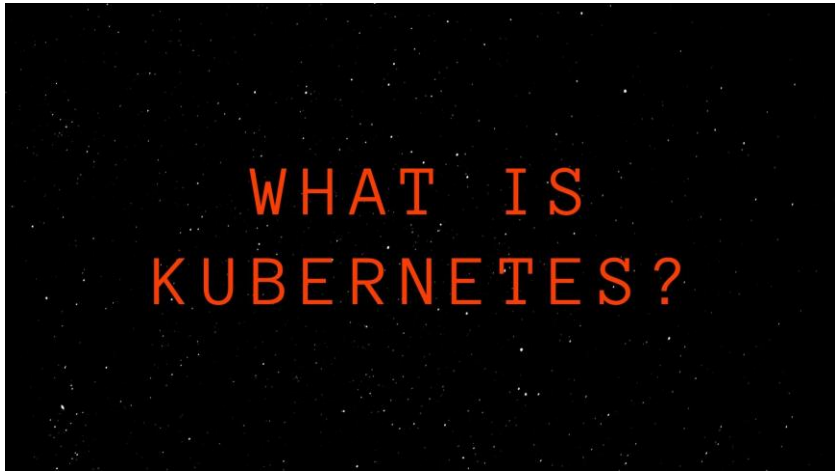
Using docker compose to compose a project:

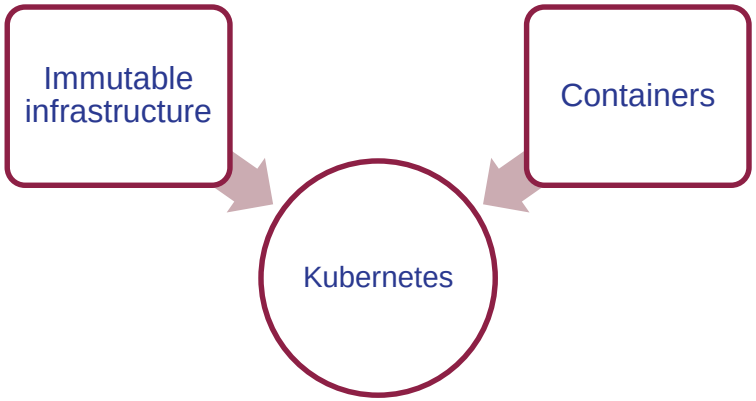
- Basics of docker-compose
- How to start services and list services
- How to stop running services

- Create a yaml file
- Docker-compose up
- Docker-compose stop

Reference: https://insights.stackoverflow.com/survey/2021/
https://docs.docker.com/get-started/overview/

Introduction to kubernetes





“Kubernetes as a container or microservice platform that orchestrates computing, networking, and storage infrastructure workloads. Because it doesn’t limit the types of apps you can deploy (any language works), Kubernetes extends how we scale containerized applications so that we can enjoy all the benefits of a truly immutable infrastructure.”

Reference: https://www.konfinity.com/What-is-kubernetes

Introduction to kubernetes

✓ **K8s Architectural Components**

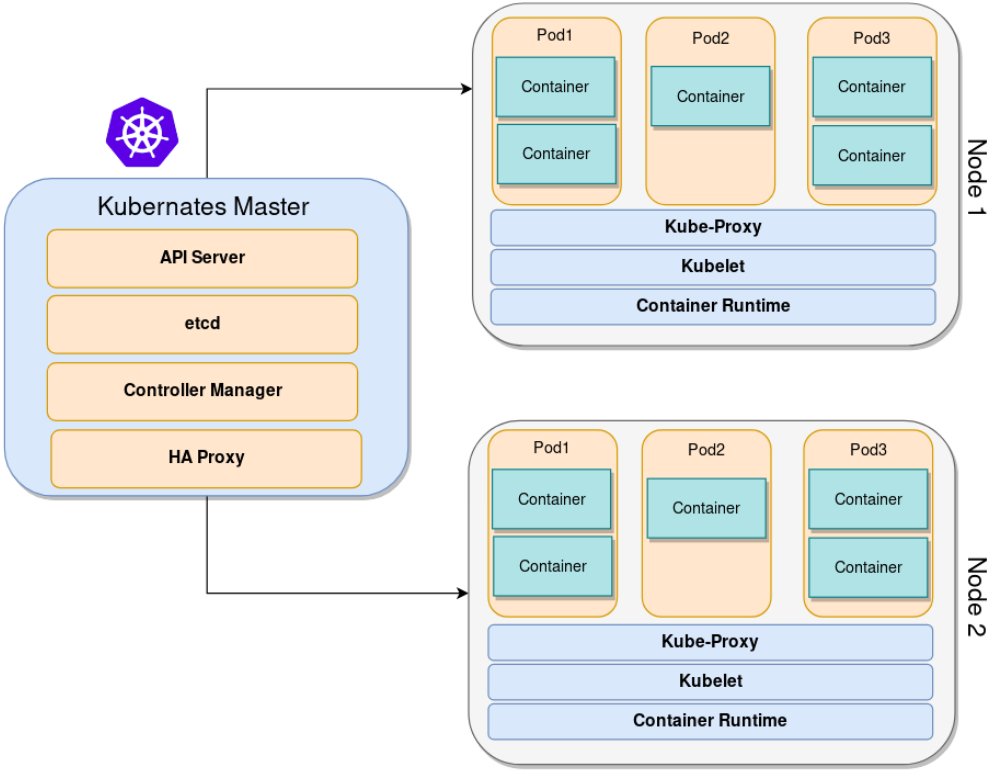


Figure 7: The Architecture of Kubernetes

Reference: https://www.oreilly.com/library/view/hands-on-cloud-native-applications/9781838821470/389d9f6f-3524-43b6-8473-1d2f6485e54f.xhtml

Introduction to kubernetes

✓ **Advantages of Kubernetes**

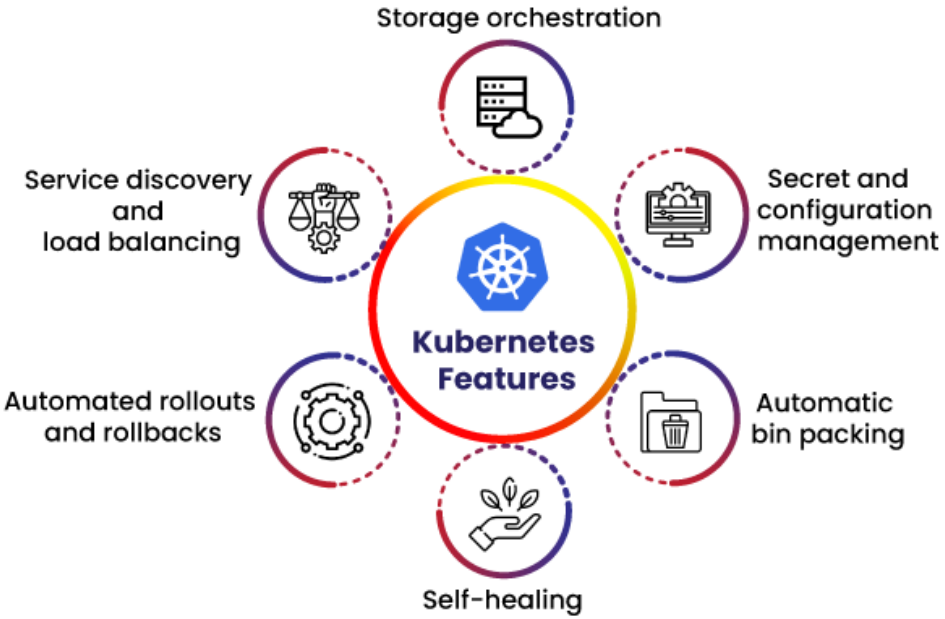


Figure 8: Merits of using kubernetes

Reference: https://www.veritis.com/services/kubernetes/

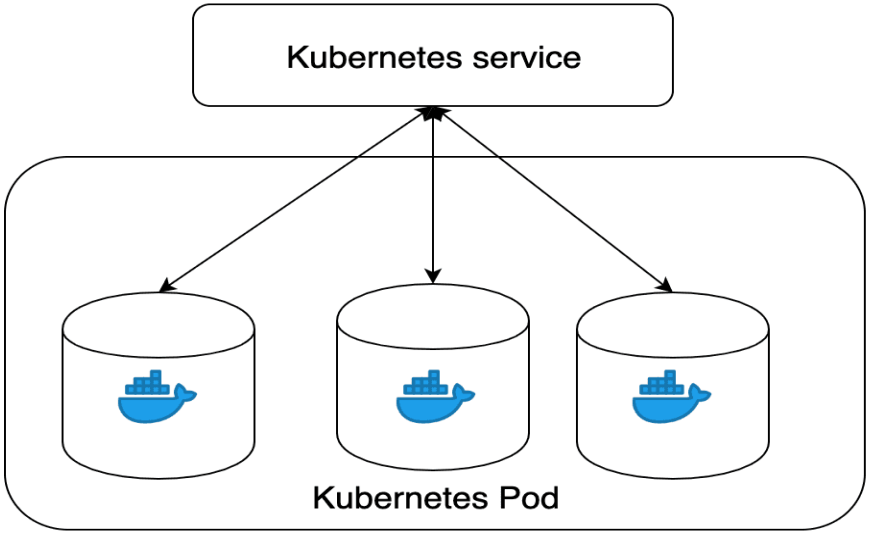
Introduction to kubernetes

✓ **Limitations of kubernetes**

- *Complexity (manage kubernetes server and container server)*
- *Running costs(hosting, staffing cost, etc)*
- *Just a tool, not a solution(its not a full solution like heroku)*

Reference: https://www.quora.com/What-are-some-major-drawbacks-of-Docker-and-Kubernetes

Components of kubernetes

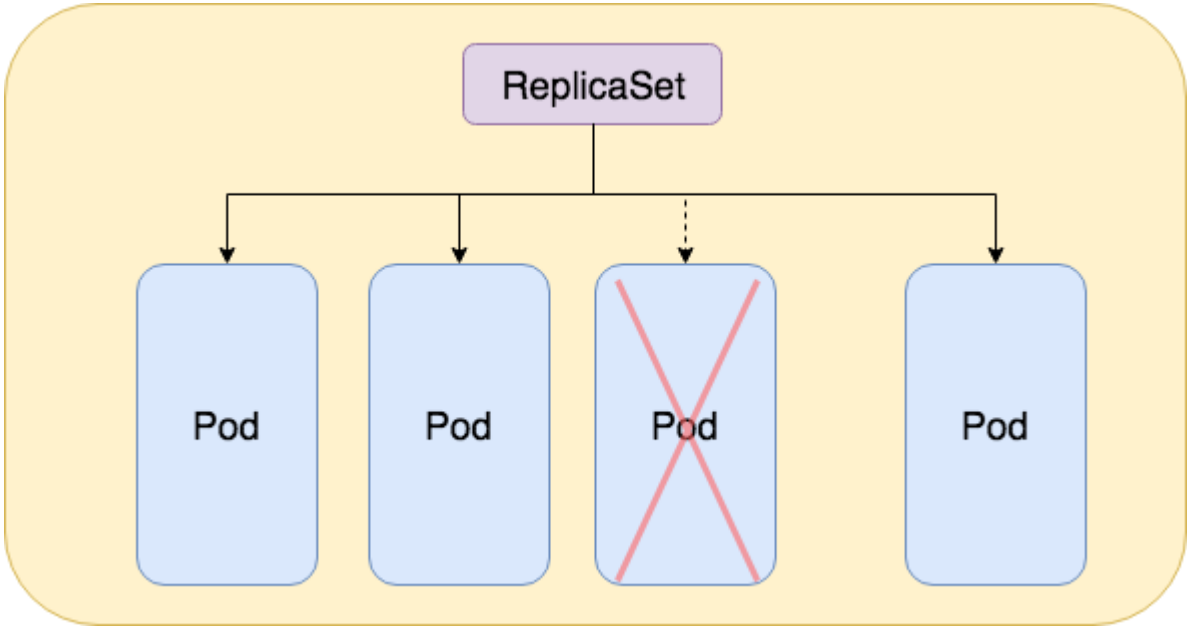


A group of running containers is refer to as **Pod**

Figure 9: A kubernetes pod

Reference: https://www.veritis.com/services/kubernetes/

Components of kubernetes



The ability of given number of pods to run at the same is enabled by **Replica Set**.

Figure 10: A kubernetes Replicaset

Reference: https://medium.com/@jiamin_ning/build-your-first-kubernetes-service-with-replicaset-7c37d9be689c

Components of kubernetes

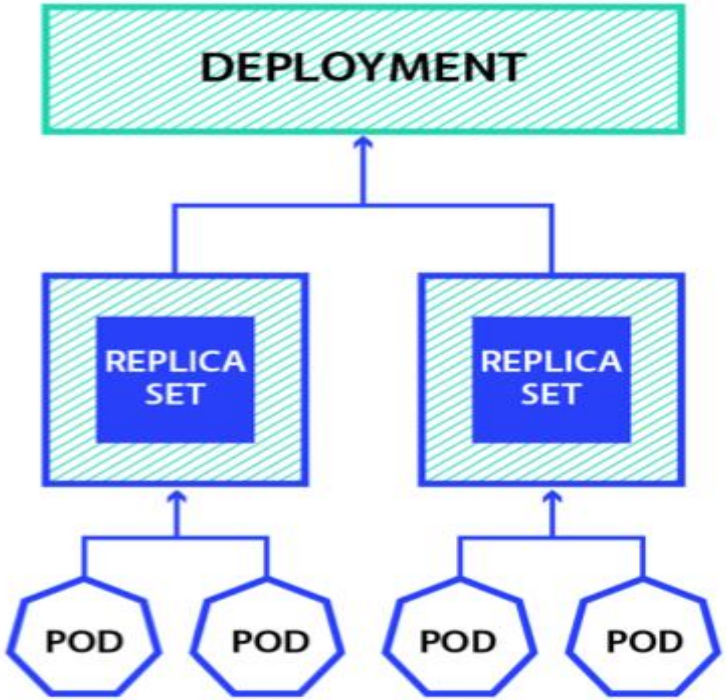


Figure 11: A kubernetes deployment

The rollback and rollout of pods is referred to as **Deployments.**

Reference: https://thenewstack.io/deletion-garbage-collection-kubernetes-objects/

Components of kubernetes

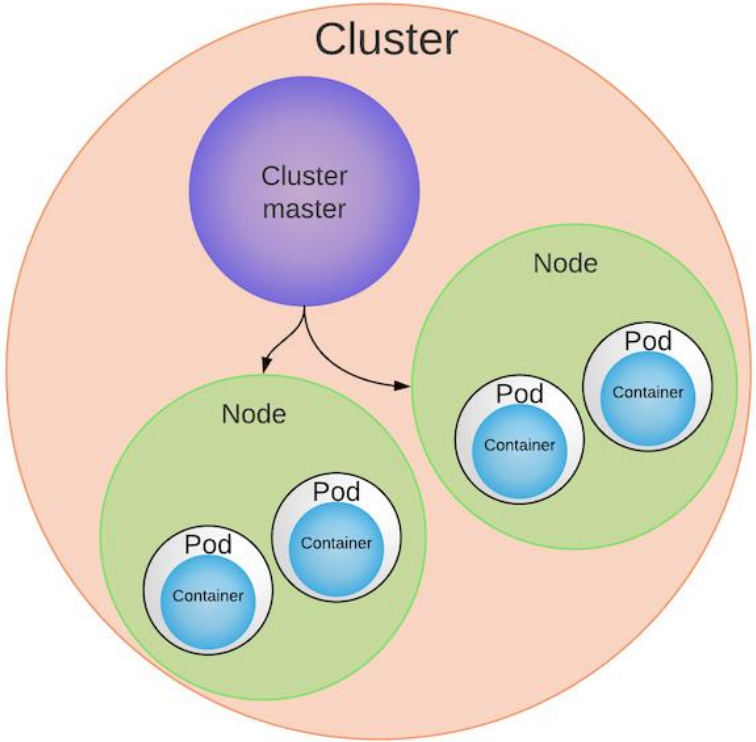


Figure 12: A kubernetes cluster

The entire system or all collective running machine is referred to as a **Cluster.**

So a group of nodes forms a cluster.

Reference: https://godleon.github.io/blog/Kubernetes/k8s-Deployment-Overview/

Components of kubernetes

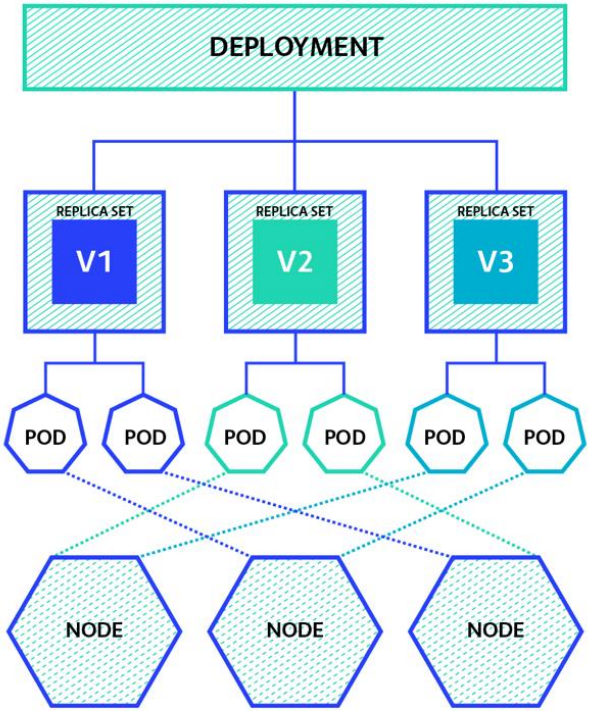


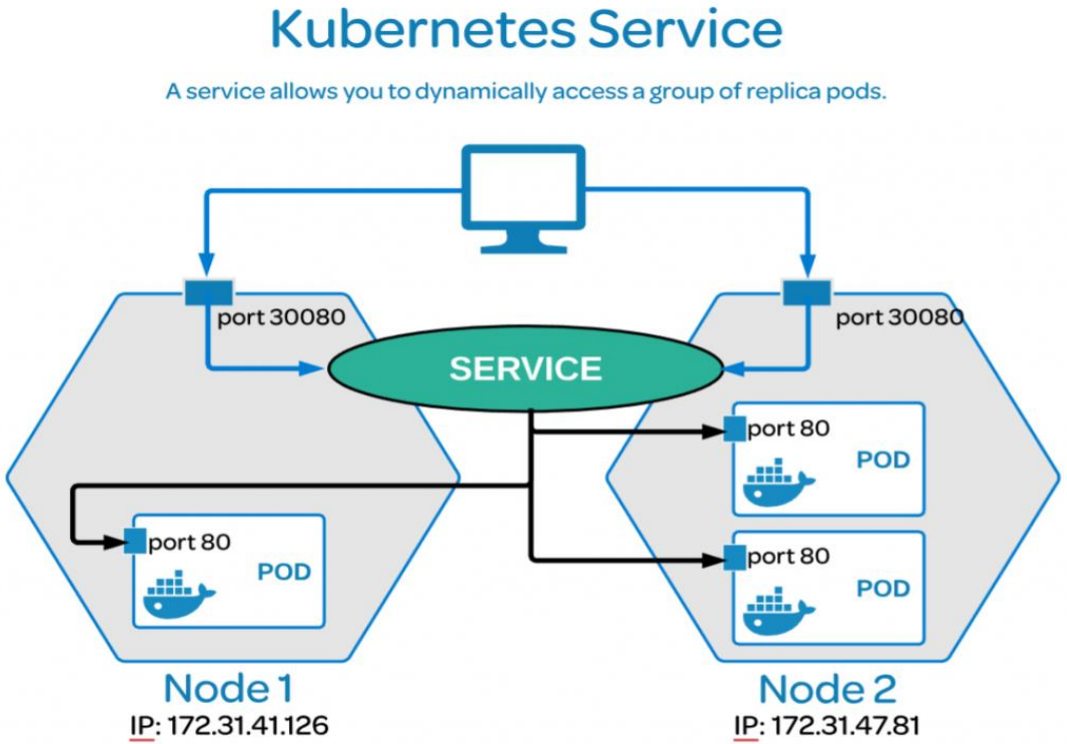
Figure 13: Kubernetes Nodes

The machines in a cluster are referred to as **Nodes**.

Nodes can be a **worker** or a **master**. The control panel is run by the master node. While the worker node consist of software to run containers and its managed by the control plane.

Reference: https://godleon.github.io/blog/Kubernetes/k8s-Deployment-Overview/

Components of kubernetes



How do we access our running pods?

Figure 14: The life cycle of a typical deep learning project

Reference: https://medium.com/avmconsulting-blog/single-and-multi-port-service-in-kubernetes-k8s-8b08529d9ba6

Tea Break | Quiz

1) Which of the following allows one to access pods?
a) Kubernetes service, b) containers, c) pods

2) A group of nodes is refer to as:
a) Replicaset, b) Cluster, c) None of the above

3) Nodes can be categorize as:
a) Worker and walker node, b) Cluster and walker node, c) Worker and master node

Introduction to kubernetes

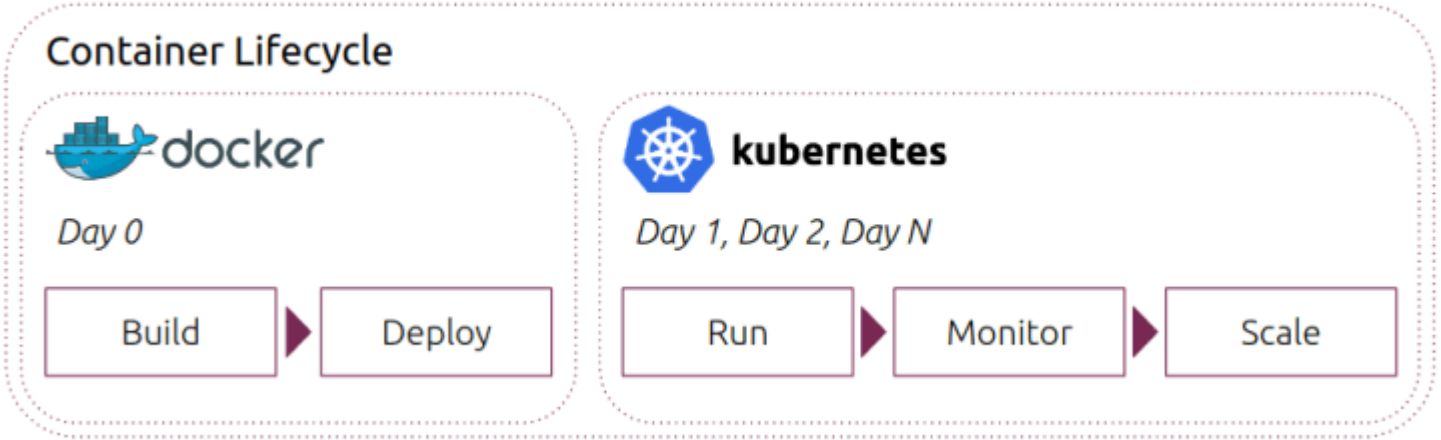


Figure 15: The life cycle of a container

Reference: https://ubuntu.com/blog/kubernetes-versus-docker

Introduction to kubernetes- Alternative options

- AWS Fargate / EC2
- Azure Container Instance
- Google Cloud Run
- Amazon Elastic Kubernetes Service
- Azure Kubernetes Service
- Open shift Container Platform

Reference: https://www.researchgate.net/figure/Life-cycle-for-a-deep-learning-model_fig3_345388655

Deployment of container on kubernetes (EKS, GKE, etc)

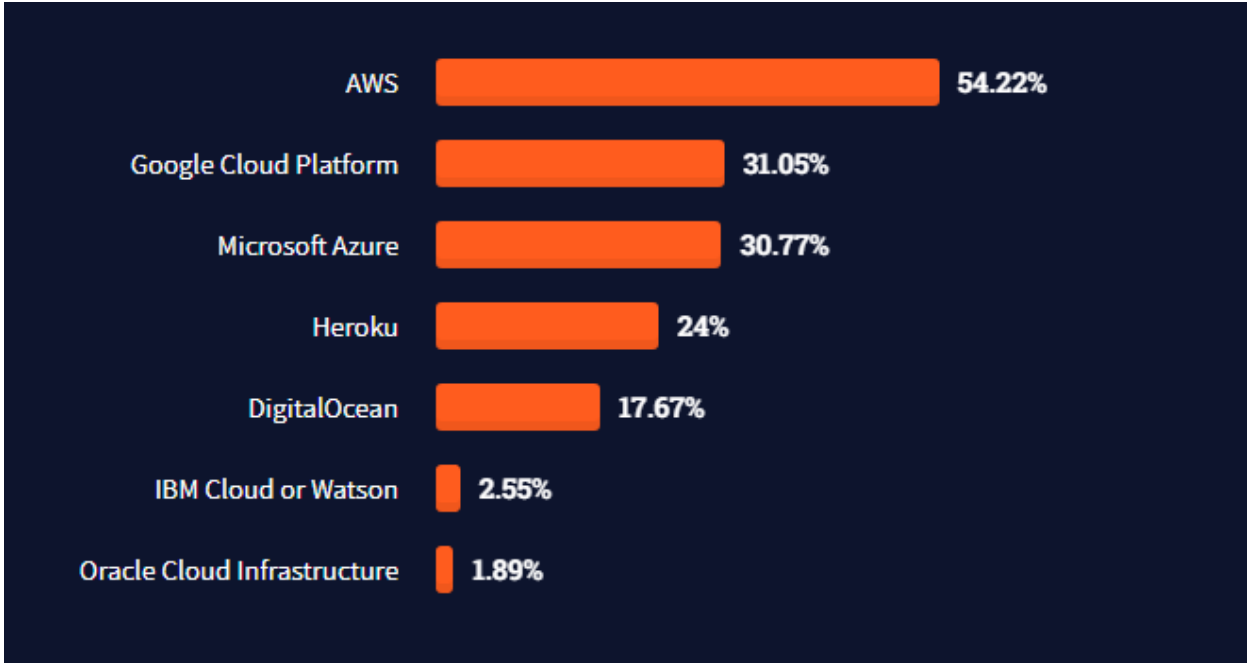


Figure 16: Stackoverflow survey on most used cloud services by developers

An introduction to automating ML deployment workflow

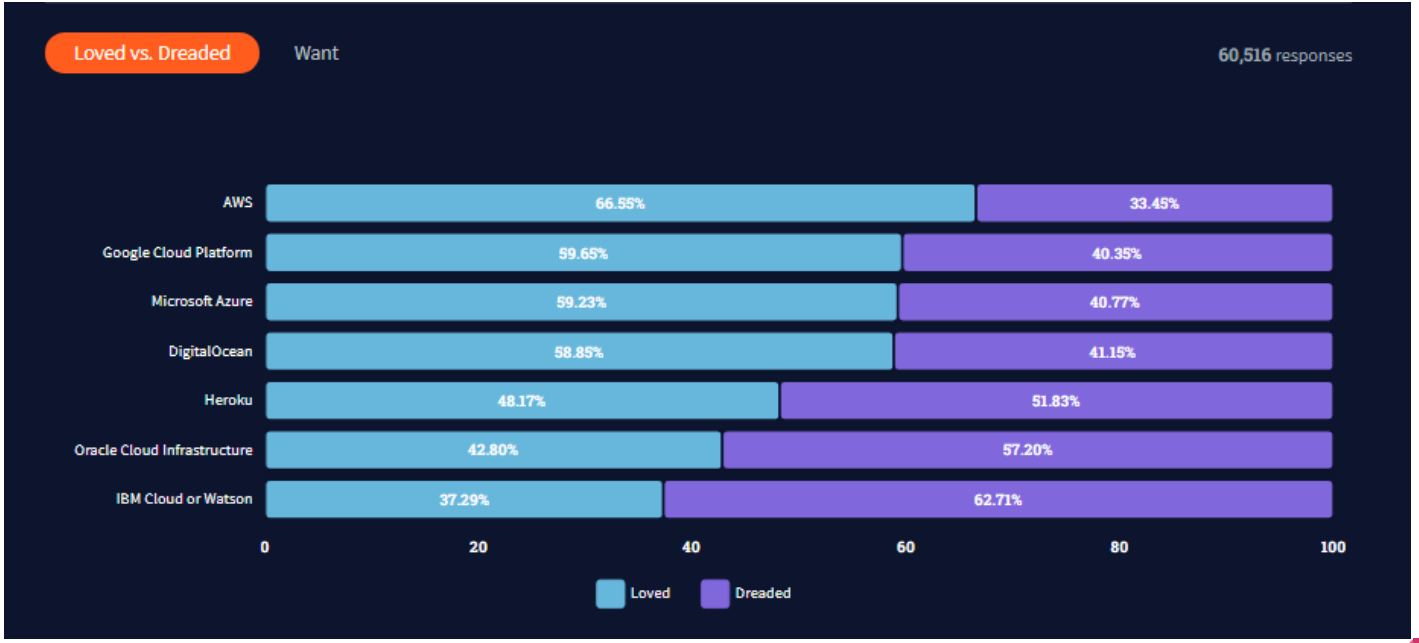


Figure 17: Stackoverflow survey on most loved vs most dreaded

Containerize a python web app using docker

1) **Create** a project folder (any name of your choice)
2) **Create** a git repo
3) **clone** a github repo to the named folder above.

→ Linux terminal: git init

→ Linux terminal: git clone <repo url>

1) Create app folder: mkdir kessie-app && cd kessie-app
2) **Create** a virtual environment

→ Linux terminal: pip install virtualenv

→ Linux terminal: python –m venv venv

→ Linux terminal: source venv/bin/activate/

1) Install Flask or Fastapi and uvicorn. Work with one of the two api or if you intend to work with the two, create different folders and virtual environment for the two different apis.

→ Linux terminal: pip install flask

→ Linux terminal: pip install fastapi uvicorn

1) **Develop** a module(or script to solve a problem import it into the Flask/Fast app.

→ Linux terminal: mkdir app && cd app

→ Linux terminal: touch flask-app.py

→ Linux terminal: touch custom-function.py

→ Linux terminal: code .

Containerize a python web app using docker

1) Build and run your apps
2) Test it using postman

-→ post the URI on the postman, and test with json inputs, take screenshots.

1) Create an empty dockerfile at the root level of the project folder
2) Create an empty yaml file at the root level of the project folder
3) Push to github

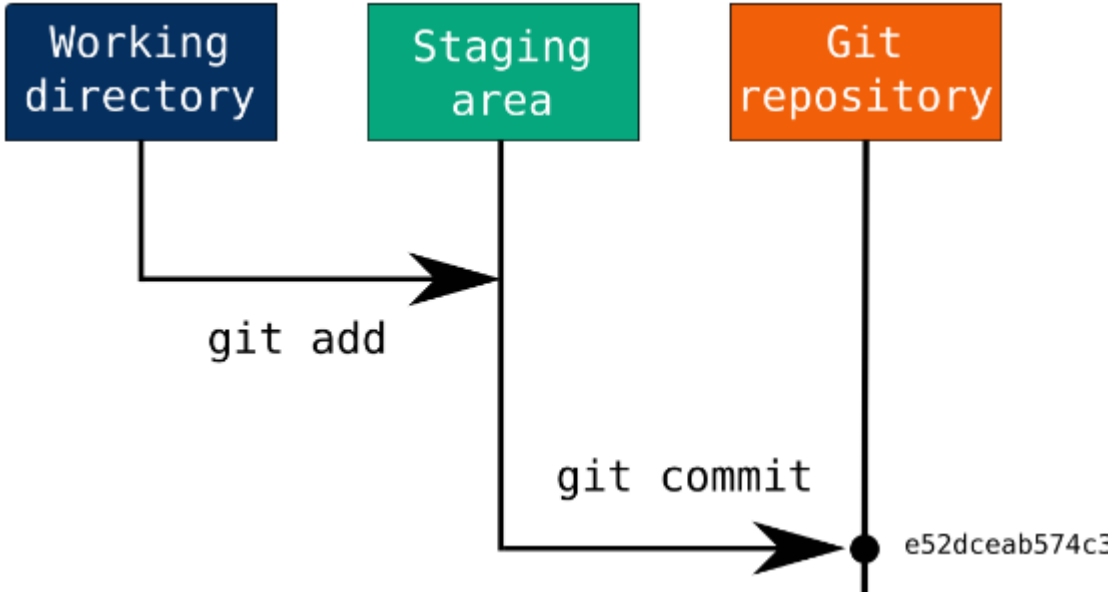
-> linux terminal: git add .

-> linux terminal: git commit –m “assignment”

-> linux terminal: git branch –M main

-> linux terminal: push –u origin main

Containerize a python web app using docker



Reference:
https://miro.medium.com/max/700/1*rCyvV8hAhAhqNjkLt7Wi7g.png

An introduction to ML deployment workflow

An introduction to ML deployment workflow

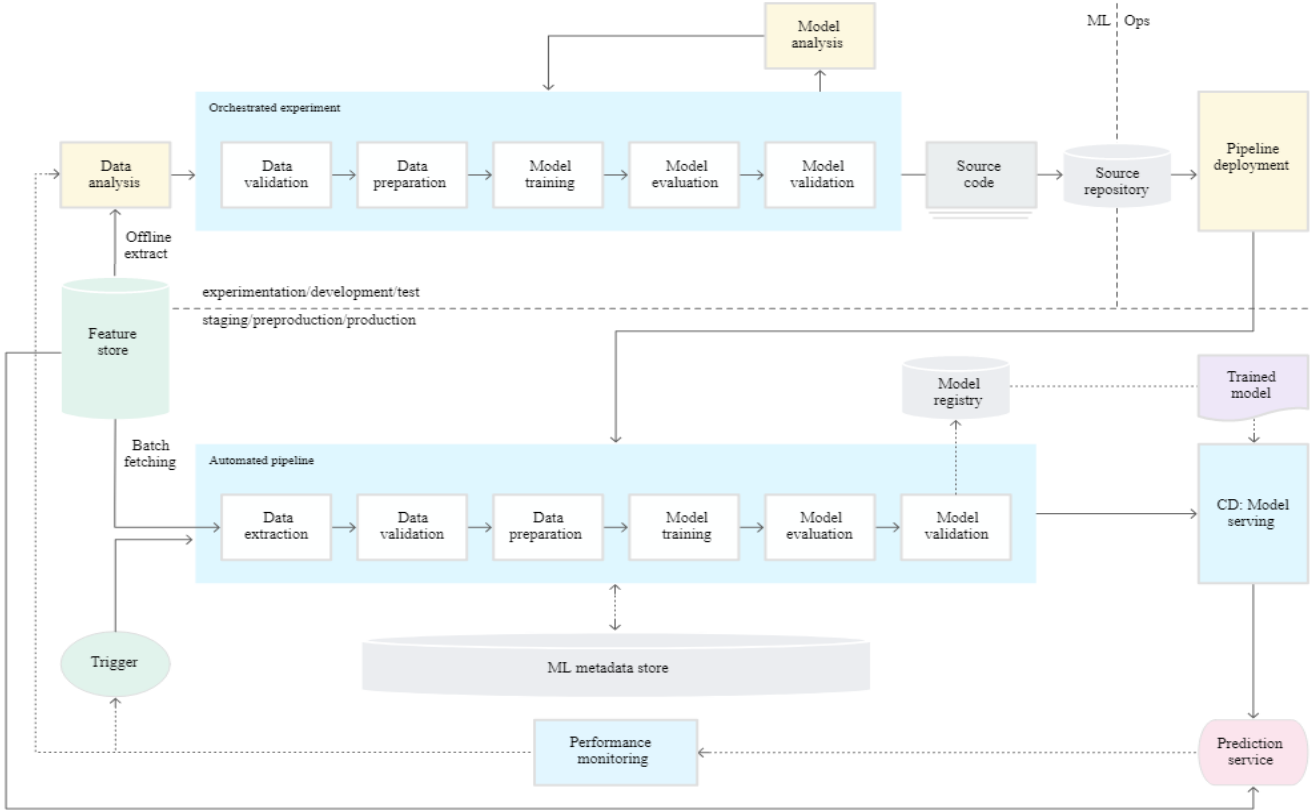


Figure 17: ML pipeline automation for CT

Reference: https://bit.ly/3IsaoLi

An introduction to ML deployment workflow

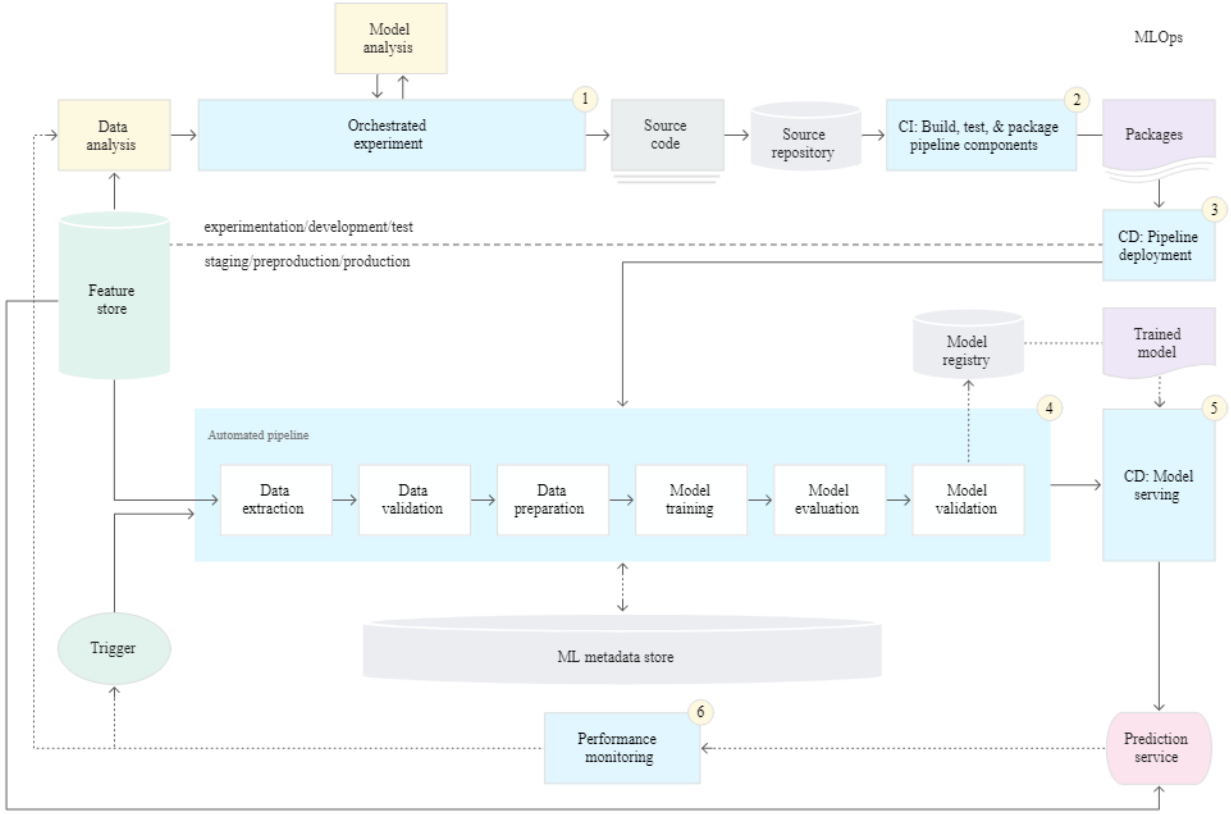


Figure 18: CI/CD and automated ML pipeline

Reference: https://bit.ly/3IsaoLi

An introduction to ML deployment workflow

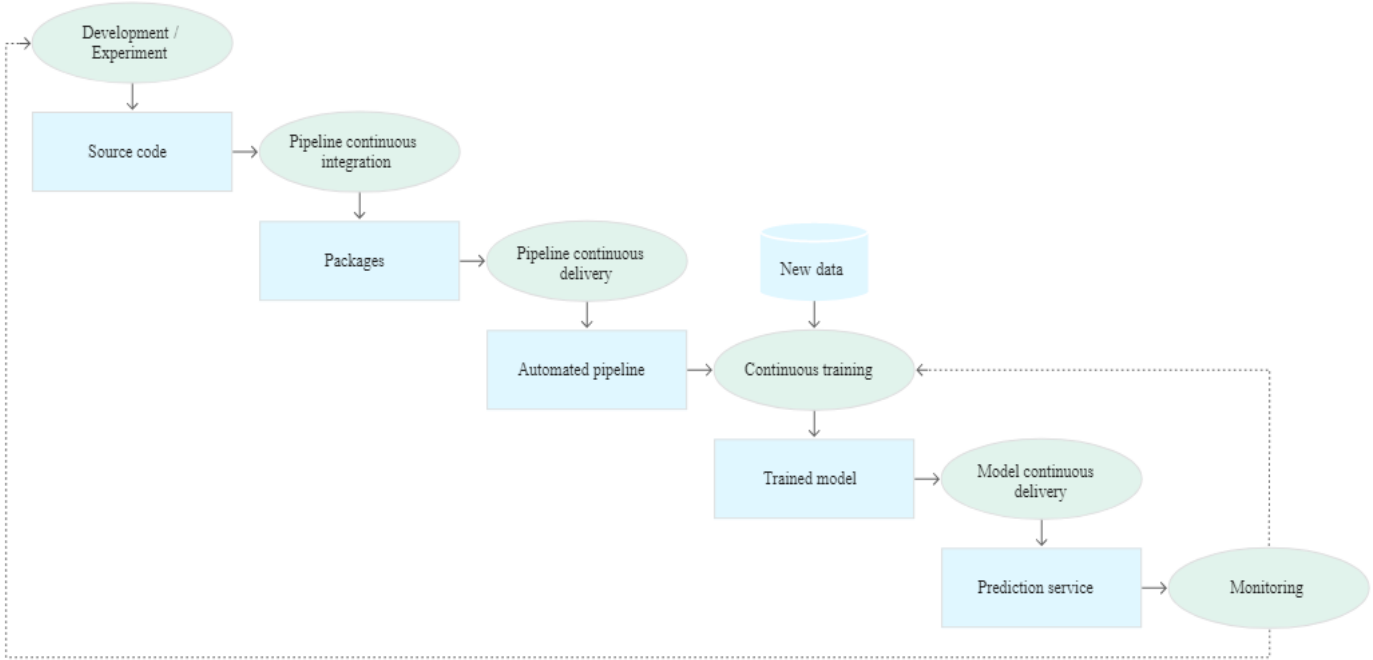


Figure 18: Stages of the CI/CD automated ML pipeline

Reference: https://bit.ly/3IsaoLi

RECOMMENDED READING

- https://stackify.com/docker-build-a-beginners-guide-to-building-docker-images/
- https://pythonbasics.org/flask-rest-api/
- https://www.digitalocean.com/community/cheatsheets/how-to-use-git-a-reference-guide
- https://docs.github.com/en/actions/learn-github-actions
- https://towardsdatascience.com/a-gentle-introduction-automating-machine-learning-pipelines-71f97192eabf
- https://cloudacademy.com/blog/how-to-deploy-an-app-from-github-with-aws-codedeploy/
- http://docs.aws.amazon.com/elasticbeanstalk/latest/dg/create_deploy_docker_image.html#create_deploy_docker_image_dockerrun

ASSIGNMENT

1) Create a program that reads the length and width of a farmer’s field from the user in feet. Display the area of the field in acres.
Hint: There are 43,560 square feet in an acre. [source: The python workbook]

2) push your app to github.

REFERENCE

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- https://cloud.google.com/architecture/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning#mlops_level_2_cicd_pipeline_automation
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Q&A