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Automated Deployment of Flask Applications Using GitLab CI/CD and Docker

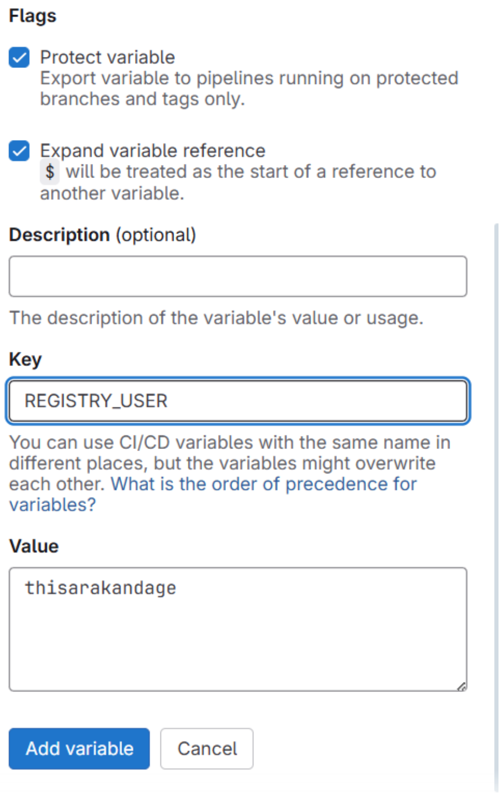
Project Description:

This project is a simple **Python Flask web application** that is developed, tested, containerized, and deployed using a **GitLab CI/CD pipeline**. The pipeline automates three main stages:

1. **Testing** – The application code is validated using Python's testing framework to ensure functionality before deployment.
2. **Building** – A Docker image of the application is created and pushed to a container registry for easy deployment.
3. **Deployment** – The image is deployed to a **DigitalOcean Ubuntu server** using SSH and Docker, ensuring that the latest version is running in a clean container environment.

The deployment environment is fully containerized, making it portable and consistent across development and production. The use of **DigitalOcean Droplets** provides a reliable cloud infrastructure, while Docker ensures quick updates and minimal downtime during deployments.

1. Create Secret Variables in GitLab repo



Flags

☑ Protect variable
Export variable to pipelines running on protected branches and tags only.

☑ Expand variable reference
`$` will be treated as the start of a reference to another variable.

Description (optional)

The description of the variable's value or usage.

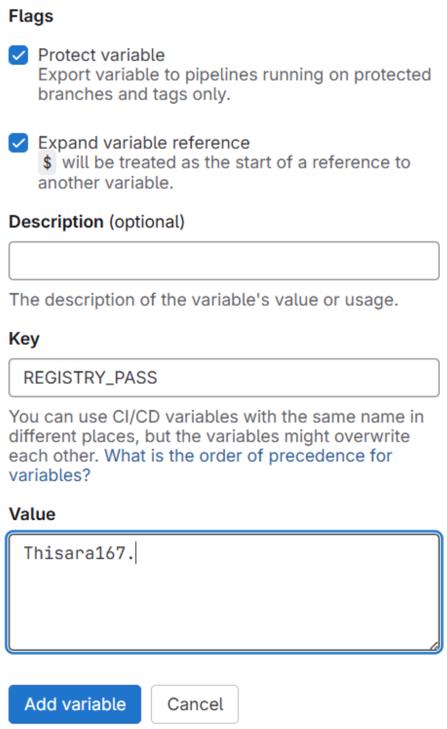
Key

REGISTRY_USER

You can use CI/CD variables with the same name in different places, but the variables might overwrite each other. What is the order of precedence for variables?

Value

thisarakandage



Flags

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☑ Expand variable reference
`$` will be treated as the start of a reference to another variable.

Description (optional)

The description of the variable's value or usage.

Key

REGISTRY_PASS

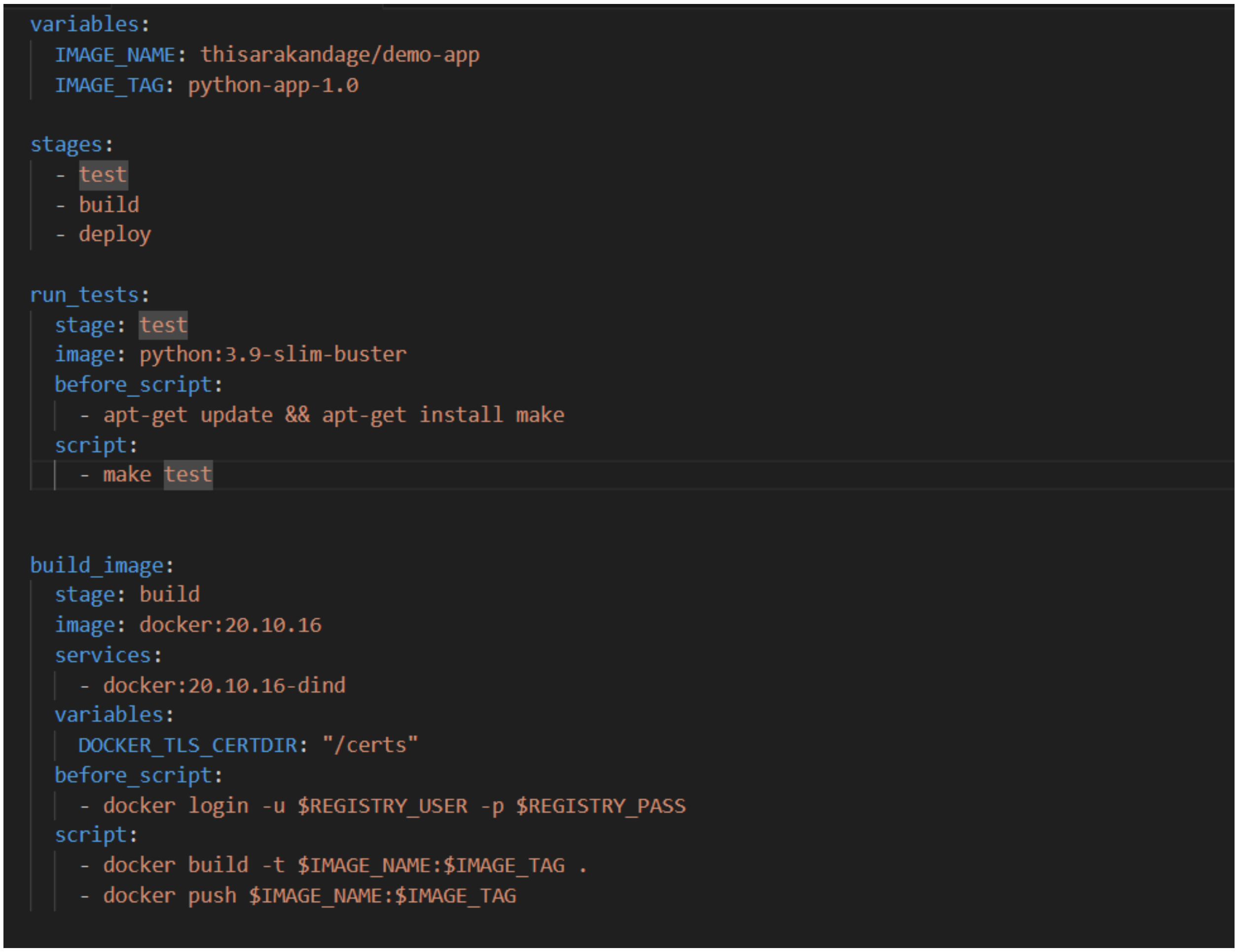
You can use CI/CD variables with the same name in different places, but the variables might overwrite each other. What is the order of precedence for variables?

Value

Thisara167.

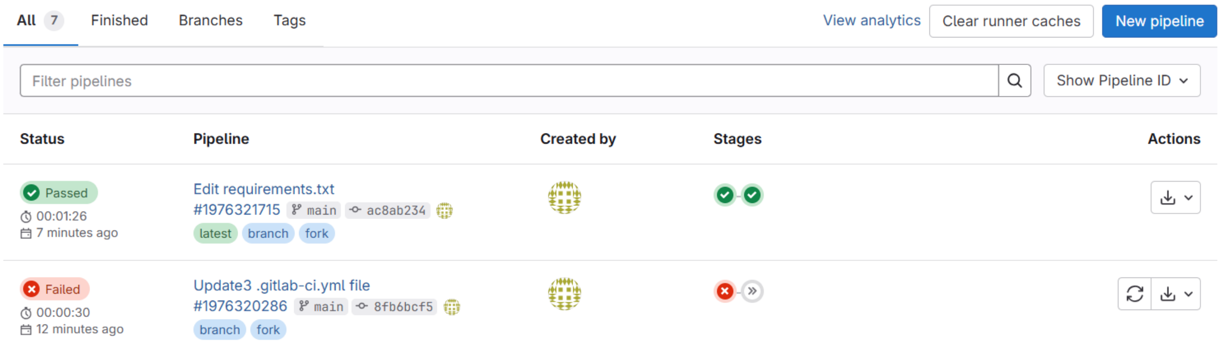
- **First, I tried to build and push the docker image to docker hub container registry using Git Lab CI/CD pipeline**

2. Pipeline script



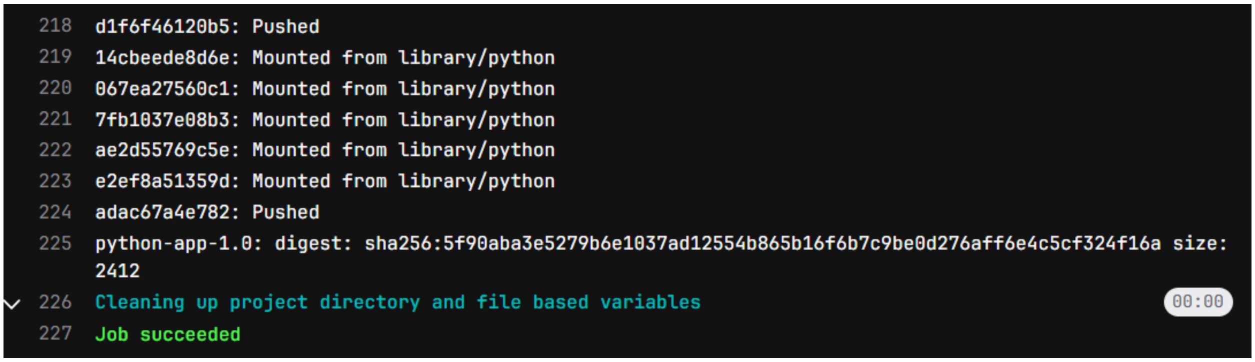
```
variables:
  IMAGE_NAME: thisarakandage/demo-app
  IMAGE_TAG: python-app-1.0

stages:
  - test
  - build
  - deploy

run_tests:
  stage: test
  image: python:3.9-slim-buster
  before_script:
    - apt-get update && apt-get install make
  script:
    - make test


build_image:
  stage: build
  image: docker:20.10.16
  services:
    - docker:20.10.16-dind
  variables:
    DOCKER_TLS_CERTDIR: "/certs"
  before_script:
    - docker login -u $REGISTRY_USER -p $REGISTRY_PASS
  script:
    - docker build -t $IMAGE_NAME:$IMAGE_TAG .
    - docker push $IMAGE_NAME:$IMAGE_TAG
```

3. After Completing the pipeline



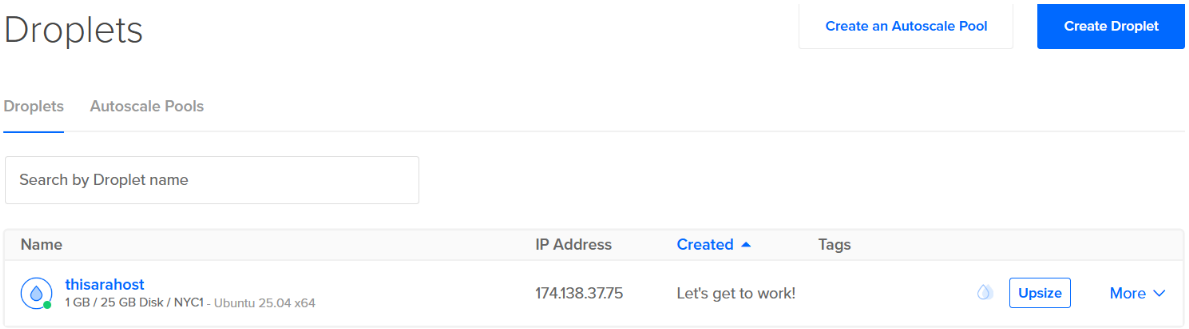
Status	Pipeline	Created by	Stages	Actions
✓ Passed 00:01:26 7 minutes ago	Edit requirements.txt #1976321715 main ac8ab234 latest branch fork		✓ ✓	
✗ Failed 00:00:30 12 minutes ago	Update3 .gitlab-ci.yml file #1976320286 main 8fb6bcf5 branch fork		✗ »	

4. Pipeline Logs



```
d1f6f46120b5: Pushed
14cbeede8d6e: Mounted from library/python
067ea27560c1: Mounted from library/python
7fb1037e08b3: Mounted from library/python
ae2d55769c5e: Mounted from library/python
e2ef8a51359d: Mounted from library/python
adac67a4e782: Pushed
python-app-1.0: digest: sha256:5f90aba3e5279b6e1037ad12554b865b16f6b7c9be0d276aff6e4c5cf324f16a size:
2412
Cleaning up project directory and file based variables                                         00:00
Job succeeded
```

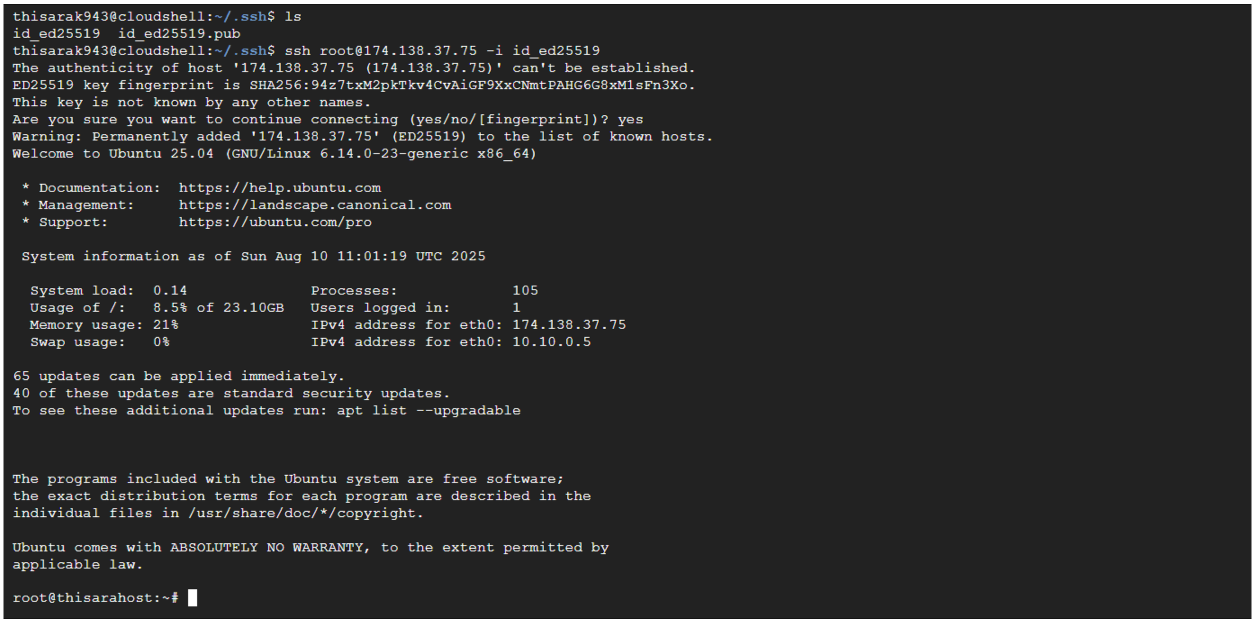
5. Create a droplet in Digital Ocean (Ubuntu server) for deploying the web application



Droplets

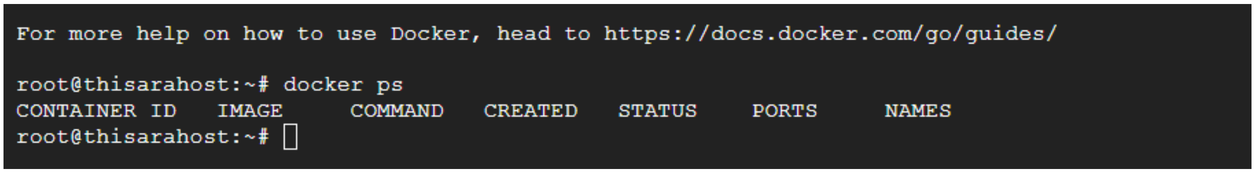
Name	IP Address	Created	Tags		
thisarahost 1 GB / 25 GB Disk / NYC1 - Ubuntu 25.04 x64	174.138.37.75	Let's get to work!		Upsize	More

6. Connect to Server using SSH



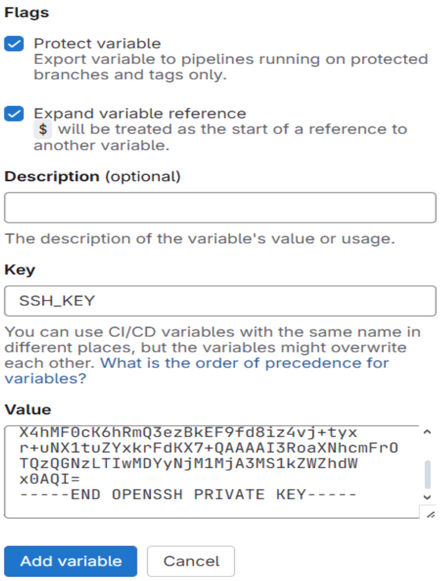
```
thisarak943@cloudshell:~/.ssh$ ls
id_ed25519  id_ed25519.pub
thisarak943@cloudshell:~/.ssh$ ssh root@174.138.37.75 -i id_ed25519
The authenticity of host '174.138.37.75 (174.138.37.75)' can't be established.
ED25519 key fingerprint is SHA256:94z7txM2pkTkv4CvAiGF9XxCNmtPAHG6G8xM1sFn3Xo.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '174.138.37.75' (ED25519) to the list of known hosts.
Welcome to Ubuntu 25.04 (GNU/Linux 6.14.0-23-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

 System information as of Sun Aug 10 11:01:19 UTC 2025

  System load:  0.14               Processes:             105
  Usage of /:   8.5% of 23.10GB    Users logged in:       1
  Memory usage: 21%                IPv4 address for eth0: 174.138.37.75
  Swap usage:   0%                 IPv4 address for eth0: 10.10.0.5

65 updates can be applied immediately.
40 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable



The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

root@thisarahost:~# 
```

7. Docker installed on server



```
For more help on how to use Docker, head to https://docs.docker.com/go/guides/

root@thisarahost:~# docker ps
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS     NAMES
root@thisarahost:~# 
```

8. Variables create for Private key



Flags

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Description (optional)

The description of the variable's value or usage.

Key

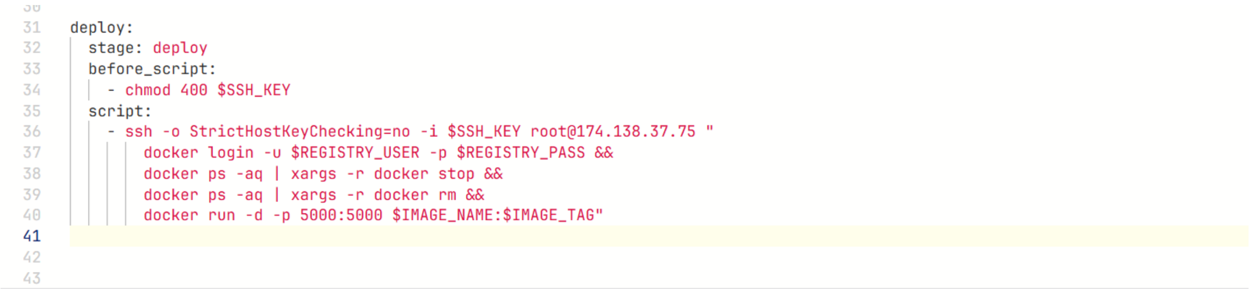
SSH_KEY

You can use CI/CD variables with the same name in different places, but the variables might overwrite each other. What is the order of precedence for variables?

Value

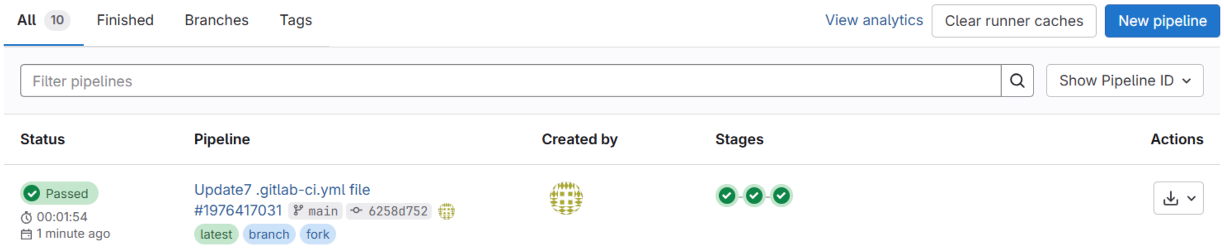
```
X4hMF0cK6hRmQ3ezBkEF9fd8iz4vj+tyx
r+uNX1tuZYxkrFdKX7+QAAAAI3RoaXNhcmFrO
TQzQGNzLTIwMDYyNjM1MjA3MS1kZWZhdW
x0AQI=
-----END OPENSSH PRIVATE KEY-----
```

9. Then tried to deploy the app on Digital Ocean ubuntu server



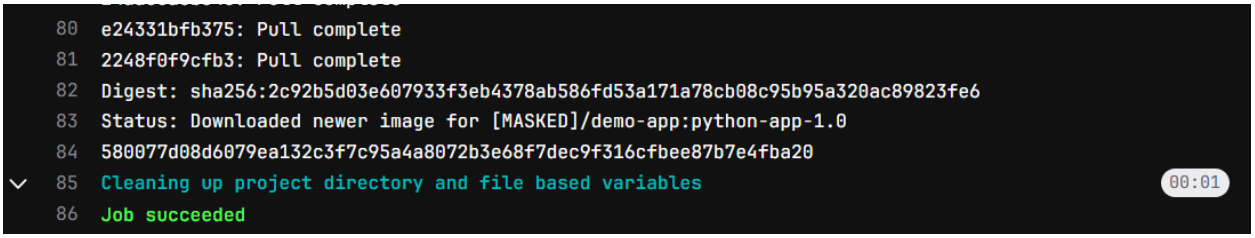
```yaml
deploy:
  stage: deploy
  before_script:
    - chmod 400 $SSH_KEY
  script:
    - ssh -o StrictHostKeyChecking=no -i $SSH_KEY root@174.138.37.75 "
        docker login -u $REGISTRY_USER -p $REGISTRY_PASS &&
        docker ps -aq | xargs -r docker stop &&
        docker ps -aq | xargs -r docker rm &&
        docker run -d -p 5000:5000 $IMAGE_NAME:$IMAGE_TAG"
```

10.Pipeline view



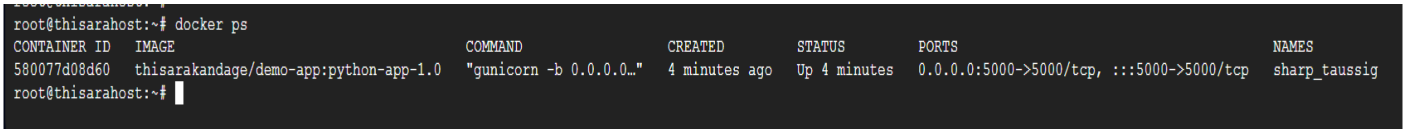
Status	Pipeline	Created by	Stages	Actions
Passed 00:01:54 1 minute ago	Update7 .gitlab-ci.yml file #1976417031 main 6258d752 latest branch fork		✓ ✓ ✓	

11. Pipeline logs



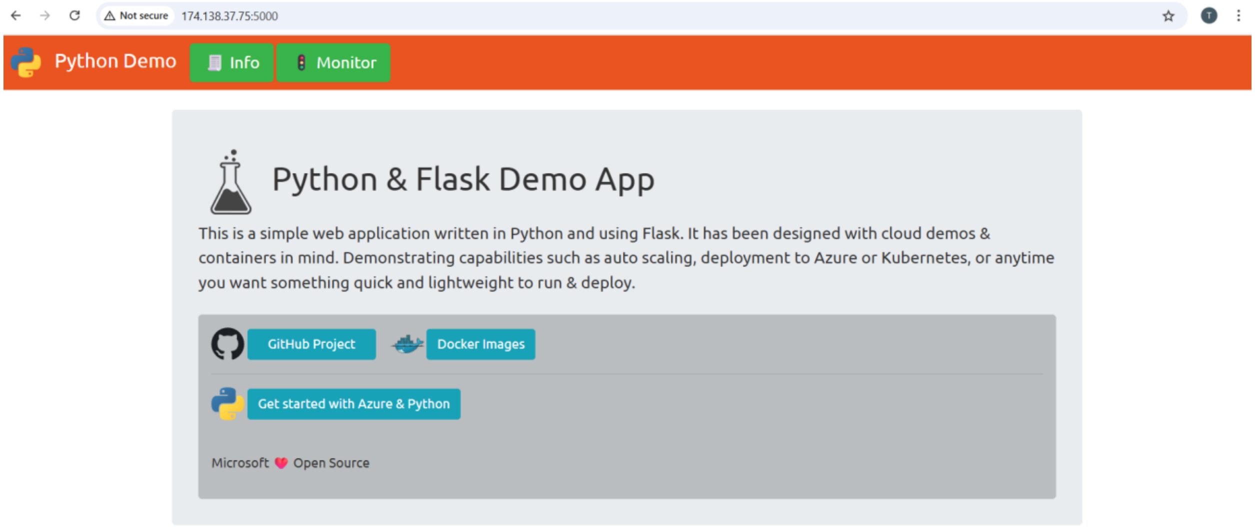
```
e24331bfb375: Pull complete
2248f0f9cfb3: Pull complete
Digest: sha256:2c92b5d03e607933f3eb4378ab586fd53a171a78cb08c95b95a320ac89823fe6
Status: Downloaded newer image for [MASKED]/demo-app:python-app-1.0
580077d08d6079ea132c3f7c95a4a8072b3e68f7dec9f316cfbee87b7e4fba20
Cleaning up project directory and file based variables                    00:01
Job succeeded
```

12. Docker Container is running in server



```
root@thisarahost:~# docker ps
CONTAINER ID   IMAGE                                  COMMAND                  CREATED         STATUS         PORTS                                       NAMES
580077d08d60   thisarakandage/demo-app:python-app-1.0   "gunicorn -b 0.0.0.0…"   4 minutes ago   Up 4 minutes   0.0.0.0:5000->5000/tcp, :::5000->5000/tcp   sharp_taussig
root@thisarahost:~# 
```

13. Final checks in browser



Python & Flask Demo App

This is a simple web application written in Python and using Flask. It has been designed with cloud demos & containers in mind. Demonstrating capabilities such as auto scaling, deployment to Azure or Kubernetes, or anytime you want something quick and lightweight to run & deploy.

Summary:

Through this project, I learned how to take a simple Flask application from local development to production using modern DevOps practices. I gained hands-on experience with:

- **Flask Application Basics** – Building and structuring a Python web application.
- **GitLab CI/CD Pipelines** – Automating testing, building, and deployment workflows.
- **Docker** – Packaging the application into portable containers for consistent runtime environments.
- **Container Registry** – Storing and retrieving application images securely for deployment.
- **DigitalOcean Droplet Management** – Setting up an Ubuntu server for hosting containerized applications.
- **Remote Deployment via SSH** – Automating remote server commands to stop old containers and start new ones.
- **Error Handling in Pipelines** – Debugging and fixing common CI/CD issues such as empty container lists and deployment failures.

This project improved my understanding of **automation, containerization, and cloud deployment**. It also strengthened my problem-solving skills in real-world deployment scenarios, making me more confident in delivering production-ready applications.