

☁️ Cloud Deployment Guide - Complete Beginner's Guide

🎯 Overview

This guide will teach you **step-by-step** how to deploy your Heart Disease Prediction MLOps project to the cloud.

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🌐 Azure Container Apps

Step 1: Create Azure Account

1. Go to: azure.microsoft.com/free/students
 2. Click "Start Free" or "Activate Now"
 3. Sign in with your school email
 4. Complete verification (you'll get \$200 credit)
 5. Access Azure Portal: portal.azure.com
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Step 2: Install Azure CLI

For macOS:

```
brew install azure-cli
```

For Windows:

Download from: aka.ms/installazurecliwindows

For Linux:

```
curl -sL https://aka.ms/InstallAzureCLIDeb | sudo bash
```

Verify Installation:

```
az --version
```

Step 3: Login to Azure

```
# Login
az login

# Set your subscription (if you have multiple)
az account list --output table
az account set --subscription "Your-Subscription-Name"

# Verify
az account show
```

Step 4: Create Resource Group

```
# Create a resource group (like a folder for your resources)
az group create \
  --name heart-disease-rg \
  --location eastus

# Verify
az group list --output table
```

Choose a location near you:

- US: `eastus`, `westus2`
 - Europe: `westeurope`, `northeurope`
 - Asia: `southeastasia`, `eastasia`
-

Step 5: Create Container Registry (To Store Your Docker Image)

```
# Create Azure Container Registry
az acr create \
  --resource-group heart-disease-rg \
  --name heartdiseaseacr \
  --sku Basic \
  --admin-enabled true

# Login to registry
az acr login --name heartdiseaseacr
```

```
# Get login server
az acr show --name heartdiseaseacr --query loginServer --output table
```

Note: Registry name must be globally unique. If taken, try: `heartdiseaseacr123`, `hdacr2024`, etc.

Step 6: Build and Push Docker Image to Azure

```
# Navigate to your project
cd heart-disease-mlops

# Build and push in one command (Azure will do it for you!)
az acr build \
    --registry heartdiseaseacr \
    --image heart-disease-api:v1 \
    --file Dockerfile \
    .

# This will take 3-5 minutes
# Azure builds your Docker image in the cloud!
```

Expected Output:

```
Successfully tagged heartdiseaseacr.azurecr.io/heart-disease-api:v1
Successfully pushed heartdiseaseacr.azurecr.io/heart-disease-api:v1
```

Step 7: Create Container App Environment

```
# Install Container Apps extension
az extension add --name containerapp --upgrade

# Register providers
az provider register --namespace Microsoft.App
az provider register --namespace Microsoft.OperationalInsights

# Create environment (like a hosting space)
az containerapp env create \
    --name heart-disease-env \
    --resource-group heart-disease-rg \
    --location eastus
```

Step 8: Deploy Your Container App

```
# Get ACR credentials
ACR_USERNAME=$(az acr credential show --name heartdiseaseacr --query
username --output tsv)
ACR_PASSWORD=$(az acr credential show --name heartdiseaseacr --query
passwords[0].value --output tsv)

# Deploy the container app
az containerapp create \
--name heart-disease-api \
--resource-group heart-disease-rg \
--environment heart-disease-env \
--image heartdiseaseacr.azurecr.io/heart-disease-api:v1 \
--registry-server heartdiseaseacr.azurecr.io \
--registry-username $ACR_USERNAME \
--registry-password $ACR_PASSWORD \
--target-port 8000 \
--ingress external \
--min-replicas 1 \
--max-replicas 3 \
--cpu 0.5 \
--memory 1Gi

# Get the URL
az containerapp show \
--name heart-disease-api \
--resource-group heart-disease-rg \
--query properties.configuration.ingress.fqdn \
--output tsv
```

We'll get a URL like: <https://heart-disease-api.azurecontainerapps.io>

Step 9: Test Your Cloud API

```
# Replace with your actual URL
export API_URL="https://heart-disease-api.azurecontainerapps.io"

# Test health endpoint
curl $API_URL/health

# Test prediction
curl -X POST "$API_URL/predict" \
-H "Content-Type: application/json" \
-d '{
  "age": 63,
  "sex": 1,
  "cp": 3,
  "trestbps": 145,
  "chol": 233,
  "fbs": 1,
  "restecg": 0,
```

```
"thalach": 150,  
"exang": 0,  
"oldpeak": 2.3,  
"slope": 0,  
"ca": 0,  
"thal": 1  
}'  
  
# Open in browser  
open "$API_URL/docs"
```

 Your API is now live on the internet!

Step 10: View Logs and Monitor

```
# View logs  
az containerapp logs show \  
--name heart-disease-api \  
--resource-group heart-disease-rg \  
--follow  
  
# Check metrics in Azure Portal  
# Go to: portal.azure.com → Resource Groups → heart-disease-rg → heart-  
disease-api
```

Setup CI/CD Pipeline with GitHub Actions

Step 1: Create GitHub Repository

```
# Initialize git (if not already done)  
cd heart-disease-mlops  
git init  
git add .  
git commit -m "Initial commit"  
  
# Create repo on GitHub.com, then:  
git remote add origin https://github.com/YOUR_USERNAME/heart-disease-  
mlops.git  
git branch -M main  
git push -u origin main
```

Step 2: Setup GitHub Secrets

Go to: **GitHub Repository → Settings → Secrets and variables → Actions**

For Azure:

Add these secrets:

- **AZURE_CREDENTIALS** (Get from: `az ad sp create-for-rbac --name "github-actions" --role contributor --scopes /subscriptions/YOUR_SUBSCRIPTION_ID/resourceGroups/heart-disease-rg --sdk-auth`)
- **AZURE_REGISTRY_NAME**: `heartdiseaseacr`
- **AZURE_REGISTRY_USERNAME**: (From Azure portal)
- **AZURE_REGISTRY_PASSWORD**: (From Azure portal)

For AWS:

- **AWS_ACCESS_KEY_ID**
- **AWS_SECRET_ACCESS_KEY**
- **AWS_ACCOUNT_ID**

For Google Cloud:

- **GCP_PROJECT_ID**
- **GCP_SA_KEY** (Service account key JSON)

Step 3: Create GitHub Actions Workflow

Create `.github/workflows/azure-deploy.yml`:

```
name: CI/CD Pipeline - Azure Deployment

on:
  push:
    branches: [ main, develop ]
  pull_request:
    branches: [ main ]

jobs:
  test:
    name: Run Tests
    runs-on: ubuntu-latest

    steps:
      - uses: actions/checkout@v3

      - name: Set up Python
        uses: actions/setup-python@v4
        with:
          python-version: '3.9'

      - name: Install dependencies
        run: |
```

```
python -m pip install --upgrade pip
pip install -r requirements.txt
pip install pytest pytest-cov flake8

- name: Lint with flake8
  run: |
    flake8 src/ --count --select=E9,F63,F7,F82 --show-source --
statistics

- name: Run tests
  run: |
    pytest tests/ -v --cov=src

build-and-deploy:
  name: Build and Deploy to Azure
  needs: test
  runs-on: ubuntu-latest
  if: github.ref == 'refs/heads/main' && github.event_name == 'push'

  steps:
  - uses: actions/checkout@v3

  - name: Azure Login
    uses: azure/login@v1
    with:
      creds: ${{ secrets.AZURE_CREDENTIALS }}

  - name: Build and push image to ACR
    run: |
      az acr build \
        --registry ${{ secrets.AZURE_REGISTRY_NAME }} \
        --image heart-disease-api:${{ github.sha }} \
        --image heart-disease-api:latest \
        --file Dockerfile \
      .

  - name: Deploy to Azure Container Apps
    run: |
      az containerapp update \
        --name heart-disease-api \
        --resource-group heart-disease-rg \
        --image ${{ secrets.AZURE_REGISTRY_NAME }}.azurecr.io/heart-
disease-api:${{ github.sha }}

  - name: Verify Deployment
    run: |
      URL=$(az containerapp show \
        --name heart-disease-api \
        --resource-group heart-disease-rg \
        --query properties.configuration.ingress.fqdn \
        --output tsv)

      echo "Testing health endpoint..."
      curl -f https://$URL/health || exit 1
```

```
echo "✅ Deployment successful!"  
echo "API URL: https://$URL"
```

Step 4: Push and Watch CI/CD in Action

```
# Make a change  
echo "# Test CI/CD" >> README.md  
  
# Commit and push  
git add .  
git commit -m "Test CI/CD pipeline"  
git push origin main  
  
# Go to GitHub → Actions tab to watch the magic happen!
```

What happens:

1. ✅ Code is checked out
 2. ✅ Tests run automatically
 3. ✅ Docker image is built
 4. ✅ Image is pushed to container registry
 5. ✅ Application is deployed to cloud
 6. ✅ Health check verifies deployment
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🧪 Testing Your Cloud Deployment

Test Health Endpoint

```
curl https://YOUR_CLOUD_URL/health
```

Test Prediction Endpoint

```
curl -X POST "https://YOUR_CLOUD_URL/predict" \  
-H "Content-Type: application/json" \  
-d '{  
  "age": 63,  
  "sex": 1,  
  "cp": 3,  
  "trestbps": 145,  
  "chol": 233,  
  "fbs": 1,  
  "restecg": 0,  
  "thalach": 150,
```

```
"exang": 0,  
"oldpeak": 2.3,  
"slope": 0,  
"ca": 0,  
"thal": 1  
}'
```

Test in Browser

Open: https://YOUR_CLOUD_URL/docs

Test with Python

```
import requests  
  
API_URL = "https://YOUR_CLOUD_URL"  
  
# Health check  
response = requests.get(f"{API_URL}/health")  
print("Health:", response.json())  
  
# Prediction  
data = {  
    "age": 63,  
    "sex": 1,  
    "cp": 3,  
    "trestbps": 145,  
    "chol": 233,  
    "fbs": 1,  
    "restecg": 0,  
    "thalach": 150,  
    "exang": 0,  
    "oldpeak": 2.3,  
    "slope": 0,  
    "ca": 0,  
    "thal": 1  
}  
  
response = requests.post(f"{API_URL}/predict", json=data)  
print("Prediction:", response.json())
```

💰 Cost Management

Azure

```
# Check costs  
az consumption usage list --output table
```

```
# Set up budget alert
az consumption budget create \
--budget-name monthly-budget \
--amount 10 \
--time-grain Monthly
```

Stop Services When Not Needed

```
# Azure
az containerapp update --name heart-disease-api \
--resource-group heart-disease-rg \
--min-replicas 0
```