Stroke Prediction Project using Machine Learning on Google Cloud Platform

From Development to Production: with Flask, Docker, and Kubernetes

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April 4, 2024

Introduction

Using Python to build a predictive model on GCP to determine whether a patient has a high risk of stroke or not

What will we learn?

- What are Cloud Repositories in GCP and how to create them?
- What is Docker, DockerHub? How to create and build Docker images?
- What is Kubernetes and how to use Google Kubernetes Engine?
- How to push Docker images to Google Container Registry and create Kubernetes cluster?
- What is Flask and how to deploy and run Flask application on GKE cluster?

Tech Stack

Language: Python

Packages: Pandas, Numpy, Scikit-Learn

Services: Flask, Docker

Cloud: GCP

- Google Cloud Repositories
- Google Container Registry
- Google Kubernetes Engine

Tech Stack Overview

Flask is a lightweight web framework also built with Python. It's designed to make web development quick and straightforward.

We use Flask to build a web service that exposes our machine learning model's predictions as an API. This will enable other applications to interact with our model easily.

pip install Flask

https://pypi.org/project/Flask/

Tech Stack Overview

Docker simplifies the process of packaging an application and its dependencies into a standardized container. Containers ensure that our application runs consistently across various environments, making deployment smoother.

We use Docker to encapsulate our Flask application, along with its dependencies, into a portable container.

https://www.docker.com/get-started/

Tech Stack Overview

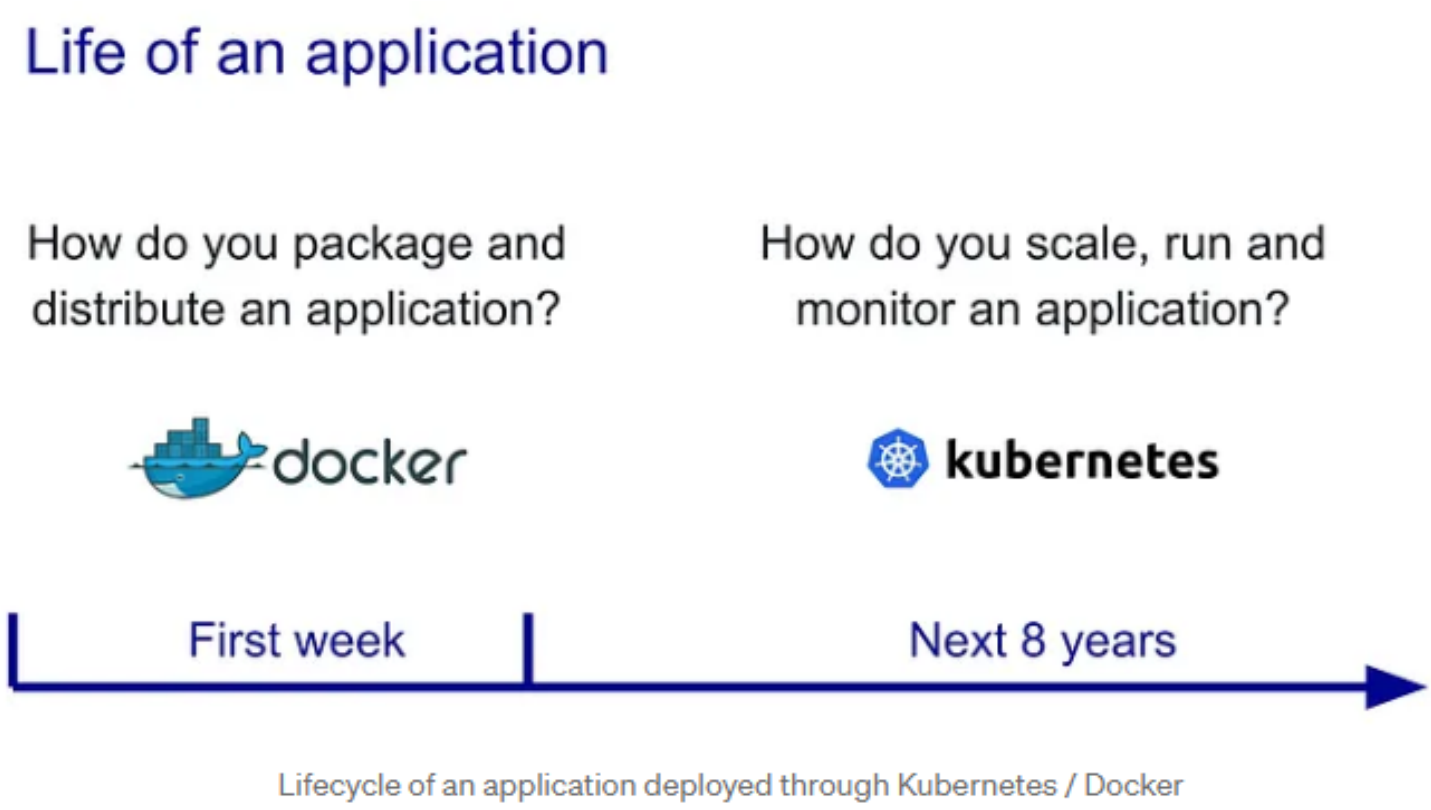
Kubernetes is a container management system that allows to create, scale and monitor containers/containerized applications across a cluster of machines. It is an open-source software and was developed by Google.

Features:

- Load Balancing: automatically (re-) distributes the load between containers.
- Self-healing: it restarts containers that fail, replaces containers, kills containers that don't respond to user-defined checks
- Scaling: automatically scale up or down the application (e.g. during peak hours)

https://kubernetes.io/docs/concepts/overview/

Tech Stack Overview



Lifecycle of an application deployed through Kubernetes / Docker

We use GCP's resources to set up a Kubernetes cluster using Google Kubernetes Engine (GKE)

Self-Check: Understanding Containerization

- **Container:**
  Container is a type of software that packages up an application and all its dependencies so the application runs reliably from one computing environment to another.

- **Docker:**
  Docker is a software used for building and managing containers.

- **Kubernetes:**
  Kubernetes is an open-source system for managing containerized applications in a clustered environment.

- **Google Kubernetes Engine (GKE):**
  Google Kubernetes Engine is an implementation of the open-source Kubernetes framework on Google Cloud Platform.

Data, Model, App, Deployment: Tasks

Tasks:

- Train and develop a machine learning pipeline for deployment.
- Build a web application using a Flask framework. It will use the trained ML pipeline to generate predictions on new data points in real-time.
- Create a new repository on Google Cloud Source Repository
- Activate Cloud Shell, copy the created repository
- Define the variables, create Docker image of the application and push it to .Google Container Registry (GCR)
- Create clusters and deploy the application on Google Kubernetes Engine

Data and Model: Live Demo

Kaggle Stroke Dataset

Attribute Information

1) id: unique identifier

2) gender: "Male", "Female" or "Other"

3) age: age of the patient

4) hypertension: 0 if the patient doesn't have hypertension, 1 if the patient has hypertension

5) heart_disease: 0 if the patient doesn't have any heart diseases, 1 if the patient has a heart disease

6) ever_married: "No" or "Yes"

7) work_type: "children", "Govt_jov", "Never_worked", "Private" or "Self-employed"

8) Residence_type: "Rural" or "Urban"

9) avg_glucose_level: average glucose level in blood

10) bmi: body mass index

11) smoking_status: "formerly smoked", "never smoked", "smokes" or "Unknown"*

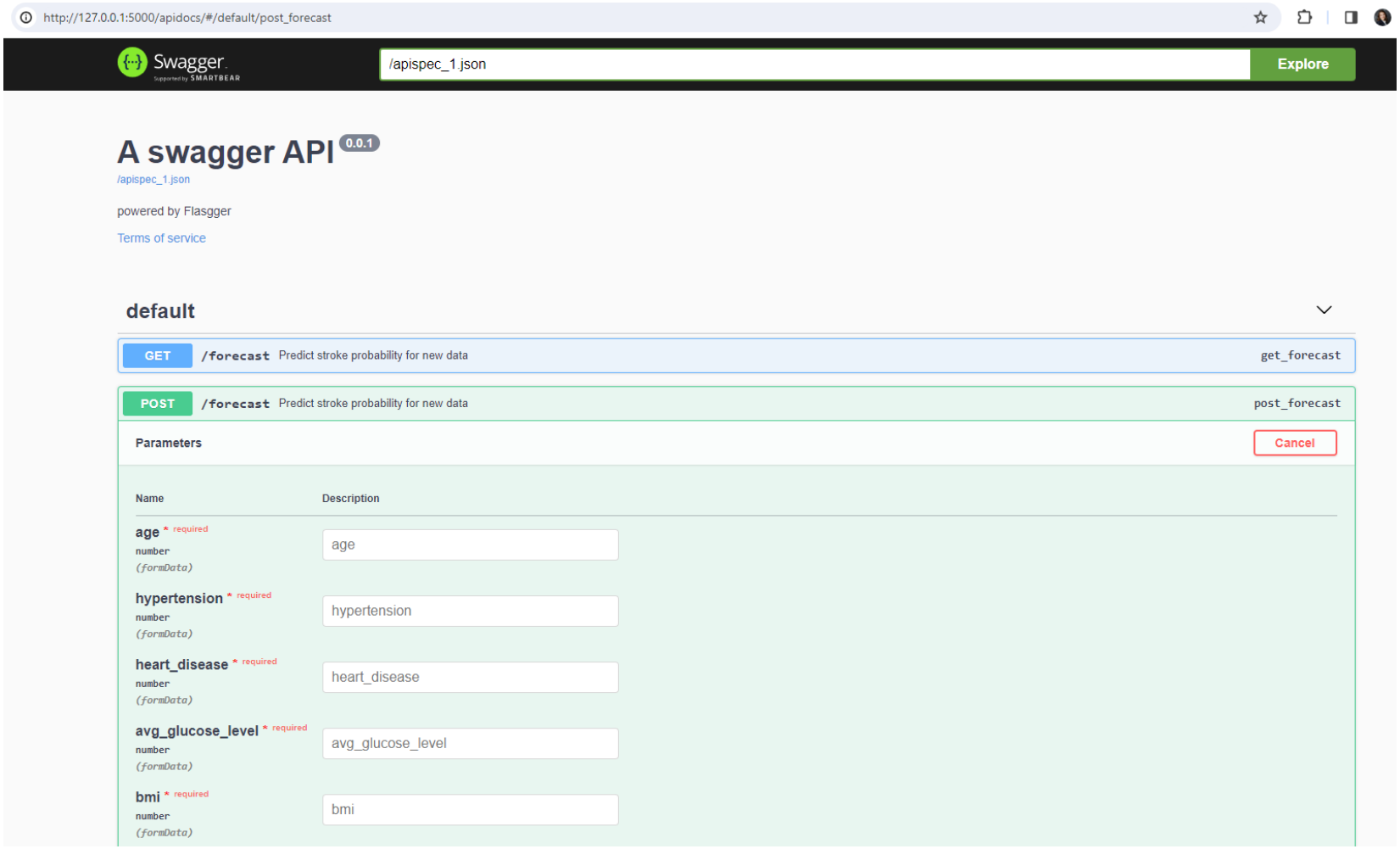
12) stroke: 1 if the patient had a stroke or 0 if not

```python
def create_pipeline():
    # Create a pipeline with preprocessing and model
    preprocessor = create_data_preprocessor()
    pipeline = Pipeline([
        ('preprocessor', preprocessor),
        ('model', DecisionTreeClassifier(random_state=42))
    ])
    return pipeline
```

Data, Model, App: Live Demo

Flask Docs & Minimal Example

Swagger GitHub repo & Docs



Data, Model, App, Docker: Live Demo

Useful commands:

```
python main.py
python app.py

docker build -t api .
docker run -p 5000:5000 api
docker images
docker rmi -f XXX
docker ps
```

Google Cloud CLI Documentation

Install the gcloud CLI to communicate with Google Cloud Platform through your terminal:

Google Cloud Command Line Interface

Configure Cloud sdk

- Authenticate the `gcloud` CLI with the google account you used for GCP

```
gcloud auth login --no-launch-browser
```

- Login to your Google account on the new tab opened in your web browser
- List your active account and check your email address you used for GCP is present

```
gcloud auth list
```

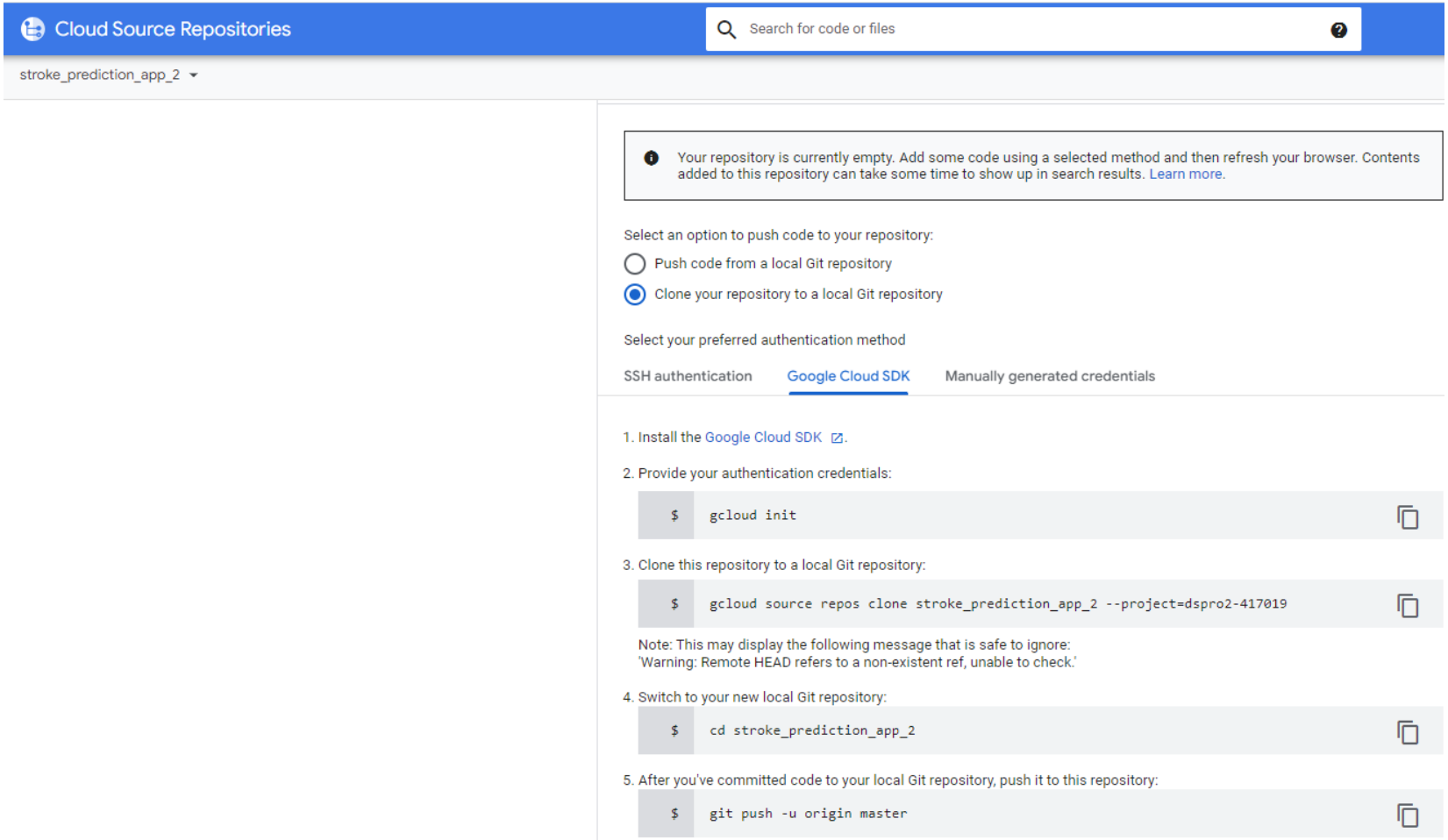
- Set your current project (replace `PROJECT_ID` with the `ID` of your project, e.g. *DSPRO2*

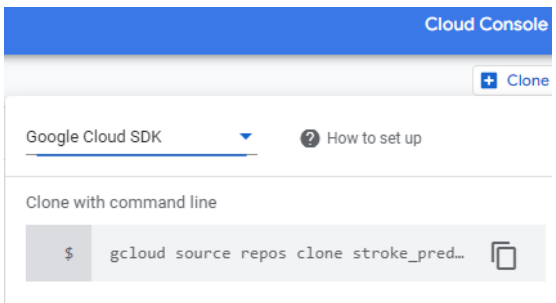
```
gcloud config set project PROJECT_ID
```

- List your active account and current project and check your project is present

```
gcloud config list
```

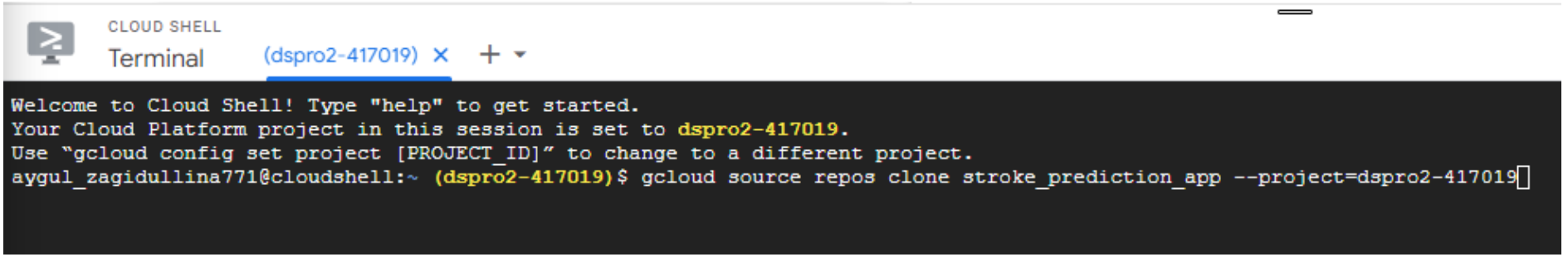
Cloud Source Repositories





Cloud Shell Commands: Docker

- Copy the repository:



- Define the project ID variable
- Create the Docker image and assign a tag to it
- Provide Google authentication to be able to push Docker image to Google Container Registry
  Docker image to Registry

```
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ gcloud source repos clone stroke_prediction_app --project=dspro2-417019
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ cd stroke_prediction_app
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ export PROJECT_ID=dspro2-417019
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ docker build -t gcr.io/${PROJECT_ID}/stroke-prediction:v1 .
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ gcloud auth configure-docker
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ docker push gcr.io/${PROJECT_ID}/stroke-prediction:v1
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$
```

Cloud Shell Commands: GKE

- Set up project configurations:

```
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ gcloud config set project $PROJECT_ID
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ gcloud config set compute/zone asia-northeast3-b
aygul_zagidullina771@cloudshell:~ (dspro2-417019)$ gcloud container clusters create stroke-cluster --num-nodes=2
```

- Deploy application on Kubernetes cluster
- Expose deployed application on the port 5000
- Verify that services are running

```
cloudshell:~ (dspro2-417019)$ gcloud config set project $PROJECT_ID
cloudshell:~ (dspro2-417019)$ gcloud config set compute/zone asia-northeast3-b
cloudshell:~ (dspro2-417019)$ gcloud container clusters create stroke-cluster --num-nodes=2
```

- Kubernetes will show external IP address once the application is deployed. We can use it together with the port to access the Swagger API.

Cloud Shell Commands: Finalize

Don't forget to check which clusters are running and delete them (not to incur any charges)!

```
cloudshell:~ (dspro2-417019)$ gcloud container clusters list
cloudshell:~ (dspro2-417019)$ gcloud container clusters delete stroke-cluster
```

Bonus/Optional ! ResNet Prediction/Tensorflow/GKE