COMP4651 Project - Serverless Image Recognizer

Deadline: 11:59 pm, May 9 (Sunday)

Name	Student ID	Email
Kyler, Tang Chun Yi	2061 9766	cytangao@connect.ust.hk
Chan Yui Ming	2061 9986	ymchanam@connect.ust.hk

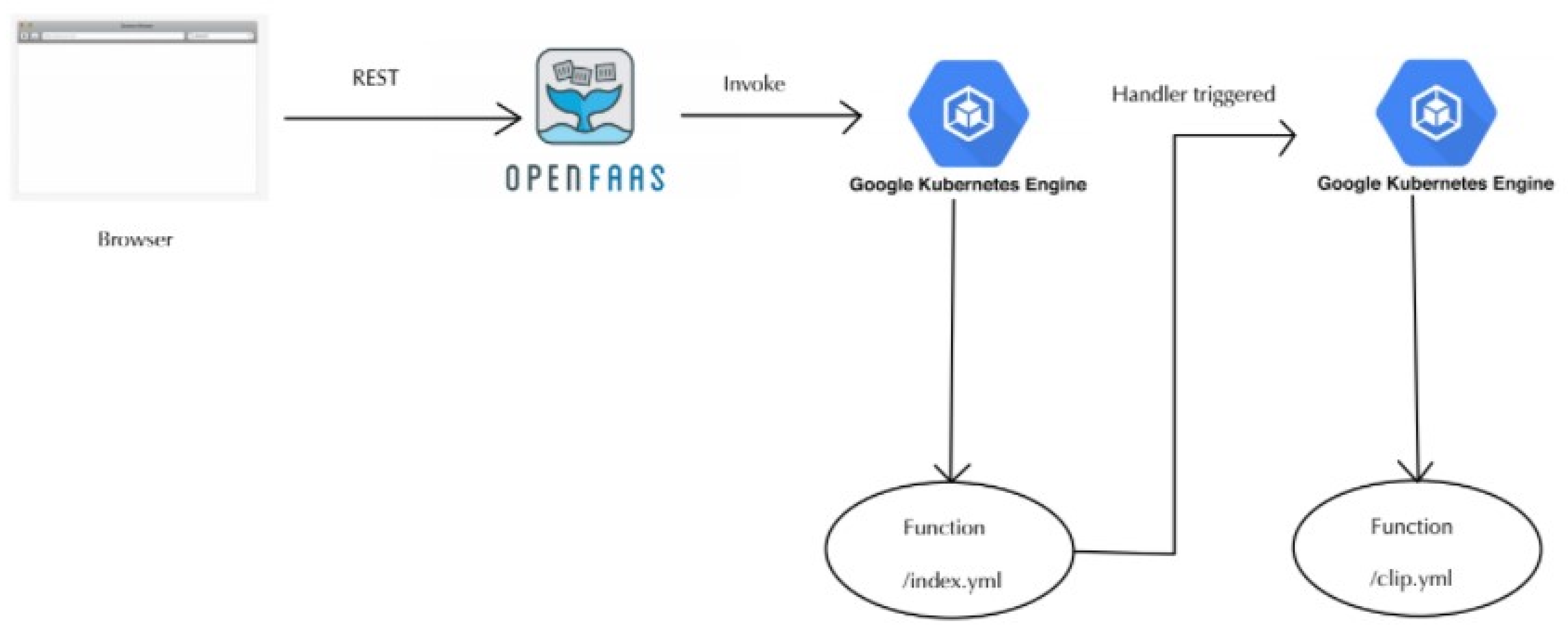
Application Description

Application link : http://35.239.220.129:8080/function/index

Overview

The is a web application to perform image recognition for classification. The backend demonstrates how to use OpenFaaS to maintain the web function and the python classification model. The workflow processes the image upload to the web service and copies the image to the python function to perform the classification process. It then returns the classification label to the web function and responds to the request from the browser.

This repository contains sample code for all the OpenFaaS functions. The font-end repository contains the web application code and the back-end repository mainly contains the python code for image processing. The workflow of the OpenFaaS is depicted as follows.



Architecture

1. A web request is handled by the OpenFaaS maintaining with the google cloud Kubernetes.
2. An image is uploaded and handled by the front-end (/index) OpenFaaS function.
3. The front-end function triggers the handler of the back-end OpenFaaS function.
4. The back-end function performs the image recognition by the CLIP model.

Classification Model

In this project, we use a deep neural network model named Connecting Text and Images(CLIP), which is a zero-shot image classifier combining encoded text and images to aim to generalize to correctly predicting objects outside the original training set. In addition, although the model classification performance is proportional to the size of label classes, it will dramatically prolong the computation and response time if we increase the size. Therefore, we use CIFAR-100 for the testing dataset which is a subset of tiny images dataset. It consists of 60,000 testing images and 100 classes, which are suitable for our case to allow us to keep the response time within 20 seconds.

Implementation Procedures

Pre-preparation

Sign up account

- Amazon Web Services
- Docker Hub
- Google Cloud

Environment Setup

Google Cloud

- Creating Project
- Enable billing for the project

Amazon Web Services

- Create and launch EC2 instance

Development Environment

Linux Server

- System : `Ubuntu Server 18.04 LTS (HVM),EBS General Purpose (SSD)`
- Instance Type : `t3.micro`
- Volume size : `16 GiB`

SSH Client

- Software : Visual Studio Code (1.54)

Prepare for OpenFaaS

Install Docker CE

Set up the repository

```
sudo apt-get update

sudo apt-get install \
    apt-transport-https \
    ca-certificates \
    curl \
    gnupg \
    lsb-release

curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /usr/share/keyrings/docker-archive-keyring.gpg

echo \
  "deb [arch=amd64 signed-by=/usr/share/keyrings/docker-archive-keyring.gpg] https://download.docker.com/linux/ubuntu \
  $(lsb_release -cs) stable" | sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
```

Install Docker Engine

```
sudo apt-get update

sudo apt-get install docker-ce docker-ce-cli containerd.io
```

Log into Docker Hub

```
export OPENFAAS_PREFIX="<Docker Hub username>"

sudo docker login
```

Install OpenFaas CLI

```
curl -sLSf https://cli.openfaas.com | sudo sh
```

Set-up OpenFaaS with Kubernetes

Install kubectl

```
export VER=$(curl -s https://storage.googleapis.com/kubernetes-release/release/stable.txt)

curl -LO https://storage.googleapis.com/kubernetes-release/release/$VER/bin/linux/amd64/kubectl

chmod +x kubectl

mv kubectl /usr/local/bin/
```

Create a remote cluster on Google Kubernetes Engine

Install Google Cloud SDK

```
echo "deb [signed-by=/usr/share/keyrings/cloud.google.gpg] https://packages.cloud.google.com/apt cloud-sdk main" | sudo tee -a
/etc/apt/sources.list.d/google-cloud-sdk.list

sudo apt-get install apt-transport-https ca-certificates gnupg

curl https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo apt-key --keyring /usr/share/keyrings/cloud.google.gpg add -

sudo apt-get update && sudo apt-get install google-cloud-sdk
```

Configure project

```
gcloud init

gcloud config set project <PROJECT_ID>

gcloud config set compute/region <region>

gcloud config set compute/zone <zone>
```

Enable the Kubernetes service

```
gcloud services enable container.googleapis.com
```

Install kubectl

```
gcloud components install kubectl
```

Create a Kubernetes cluster

```
gcloud container clusters create openfaas \
--zone=<zone> \
--num-nodes=1 \
--machine-type=n1-standard-2 \
--disk-size=30 \
--no-enable-cloud-logging
```

Set up credentials for kubectl

```
gcloud container clusters get-credentials openfaas
```

Create a cluster admin role binding

```
sudo kubectl create clusterrolebinding "cluster-admin-$(whoami)" \
--clusterrole=cluster-admin \
--user="$(gcloud config get-value core/account)"
```

Install OpenFaaS with arkade

Install arkade

```
curl -SLsf https://dl.get-arkade.dev/ | sudo sh
```

Get external ip

```
sudo kubectl get svc -o wide gateway-external -n openfaas
```

Log in

```
export OPENFAAS_URL="<external ip>"

PASSWORD=$(kubectl get secret -n openfaas basic-auth -o jsonpath="{.data.basic-auth-password}" | base64 --decode; echo)

echo -n $PASSWORD | faas-cli login --username admin --password-stdin
```

Create Functions

Clone project repository

Through HTTPS

```
cd ~

git clone https://github.com/hkust-comp4651-21S/project-serverless-image-recognizer.git
```

Through SSH

- Follow the steps: Connecting to GitHub with SSH

```
cd ~

git clone git@github.com:hkust-comp4651-21S/project-serverless-image-recognizer.git
```

Create working directories

```
cd ~

mkdir -p project \
   && cd project

mkdir frontend backend
```

Create front-end interface function

Scaffold a Python 3 function

```
cd ~/project/frontend

sudo faas-cli new --lang python3 index --prefix="<docker username>"
```

Edit index.yml

```
version: 1.0
provider:
  name: openfaas
  gateway: http://<external ip>:8080
functions:
  index:
    lang: python3
    handler: ./index
    image: <docker username>/index:latest
    environment:
        content_type: text/html
```

Copy front-end documents

```
cd ~/project-serverless-image-recognizer/src/frontend/index/

cp * ~/project/frontend/index/
```

Deploy front-end interface function

```
cd ~/project/frontend/

sudo faas-cli up -f index.yml
```

```
faas-cli deploy -f index.yml
```

Create back-end interface function

Scaffold a Python 3(debian) function

```
cd ~/project/backend/

sudo faas-cli new --lang python3-debian clip --prefix="<docker username>"
```

Edit clip.yml

```
version: 1.0
provider:
  name: openfaas
  gateway: http://<external ip>:8080
functions:
  clip:
    lang: python3-debian
    handler: ./clip
    image: <docker username>/clip:latest
  environment:
    read_timeout: "60s"
    write_timeout: "60s"
    exec_timeout: "60s"
```

Copy back-end documents

```
cd ~/project-serverless-image-recognizer/src/backend/clip/

cp * ~/project/backend/clip/
```

Copy dockerfile template

```
cd ~/project-serverless-image-recognizer/src/backend/template/python3-debian/

cp * ~/project/backend/template/python3-debian/
```

Deploy back-end interface function

```
cd ~/project/backend/

sudo faas-cli up -f clip.yml

faas-cli deploy -f clip.yml
```

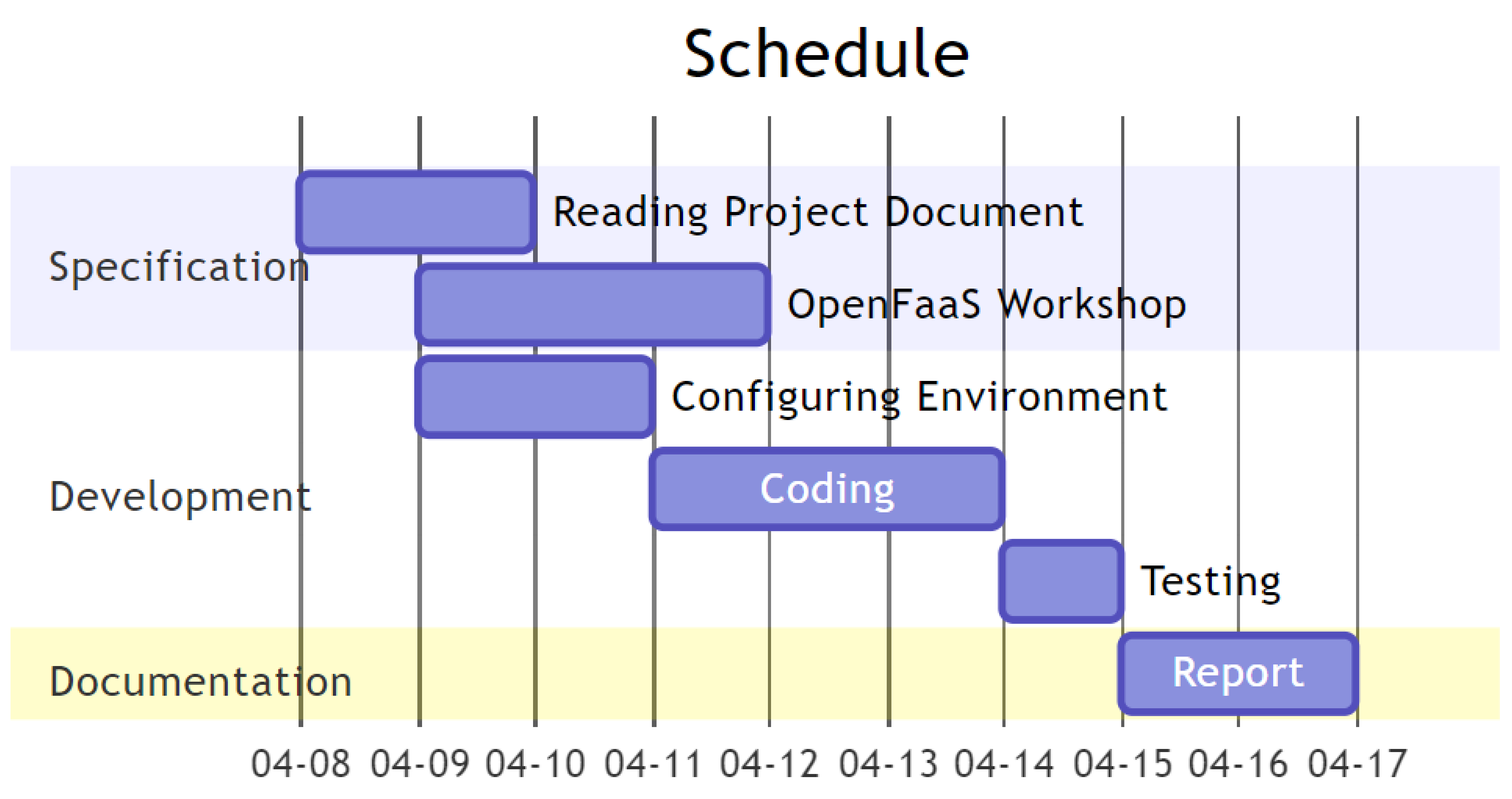
Initialize back-end interface function

```
# ignore any error
echo | faas-cli invoke clip
```

Test Web Application

1. Open web page on : `http://<external ip>:8080/function/index`
2. Click `GET START`
3. Upload an image from `hkust-comp4651-21S/project-serverless-image-recognizer/test/` OR anywhere
4. Test the result
5. Click `GO BACK`
6. Repeat step 2 - step 5

Project Timeline



Appendix

Last Update : 08 - 05 - 2021

A. Ellis, K. Fukuyama, L. Roesler, V. Singh and A. Hey, "openfaas/workshop", GitHub, 2021. [Online]. Available: https://github.com/openfaas/workshop. [Accessed: 09- Apr- 2021].

A. Radford, I. Sutskever, J. Kim, G. Krueger and S. Agarwal, "CLIP: Connecting Text and Images", OpenAI, 2021. [Online]. Available: https://openai.com/blog/clip/. [Accessed: 12- Apr- 2021].

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