



Automated Essay Scoring System with Kubernetes



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Table of Contents

- Introduction
- Design
- Setup Virtual Environment
- Integration of AES system
- Kubernetes Deployment
- Test
- Conclusion

Introduction

The AES system designed on two stage approach.

At the first deep learning model to create text-summary and second stage grading the student essay by comparing with instructor essay summary.

Built on Python Flask and PyTorch and developed by SFBU students (Zhou Quan, Thanga Rani Prabhu, Chris Zhang)

It's running on GCP with Kubernetes deployment platform.

Design

Step 1 Create a new project on GCP for this project work.

Select from MAIL.NPU.EDU ▾ NEW PROJECT ⋮

Search projects and folders

Q |

RECENT STARRED ALL

Select the project that you created and open the GCP terminal windows.

New Project

⚠ You have 22 projects remaining in your quota. Request an increase or delete projects. [Learn more](#)

[MANAGE QUOTAS](#)

Project name *
cs571-aes-project ?

Project ID: cs571-aes-project. It cannot be changed later. [EDIT](#)

Organization *
mail.npu.edu ▾ ?

Select an organization to attach it to a project. This selection can't be changed later.

Location *
mail.npu.edu [BROWSE](#)

Parent organization or folder

[CREATE](#) [CANCEL](#)

Design

Step 2 To host the AES project on GKE cluster

Create and launch the new **aes-project** Kubernetes cluster

```
gcloud container clusters create aes-project --num-nodes=1 --machine-type=e2-micro --region=us-west1
```

```
patel19619@cloudshell:~ (cs571-aes-project)$ gcloud container clusters create aes-project --num-nodes=1 --
machine-type=e2-micro --region=us-west1
Default change: VPC-native is the default mode during cluster creation for versions greater than 1.21.0-gk
e.1500. To create advanced routes based clusters, please pass the `--no-enable-ip-alias` flag
Note: Your Pod address range (`--cluster-ipv4-cidr`) can accommodate at most 1008 node(s).
Creating cluster aes-project in us-west1... Cluster is being health-checked (master is healthy)..
.done.
Created [https://container.googleapis.com/v1/projects/cs571-aes-project/zones/us-west1/clusters/aes-projec
t].
To inspect the contents of your cluster, go to: https://console.cloud.google.com/kubernetes/workload/_gclo
ud/us-west1/aes-project?project=cs571-aes-project
kubeconfig entry generated for aes-project.
NAME: aes-project
LOCATION: us-west1
MASTER_VERSION: 1.21.6-gke.1503
MASTER_IP: 34.145.112.181
MACHINE_TYPE: e2-micro
NODE_VERSION: 1.21.6-gke.1503
NUM_NODES: 3
STATUS: RUNNING
```

Setup Virtual Environment

Download the latest Anaconda Miniconda shell script

wget

https://repo.anaconda.com/miniconda/Miniconda3-latest-Linux-x86_64.sh

Execute the miniconda installation script

chmod +x Miniconda3-latest-Linux-x86_64.sh
./Miniconda3-latest-Linux-x86_64.sh

```
(base) patel19619@cloudshell:~/final_project$ wget https://repo.anaconda.com/miniconda3-latest-Linux-x86_64.sh
--2022-04-06 03:34:16-- https://repo.anaconda.com/miniconda/Miniconda3-latest-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.131.3, 104.16.130.3, 104.16.132.3, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.131.3|:443... connected
HTTP request sent, awaiting response... 200 OK
Length: 75660608 (72M) [application/x-sh]
Saving to: 'Miniconda3-latest-Linux-x86_64.sh.1'

Miniconda3-latest-Linux 100%[=====>] 72.16M 165MB/s
```

```
(base) patel19619@cloudshell:~/final_project$ ./Miniconda3-latest-Linux-x86_64.sh
Welcome to Miniconda3 py39_4.11.0

In order to continue the installation process, please review the license
agreement.
Please, press ENTER to continue
>>>
=====
End User License Agreement - Miniconda
=====

Copyright 2015-2021, Anaconda, Inc.

All rights reserved under the 3-clause BSD License:
```

Activate a Virtual Environment

Create and activate a Python environment

```
conda create -n myenv python=3.6
```

```
(base) patel19619@cloudshell:~/final_project$ conda create -n myenv python=3.6
WARNING: A conda environment already exists at '/home/patel19619/miniconda3/envs/myenv'
Remove existing environment (y/[n])? y

Collecting package metadata (current_repodata.json): done
Solving environment: done

==> WARNING: A newer version of conda exists. <==
  current version: 4.11.0
  latest version: 4.12.0

Please update conda by running

  $ conda update -n base -c defaults conda
```

```
conda activate myenv
```

```
(base) patel19619@cloudshell:~/final_project$ conda activate myenv
(myenv) patel19619@cloudshell:~/final_project$
```

Integration of AES system

Clone the SFBU students AES Github Project

```
git clone https://github.com/Quan25/flask-summary.git aes_project (directory name)
```

Download rough.zip dependency file

```
wget --load-cookies /tmp/cookies.txt  
"https://docs.google.com/uc?export=download&confirm=$(wget --quiet  
--savecookies /tmp/cookies.txt --keep-session-cookies --no-check-certificate  
'https://drive.google.com/file/d/1RxfZOYyNvzvCf37_vABfJMkohAsEZKtH/' -O- | sed -  
rn 's/\.confirm=([0-9A-Za-z_]+).\/1\n/p')&id=1RxfZOYyNvzvCf37_vABfJMkohAsEZKtH"  
-O rough.zip && rm -rf /tmp/cookies.txt
```


Download Python Dependencies

Extract the rough.zip file

```
unzip rough.zip
```

Download the following dependencies

```
sudo apt-get install libxml-parser-perl
```

```
sudo cpan install XML::Parser::PerlSAX
```

```
sudo cpan install XML::RegExp
```

```
sudo cpan install XML::DOM
```

```
./runROUGE-test.pl
```

Download Python Dependencies

Install pyrouge library

```
git clone https://github.com/bheinzerling/pyrouge.git  
cd pyrouge  
pip3 install -e .
```

```
(myenv) patel19619@cloudshell:~/.../RELEASE-1.5.5/pyrouge$ pip install -e .  
Obtaining file:///home/patel19619/final_project/aes_project/RELEASE-1.5.5/pyrouge  
Installing collected packages: pyrouge  
  Running setup.py develop for pyrouge  
Successfully installed pyrouge-0.1.3
```

Integration Of Deep Learning Model

Download the bert-large-uncased-model on Home directory

```
wget https://s3.amazonaws.com/models.huggingface.co/bert/bert-large-uncased.tar.gz
```

Change the path on BertParent.py file

```
# from
self.model = BertModel.from_pretrained('/home/quantum/Downloads/bert-large-uncased')
# to
self.model = BertModel.from_pretrained('/home/your_username/bert-large-uncased.tar.gz')
```

```
self.model = BertModel.from_pretrained('/home/patel19619/final_project/
aes_project/bert-large-uncased.tar.gz')
self.tokenizer = self.token_handler[model_type].from_pretrained(self.
```

Download Python Dependencies

```
pip3 install torch torchvision torchaudio --extra-index-url
```

```
https://download.pytorch.org/whl/cpu
```

```
pip3 install flask pandas sklearn nltk
```

```
pip3 install gensim==3.8.3
```

```
pip3 install pytorch-pretrained-bert
```

```
pip3 install matplotlib==3.0.1
```

```
$ python3
```

```
>import nltk
```

```
>nltk.download('punkt')
```

Run AES system on local machine

`python3 app.py`

Use Web Preview and change the port to 5000

```
(myenv) patel19619@cloudshell:~/final_project
* Serving Flask app 'app' (lazy loading)
* Environment: production
  WARNING: This is a development server. Do not use it in production.
  Use a production WSGI server instead.
* Debug mode: on
WARNING:werkzeug: * Running on all addresses
WARNING: This is a development server. Do not use it in production.
INFO:werkzeug: * Running on http://172.17.0.1:5000
INFO:werkzeug: * Restarting with stat
WARNING:werkzeug: * Debugger is active!
INFO:werkzeug: * Debugger PIN: 230-025-357
```

Change Preview Port

Port Number *

CANCEL

CHANGE AND PREVIEW

Run AES System on local machine

Add text on the to text box and select to summarize as Instructor/Student and press submit

Please paste the contents that you want to summarize:

The hacking group known as APT29, or "Cozy Bear," is largely believed to operate as part of Russia's security services, and the three countries allege that it is carrying out a persistent and ongoing cyber campaign to steal intellectual property about a possible coronavirus vaccine.

☒ Add To Instructor

☐ Add To Student

 20%

submit

Grade Students

Reset

Potential Summary:

Russia is facing renewed scrutiny for its cyber espionage efforts after the U. S. , Great Britain and Canada alleged Thursday that a Kremlin-linked hacking group is attempting to steal research related to coronavirus vaccine developments and testing.

Total Time cost:25.02s

Configuration

Hosting the AES system with Kubernetes and docker.

Create the Docker hub repository

Create a Docker file

```
FROM ubuntu:20.04

ENV TZ=America/Los_Angeles
RUN ln -snf /usr/share/zoneinfo/$TZ /etc/localtime && echo $TZ > /etc/timezone
RUN mkdir -p /home/project/

COPY rough.zip /home/project/
COPY punktDownload.py /home/project/
COPY bert-large-uncased.tar.gz /home/project/

WORKDIR /home/project/
RUN apt-get update -y
RUN apt-get upgrade -y
RUN apt-get install -y build-essential python3-pip libxml-parser-perl unzip git
RUN apt-get install -y pkg-config libpng-dev libfreetype6-dev freetype2-demos

RUN unzip rough.zip
RUN cpan install XML::Parser::PerlSAX
RUN cpan install XML::RegExp
RUN cpan install XML::DOM

WORKDIR /home/project/RELEASE-1.5.5
RUN ./runROUGE-test.pl
```

Build the docker image

```
patel19619@instance-1:~$ sudo docker build -t cs571/aes .
Sending build context to Docker daemon 2.932GB
Step 1/33 : FROM ubuntu:20.04
--> 825d55fb6340
Step 2/33 : ENV TZ=America/Los_Angeles
--> Using cache
--> 82dcb7b71838
Step 3/33 : RUN ln -snf /usr/share/zoneinfo/$TZ /etc/localtime && echo $TZ > /etc/timezone
--> Using cache
--> 0f6154791a0b
Step 4/33 : RUN mkdir -p /home/project/
--> Using cache
--> 0bd0b11801bf
Step 5/33 : COPY rough.zip /home/project/
--> 0aaff57fd5b9
Step 6/33 : COPY punktDownload.py /home/project/
--> 85e1be8ba01d
Step 7/33 : COPY bert-large-uncased.tar.gz /home/project/
```

Configuration

Push image to Docker hub

Run the created docker image

```
docker run -p 5000:5000 -t your_dockerhub_ID/repository_name
```

```
patell19619@instance-1:~$ docker run -p 5000:5000 -t cs571/aes
* Serving Flask app 'app' (lazy loading)
* Environment: production
  WARNING: This is a development server. Do not use it in a production deployment.
  Use a production WSGI server instead.
* Debug mode: on
INFO:werkzeug: * Running on all addresses (0.0.0.0)
  WARNING: This is a development server. Do not use it in a production deployment.
* Running on http://127.0.0.1:5000
* Running on http://172.17.0.2:5000 (Press CTRL+C to quit)
INFO:werkzeug: * Restarting with stat
WARNING:werkzeug: * Debugger is active!
INFO:werkzeug: * Debugger PIN: 514-278-626
```


Configuration on Kubernetes

To host the system on GCP for users

minikube start

```
patel19619@cloudshell:~/aes-project$ minikube start
😄 minikube v1.25.2 on Debian 11.2 (amd64)
  ▪ MINIKUBE_FORCE_SYSTEMD=true
  ▪ MINIKUBE_HOME=/google/minikube
  ▪ MINIKUBE_WANTUPDATENOTIFICATION=false
🌟 Automatically selected the docker driver. Other choices:
👍 Starting control plane node minikube in cluster minikube
📦 Pulling base image ...
📦 Downloading Kubernetes v1.23.3 preload ...
  > preloaded-images-k8s-v17-v1...: 505.68 MiB / 505.68 MB
🔥 Creating docker container (CPUs=2, Memory=4000MB) ...
🏠 Preparing Kubernetes v1.23.3 on Docker 20.10.12 ...
  ▪ kubelet.cgroups-per-qos=false
  ▪ kubelet.enforce-node-allocatable=""
  ▪ kubelet.housekeeping-interval=5m
  ▪ Generating certificates and keys ...
  ▪ Booting up control plane ...
  ▪ Configuring RBAC rules ...
🔍 Verifying Kubernetes components...
  ▪ Using image gcr.io/k8s-minikube/storage-provisioner:v
🌟 Enabled addons: storage-provisioner, default-storageclass
🏠 Done! kubectl is now configured to use "minikube" cluster
```

minikube addons enable ingress

freshpod	minikube	disabled	google
gcp-auth	minikube	disabled	google
gvisor	minikube	disabled	google
helm-tiller	minikube	disabled	third-party (helm)
ingress	minikube	enabled	unknown (third-party)
ingress-dns	minikube	disabled	google
istio	minikube	disabled	third-party (istio)
istio-provisioner	minikube	disabled	third-party (istio)
kang	minikube	disabled	third-party (Kang-IO)

Configuration on Kubernetes

Create the deployment and service yaml file

vim aes-project-deployment.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: aes-deployment
spec:
  selector:
    matchLabels:
      app: aes-deployment
  replicas: 1
  template:
    metadata:
      labels:
        app: aes-deployment
    spec:
      containers:
        - name: aes-deployment
          image: cs571/aes
          ports:
            - containerPort: 5000
```

vim aes-project-service.yaml

```
apiVersion: v1
kind: Service
metadata:
  name: aes-service
spec:
  selector:
    app: aes-deployment
  ports:
    - protocol: TCP
      port: 5000
      targetPort: 5000
```

Configuration on Kubernetes

vim aes-ingress.yaml

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: aes-ingress
  annotations:
    nginx.ingress.kubernetes.io/rewrite-target: /$2
spec:
  rules:
    - host: cs571.aesproject.com
      http:
        paths:
          - path: /
            pathType: Prefix
            backend:
              service:
                name: aes-service
                port:
                  number: 5000
```

Build the deployment, service and ingress file

kubectl apply -f aes-deployment.yaml

kubectl apply -f aes-service.yaml

kubectl apply -f aes-ingress.yaml

Kubectl get ingress

```
patel19619@cloudshell:~/aes-project$ kubectl get ingress
NAME           CLASS    HOSTS           ADDRESS          PORTS   AGE
aes-ingress    nginx    aesproject.com  192.168.49.2     80      118s
```

Configuration on Kubernetes

Add the IP address mentioned on get ingress result to end of the file

```
vi /etc/hosts
```

```
# Kubernetes-managed hosts file.
127.0.0.1    localhost
::1         localhost ip6-localhost ip6-loopback
fe00::0     ip6-localnet
fe00::0     ip6-mcastprefix
fe00::1     ip6-allnodes
fe00::2     ip6-allrouters
172.17.0.4   cs-810844977107-default
192.168.49.2 cs571.aesproject.com
```

```
kubectl get all
```

```
patel19619@cloudshell:~/aes-project$ kubectl get all
NAME                                READY   STATUS    RESTARTS   AGE
pod/aes-deployment-575cffc449-5hmbm 1/1     Running   0           5m47s

NAME                                TYPE          CLUSTER-IP    EXTERNAL-IP  PORT(S)    AGE
service/aes-service                 ClusterIP     10.111.168.108 <none>       5000/TCP   5m29s
service/kubernetes                   ClusterIP     10.96.0.1      <none>       443/TCP    46m

NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/aes-deployment       1/1     1             1           5m47s

NAME                                DESIRED   CURRENT   READY   AGE
replicaset.apps/aes-deployment-575cffc449 1         1         1       5m47s
```

Run the Application with Domain name

Go to Web browser and search **cs571.aesproject.com**

Please paste the contents that you want to summarize:

The Minute Man is an 1874 sculpture by Daniel Chester French located in Minute Man National Historical Park in Concord, Massachusetts. The statue depicts a minuteman stepping away from his plow to join the patriot forces at the Battle of Concord, with a musket in his hand. Cast from ten bronze cannons, it was unveiled on April 19, 1875, during the centennial

☒ Add To Instructor

☐ Add To Student

 20%

submit

Grade Students

Reset

Potential Summary:

The Minute Man is an 1874 sculpture by Daniel Chester French located in Minute Man National Historical Park in Concord, Massachusetts. The statue depicts a minuteman stepping away from his plow to join the patriot forces at the Battle of Concord, with a musket in his hand.

Total Time cost:85.24s

Instructor Essay Summary

• Instructor:

Essay Summary: The Minute Man is an 1874 sculpture by Daniel Chester French located in Minute Man National Historical Park in Concord, Massachusetts. The statue depicts a minuteman stepping away from his plow to join the patriot forces at the Battle of Concord, with a musket in his hand.

Student Grade Rank (From High to Low)

Student Score Percentile

Name	Student 2	Student 5	Student 1	Student 3	Student 4
student percentile	1.0	0.8	0.6	0.4	0.2

• Student Name: Student 2

Essay Summary: the first us deaths related to coronavirus might have occurred weeks earlier than previously thought

• Student Name: Student 5

Essay Summary: The Minute Man is an 1874 sculpture by Daniel Chester French located in Minute Man National Historical Park in Concord, Massachusetts. The statue depicts a minuteman stepping away from his plow to join the patriot forces at the Battle of Concord, with a musket in his hand.

• Student Name: Student 1

Essay Summary: the contagious respiratory illness continues to spread worldwide, health and government officials have asked every one of us to help slow the spread in our communities

• Student Name: Student 3

Essay Summary: the cdc recommend that all people wear cloth face masks in public places where it is difficult to maintain a 6-foot (2-meter) distance from others. this will help slow the spread of the virus from asymptomatic people and people who do not know that they have contracted it.

• Student Name: Student 4

Essay Summary: the entire speech requires about 10 minutes to read. there are two sections i wish to draw to your attention. the first principle is that you must not fool yourself