PROJECT TITLE :

Building and Deploying a Node.js Application with Azure Blob Storage Integration on Kubernetes Using Helm Charts

PROJECT OVERVIEW :

This project demonstrates the process of building and deploying a Node.js application integrated with Azure Blob Storage onto a Kubernetes cluster using Helm charts. The application retrieves content from Azure Blob Storage and serves it over HTTP. Key components of the project include:

Node.js Application: The core application written in Node.js fetches content from Azure Blob Storage and serves it over HTTP.

Azure Blob Storage: Content storage solution provided by Azure for storing files such as images, documents, and logs.

Kubernetes Cluster (AKS): A managed Kubernetes service on Azure used to orchestrate and manage containerized applications.

Helm Charts: Helm is used for managing Kubernetes applications. Helm charts define, install, and upgrade even the most complex Kubernetes applications.

Deployment Pipeline: A deployment pipeline automates the process of building, testing, and deploying the application onto the Kubernetes cluster.

Monitoring: Monitoring and logging mechanisms are integrated to track the health and performance of the application.

Throughout the project, emphasis is placed on best practices for containerization, deployment, and scalability to ensure the reliability and efficiency of the application in a production environment.

TABLE OF CONTENTS :

PREREQUISITES :

Prerequisites

Before starting with the setup, ensure you have the following prerequisites installed on your system:

- Node.js
- Docker
- Helm
- Azure CLI
- kubectl

You'll also need access to an Azure account and an Azure Kubernetes Service (AKS) cluster created.

Environment Setup

Follow these steps to set up your environment:

- Install Node.js from nodejs.org.
- Install Docker from docker.com.
- Install Helm by following the instructions on helm.sh.
- Install Azure CLI by following the instructions on docs.microsoft.com.
- Install kubectl by following the instructions on kubernetes.io.

Ensure that you have access to your Azure account and have permissions to create and manage resources

OBJECTIVES

The objectives of this project are as follows:

- Develop a simple HTTP application that retrieves data from Azure Blob Storage and returns it in JSON format upon query.
- Create a Dockerfile to containerize the application, making it portable and scalable.
- Build a Helm chart to deploy the application to an Azure Kubernetes Service (AKS) cluster, enabling easier management and scaling.
- Ensure proper configuration of the application via the Helm chart, including details for connecting to Azure Blob Storage.
- Implement a mechanism to validate the application's health, ensuring continuous availability and reliability.
- Organize all components of the application, including the code, Dockerfile, and Helm chart, into a single GitHub repository for easy access and version control.

Overall, the project aims to demonstrate the development, containerization, deployment, and management of a simple web application using Kubernetes, Helm, and Azure Blob Storage.

DEVELOPMENT

Application Development

This section covers the steps involved in developing the application and integrating it with Azure Blob Storage

Create Express.js Application: Set up an Express.js application to create the HTTP endpoints

- **Install Node.js**: If you haven't already, install Node.js from nodejs.org.

- **Initialize a Node.js project**: Create a new directory for your project and navigate into it. Then, initialize a new Node.js project using npm. Run the following commands in your terminal:

```
mkdir my-express-app
cd my-express-app
npm init -y
```

- **Install Express.js**: Install Express.js as a dependency for your project using npm:

```
npm install express
```

- **Create the main application file**: Create a file named app.js or index.js in your project directory. This will be the entry point for your Express application.

- **Set up Express.js**: Open the app.js (or index.js) file and set up your Express application. Here's a basic example to get you started:

```
const express = require('express');
const app = express();
const PORT = process.env.PORT || 3000; // Set the port for the server

// Define a route for the root URL
app.get('/', (req, res) => {
    res.send('Hello, World!');
});

// Define additional routes as needed

// Start the server
app.listen(PORT, () => {
    console.log(`Server is running on port ${PORT}`);
});
```

- **Run the application**: Save the changes to app.js and run your Express application using Node.js:

```
node app.js
```

Define routes for health checks and fetch data from Azure Blob Storage in your Express.js application

To define routes for health checks and fetching data from Azure Blob Storage in your Express.js application, follow these steps:

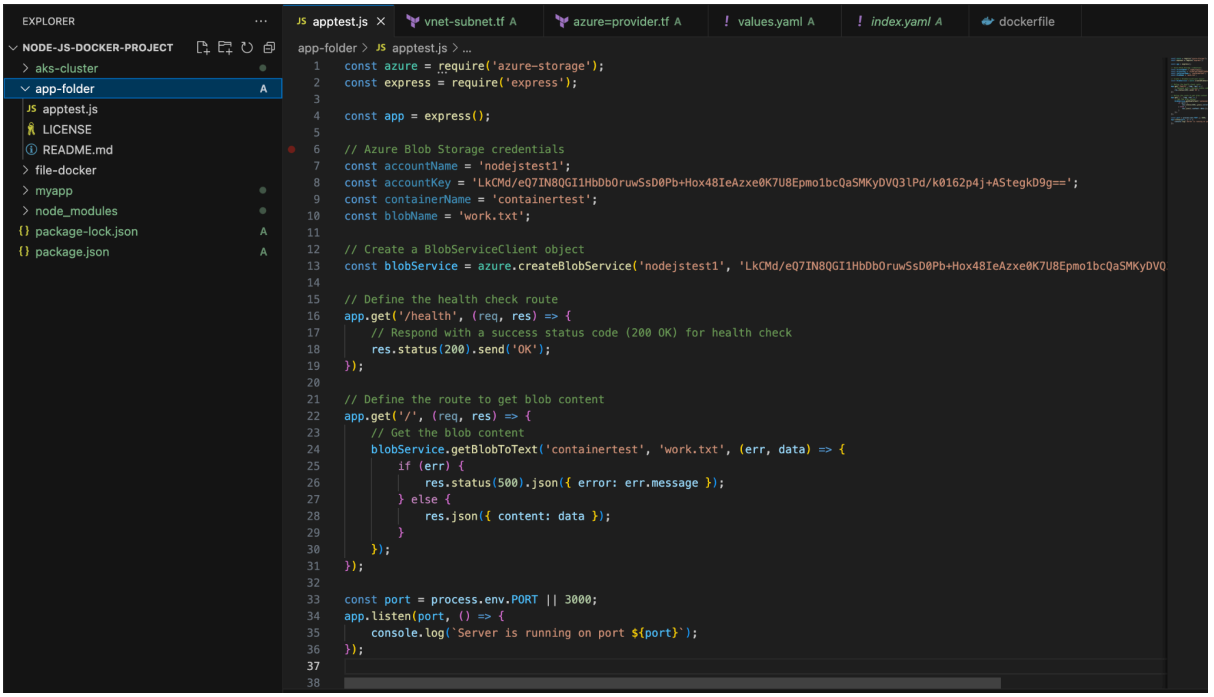
- Create an azure storage account either through the portal or terraform or azure cli And note down the access key

- Install the Azure Storage SDK package in your project to interact with Azure Blob Storage. Run the following command in your terminal

```
npm install @azure/storage-blob
```

- Define Routes: Open your app.js (or index.js) file and define routes for the health check and fetching data from Azure Blob Storage.here's an example of the code and Here's a screenshot of my app.js from my vscode

```
const express = require('express');
const { BlobServiceClient } = require('@azure/storage-blob');

const app = express();
const PORT = process.env.PORT || 3000;

// Health check route
app.get('/health', (req, res) => {
    res.status(200).send('OK');
});

// Route to fetch data from Azure Blob Storage
app.get('/fetch-data', async (req, res) => {
    try {
        // Connect to Azure Blob Storage
        const connectionString = '<YOUR_CONNECTION_STRING>';
        const blobServiceClient = BlobServiceClient.fromConnectionString(connectionString);

        // Fetch data from the blob
        const containerClient = blobServiceClient.getContainerClient('<CONTAINER_NAME>');
        const blobClient = containerClient.getBlobClient('<BLOB_NAME>');
        const downloadBlockBlobResponse = await blobClient.download();
        const downloadedContent = await streamToString(downloadBlockBlobResponse.readableStreamBody);

        // Send the fetched data as the response
        res.send(downloadedContent);
    } catch (error) {
        console.error('Error fetching data from Azure Blob Storage:', error);
        res.status(500).send('Internal Server Error');
    }
});

// Helper function to convert stream to string
async function streamToString(readableStream) {
    const chunks = [];
    for await (const chunk of readableStream) {
        chunks.push(chunk);
    }
    return Buffer.concat(chunks).toString();
}

// Start the server
app.listen(PORT, () => {
    console.log(`Server is running on port ${PORT}`);
});
```

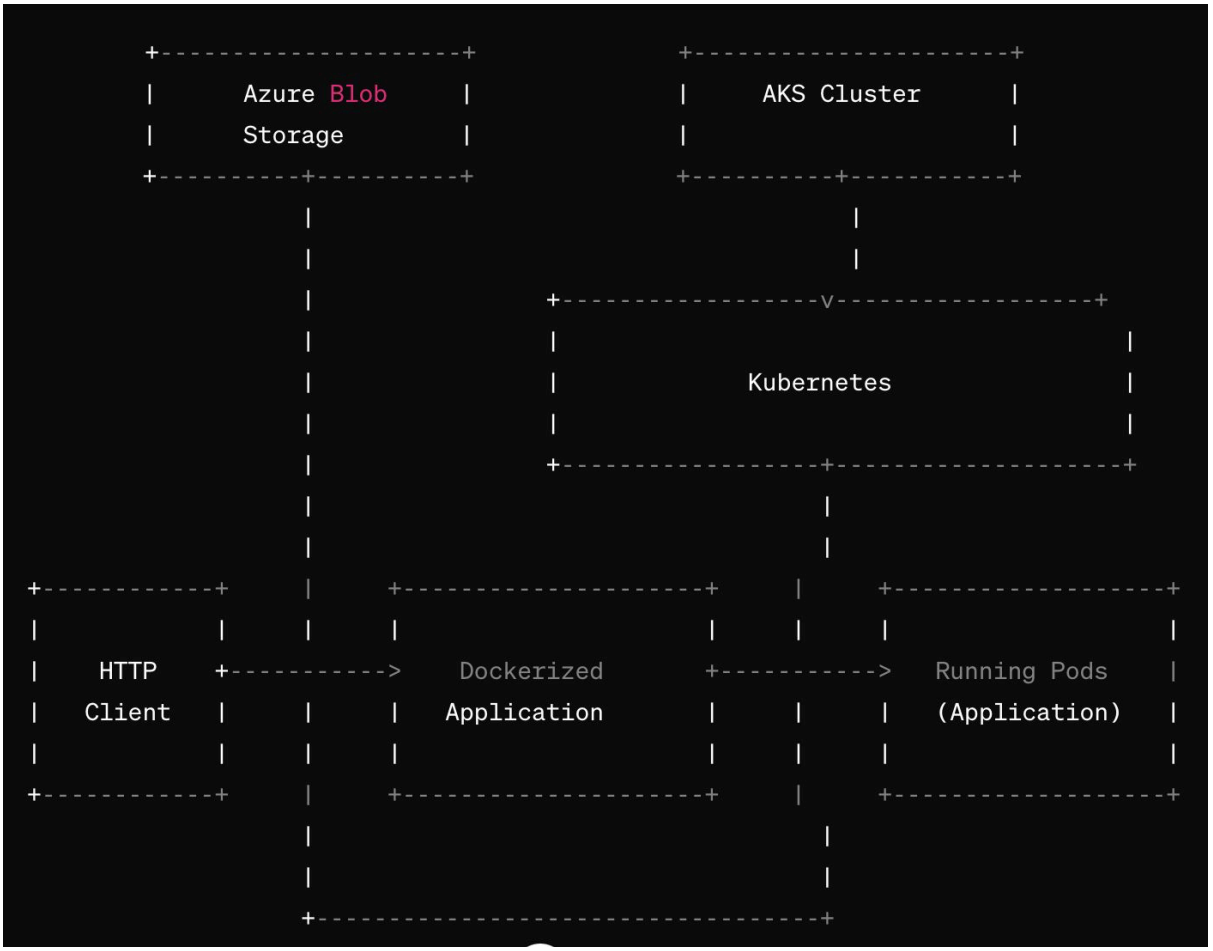


- Run the application - run the application through the ‘node app.js’ command

- Test the Endpoints: Use a tool like cURL or Postman to test the /health and /fetch-data endpoints i.e Health check: http://localhost:3000/health

DEPLOYMENT

Pictographic representation of the project's architecture



Azure Blob Storage: Used to store the content accessed by the HTTP application. This provides reliable and scalable storage for the application's data.

Dockerized Application: The HTTP application is containerized using Docker, allowing it to be easily deployed and managed across different environments.

AKS Cluster: Azure Kubernetes Service (AKS) is used to orchestrate and manage the Docker containers. The AKS cluster ensures scalability, availability, and resilience of the application.

Running Pods (Application): Within the AKS cluster, the Docker containers are scheduled as pods. These pods contain instances of the HTTP application, which serve incoming requests from clients.

HTTP Client: External users or systems interact with the HTTP application by sending requests to its endpoints. These requests are processed by the application, which retrieves content from Azure Blob Storage as needed.

This architecture enables the development of a scalable and reliable HTTP application that can efficiently retrieve content from Azure Blob Storage while being managed and orchestrated by Kubernetes in the AKS cluster.

Creating a dockerfile

In your root directory of the project, a dockerfile was created using a text editor like vscode and this is it the content

```
# Use an official Node.js runtime as the base image
FROM node:latest

# Set the working directory in the container
WORKDIR /usr/src/app

# Copy package.json and package-lock.json to the working directory
COPY package*.json ./

# Install Node.js dependencies
RUN npm install

# Copy the application code to the working directory
COPY . .

# Expose the port that the app runs on
EXPOSE 3000

# Define the command to run the application
CMD ["node", "app.js"]
```

Then run ‘docker build’

Deploying AKS Cluster

You can create an azure kubernetes cluster using terraform or cli, in my case i used terraform so here is the code i used for deploying the cluster

```
provider "azurerm" {
  features {}
}

resource "azurerm_resource_group" "aks" {
  name     = "<resource-group-name>"
  location = "<location>"
}

resource "azurerm_virtual_network" "aks_vnet" {
  name                = "aks-vnet"
  resource_group_name = azurerm_resource_group.aks.name
  location            = azurerm_resource_group.aks.location
  address_space       = ["10.0.0.0/8"]
}

resource "azurerm_subnet" "aks_subnet" {
  name                 = "aks-subnet"
  resource_group_name  = azurerm_resource_group.aks.name
  virtual_network_name = azurerm_virtual_network.aks_vnet.name
  address_prefixes     = ["10.240.0.0/16"]
}

resource "azurerm_kubernetes_cluster" "aks" {
  name                = "<cluster-name>"
  location            = azurerm_resource_group.aks.location
  resource_group_name = azurerm_resource_group.aks.name
  dns_prefix          = "<dns-prefix>"

  default_node_pool {
    name           = "default"
    node_count     = <node-count>
    vm_size        = "<vm-size>"
    os_disk_size_gb = <os-disk-size-gb>
  }

  tags = {
    Environment = "Production"
  }
}
```

Helm Chart Creation

a consolidated set of commands to create a Helm chart for your application:

Step 1: Create Helm Chart Structure

‘***helm create myapp***’

Step 2: Customize Chart Values (Optional)
Update values.yaml in the myapp directory with your configuration values

Step 3: Add Application Configuration
Place your application files in the appropriate directories in the templates folder

Step 4: Define Chart Metadata
Update Chart.yaml in the myapp directory with chart metadata

Step 5: Optional - Add Dependencies
Define dependencies in requirements.yaml and run helm dependency update

Step 6: Package the Chart

‘***helm package myapp***’

Step 7: Optional - Publish the Chart
Publish the packaged chart to a Helm repository (e.g., GitHub Pages)

Step 8: Use the Chart
Deploy the Helm chart to a Kubernetes cluster using helm install

‘helm install myapp ./myapp-<version>.tgz’

Deploying The App on the AKS Cluster

a consolidated step including all the commands for deploying your application to an AKS cluster:

- Connect to AKS Cluster
  'az aks get-credentials --resource-group <resourcegroupname> --name <clustername>'

- Start Application
  'python3 http.server 8879'

- Package Application
  'docker build -t myapp-image .'

- Push Container Image

'docker tag myapp-image <registryname>.azurecr.io/myapp-image:latest
docker push <registryname>.azurecr.io/myapp-image:latest'

- Create Kubernetes Deployment

```
cat <<EOF > deployment.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
name: myapp-deployment
spec:
replicas: 3
selector:
matchLabels:
app: myapp
template:
metadata:
labels:
app: myapp
spec:
containers:
- name: myapp
image: <registryname>.azurecr.io/myapp-image:latest
ports:
- containerPort: 8879
EOF
```

- Apply Deployment
  'kubectl apply -f deployment.yaml'

- Expose Service
  'kubectl expose deployment myapp-deployment --type=LoadBalancer
  --port=8879'

- Verify Application Startup

  'kubectl get pods'

- Access Application

  You can access your application using the external IP address provided by the load balancer.

TESTING

Verify Pods: Ensure that all pods are in a Running state by executing the command:

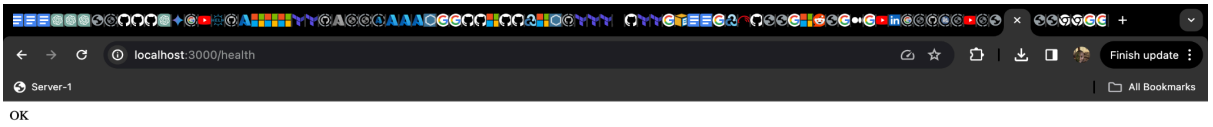
'kubectl get pods' (to verify it has been deployed on the aks cluster pods and is running)

```
→  myapp git:(main) ✗ kubectl get pods
NAME                    READY   STATUS    RESTARTS   AGE
myapp-fc5456dbd-wsspg   1/1     Running   0          53s
```

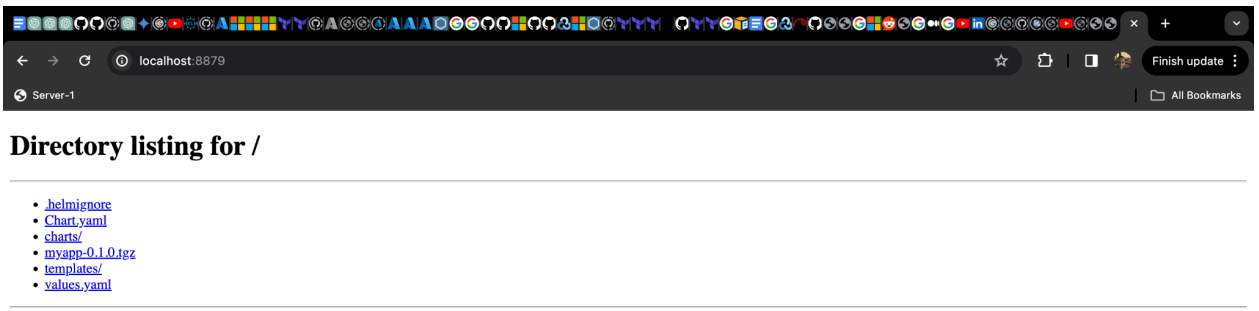
Check Application Status: Access your application's health endpoint to verify its status. If your application exposes a health check endpoint, you can use curl or a web browser to access it. For example:

'localhost:3000/health'

'Localhost:8879' (you should the see the directory listings for the helm chart folder)



OK

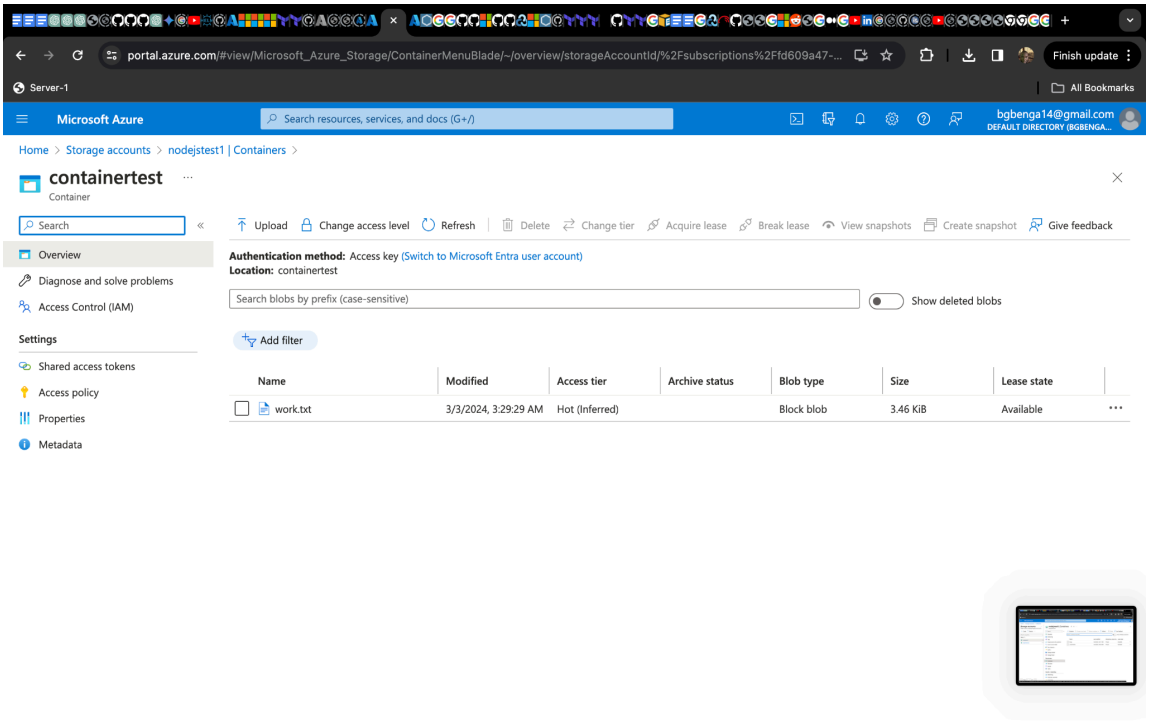


Check Logs: Monitor the logs of your application pods to identify any errors or issues. You can use the following command to view logs:

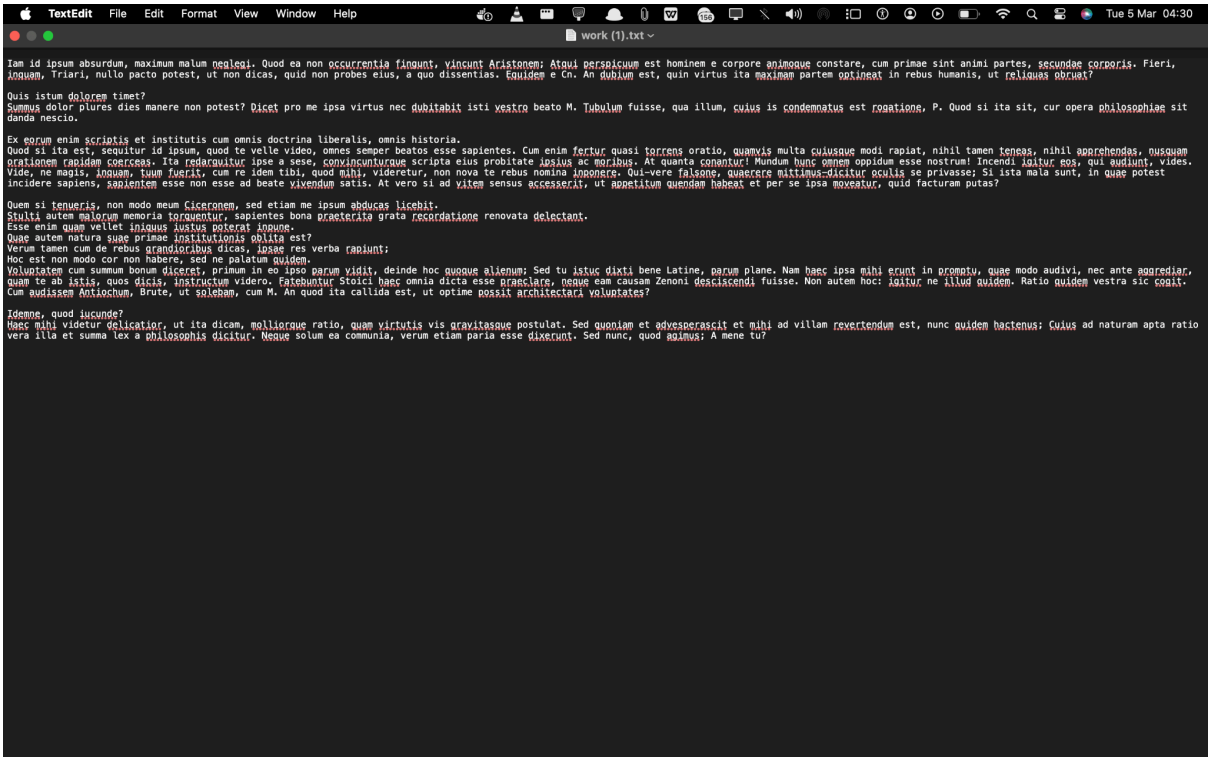
'kubectl logs <pod_name>'

Check the content of the Azure Blob Container : connect to the blob container through localhost:3000(this can be done anytime before or after packaging the helm charts and deploying to the container)

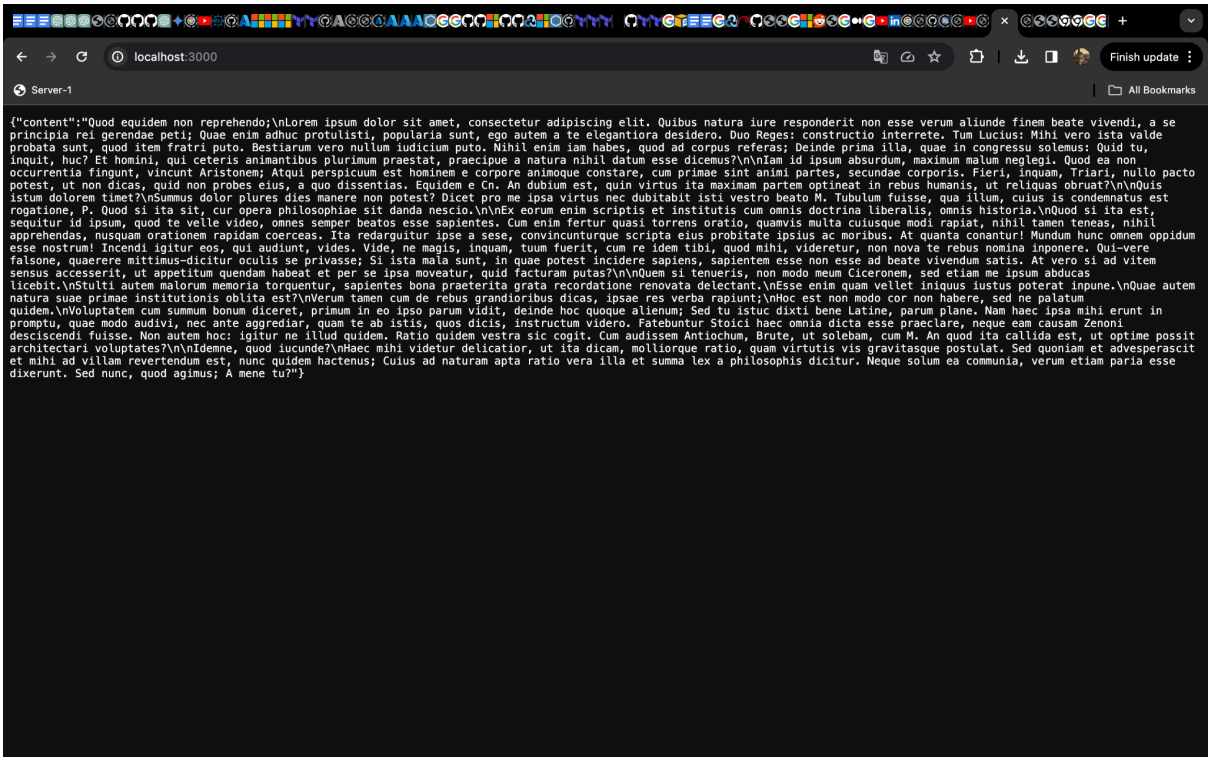
Here is the content of my blob container, it is named “work.txt”



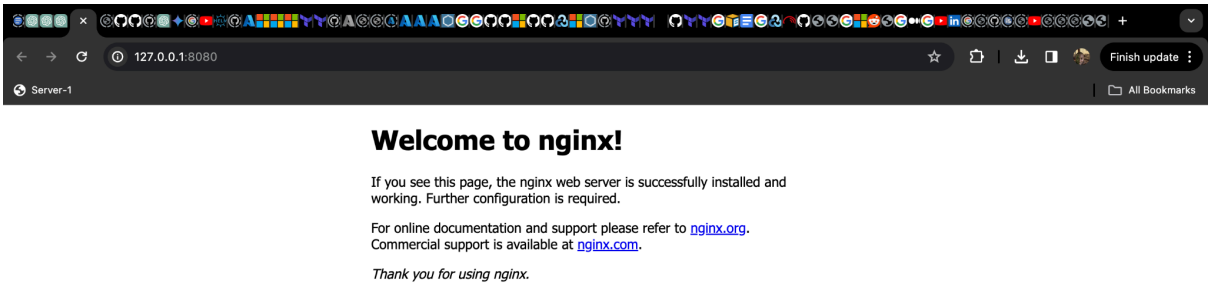
And here is the file,



Here is it me connecting to the container through the details i had already specified to confirming it did return it in json format according to the code specified, i connected to it through the localhost:3000 url



Connecting to the web server - connect to it through localhost:8080 url



CONCLUSION

In conclusion, this project has demonstrated the development and deployment of a web application integrated with Azure Blob Storage using Kubernetes and Helm. Here's a summary of the key points covered:

Summary:

- The project involved creating a Node.js application with Express.js to create HTTP endpoints for serving data.
- Integration with Azure Blob Storage was achieved using the Azure Storage SDK to fetch data from blob storage containers.
- A Dockerfile was created to containerize the application, allowing it to be deployed consistently across different environments.
- An AKS cluster was provisioned using Terraform, providing a scalable and managed Kubernetes environment.
- A Helm chart was created to package and deploy the application to the AKS cluster, simplifying the deployment process.
- Testing was performed at various stages, including unit testing, integration testing, and end-to-end testing, to ensure the reliability and functionality of the application.
- Health checks were implemented to monitor the application's health and ensure continuous availability.

Next Steps:

- Further optimize and enhance the application for performance, scalability, and security.
- Implement additional features and functionality based on user feedback and requirements.
- Monitor and analyze application performance metrics to identify areas for improvement.

- Continuously update and maintain the application to address any bugs, security vulnerabilities, or changes in requirements.
- Explore additional Azure services and integrations to enhance the application's capabilities.

In summary, this project serves as a foundation for building and deploying modern web applications on Kubernetes, leveraging cloud-native technologies and best practices to deliver reliable and scalable solutions.

GITHUB

Here is the link to the github repository the whole project is stored in

 - https://github.com/Gbeengah/k8s-helm-blob-health-app

AUTHOR - BALOGUN ABDULLAHI GBENGA

 - https://www.linkedin.com/in/balogun-gbenga-422277193/