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Matriculation Number: A0218348Y

Github Link: <https://github.com/simjunheng/OTOT-A2-A3>

A2 Video Link: https://drive.google.com/file/d/1pYifqFVKvFLchJ_txQVEzUQpS-Dbvb5s/view?usp=sharing

A3 Video Link:

<https://drive.google.com/file/d/1jFxDTWCCztP8DDJ2UG9rmeJVsj2QleJ/view?usp=sharing>

PREREQUISITES TO TASK A2 & A3

Pushing A1 App Image to Docker Hub

Step 1: Push your image from A1 into docker hub by running the command **docker login** and **docker push simjunheng1/myfirstapp**

INSTRUCTIONS FOR TASK A2.1

Creating a Local Cluster

Step 1: Switch to the manifest directory using the command `cd k8s/manifests`

Step 2: Run the command `kind create cluster --name kind-1 --config ../kind/cluster-config.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kind create cluster --name kind-1 --config ../kind/cluster-config.yaml
Creating cluster "kind-1" ...
  • Ensuring node image (kindest/node:v1.25.3)  𐄂 ...
  ✓ Ensuring node image (kindest/node:v1.25.3)  𐄂
  • Preparing nodes  𐄂  𐄂  𐄂  𐄂 ...
  ✓ Preparing nodes  𐄂  𐄂  𐄂  𐄂
  • Writing configuration  𐄂 ...
  ✓ Writing configuration  𐄂
  ✓ Starting control-plane  𐄂
  • Installing CNI  𐄂 ...
  ✓ Installing CNI  𐄂
  • Installing StorageClass  𐄂 ...
  ✓ Installing StorageClass  𐄂
  • Joining worker nodes  𐄂 ...
Set kubectl context to "kind-kind-1"
You can now use your cluster with:
kubectl cluster-info --context kind-kind-1
```

Check if Local Cluster is Running

Step 3: Check if the cluster is running using the command `kubectl cluster-info`

```
TOT-A2-A3\k8s\manifests> kubectl cluster-info
Kubernetes control plane is running at https://127.0.0.1:52381
CoreDNS is running at https://127.0.0.1:52381/api/v1/namespaces/kube-system/services/ku
```

INSTRUCTIONS FOR TASK A2.2

Creating a Deployment Manifest

Step 1: Create a backend-deployment.yaml file (located in the repo).

Step 2: Run the command `kubectl apply -f backend-deployment.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\0
TOT-A2-A3\k8s\manifests> kubectl get deployment/backend
```

Check if Deployment is Running & Ready

Step 3: Run the command `kubectl get deployment/backend` to check if the deployments are running fine.

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\0
TOT-A2-A3\k8s\manifests> kubectl get deployment/backend
NAME      READY   UP-TO-DATE   AVAILABLE   AGE
backend   3/3     3             3           8m54s
```

Step 4: Run the command `kubectl get pods` to check if the pods are running

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\0
TOT-A2-A3\k8s\manifests> kubectl get pods
NAME                                READY   STATUS    RESTARTS   AGE
backend-757f6c7c8-jqqws             1/1     Running   0           9m8s
backend-757f6c7c8-qwjg              1/1     Running   0           9m8s
backend-757f6c7c8-s57ld             1/1     Running   0           9m8s
```

Creating an Ingress Controller

Step 5: Run the command `kubectl apply -f`
<https://raw.githubusercontent.com/kubernetes/ingress-nginx/main/deploy/static/provider/kind/deploy.yaml>

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\O
TOT-A2-A3\k8s\manifests> kubectl apply -f https://raw.githubusercontent.com/kubernetes/
ingress-nginx/main/deploy/static/provider/kind/deploy.yaml
namespace/ingress-nginx created
serviceaccount/ingress-nginx created
serviceaccount/ingress-nginx-admission created
role.rbac.authorization.k8s.io/ingress-nginx created
role.rbac.authorization.k8s.io/ingress-nginx-admission created
clusterrole.rbac.authorization.k8s.io/ingress-nginx created
rolebinding.rbac.authorization.k8s.io/ingress-nginx created
rolebinding.rbac.authorization.k8s.io/ingress-nginx-admission created
clusterrolebinding.rbac.authorization.k8s.io/ingress-nginx created
clusterrolebinding.rbac.authorization.k8s.io/ingress-nginx-admission created
service/ingress-nginx-controller created
service/ingress-nginx-controller-admission created
deployment.apps/ingress-nginx-controller created
job.batch/ingress-nginx-admission-patch created
ingressclass.networking.k8s.io/nginx created
ated
```

Check if Ingress Controller is Running & Ready

Step 6: Run the command `kubectl -n ingress-nginx get deploy` to check if the deployment of the ingress controller is ready.

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\O
TOT-A2-A3\k8s\manifests> kubectl -n ingress-nginx get deploy -w
NAME                                READY    UP-TO-DATE    AVAILABLE    AGE
```

Creating a Service Manifest

Step 7: Create a backend-service.yaml file (located in the repo)..

Step 8: Run the command `kubectl apply -f backend-service.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\O
TOT-A2-A3\k8s\manifests> kubectl apply -f backend-service.yaml
service/backend created
```

Check if Service is Created

Step 9: Run the command `kubectl get svc` to check if the service is created

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\O
TOT-A2-A3\k8s\manifests> kubectl get svc
NAME            TYPE        CLUSTER-IP    EXTERNAL-IP    PORT(S)    AGE
backend         ClusterIP   10.96.166.147 <none>         8080/TCP    9s
kubernetes      ClusterIP   10.96.0.1     <none>         443/TCP    11m
```

INSTRUCTIONS FOR TASK A2.3

Creating an Ingress Manifest

Step 1: Create a backend-ingress.yaml file (located in the repo).

Step 2: Run the command `kubectl apply -f backend-ingress.yaml`

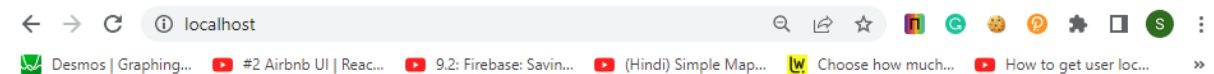
```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\0  
TOT-A2-A3\k8s\manifests> kubectl apply -f backend-ingress.yaml  
ingress.networking.k8s.io/backend created
```

Check if Ingress is Created Successfully

Step 3: Run the command `kubectl get ingress` check if the ingress is set up successfully.

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\0  
TOT-A2-A3\k8s\manifests> kubectl get ingress  
NAME      CLASS    HOSTS      ADDRESS      PORTS      AGE  
backend    <none>   *          *            80         6s
```

Check if App Can Be Accessed



4
4

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INSTRUCTIONS FOR TASK A3.1

Creating a Local Cluster

Step 1: Switch to the manifest directory using the command `cd k8s/manifests`

Step 2: Run the command `kind create cluster --name kind-1 --config ../kind/cluster-config.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kind create cluster --name kind-1 --config ../kind/cluster-config.yaml
Creating cluster "kind-1" ...
  • Ensuring node image (kindest/node:v1.25.3) ...
  ✓ Ensuring node image (kindest/node:v1.25.3) ...
  • Preparing nodes ...
  ✓ Preparing nodes ...
  • Writing configuration ...
  ✓ Writing configuration ...
  ✓ Starting control-plane ...
  • Installing CNI ...
  ✓ Installing CNI ...
  • Installing StorageClass ...
  ✓ Installing StorageClass ...
  • Joining worker nodes ...
Set kubectl context to "kind-kind-1"
You can now use your cluster with:
kubectl cluster-info --context kind-kind-1
```

Check if Local Cluster is Running

Step 3: Check if the cluster is running using the command `kubectl cluster-info`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl cluster-info
Kubernetes control plane is running at https://127.0.0.1:60787
CoreDNS is running at https://127.0.0.1:60787/api/v1/namespaces/kube-system/services/kube-dns:dns/proxy
```

Creating a Metrics Server

Step 4: Install manifest from the provided link in A3 guide using the command `kubectl apply -f https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/components.yaml`

```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A
3\k8s\manifests> kubectl apply -f https://github.com/kubernetes-sigs/metrics-server/releases/la
test/download/components.yaml
serviceaccount/metrics-server created
clusterrole.rbac.authorization.k8s.io/system:aggregated-metrics-reader created
clusterrole.rbac.authorization.k8s.io/system:metrics-server created
rolebinding.rbac.authorization.k8s.io/metrics-server-auth-reader created
clusterrolebinding.rbac.authorization.k8s.io/metrics-server:system:auth-delegator created
clusterrolebinding.rbac.authorization.k8s.io/system:metrics-server created
service/metrics-server created
deployment.apps/metrics-server created
apiservice.apiregistration.k8s.io/v1beta1.metrics.k8s.io created

```

Step 5: Run the command `kubectl -nkube-system edit deploy/metrics-server`. Then manually edit the deployment manifest to add a flag `--kubelet-insecure-tls` to `deployment.spec.containers[].args[]`.

```

strategy:
  rollingUpdate:
    maxSurge: 25%
    maxUnavailable: 0
  type: RollingUpdate
template:
  metadata:
    creationTimestamp: null
    labels:
      k8s-app: metrics-server
  spec:
    containers:
      - args:
        - --cert-dir=/tmp
        - --secure-port=4443
        - --kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname
        - --kubelet-use-node-status-port
        - --metric-resolution=15s
        - --kubelet-insecure-tls
        image: k8s.gcr.io/metrics-server/metrics-server:v0.6.1
        imagePullPolicy: IfNotPresent
        livenessProbe:
          failureThreshold: 3
          httpGet:

```

```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A
3\k8s\manifests> kubectl -nkube-system edit deploy/metrics-server
deployment.apps/metrics-server edited

```

Step 6: Run the command `kubectl -nkube-system rollout restart deploy/metrics-server` to restart the deployment.

```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A
3\k8s\manifests> kubectl -nkube-system rollout restart deploy/metrics-server
deployment.apps/metrics-server restarted

```

Check if Metrics Server is Working

Step 7: Run the command `kubectl get pods --all-namespaces | findstr "metrics-server"` to check if the metric server is running on my cluster.

```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A
3\k8s\manifests> kubectl get pods --all-namespaces | findstr "metrics-server"
kube-system          metrics-server-bf9946b6d-746b8          1/1      Running      0

```

Creating a Horizontal Pod Auto Scaler

Step 8: Create a backend-hpa file (located in the repo).

Step 9: Run the command `kubectl apply -f backend-hpa.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl apply -f backend-hpa.yaml
horizontalpodautoscaler.autoscaling/backend-zone-aware created
```

Check if Horizontal Pod Auto Scaler is Working

Step 10: Run the command `kubectl get hpa` to check if the hpa working.

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get hpa
NAME                REFERENCE                      TARGETS  MINPODS  MAXPODS  REPLICAS  AGE
backend-zone-aware  Deployment/backend-zone-aware  0%/50%   1         10        10         6s
```

INSTRUCTIONS FOR TASK A3.2

Creating a Deployment Manifest

Step 1: Create a backend-deployment-zone-aware.yaml file (located in the repo).

Step 2: Run the command `kubectl apply -f backend-deployment-zone-aware.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl apply -f backend-deployment-zone-aware.yaml
deployment.apps/backend-zone-aware created
```

Check if Deployment is Running & Ready

Step 3: Run the command `kubectl get po -lapp=backend-zone-aware -o wide --sort-by='.spec.nodeName'` to check if the deployments are running fine.


```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get po -lapp=backend-zone-aware -o wide --sort-by='.spec.nodeName'
```

NAME	NOMINATED NODE	READINESS GATES	READY	STATUS	RESTARTS	AGE	IP	NODE
backend-zone-aware-566cc6bc6d-5jtzv	<none>	<none>	1/1	Running	0	7m48s	10.244.1.5	kind-1-
worker	<none>	<none>						
backend-zone-aware-566cc6bc6d-7gn9g	<none>	<none>	1/1	Running	0	7m48s	10.244.1.3	kind-1-
worker	<none>	<none>						
backend-zone-aware-566cc6bc6d-dp8l2	<none>	<none>	1/1	Running	0	7m48s	10.244.1.4	kind-1-
worker	<none>	<none>						
backend-zone-aware-566cc6bc6d-rpxkd	<none>	<none>	1/1	Running	0	7m48s	10.244.1.2	kind-1-
worker	<none>	<none>						
backend-zone-aware-566cc6bc6d-84v8l	<none>	<none>	1/1	Running	0	7m48s	10.244.3.4	kind-1-
worker2	<none>	<none>						
backend-zone-aware-566cc6bc6d-8b7vm	<none>	<none>	1/1	Running	0	7m48s	10.244.2.6	kind-1-
worker3	<none>	<none>						
backend-zone-aware-566cc6bc6d-l55nt	<none>	<none>	1/1	Running	0	7m48s	10.244.2.3	kind-1-
worker3	<none>	<none>						
backend-zone-aware-566cc6bc6d-nwkjh	<none>	<none>	1/1	Running	0	7m48s	10.244.2.4	kind-1-
worker3	<none>	<none>						
backend-zone-aware-566cc6bc6d-rrsp5	<none>	<none>	1/1	Running	0	7m48s	10.244.2.7	kind-1-
worker3	<none>	<none>						
backend-zone-aware-566cc6bc6d-tbfxg	<none>	<none>	1/1	Running	0	7m48s	10.244.2.5	kind-1-
worker3	<none>	<none>						

Step 4: Run the command `kubectl get pods` to check if the pods are running

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get pods
```

NAME	READY	STATUS	RESTARTS	AGE
backend-zone-aware-566cc6bc6d-5jtzv	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-7gn9g	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-84v8l	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-8b7vm	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-dp8l2	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-l55nt	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-nwkjh	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-rpxkd	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-rrsp5	1/1	Running	0	8m11s
backend-zone-aware-566cc6bc6d-tbfxg	1/1	Running	0	8m11s

Creating an Ingress Controller

Step 5: Run the command `kubectl apply -f`

<https://raw.githubusercontent.com/kubernetes/ingress-nginx/main/deploy/static/provider/kind/deploy.yaml>


```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-3\k8s\manifests> kubectl apply -f https://raw.githubusercontent.com/kubernetes/ingress-nginx/main/deploy/static/provider/kind/deploy.yaml
namespace/ingress-nginx created
serviceaccount/ingress-nginx created
serviceaccount/ingress-nginx-admission created
role.rbac.authorization.k8s.io/ingress-nginx created
role.rbac.authorization.k8s.io/ingress-nginx-admission created
clusterrole.rbac.authorization.k8s.io/ingress-nginx created
clusterrole.rbac.authorization.k8s.io/ingress-nginx-admission created
rolebinding.rbac.authorization.k8s.io/ingress-nginx created
rolebinding.rbac.authorization.k8s.io/ingress-nginx-admission created
clusterrolebinding.rbac.authorization.k8s.io/ingress-nginx created
clusterrolebinding.rbac.authorization.k8s.io/ingress-nginx-admission created
configmap/ingress-nginx-controller created
service/ingress-nginx-controller created
service/ingress-nginx-controller-admission created
deployment.apps/ingress-nginx-controller created
job.batch/ingress-nginx-admission-create created
job.batch/ingress-nginx-admission-patch created
ingressclass.networking.k8s.io/nginx created
validatingwebhookconfiguration.admissionregistration.k8s.io/ingress-nginx-admission created

```

Check if Ingress Controller is Running & Ready

Step 6: Run the command `kubectl -n ingress-nginx get deploy` to check if the deployment of the ingress controller is ready.

```

PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl -n ingress-nginx get deploy

```

NAME	READY	UP-TO-DATE	AVAILABLE	AGE
ingress-nginx-controller	1/1	1	1	82s

Creating a Service Manifest

Step 7: Create a backend-service-zone-aware.yaml file (located in the repo)..

Step 8: Run the command `kubectl apply -f backend-service-zone-aware.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl apply -f backend-service-zone-aware.yaml
service/backend-zone-aware created
```

Check if Service is Created

Step 9: Run the command `kubectl get svc` to check if the service is created

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get svc
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
backend	ClusterIP	10.96.40.251	<none>	8080/TCP	110s
backend-zone-aware	ClusterIP	10.96.31.200	<none>	8080/TCP	3s
kubernetes	ClusterIP	10.96.0.1	<none>	443/TCP	17m

Creating an Ingress Manifest

Step 10: Create a backend-ingress-zone-aware.yaml file (located in the repo)..

Step 11: Run the command `kubectl apply -f backend-ingress-zone-aware.yaml`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl apply -f backend-ingress-zone-aware.yaml
ingress.networking.k8s.io/backend-zone-aware created
```

Check if Ingress is Created Successfully

Step 12: Run the command `kubectl get ingress` check if the ingress is set up successfully.

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get ingress
```

NAME	CLASS	HOSTS	ADDRESS	PORTS	AGE
backend-zone-aware	<none>	*	localhost	80	93s

Check if Pods are Running On Different Zones

Step 13: Run the command `kubectl get nodes -L topology.kubernetes.io/zone`

```
PS C:\Users\sjh_9\Desktop\NUS Y3S1\CS3219 Software Engineering Principles\Assignments\OTOT-A2-A3\k8s\manifests> kubectl get nodes -L topology.kubernetes.io/zone
```

NAME	STATUS	ROLES	AGE	VERSION	ZONE
kind-1-control-plane	Ready	control-plane	20m	v1.25.3	
kind-1-worker	Ready	<none>	20m	v1.25.3	a
kind-1-worker2	Ready	<none>	20m	v1.25.3	a
kind-1-worker3	Ready	<none>	20m	v1.25.3	b

Check if HPA is Scaling Properly

Step 14: Run the command `kubectl get hpa -w` check if the hpa is scaling properly.

BEFORE (1 Replica) AND AFTER SCALE (4 Replica)

Explanation: HPA will always seek to achieve an average of 50% CPU utilization rate among the pods. If it exceeds this range, HPA will increase the number of replicas/pods as seen below.

backend-zone-aware	Deployment/backend-zone-aware	0%/50%	1	10	1	22m
backend-zone-aware	Deployment/backend-zone-aware	10%/50%	1	10	1	23m
backend-zone-aware	Deployment/backend-zone-aware	100%/50%	1	10	1	23m
backend-zone-aware	Deployment/backend-zone-aware	97%/50%	1	10	2	23m
backend-zone-aware	Deployment/backend-zone-aware	100%/50%	1	10	2	24m
backend-zone-aware	Deployment/backend-zone-aware	88%/50%	1	10	2	24m
backend-zone-aware	Deployment/backend-zone-aware	57%/50%	1	10	4	24m
backend-zone-aware	Deployment/backend-zone-aware	55%/50%	1	10	4	24m

Check if App Can Be Accessed

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 Desmos | Graphing...

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 #2 Airbnb UI | Reac...

🔴

 9.2: Firebase: Savin...

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 (Hindi) Simple Map...

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4

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Matric No.: A0218348Y

Name: Sim Jun Heng