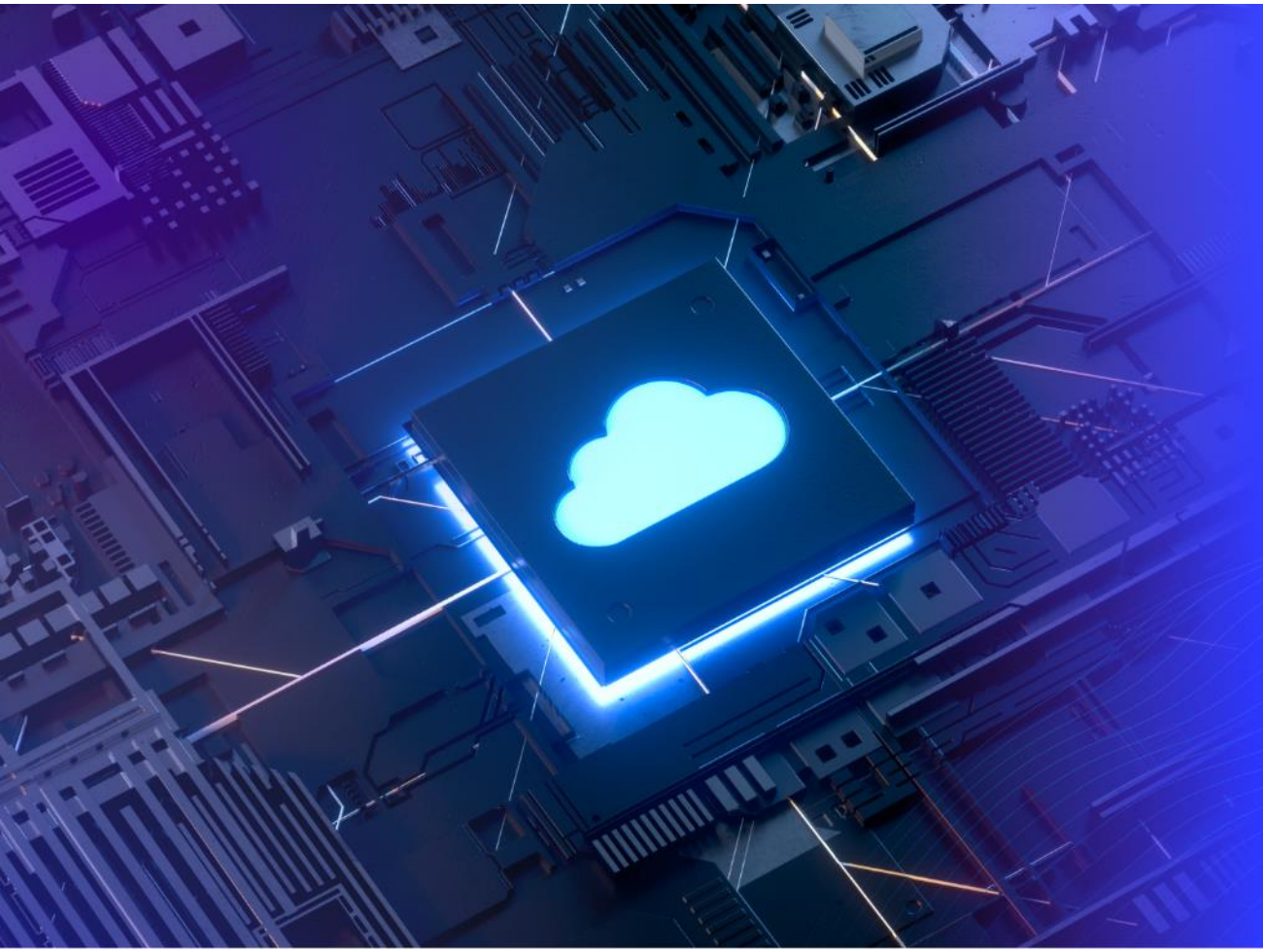
台灣積體電路製造股份有限公司
Taiwan Semiconductor Manufacturing Company, Ltd.



TSMC IT × NCTU CS 課號 5270

CLOUD NATIVE
Development Best Practice

設計以及架構建置 K8S 自有叢集 - LAB

資訊系統暨通訊服務處 系統建構一部 | 李青峰

March 16, 2022

AGENDA

Lab 0: Preparation

Lab 1: Pod

Lab 2: Service & Ingress

Lab 3: Deployments

Bonus

Lab 0: Preparation

1. Open Google Cloud Console
2. Spin-up GKE Worker Instances
3. Open Cloud Shell

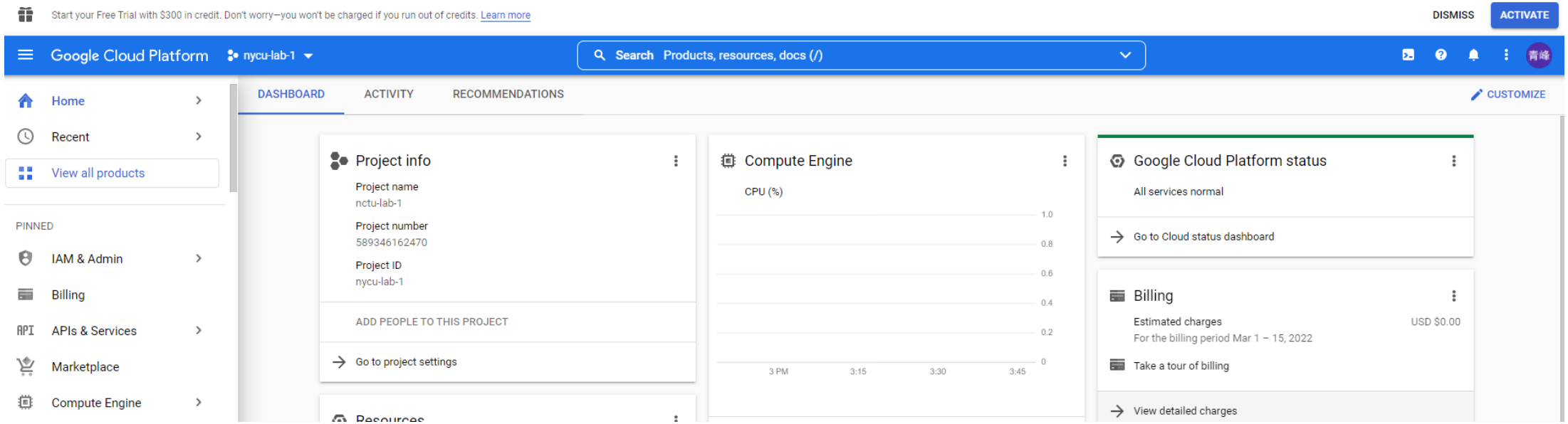
Lab 0: Preparation

1. ▶ Open Google Cloud Console
2. Spin-up GKE Worker Instances
3. Open Cloud Shell

- Let’s get started!

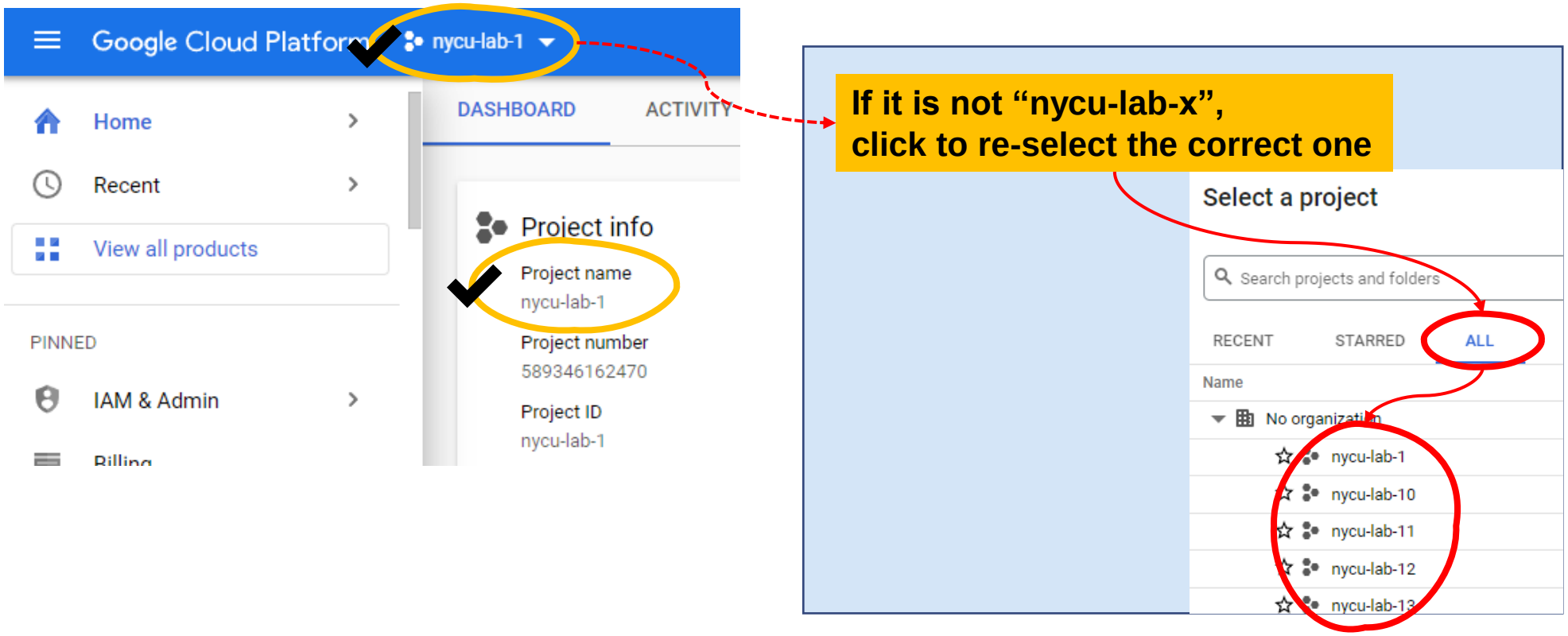
Lab 0-1: Open Google Cloud Console

1. **Navigate to https://console.cloud.google.com/ and use your gmail account to login**
2. **You should see the Google cloud console:**



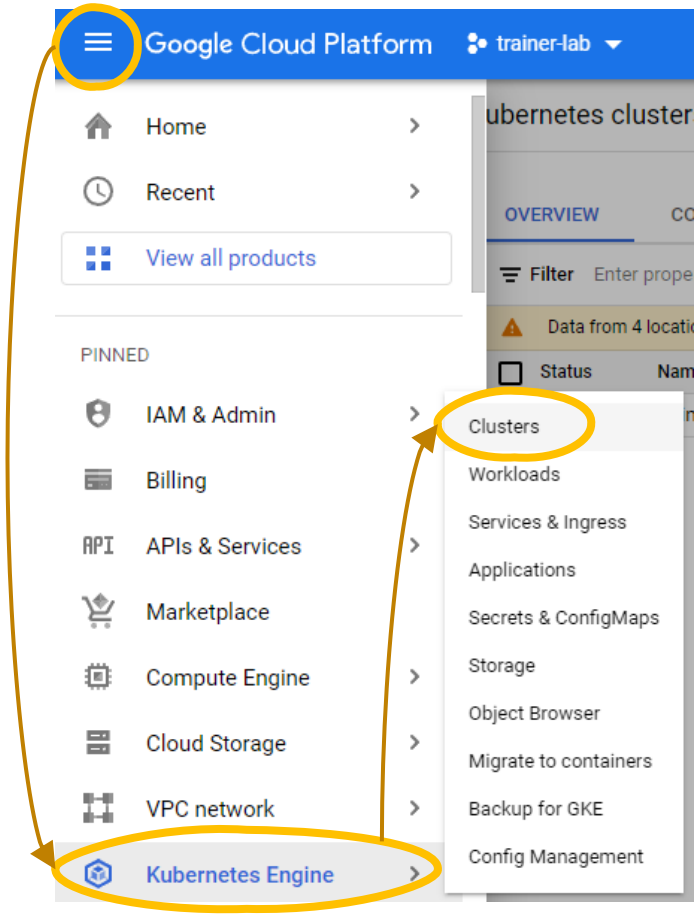
Lab 0-1: Open Google Cloud Console

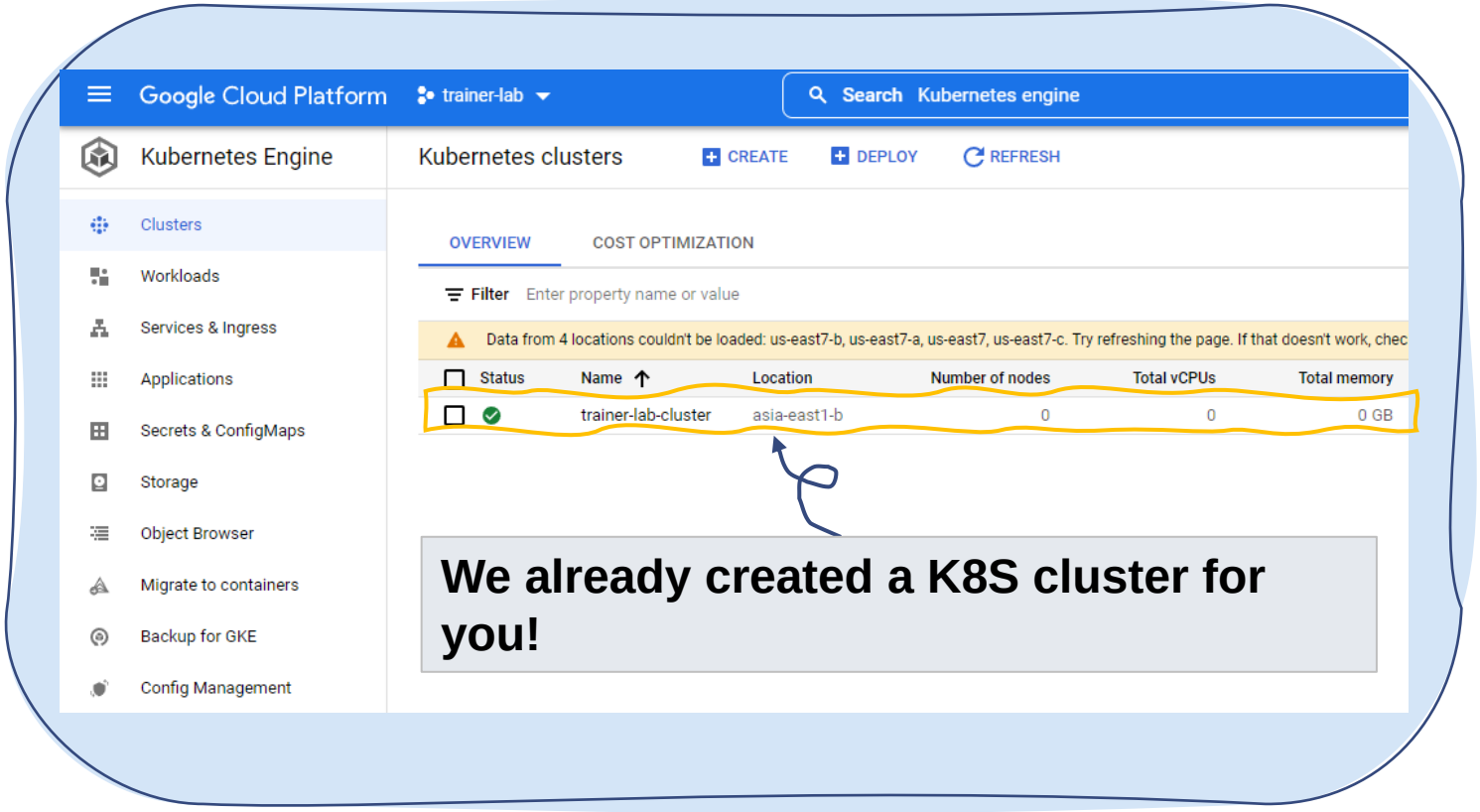
3. **Please make sure your current project is correct:**



Lab 0-1: Open Google Cloud Console

4. Navigate to “Kubernetes Engine” → “Clusters”





We already created a K8S cluster for you!

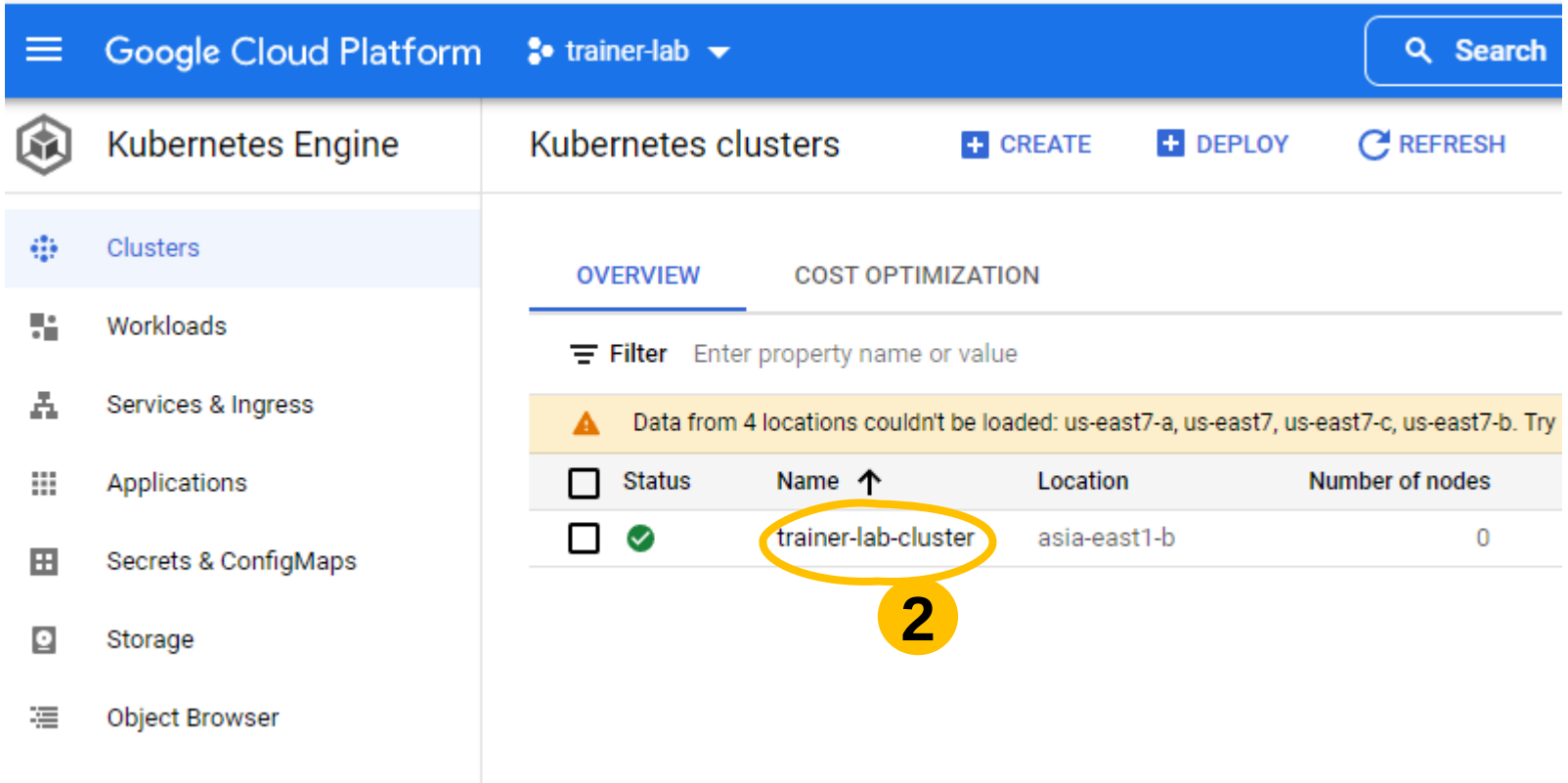
Lab 0: Preparation

1. Open Google Cloud Console
2. ▶ Spin-up GKE Worker Instances
3. Open Cloud Shell

- Our K8s cluster looks fine, but it does not have any worker nodes…
- Let’s add some instances to it

Lab 0-2: Spin-up GKE Worker Instances

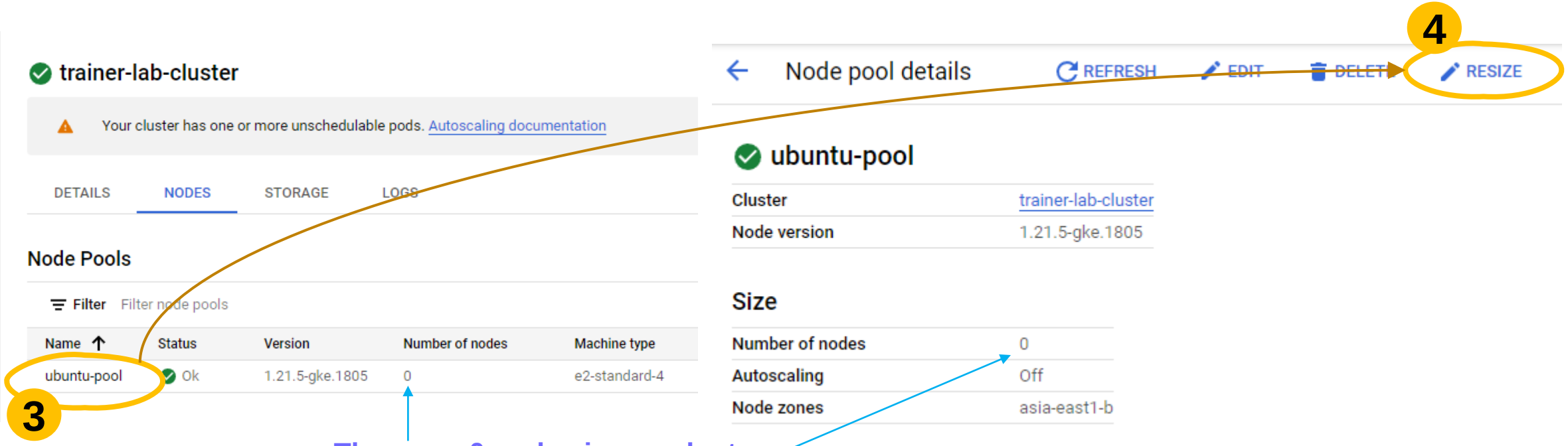
1. **Navigate to “Kubernetes Engine” → “Clusters” (Lab 0-1)**
2. **Click on the cluster name**



Lab 0-2: Spin-up GKE Worker Instances

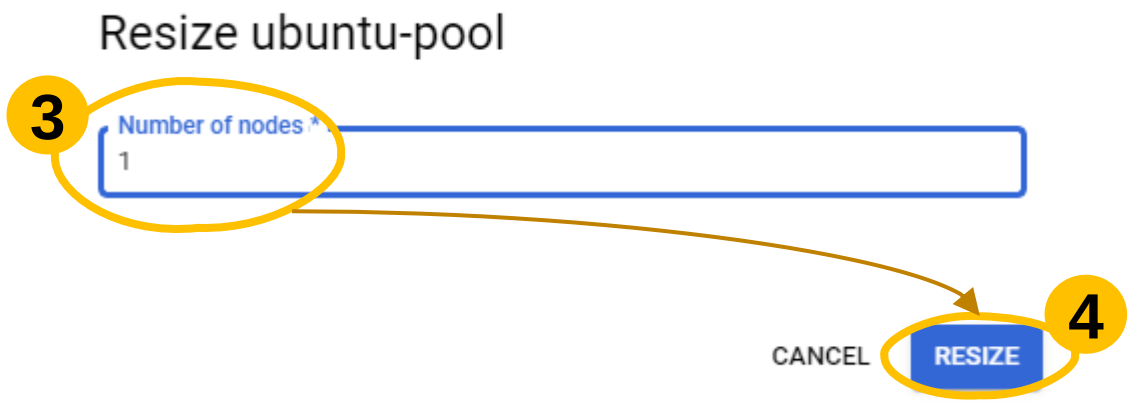
- Notice we have 0 node in the node pool 😥

3. Click on the node pool name
4. Then click “Resize”



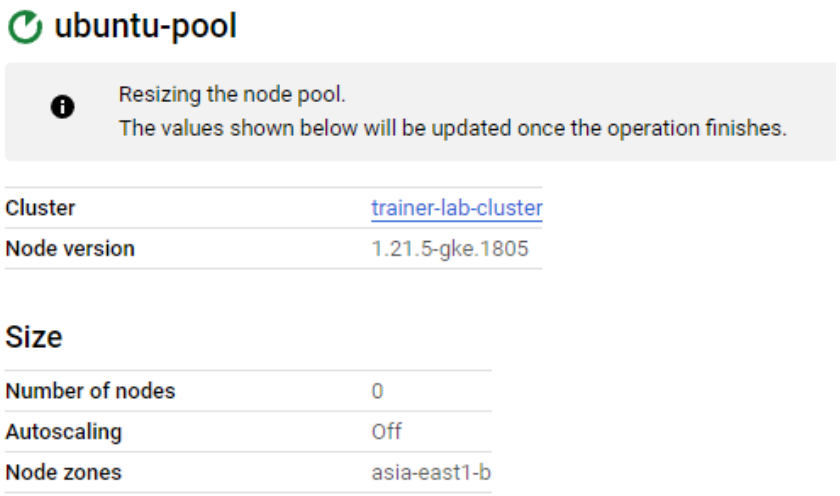
Lab 0-2: Spin-up GKE Worker Instances

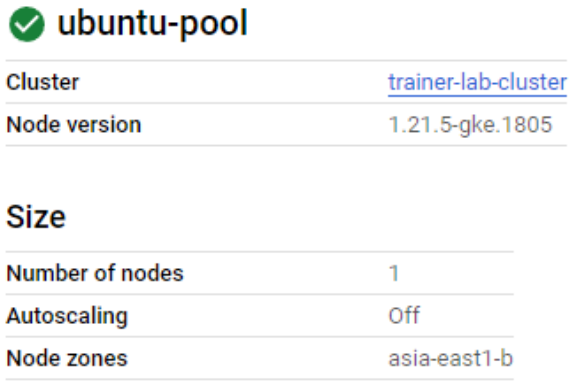
5. **Input “1” as our target number of nodes**
6. **Then click “Resize”**



Lab 0-2: Spin-up GKE Worker Instances

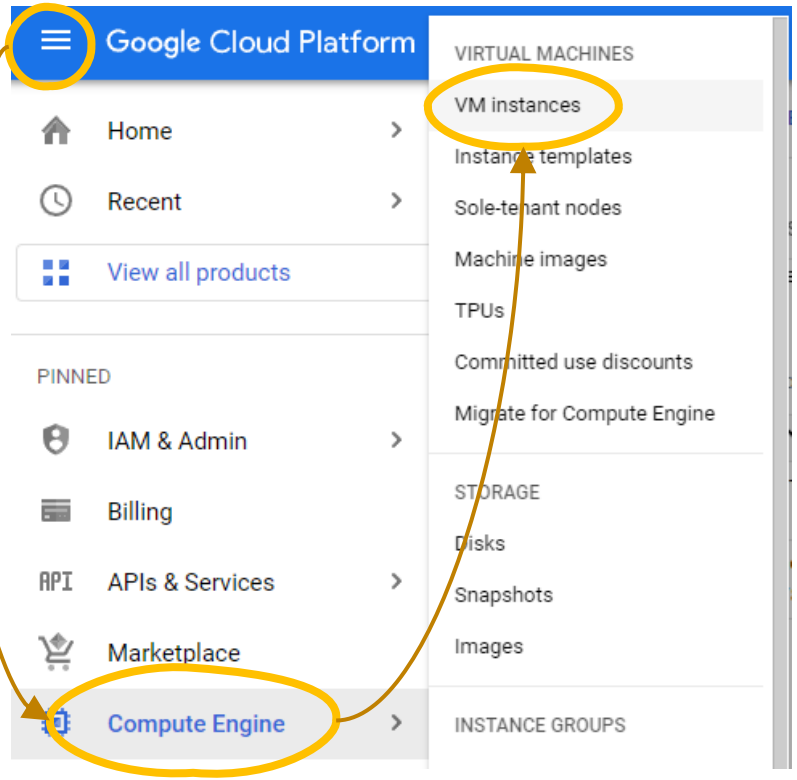
- Your node pool should be resized briefly

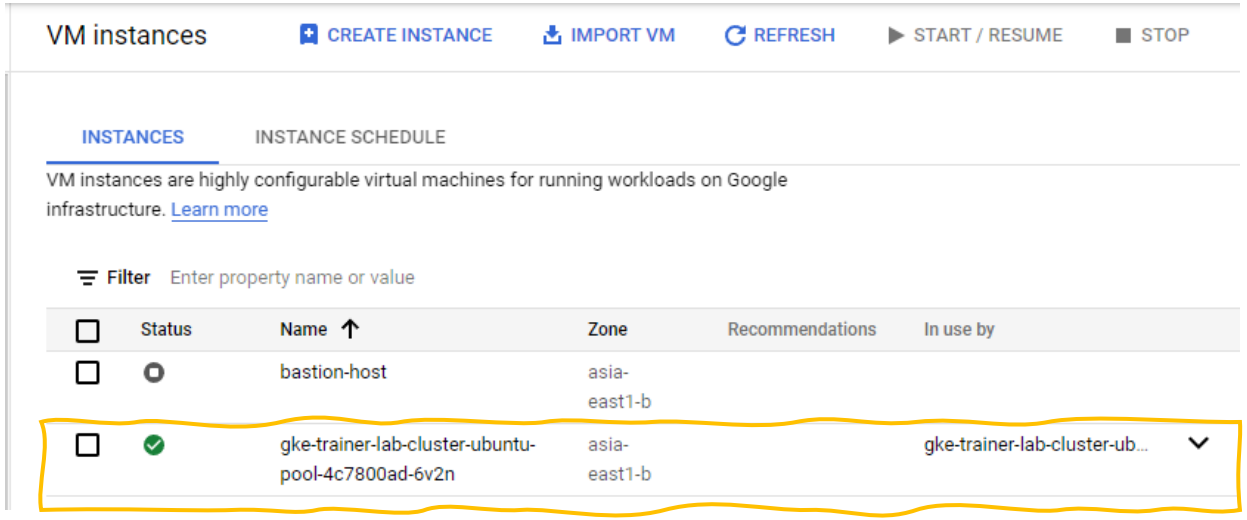




Lab 0-2: Spin-up GKE Worker Instances

- A VM instance will be spin-up under your project





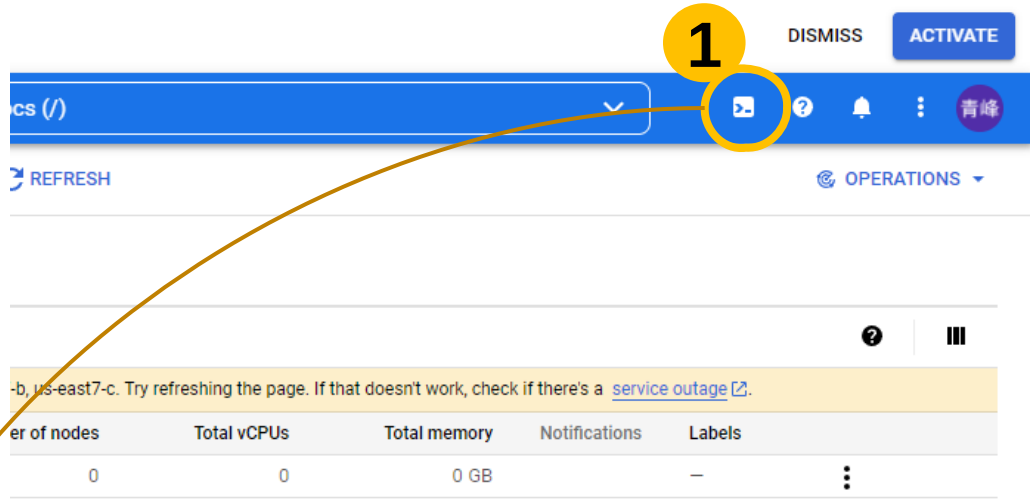
Lab 0: Preparation

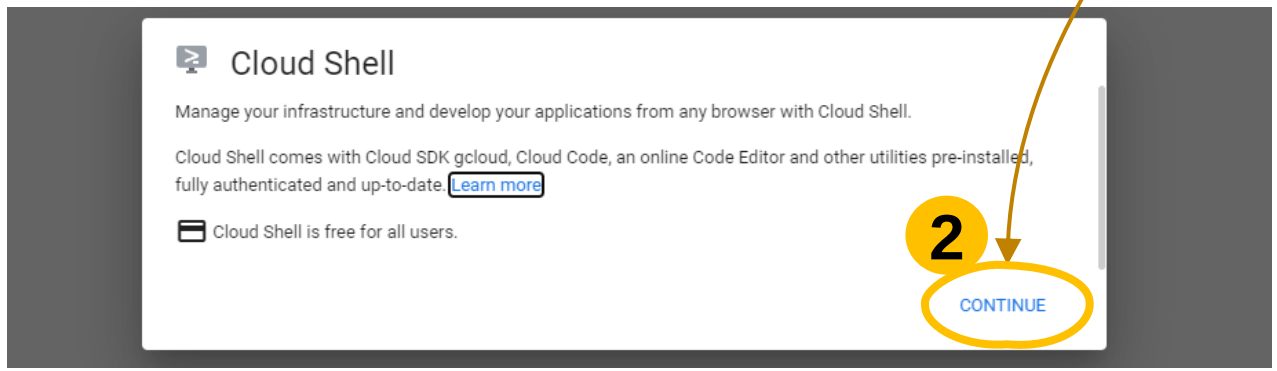
1. Open Google Cloud Console
2. Spin-up GKE Worker Instances
3. ▶ Open Cloud Shell

- Use Google Cloud Shell to access our K8S cluster

Lab 0-3: Open Cloud Shell

1. On the upper-right corner of the webpage, click the icon to activate cloud shell





2. Click “CONTINUE”

Lab 0-3: Open Cloud Shell

3. **Set our project/region/zone:**

```
gcloud config set project nycu-lab-xx
gcloud config set compute/zone asia-east1-b
gcloud config set compute/region asia-east1
```

- **Result:**

```
chh9513136@cloudshell:~ (trainer-lab)$ gcloud config set project trainer-lab
Updated property [core/project].
chh9513136@cloudshell:~ (trainer-lab)$ gcloud config set compute/zone asia-east1-b
Updated property [compute/zone].
chh9513136@cloudshell:~ (trainer-lab)$ gcloud config set compute/region asia-east1
Updated property [compute/region].
chh9513136@cloudshell:~ (trainer-lab)$
```

Lab 0-3: Open Cloud Shell

- We can list our K8s clusters:

```
chh9513136@cloudshell:~ (trainer-lab)$ gcloud container clusters list
WARNING: The following zones did not respond: us-east7-c, us-east7-a, us-east7, us-east7-b. List results may be incomplete.
NAME: trainer-lab-cluster
LOCATION: asia-east1-b
MASTER_VERSION: 1.21.5-gke.1805
MASTER_IP: 35.229.168.164
MACHINE_TYPE: e2-standard-4
NODE_VERSION: 1.21.5-gke.1805
NUM_NODES: 1
STATUS: RUNNING
chh9513136@cloudshell:~ (trainer-lab)$
```

4. Get the credential of the K8s cluster

```
gcloud container clusters get-credentials YOUR_CLUSTER_NAME
```

- Result:

```
chh9513136@cloudshell:~ (trainer-lab)$ gcloud container clusters get-credentials trainer-lab-cluster
Fetching cluster endpoint and auth data.
kubeconfig entry generated for trainer-lab-cluster.
```

Lab 0-3: Open Cloud Shell

5. **Verify you can get the cluster information**

```
kubectl cluster-info
```

```
chh9513136@cloudshell:~ (trainer-lab)$ kubectl cluster-info
Kubernetes control plane is running at https://35.229.168.164
GLBCDefaultBackend is running at https://35.229.168.164/api/v1/namespaces/kube-system/services/default-http-backend:http/proxy
KubeDNS is running at https://35.229.168.164/api/v1/namespaces/kube-system/services/kube-dns:dns/proxy
Metrics-server is running at https://35.229.168.164/api/v1/namespaces/kube-system/services/https:metrics-server:/proxy

To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
```

6. **Try to list our K8S worker nodes**

```
kubectl get nodes
```

The worker instance created in Lab 0-2

```
chh9513136@cloudshell:~ (trainer-lab)$ kubectl get nodes
NAME                                          STATUS   ROLES    AGE     VERSION
gke-trainer-lab-cluster-ubuntu-pool-4c7800ad-1z7t   Ready    <none>   3m56s   v1.21.5-gke.1805
chh9513136@cloudshell:~ (trainer-lab)$
```

Lab 1: Create a *Pod*

1. Create a K8S Namespace
2. Deploy a NGINX Pod
3. Port-Forwarding through Cloud Shell
4. Cleanup

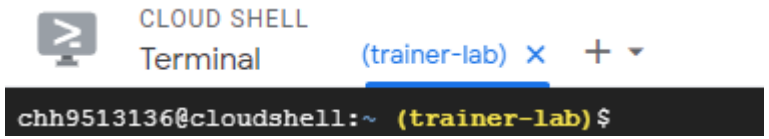
Lab 1: Create a *Pod*

1. ▶ **Create a K8S Namespace**
2. Deploy a NGINX Pod
3. Port-Forwarding through Cloud Shell
4. Cleanup

- Create a new namespace for our lab environment

Lab 1-1: Create a K8S Namespace

1. **Finish Lab 0, and navigate to Cloud Shell**



2. **List K8s namespaces**

```
kubectl get namespaces
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl get namespaces
NAME              STATUS   AGE
default           Active   2d8h
kube-node-lease   Active   2d8h
kube-public       Active   2d8h
kube-system       Active   2d8h
```

TSMC IT × NCTU CS
2022 CLOUD NATIVE
Development Best Practice

Lab 1-1: Create a K8S Namespace

3. **Create a K8S namespace: “lab”**

```
kubectl create namespace lab
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl create namespace lab
namespace/lab created
```

4. **List K8s namespaces**

```
kubectl get namespaces
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl get namespaces
NAME              STATUS   AGE
default           Active   2d8h
kube-node-lease   Active   2d8h
kube-public       Active   2d8h
kube-system       Active   2d8h
lab               Active   25s
```

5. **Set the “lab” namespace as default for kubectl context**

```
kubectl config set-context –current –namespace=lab
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl config set-context --current --namespace=lab
Context "gke_trainer-lab_asia-east1-b_trainer-lab-cluster" modified.
```

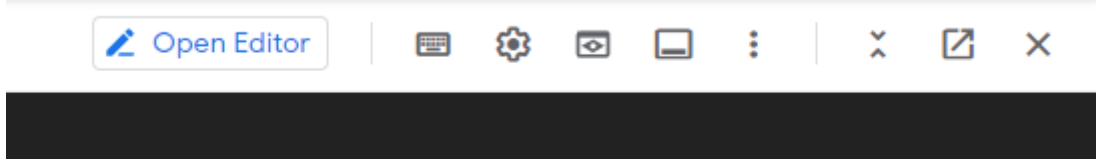
Lab 1: Create a *Pod*

1. Create a K8S Namespace
2. ▶ **Deploy a NGINX Pod**
3. Port-Forwarding through Cloud Shell
4. Cleanup

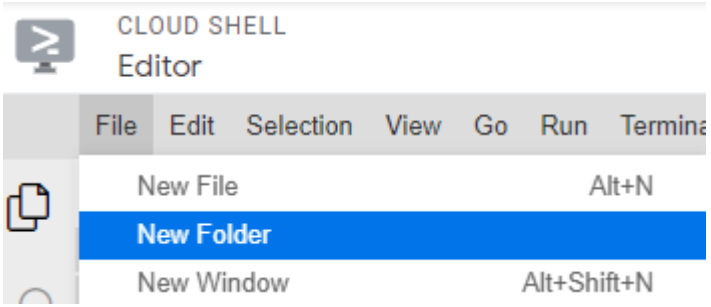
- Learn how to deploy a simple Pod

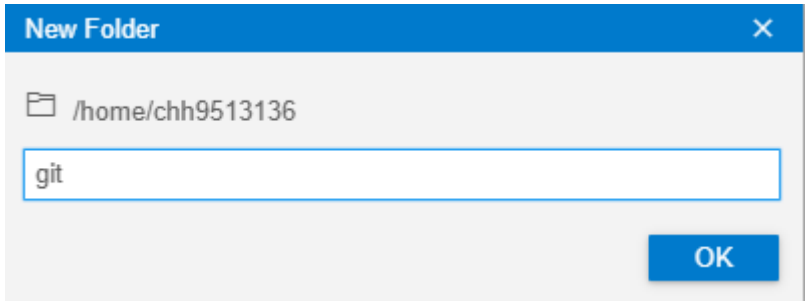
Lab 1-2: Deploy a NGINX Pod

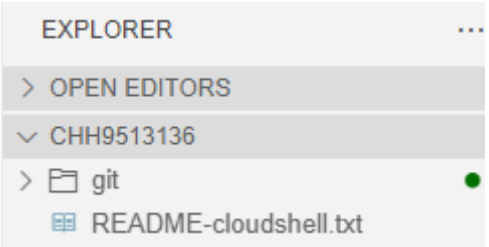
1. **Open editor on your cloud shell**



2. **Create a new folder named “git”**

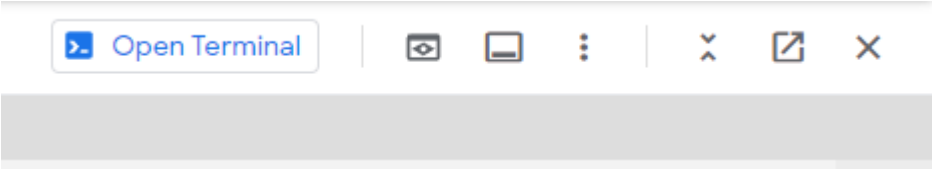






Lab 1-2: Deploy a NGINX Pod

3. **Go back to Terminal mode**



4. **Change directory, clone the lab repo**

```
cd ~/git
```

```
git clone https://github.com/truffles/nycu-k8s-lab.git
```

```
cd nycu-k8s-lab
```

```
ls
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab (trainer-lab)$ ls
lab1  lab2  lab3  lab-bonus  README.md
```

Lab 1-2: Deploy a NGINX Pod

5. Change directory into “lab1”

```
cd lab1
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab (trainer-lab)$ cd lab1
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$
```

6. Deploy the Pod

```
kubectl apply -f pod-nginx.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl apply -f pod-nginx.yaml
pod/nginx-standalone-pod created
```

7. List the Pods

```
kubectl get pod
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl get pod
NAME                   READY   STATUS    RESTARTS   AGE
nginx-standalone-pod   1/1     Running   0          3s
```

- You can view the content of the “pod-nginx.yaml” file in the Editor mode.
- What’s in the YAML file?

Lab 1-2: Deploy a NGINX Pod

- You can open a bash shell into the pod we just deployed
- Have a look around😉

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl exec -it pod/nginx-standalone-pod -- bash
root@nginx-standalone-pod:/# ls
bin  boot  dev  docker-entrypoint.d  docker-entrypoint.sh  etc  home  lib  lib64  media  mnt  opt  proc  root  run  sbin  srv  sys  tmp  usr  var
root@nginx-standalone-pod:/#
```

- To exit, type “exit”

```
root@nginx-standalone-pod:/# exit
exit
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$
```

Lab 1: Create a *Pod*

1. Create a K8S Namespace
2. Deploy a NGINX Pod
3. ▶ **Port-Forwarding through Cloud Shell**
4. Cleanup

- Learn how to use port-forwarding to troubleshoot a pod

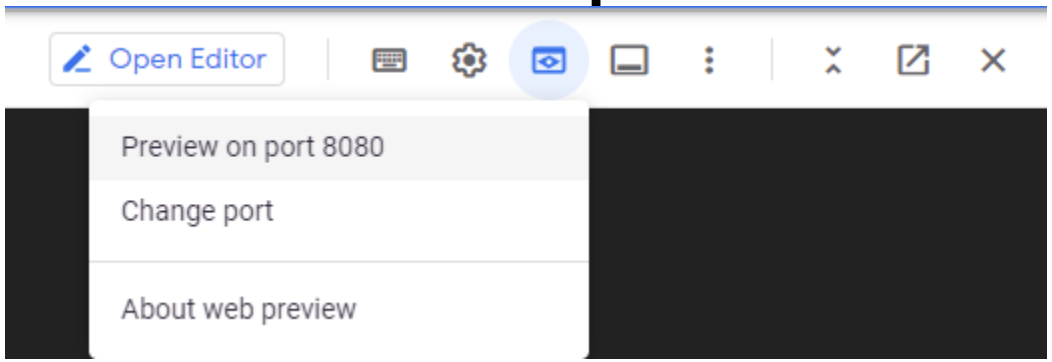
Lab 1-3: Port-Forwarding through Cloud Shell

1. **Enable port-forwarding for the nginx pod**

```
kubectl port-forward pod/nginx-standalone-pod 8080:80
```

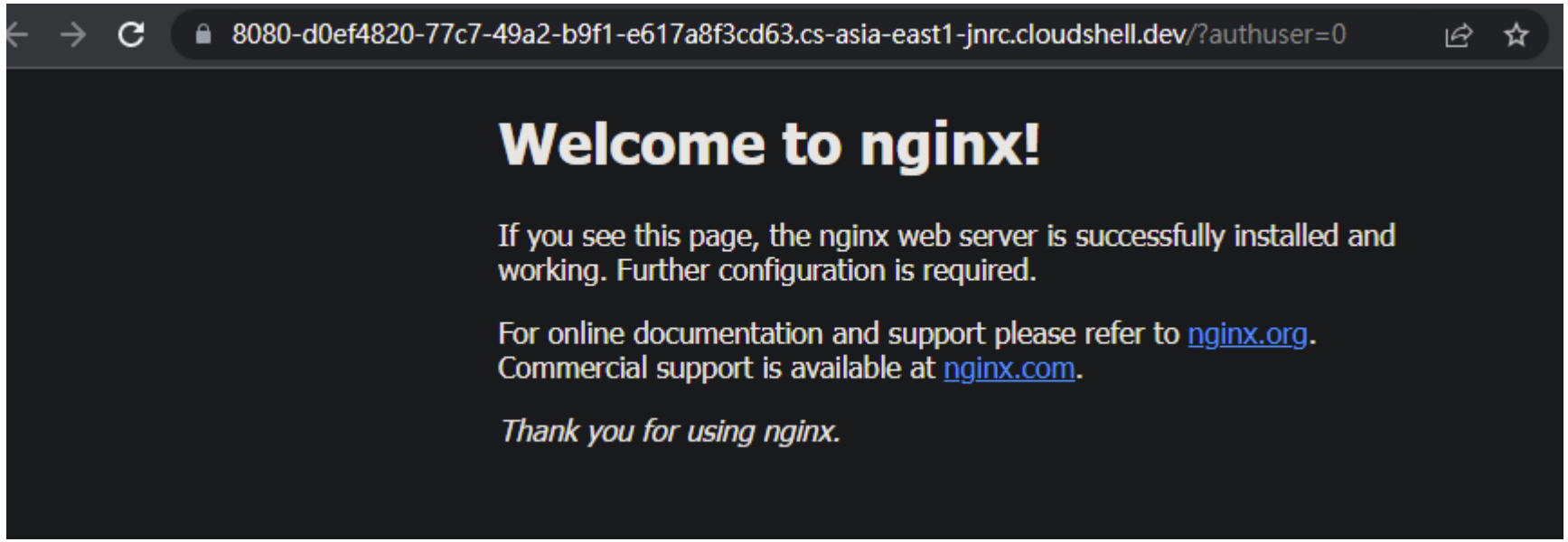
```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl port-forward pod/nginx-standalone-pod 8080:80
Forwarding from 127.0.0.1:8080 -> 80
```

2. **Click “Preview on port 8080”**



Lab 1-3: Port-Forwarding through Cloud Shell

3. **A new browser tab will open, showing the default webpage:**



Lab 1: Create a *Pod*

1. Create a K8S Namespace
2. Deploy a NGINX Pod
3. Port-Forwarding through Cloud Shell
4. ▶ **Cleanup**

Lab 1-4: Cleanup

1. **End the port forwarding session by "Ctrl+C" on the terminal**

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl port-forward pod/nginx-standalone-pod 8080:80
Forwarding from 127.0.0.1:8080 -> 80
Handling connection for 8080
^Cchh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$
```

2. **Delete the pod**

```
kubectl delete pod nginx-standalone-pod
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ kubectl delete pod nginx-standalone-pod
pod "nginx-standalone-pod" deleted
```

Lab 2: Expose Pods with *Service* & *Ingress*

1. Deploy application pods
2. Deploy a Service
3. Deploy an Ingress

Lab 2: Expose Pods with *Service* & *Ingress*

1. ▶ **Deploy Application Pods**
2. Deploy a Service
3. Deploy an Ingress

- ☐ Setup 1 bastion pod & 2 nginx pods for this lab
- ☐ Access the NGINX pods with their pod IPs

Lab 2-1: Deploy Application Pods

1. **Change directory to “lab2”**

```
cd lab2
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab1 (trainer-lab)$ cd ../lab2
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$
```

2. **Deploy a bastion pod**

```
kubectl apply -f pod-bastion.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl apply -f pod-bastion.yaml
pod/bastion created
```

3. **Deploy 2 nginx pods**

```
kubectl apply -f pod-nginx-1.yaml -f pod-nginx-2.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl apply -f pod-nginx-1.yaml -f pod-nginx-2.yaml
pod/nginx-1 created
pod/nginx-2 created
```

Lab 2-1: Deploy Application Pods

4. **List all pods, observe the labels**

```
kubectl get pod --show-labels
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl get pod --show-labels
NAME      READY   STATUS    RESTARTS   AGE   LABELS
bastion   1/1     Running   0          17m   <none>
nginx-1   1/1     Running   0          17m   app=nginx
nginx-2   1/1     Running   0          17m   app=nginx
```

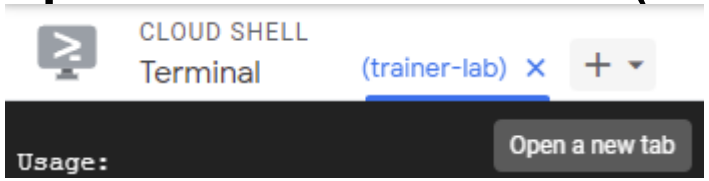
5. **List all pods with IP & node information, note the IPs**

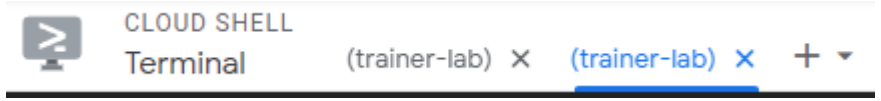
```
kubectl get pod -owide
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl get pod -owide
NAME      READY   STATUS    RESTARTS   AGE   IP             NODE
bastion   1/1     Running   0          18m   192.199.0.16   gke-trainer-lab-cluster-ubuntu-pool-4c7800ad-fgbw
nginx-1   1/1     Running   0          17m   192.199.0.17   gke-trainer-lab-cluster-ubuntu-pool-4c7800ad-fgbw
nginx-2   1/1     Running   0          17m   192.199.0.18   gke-trainer-lab-cluster-ubuntu-pool-4c7800ad-fgbw
```

Lab 2-1: Deploy Application Pods

6. **Open a new terminal tab ("Tab 2")**





7. **("Tab 2") Run a bash shell inside the bastion pod**

```
kubectl exec -it pod/bastion -- bash
```

```
chh9513136@cloudshell:~ (trainer-lab)$ kubectl exec -it pod/bastion -- bash
[root@bastion /]#
```

8. **("Tab 2") Connect to the NGINX pods by their IP**

```
curl YOUR_NGINX_POD_IP
```

```
[root@bastion /]# curl 192.199.0.17
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
<style>
html { color-scheme: light dark; }
body { width: 35em; margin: 0 auto;
font-family: Tahoma, Verdana, Arial, sans-serif; }
</style>
</head>
<body>
<h1>Welcome to nginx!</h1>
<p>If you see this page, the nginx web server is successfully installed and
working. Further configuration is required.</p>

<p>For online documentation and support please refer to
<a href="http://nginx.org/">nginx.org</a>.<br/>
Commercial support is available at
<a href="http://nginx.com/">nginx.com</a>.</p>

<p><em>Thank you for using nginx.</em></p>
</body>
</html>
[root@bastion /]#
```

Lab 2: Expose Pods with *Service* & *Ingress*

1. Deploy Application Pods
2. ▶ **Deploy a Service**
3. Deploy an Ingress

- Use service as an in-cluster load-balancer for the pods

Lab 2-2: Deploy a Service

1. ("Tab 1") **Deploy the service YAML**

```
kubectl apply -f service-nginx.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl apply -f service-nginx.yaml
service/nginx created
```

2. ("Tab 1") **List the services, note the IP addresses**

```
kubectl get service
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl get service
NAME    TYPE       CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
nginx   NodePort   192.199.13.125   <none>        80:31226/TCP   43m
```

3. ("Tab 1") **List the endpoints**

```
kubectl get endpoints
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ kubectl get endpoints
NAME    ENDPOINTS                                   AGE
nginx   192.199.0.17:80,192.199.0.18:80             2m56s
```

Lab 2-2: Deploy a Service

4. ("Tab 2") Access the service via it's IP address

```
curl YOUR_NGINX_SERVICE_CLUSTER_IP
```

```
[root@bastion /]# curl 192.199.13.125
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
```

5. ("Tab 2") Access the service using it's service name

```
curl nginx
```

```
[root@bastion /]# curl nginx
<!DOCTYPE html>
<html>
<head>
<title>Welcome to nginx!</title>
```

- What's the benefit of access web application via Service over using Pod IP address directly?
  - Try to delete one of the pods, is it still accessible via Service?
  - What if two pods under the same Service have different webpages?

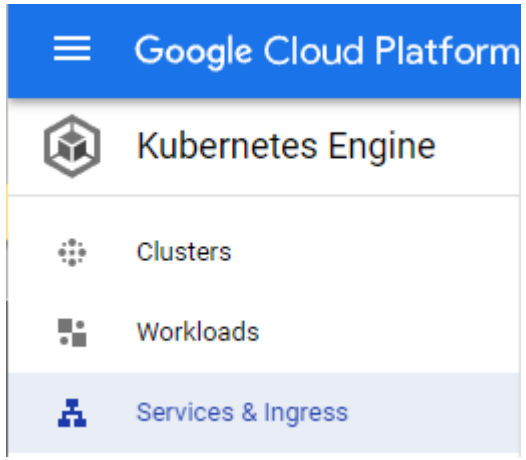
Lab 2: Expose Pods with *Service* & *Ingress*

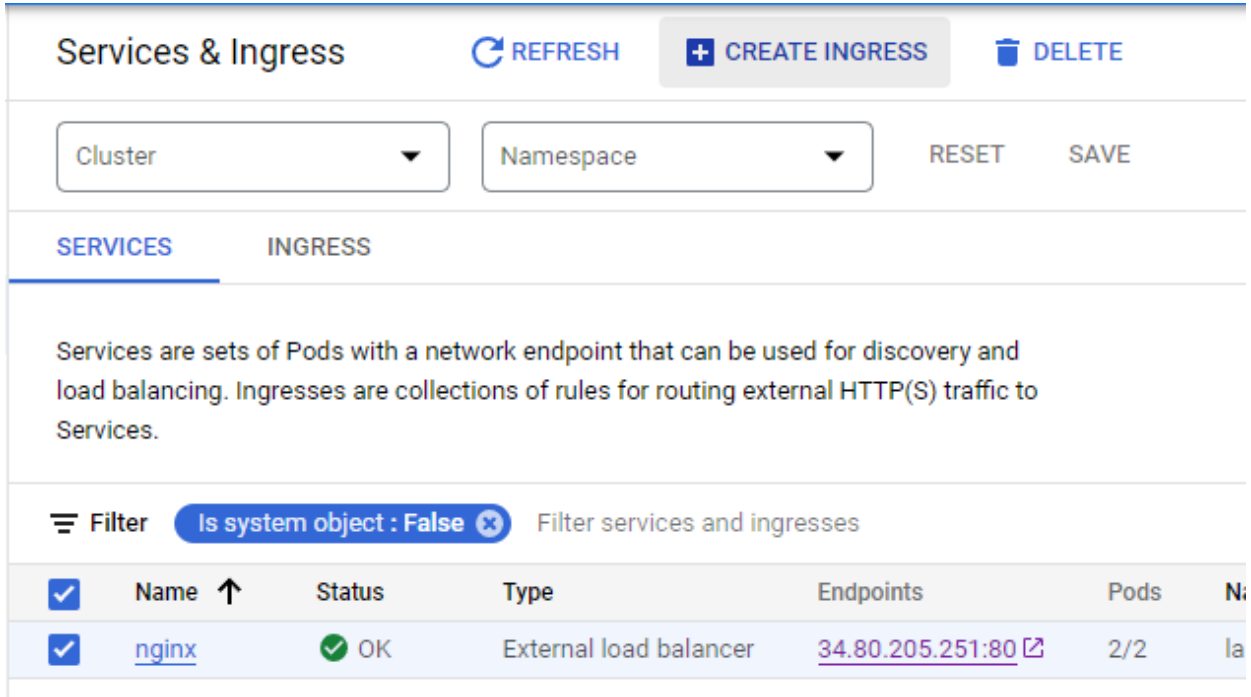
1. Deploy Application Pods
2. Deploy a Service
3. ▶ **Deploy an Ingress**

- **How to let everyone outside K8S cluster connect to our webpage with specific forwarding rules?**

Lab 2-3: Deploy an Ingress

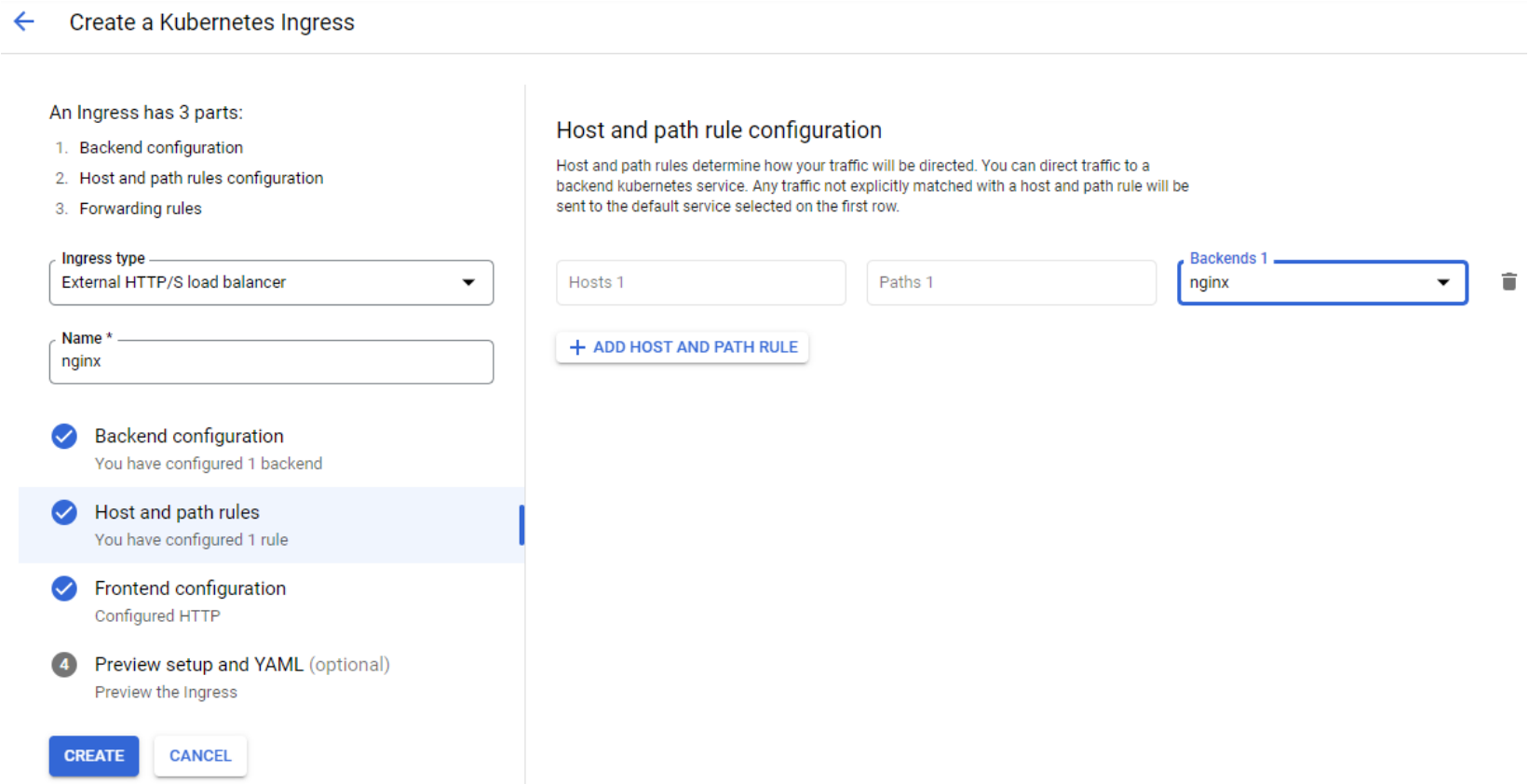
1. **Navigate to the “Services & Ingress” page**
2. **Check “nginx” service and click “create ingress” button**





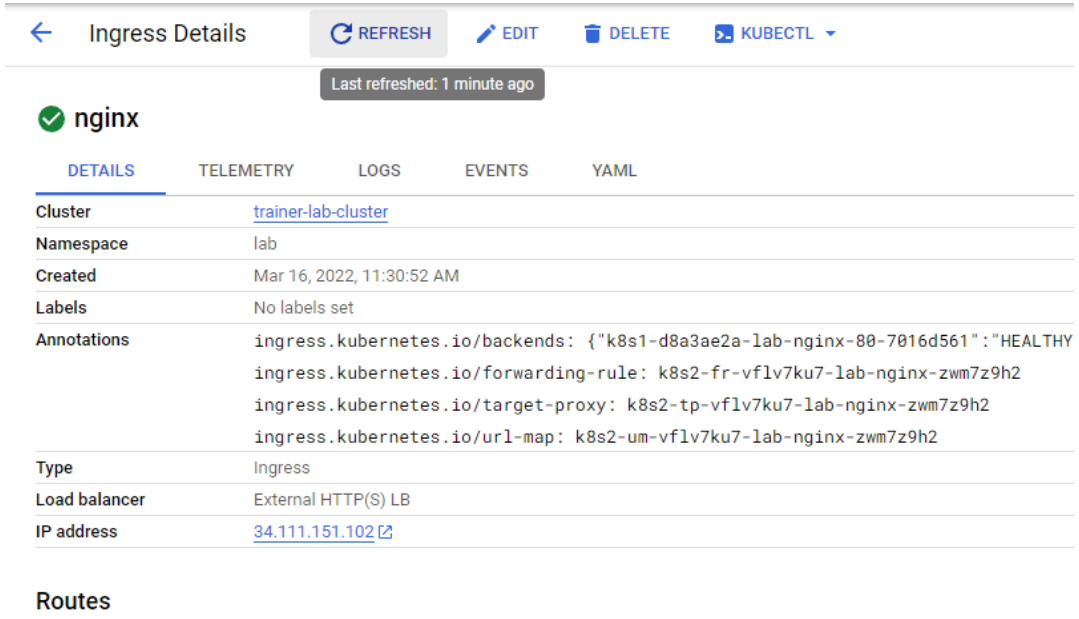
Lab 2-3: Deploy an Ingress

3. **Fill in the ingress name & default backends, then hit “create”**



Lab 2-3: Deploy an Ingress

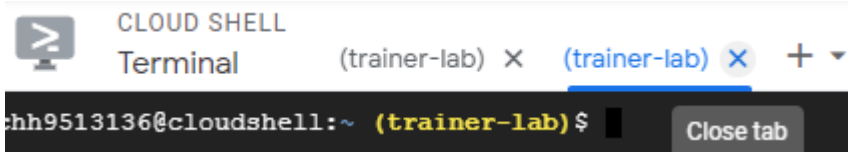
4. **Wait for it to be ready**



5. **Access the webpage on your browser via the provided IP address**

Lab 2-4: Cleanup

1. Close the 2nd terminal tab



2. Delete all ingresses

```
kubectl delete ingress
```

3. Delete all services

```
kubectl delete service
```

4. Delete all pods

```
kubectl delete pod
```

Lab 3: Use *deployments* to manage Pods

1. Deploy the “Deployment” YAML
2. Change the number of replicas
3. What if we delete pods manually
4. Cleanup

Lab 3: Use *deployments* to manage Pods

1. ▶ **Deploy the “Deployment” YAML**
2. Change the number of replicas
3. What if we delete the pods manually
4. Cleanup

Lab 3-1: Deploy the “Deployment” YAML

1. **Change directory to “lab3”**

```
cd lab3
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab2 (trainer-lab)$ cd ../lab3
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$
```

2. **Deploy the NGINX deployment YAML**

```
kubectl apply -f deployment-nginx.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl apply -f deployment-nginx.yaml
deployment.apps/nginx created
```

Lab 3-1: Deploy the “Deployment” YAML

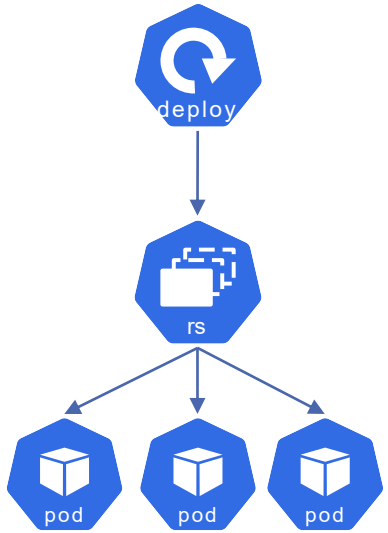
3. **Observe all the deployed resources**

```
kubectl get all
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl get all
NAME                          READY   STATUS    RESTARTS   AGE
pod/nginx-585449566-kjkdd     1/1     Running   0          103s
pod/nginx-585449566-ndqm9     1/1     Running   0          103s
pod/nginx-585449566-rsxs6     1/1     Running   0          104s

NAME                     READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/nginx    3/3     3            3           104s

NAME                                DESIRED   CURRENT   READY   AGE
replicaset.apps/nginx-585449566     3         3         3       105s
```



Lab 3: Use *deployments* to manage Pods

1. Deploy the “Deployment” YAML
2. ▶ Change the number of replicas
3. What if we delete the pods manually
4. Cleanup

- Try to change the number of replicas…
  - using “kubectl scale” command
  - by re-applying the YAML definition

Lab 3-2: Change the number of replicas

1. **Scale it using “kubectl scale” command**

```
kubectl scale deployment/nginx --replicas=2
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl scale deployment/nginx --replicas=2
deployment.apps/nginx scaled
```

2. **Observe the pods**

```
kubectl get pod
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl get pod
NAME                    READY   STATUS    RESTARTS   AGE
nginx-585449566-kjkdd   1/1     Running   0          24m
nginx-585449566-ndqm9   1/1     Running   0          24m
```

Lab 3-2: Change the number of replicas

3. **Edit number of replicas in the “deployment-nginx.yaml” file**

deployment-nginx.yaml ×

git > nycu-k8s-lab > lab3 > deployment-nginx.yaml > {} spec > replicas

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
  labels:
    app: nginx
spec:
  replicas: 4
  selector:
    matchLabels:
      app: nginx
```

4. **Apply the YAML again**

```
kubectl apply -f deployment-nginx.yaml
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl apply -f deployment-nginx.yaml
deployment.apps/nginx configured
```

5. **Observe the pods**

```
kubectl get pod
```

Lab 3: Use *deployments* to manage Pods

1. Deploy the “Deployment” YAML
2. Change the number of replicas
3. ▶ **What if we delete the pods manually**
4. Cleanup

Lab 3-3: What if we delete the pods manually

1. **Observe the pods first**

```
kubectl get pod
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl get pod
NAME                    READY   STATUS    RESTARTS   AGE
nginx-585449566-6cpn4   1/1     Running   0          6m56s
nginx-585449566-kjkdd   1/1     Running   0          35m
nginx-585449566-ndqm9   1/1     Running   0          35m
nginx-585449566-q6ctq   1/1     Running   0          6m56s
```

2. **Let's delete one of the pods**

```
kubectl delete pod YOUR_POD_NAME
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl delete pod nginx-585449566-kjkdd
pod "nginx-585449566-kjkdd" deleted
```

3. **Observe the pods again. What happened?**

```
kubectl get pod
```

Lab 3: Use *deployments* to manage Pods

1. Deploy the “Deployment” YAML
2. Change the number of replicas
3. What if we delete the pods manually
4. ▶ **Cleanup**

Lab 3-4: Cleanup

1. **Delete the “nginx” deployment**

```
kubectl delete deployment nginx
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl delete deployment nginx
deployment.apps "nginx" deleted
```

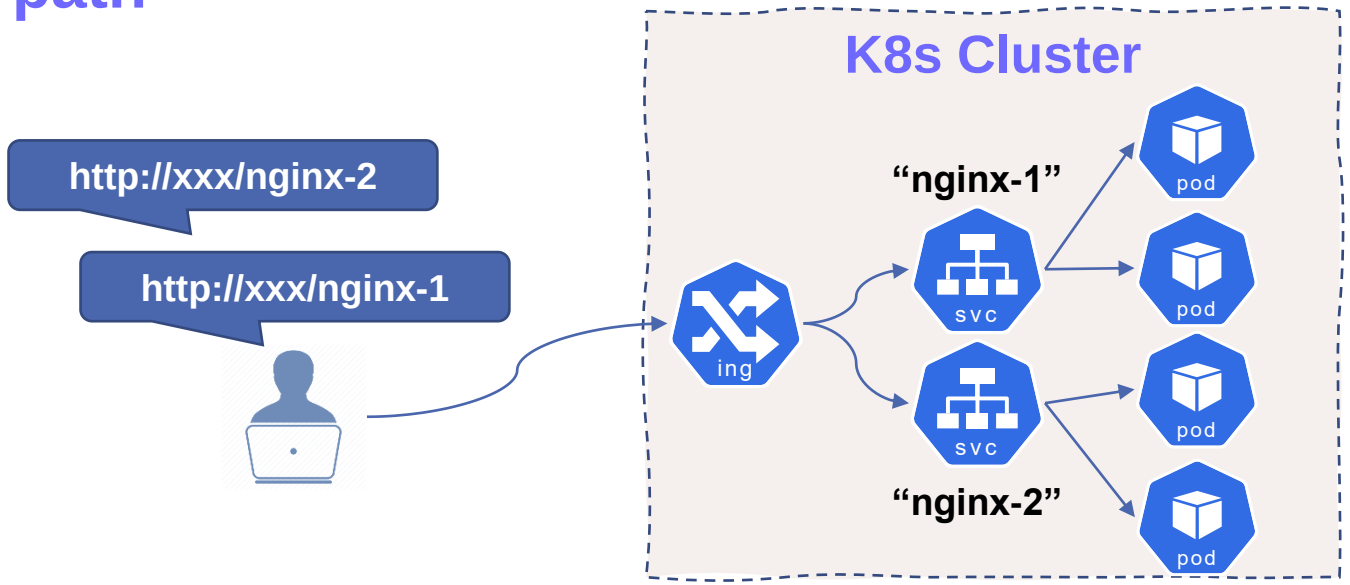
2. **Get all the resources**

```
kubectl get all
```

```
chh9513136@cloudshell:~/git/nycu-k8s-lab/lab3 (trainer-lab)$ kubectl get all
No resources found in lab namespace.
```

Bonus Lab: Advanced Ingress Routing

1. Deploy the provided YAML files to create 2 deployments with different webpage content
2. For each deployment, create a service for it
3. Create an ingress to route to different service backends base on the URL path



⚠ Reminder on Cloud Resource Usage Fees

- Running instances on Google Cloud Platform incur charges, please DO remember to *scale down / cleanup your instances* if you are not going to access it for a while 😉
- Remember to:
  - ✓ Scale down your cluster
  - ✓ Delete Ingresses & “LoadBalancer” type Services