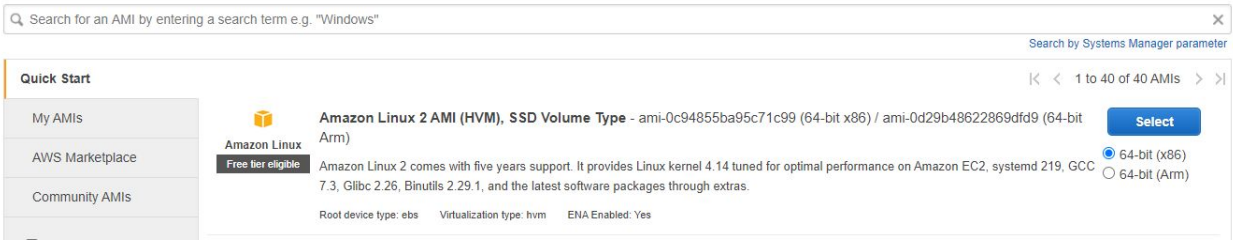
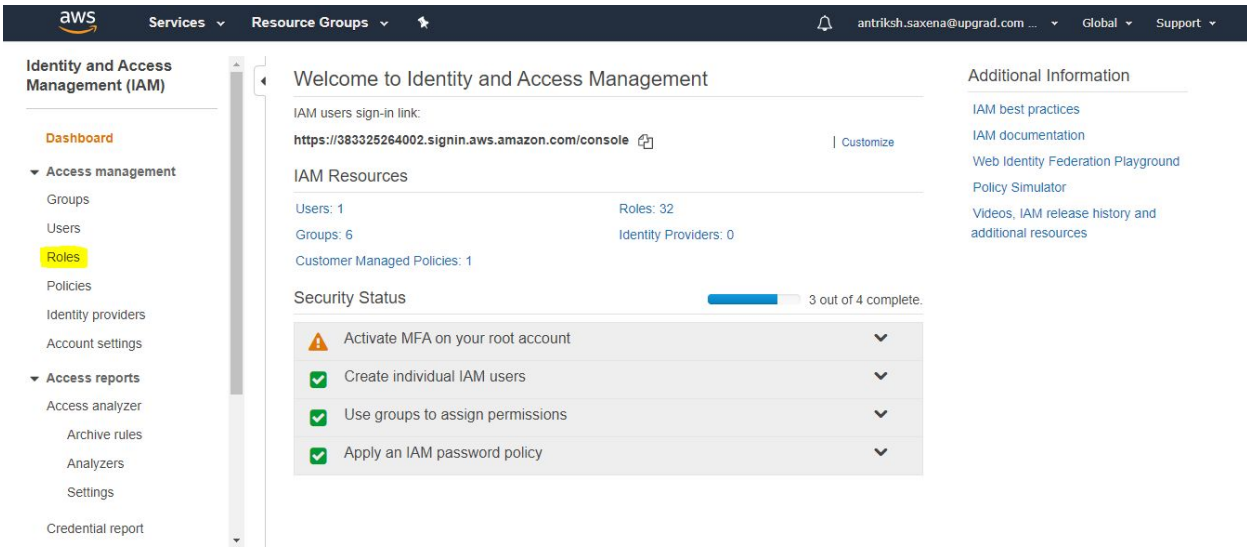
1. Launch Linux EC2 instance in AWS



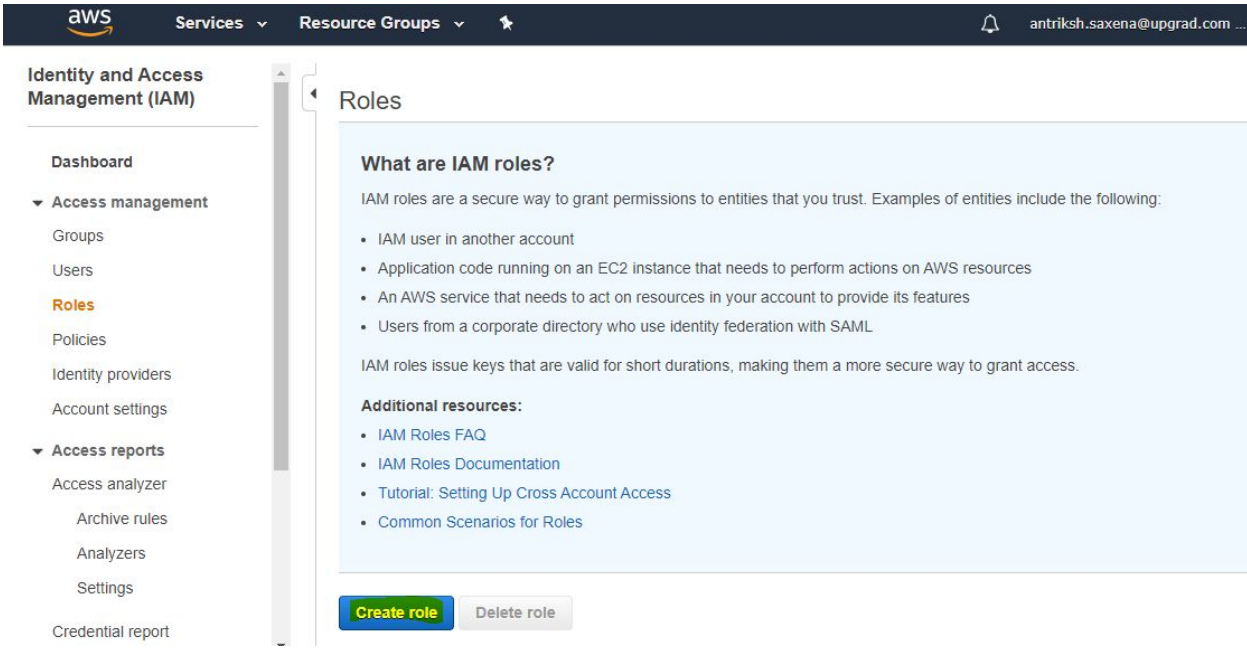
2. Create and attach the relevant policies through the IAM role to EC2 Instance. Kops need permissions to access, S3, EC2, VPC, Route53, Autoscaling, etc.
(**Note**: You can directly attach the AdministratorAccess policy to the role)

   Create an IAM role:

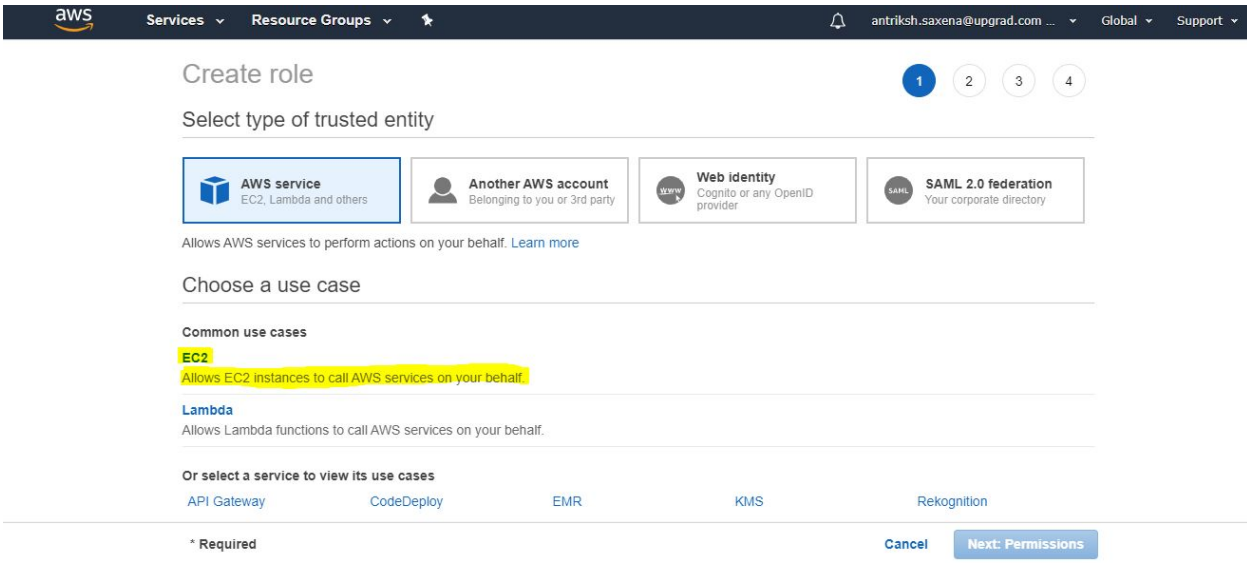
   a. Search for IAM in the services and go to the IAM policy page and click to the roles.



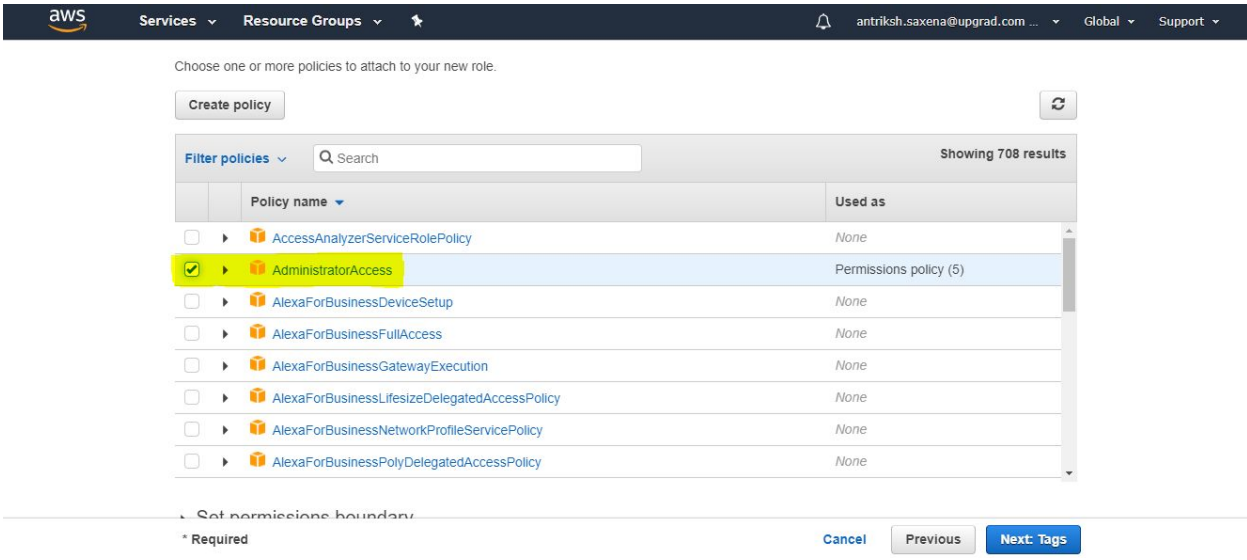
   b. Next, you need to create a role.



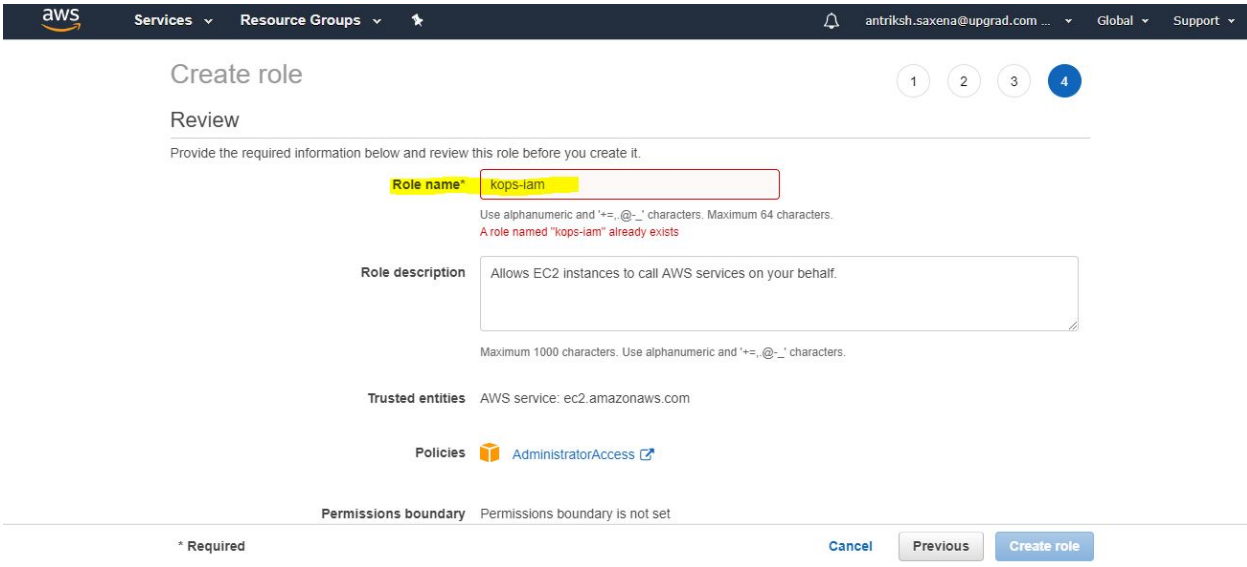
c. Select the use cases as EC2:



d. In the next step, check the AdministratorAccess policy.

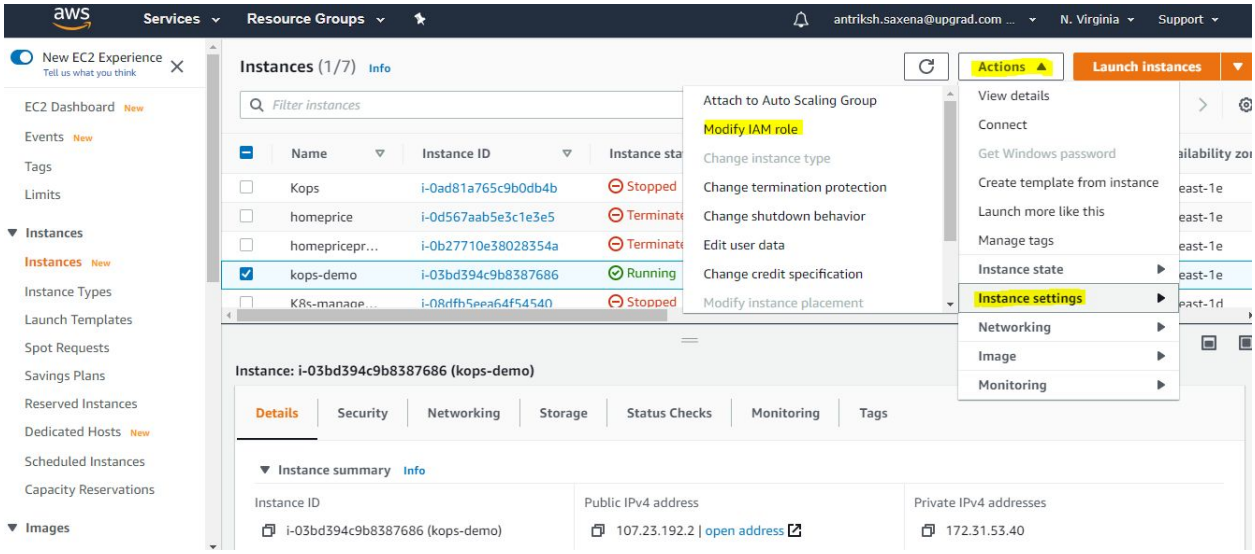


e. Enter a role name and press create role.

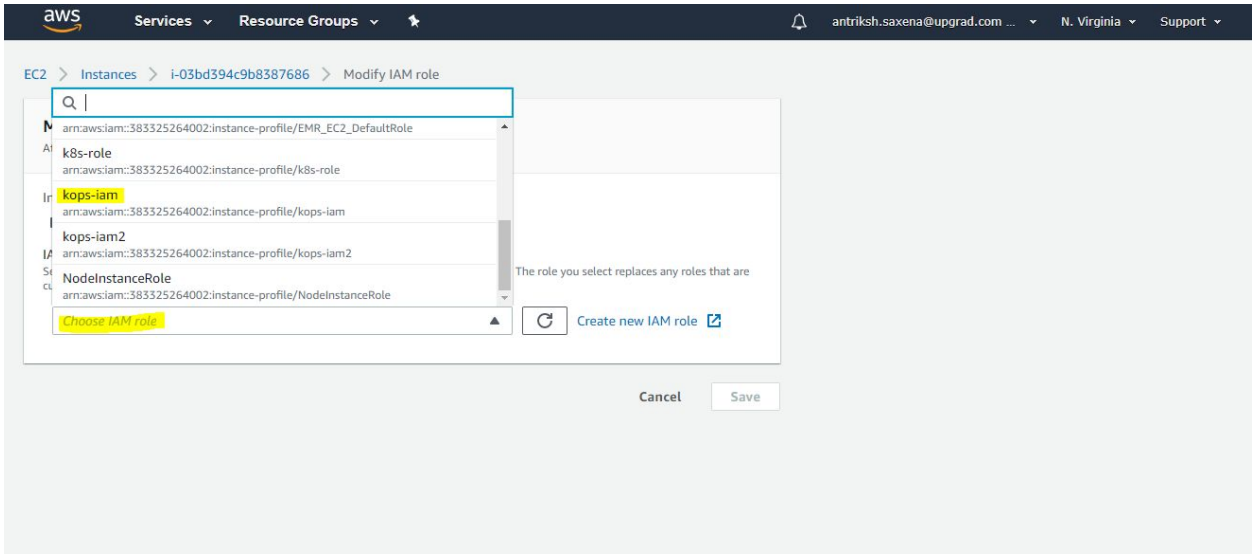


The next step is to attach this IAM role to the already created EC2 instance.

a. Go to the instance settings and then modify the IAM role.



b. Choose the appropriate IAM role and save it.



3. Install Kops on EC2

a) Download kops binary

```
curl -LO https://github.com/kubernetes/kops/releases/download/$(curl -s https://api.github.com/repos/kubernetes/kops/releases/latest | grep tag_name | cut -d '"' -f 4)/kops-linux-amd64
```

b) Execute permissions for binary

```
chmod +x kops-linux-amd64
```

c) Move binary to usr/local/bin so the command is in path

```
sudo mv kops-linux-amd64 /usr/local/bin/kops
```

d) Check installation

```
kops version
```

The final output should come out as shown below

```
[ec2-user@ip-172-31-47-90 ~]$ kops version
Version 1.18.0 (git-698bf974d8)
```

4. Install kubectl

a) Download kubectl binary

```
curl -LO https://storage.googleapis.com/kubernetes-release/release/$(curl
-s
https://storage.googleapis.com/kubernetes-release/release/stable.txt)/bin/l
inux/amd64/kubectl
```

b) Execute permissions for binary

```
chmod +x ./kubectl
```

c) Move binary to usr/local/bin so the command is in path

```
sudo mv ./kubectl /usr/local/bin/kubectl
```

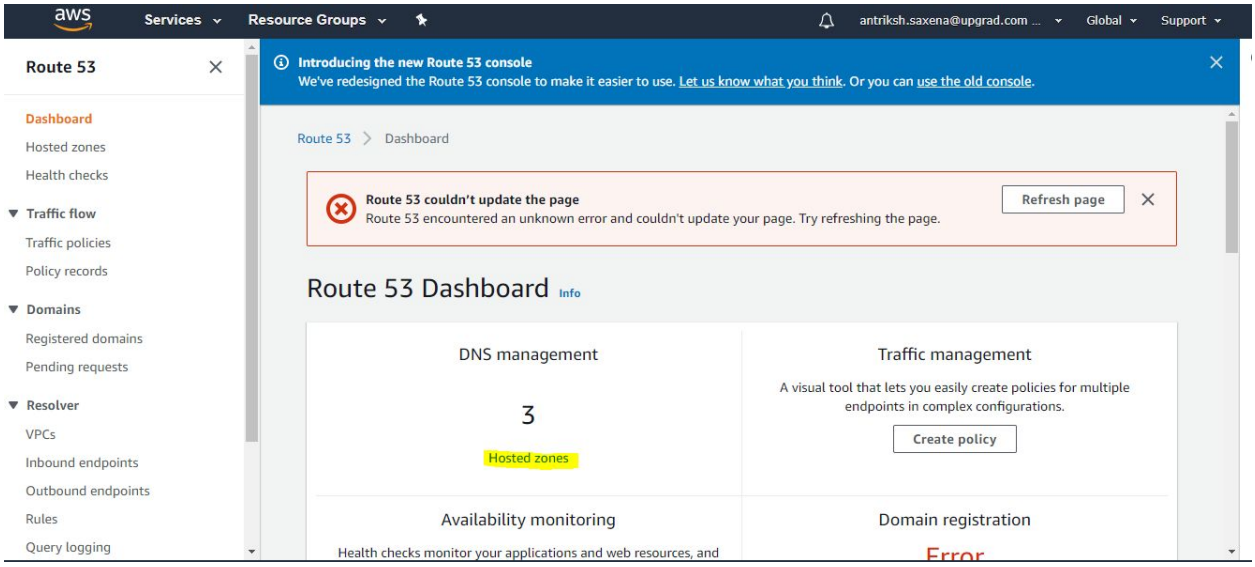
5. Create S3 Bucket in AWS

- S3 bucket is used by kubernetes to persist cluster state
- **Note**: Make sure you choose bucket name that is unique across all AWS accounts

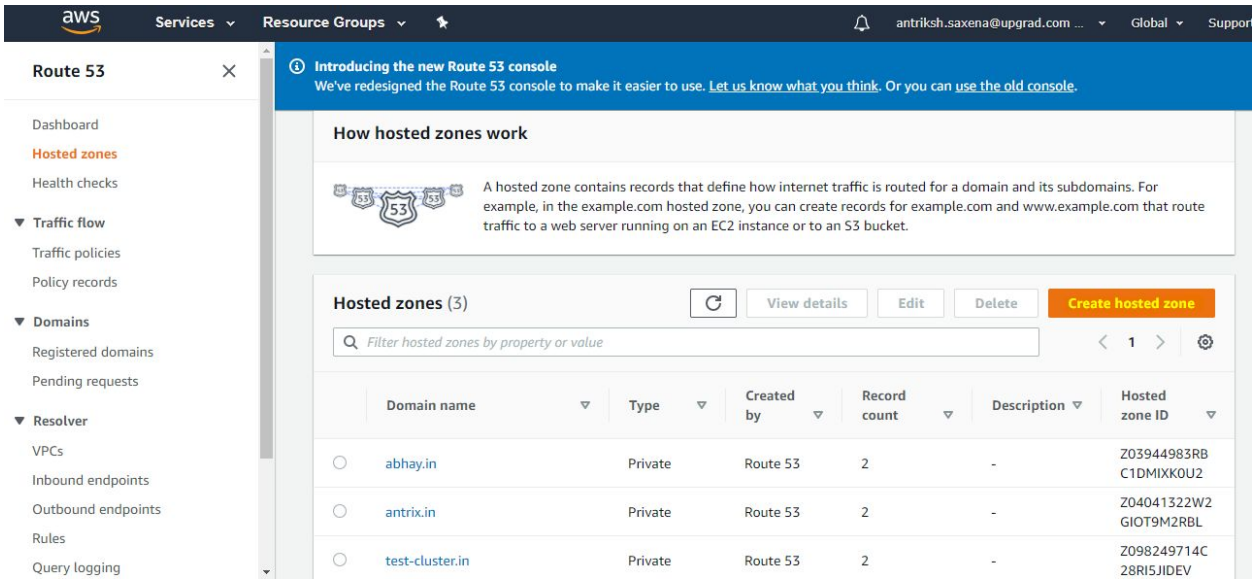
```
aws s3 mb s3://kops-bucket.in.k8s --region us-east-1
```

6. Create private hosted zone in AWS Route53

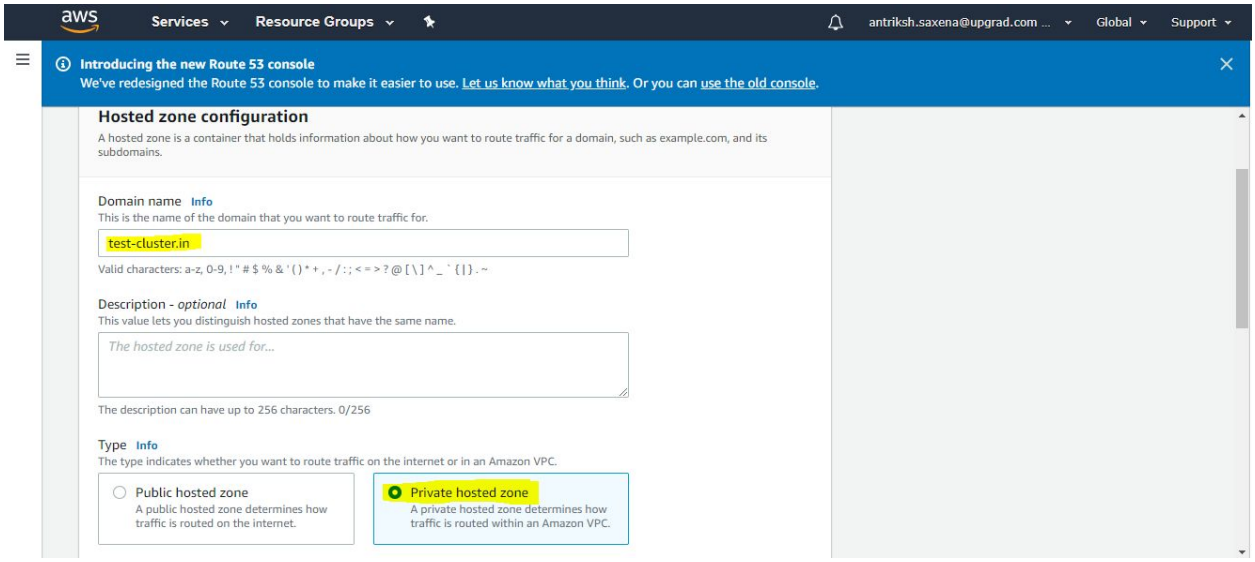
a. Head over to aws Route53 and create hostedzone.



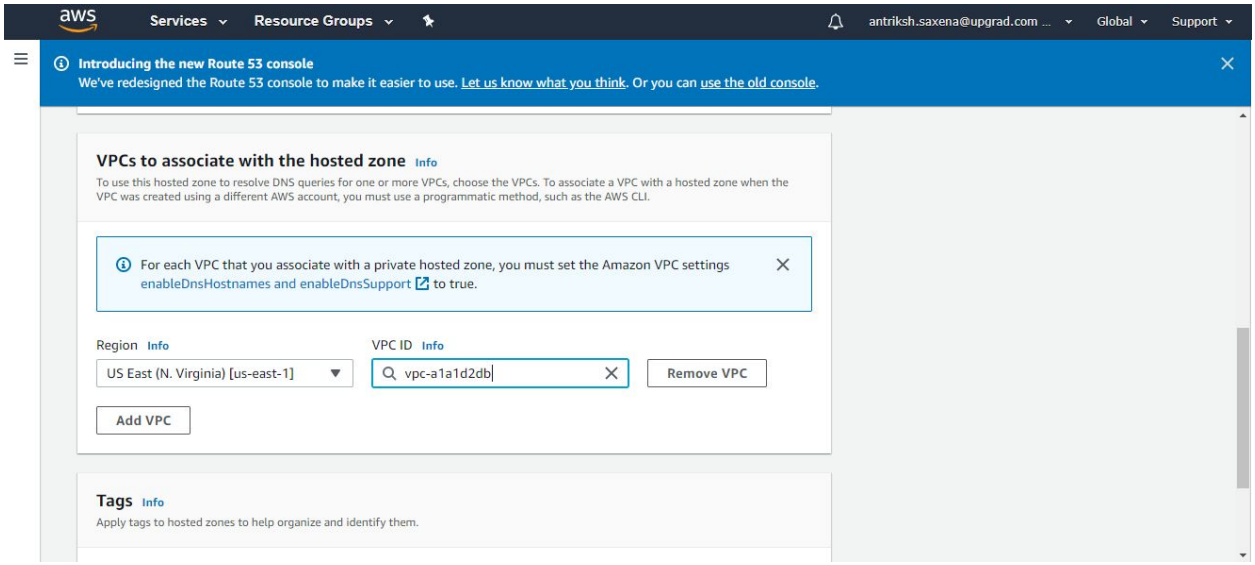
Click on the create hosted zone:



b. Choose a name for example (test-home.in).
c. Choose type as a **private hosted zone** for VPC.



d. Select default vpc in the region you are setting up your cluster.



e. Press the create button.

7. Configure environment variables.

Open .bashrc file

```
vi ~/.bashrc
```

Add the following content into .bashrc, you can choose any arbitrary name for the cluster and make sure the bucket name matches the one you created in step 5.

```
export KOPS_CLUSTER_NAME=test-cluster.in
export KOPS_STATE_STORE=s3://kops-bucket.in.k8s
```

Then run the following command to reflect the variables added to .bashrc

```
source ~/.bashrc
```

8. Create ssh key pair

This keypair is used for ssh into Kubernetes cluster

```
ssh-keygen
```

To which it will return

```
[ec2-user@ip-172-31-47-90 ~]$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/ec2-user/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/ec2-user/.ssh/id_rsa.
Your public key has been saved in /home/ec2-user/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:6tDQTSauficOXOsSqYtHMSe2myrcjMyMJBAjQa+nZLY ec2-user@ip-172-31-47-90.ec2.internal
The key's randomart image is:
+---[RSA 2048]----+
|oo               |
|+ .              |
|.o .  . o        |
|. * .o =         |
|.* B..+ S        |
|=.*.o= o         |
|OE++=.+          |
|oB=+.=o .        |
|+o...++o         |
+----[SHA256]-----+
```

9. Create a Kubernetes cluster definition using the following command

```
kops create cluster \
--state=${KOPS_STATE_STORE} \
--node-count=2 \
--master-size=t2.micro \
--node-size=t2.micro \
--zones=us-east-1b \
--name=${KOPS_CLUSTER_NAME} \
```

```
--dns private \
--master-count 1
```

10. Now create the kubernetes cluster using the following command

```
kops update cluster --yes
```

Above command may take some time to create the required infrastructure resources on AWS. Execute the validate command to check its status and wait until the cluster becomes ready

```
kops validate cluster
```

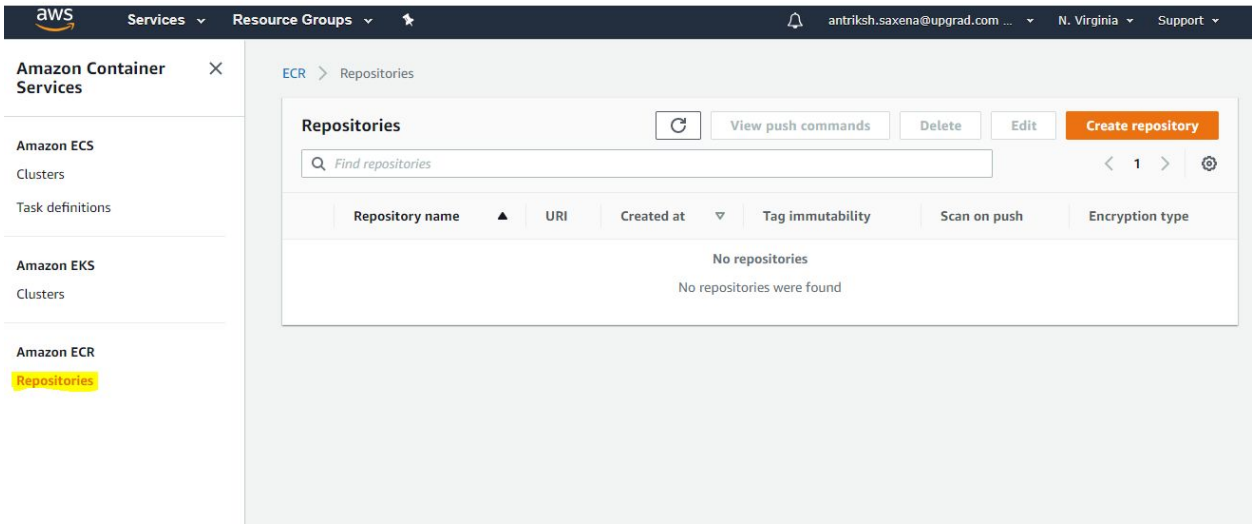
For the above command, you might see validation failed errors initially when you create a cluster and it is an expected behaviour. This means you will have to wait for some time as the cluster is still in its formation stage and you can try and run this command again after sometime.

Once the cluster is ready, the result of the command will be as follows:

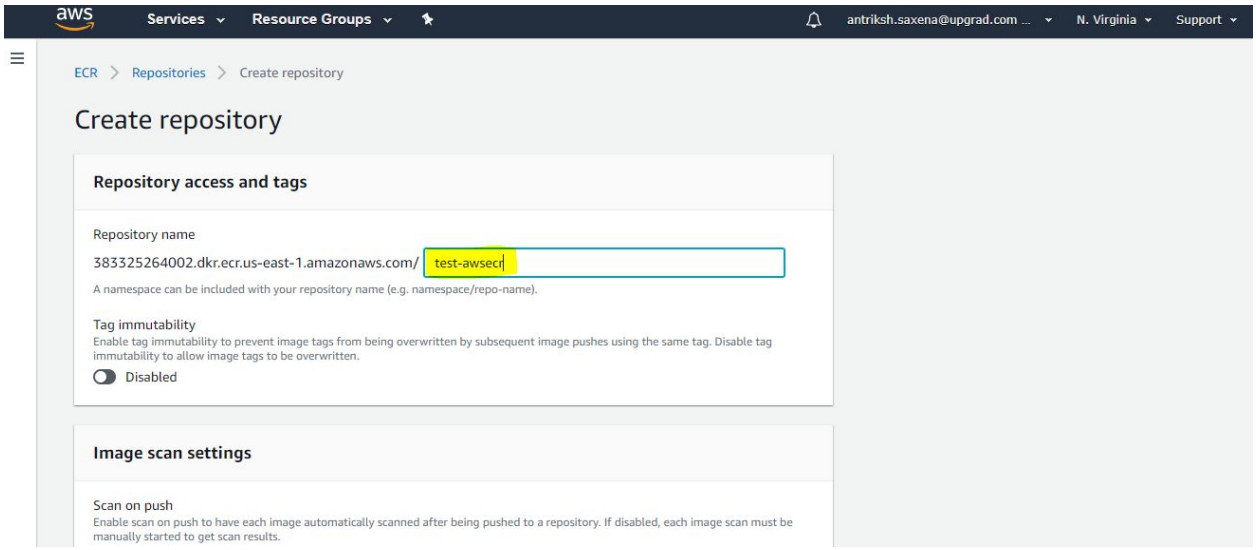
```
Validating cluster test-cluster.in

INSTANCE GROUPS
NAME                    ROLE    MACHINETYPE     MIN     MAX     SUBNETS
master-us-east-1b       Master  t2.micro        1       1       us-east-1b
nodes                   Node    t2.micro        2       2       us-east-1b

NODE STATUS
NAME                            ROLE    READY
ip-172-20-35-90.ec2.internal    node    True
ip-172-20-45-123.ec2.internal   node    True
ip-172-20-53-104.ec2.internal   master  True

Your cluster test-cluster.in is ready
```

11. In the next step, you need to create Amazon ECS (Elastic Container Services).

    a. Search for ECR (Elastic Container Registry) in services.



b. Enter a name and create the repository.



As you have seen in this demonstration, we will be using a public git repository available on the following link. Before cloning the git repository, you will first have to install git. This can be done by executing the following commands.

a) First you have to install git using the following command

```
sudo yum install git
```

b) The next step is to clone the codes into your instance. This is done using git clone command. For this step, you can perform the cloning by executing,

```
git clone https://github.com/antoinemertz/deploy-ml-flask.git
```

c) Go into the particular folder to access the contents from the git repository

```
cd deploy-ml-flask/
```

Sometimes, there are issues with AWS while trying to use 'Load Balancer', hence you should add this additional code for attaching the elastic load balancing role

```
aws iam create-service-linked-role --aws-service-name
"elasticloadbalancing.amazonaws.com"
```

Before starting the docker service, you will first need to install docker using the following command.

```
sudo yum install docker
```

Now you can start the docker service using,

```
sudo service docker restart
```

If you run the following command, you will find that
sudo docker images

Now let us build the docker image

```
sudo docker build -t insurance-app:v1 .
```

Validate that the image has been created by running **sudo docker images** again

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ sudo docker images
REPOSITORY          TAG                 IMAGE ID            CREATED              SIZE
insurance-app       v1                  01accf7e20a4        About a minute ago   916MB
python              3.6.3               a8f7167de312        2 years ago          691MB
```

14. Authenticate to container Registry AWS

sudo $(aws ecr get-login --no-include-email --region us-east-1)

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ sudo $(aws ecr get-login --no-include-email --region us-ea
st-1)
WARNING! Using --password via the CLI is insecure. Use --password-stdin.
WARNING! Your password will be stored unencrypted in /root/.docker/config.json.
Configure a credential helper to remove this warning. See
https://docs.docker.com/engine/reference/commandline/login/#credentials-store

Login Succeeded
```

Copy the url from ECR

Repository name	URI	Created at	Tag immutability	Scan on push	Encryption type
test-awsecr	177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr	08/26/20, 12:52:49 PM	Disabled	Disabled	AES-256

```
sudo docker tag insurance-app:v1
177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

Now that you have tagged it, the whole thing needs to be pushed. Hence, we will use sudo docker push followed by the url

```
sudo docker push
177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

Once this is done, you will be able to see that it is pushing everything to the ECR

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ sudo docker push 177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr
The push refers to repository [177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr]
44035a629395: Pushed
68a8ebbf3f99: Pushed
cd3f32d47dfa: Pushing [==================================>                ]  160.9MB/224.6MB
873b35128e79: Pushed
43cb5700b5b9: Pushed
c8c8418550a6: Pushed
56388ddcbf7f: Pushed
edda128d7256: Pushing [========================================>          ]  50.12MB/62.55MB
0870b36b7599: Pushed
8fe6d5dcea45: Pushing [==>                                                ]   16.3MB/323.9MB
06b8d020c11b: Pushing [=>                                                 ]  3.833MB/123MB
b9914afd042f: Waiting
4bcdffd70da2: Waiting
```

Once this is done, you can go to your AWS ECR console to verify that your image has been pushed by finding your image under the image URL.

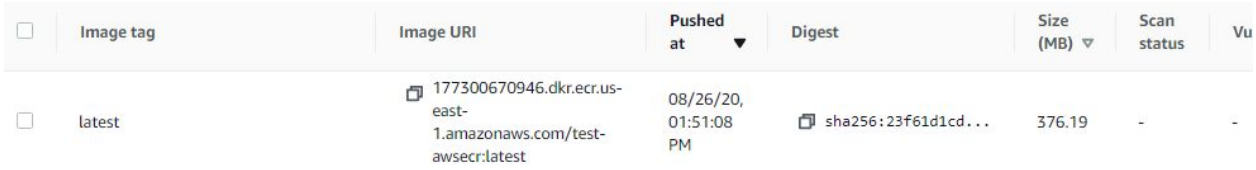


Image tag	Image URI	Pushed at	Digest	Size (MB)	Scan status	Vu
latest	177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:latest	08/26/20, 01:51:08 PM	sha256:23f61d1cd...	376.19	-	-

The next step is to deploy and manage the whole thing on the cluster. Hence we will use kubectl to create the deployment

```
kubectl create deployment insurance-app
--image=177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ kubectl create deployment insurance-app --image=177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:latest
deployment.apps/insurance-app created
```

You will see that your insurance-app has been created

18. Expose your application to the internet
By default, the containers you run on are not accessible from the internet because they do not have external IP addresses. Execute the following code to expose the application to the internet:

```
kubectl expose deployment insurance-app --type=LoadBalancer --port 5000
--target-port 5000
```

So you will get the following result

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ kubectl expose deployment insurance-app --type=LoadBalancer --port 5000 --target-port 5000
service/insurance-app exposed
```

To find the url that needs to be used, type the following code

```
kubectl get services
```

You will get the following result.

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ kubectl get services
NAME            TYPE           CLUSTER-IP     EXTERNAL-IP                                                                PORT(S)          AGE
insurance-app   LoadBalancer   100.71.62.89   a40fd2365931d4135ac5ba44984998e0-1408662421.us-east-1.elb.amazonaws.com   5000:32527/TCP   8s
kubernetes      ClusterIP      100.64.0.1     <none>                                                                     443/TCP          81m
```

Within this, you will be able to find an

```
[ec2-user@ip-172-31-47-90 deploy-ml-flask]$ kubectl get services
NAME            TYPE           CLUSTER-IP     EXTERNAL-IP                                                              PORT(S)          AGE
insurance-app   LoadBalancer   100.71.62.89   a40fd2365931d4135ac5ba44984998e0-1408662421.us-east-1.elb.amazonaws.com   5000:32527/TCP   8s
kubernetes      ClusterIP      100.64.0.1     <none>                                                                   443/TCP          81m
```

You can use '**kubectl describe services**' to check if we are getting any errors. If there is no error, your command will return a result having all the details of the cluster as shown below.

```
Name:                     insurance-app
Namespace:                default
Labels:                   app=insurance-app
Annotations:              <none>
Selector:                 app=insurance-app
Type:                     LoadBalancer
IP:                       100.71.62.89
LoadBalancer Ingress:     a40fd2365931d4135ac5ba44984998e0-1408662421.us-east-1.elb.amazonaws.com
Port:                     <unset>  5000/TCP
TargetPort:               5000/TCP
NodePort:                 <unset>  32527/TCP
Endpoints:                100.96.1.4:5000
Session Affinity:         None
External Traffic Policy:  Cluster
Events:                   <none>


Name:              kubernetes
Namespace:         default
Labels:            component=apiserver
                   provider=kubernetes
Annotations:       <none>
Selector:          <none>
Type:              ClusterIP
IP:                100.64.0.1
Port:              https  443/TCP
TargetPort:        443/TCP
Endpoints:         172.20.53.104:443
Session Affinity:  None
Events:            <none>
```

Once your model has been deployed, let us move on to our local machine and try to run the model from there.

Let's open your jupyter notebook in your local machine. And paste the following code to predict the results from the iris dataset.

Use your ML model

Now you can use your model.

```
>>> import json
>>> import requests
>>> url = "http://127.0.0.1:5000/predict"
>>> data = json.dumps({'sl': [5.84, 4.38], 'sw': [3.0, 2.16], 'pl': [3.75, 7.65], 'pw': [1.1, 1.23]})
>>> r = requests.post(url, data)
>>> print(r.json())
```

Once you write the code, make sure to replace the ip address in the url with the external url generated from running the cluster. The point where this url needs to be inserted has been highlighted in red.

```
import json
import requests
url =
"http://a40fd2365931d4135ac5ba44984998e0-1408662421.us-east-1.elb.amazonaws
.com:5000/predict"
data = json.dumps({'sl': [5.84, 4.38], 'sw': [3.0, 2.16], 'pl': [3.75,
7.65], 'pw': [1.1, 1.23]})
r = requests.post(url, data)
print(r.json())
```

If you want to run the application on user interface then you need to follow the following steps:

You have been given all related files-

- requirements.txt
- Dockerfile
- server.py
- model.pckl
- Index.html

You need to add all of such files into a directory named **deploy-ml-flask** on EC2. You already know how to add files on EC2.

Once you have added all the required files on EC2 then follow the same steps as mentioned below that you are already aware of.

- Let's restart Docker.

```
sudo service docker restart
```

- Build an iris application

```
sudo docker build -t iris-app:v1 .
```

Validate that the image has been created by running **sudo docker images** again

- Authenticate to container Registry AWS

sudo $(aws ecr get-login --no-include-email --region us-east-1)

Copy the url from ECR

Repository name	URI	Created at	Tag immutability	Scan on push	Encryption type
test-awsecr	177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr	08/26/20, 12:52:49 PM	Disabled	Disabled	AES-256

```
sudo docker tag iris-app:v1
177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

Now that you have tagged it, the whole thing needs to be pushed. Hence, we will use sudo docker push followed by the url

```
sudo docker push
177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

Once this is done, you will be able to see that it is pushing everything to the ECR

Once this is done, you can go to your AWS ECR console to verify that your image has been pushed by finding your image under the image URL.

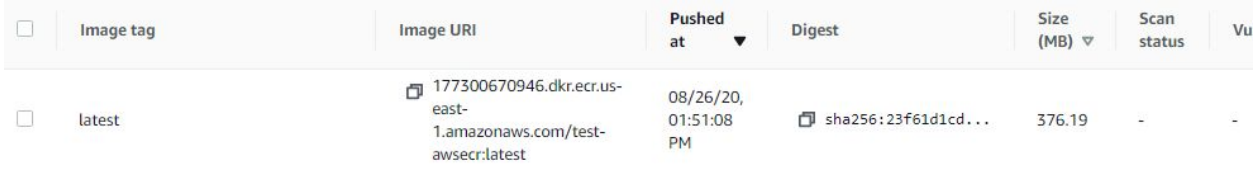


Image tag	Image URI	Pushed at	Digest	Size (MB)	Scan status	Vu
latest	177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:latest	08/26/20, 01:51:08 PM	sha256:23f61d1cd...	376.19	-	-

The next step is to deploy and manage the whole thing on the cluster. Hence we will use kubectl to create the deployment

```
kubectl create deployment iris-app
--image=177300670946.dkr.ecr.us-east-1.amazonaws.com/test-awsecr:v1
```

You will see that your iris-app has been created

- Expose your application to the internet

```
kubectl expose deployment iris-app --type=LoadBalancer --port 5000
--target-port 5000
```

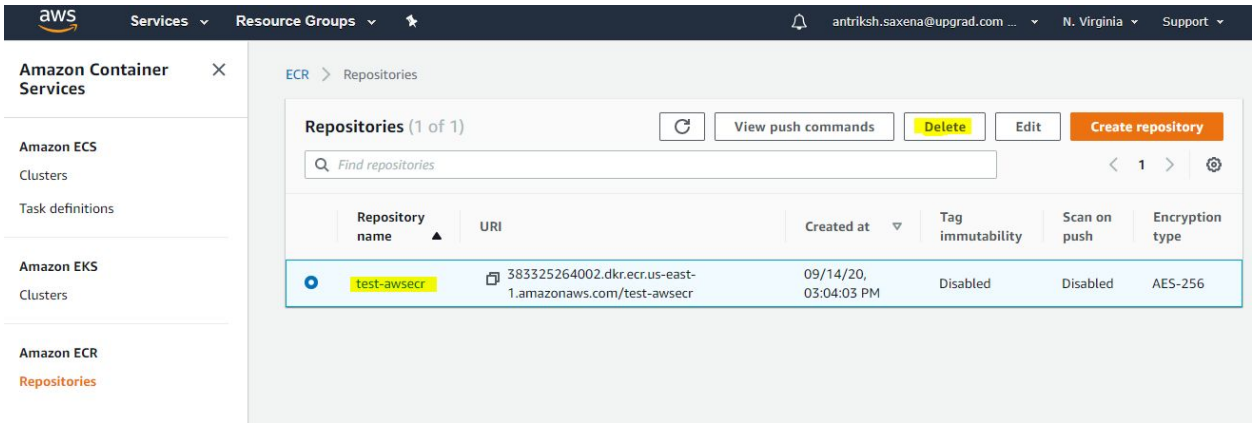
- To find the url that needs to be used, type the following code

```
kubectl get services
```

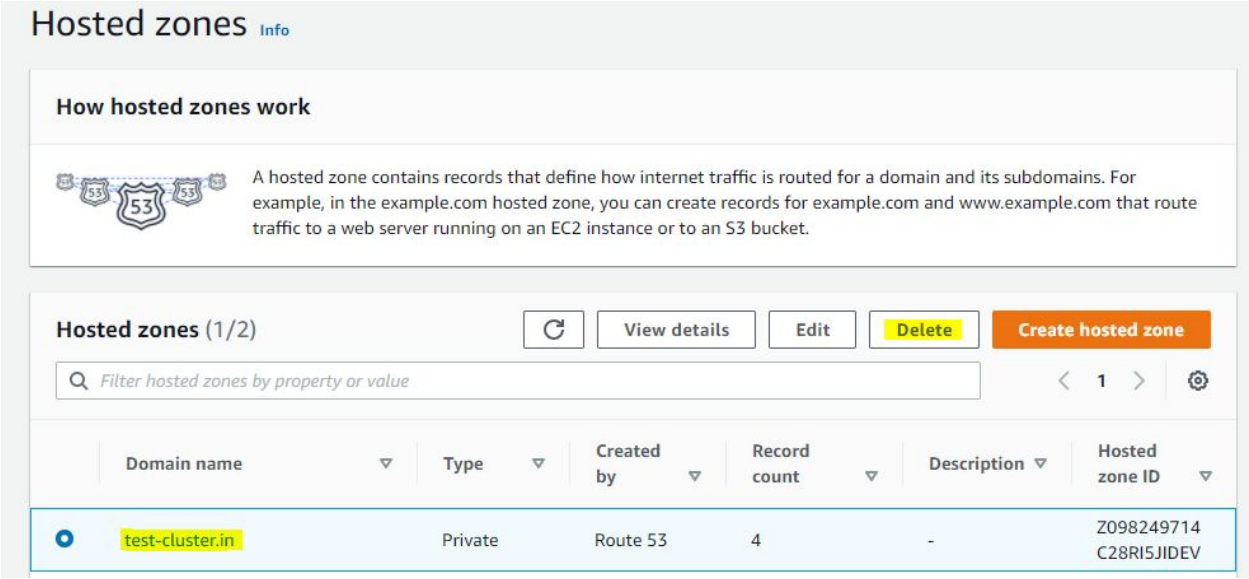
TERMINATING THE CLUSTER:
One of the important steps to save the cost.

Once you have done with your entire process, it is very important to delete the entire cluster and delete the ECR repository and private hosted zones. It costs too high if you keep it running.

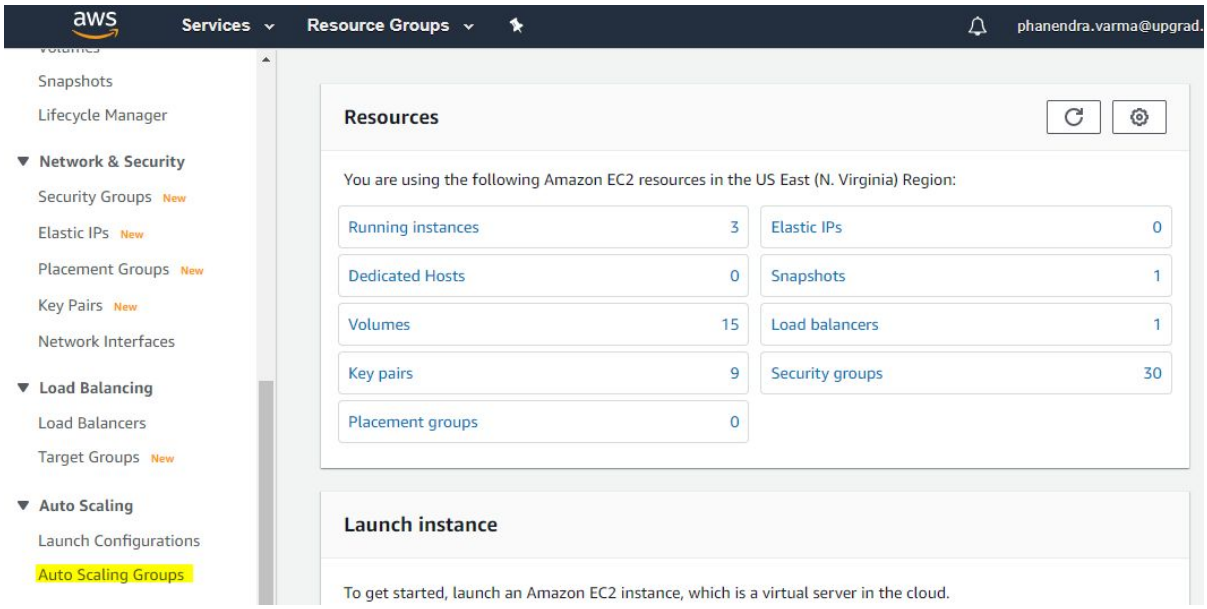
Deletion of ECR repository:

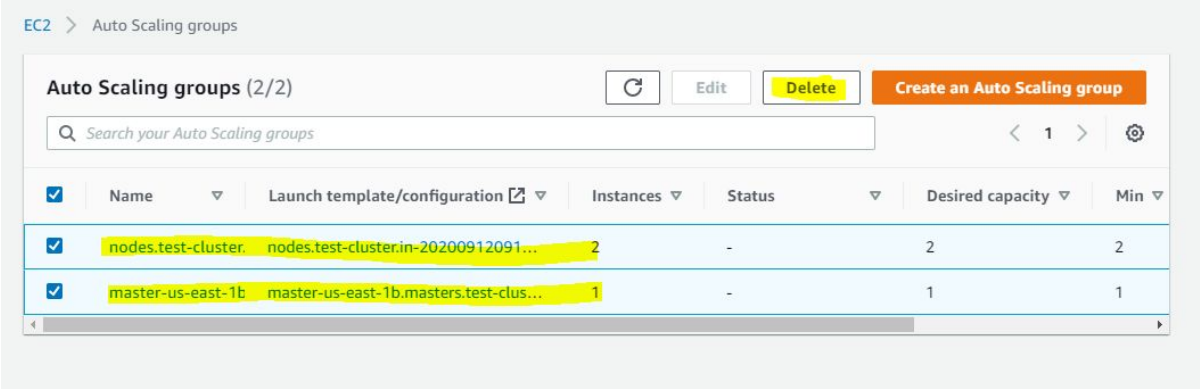


Deleting Private hosted zone

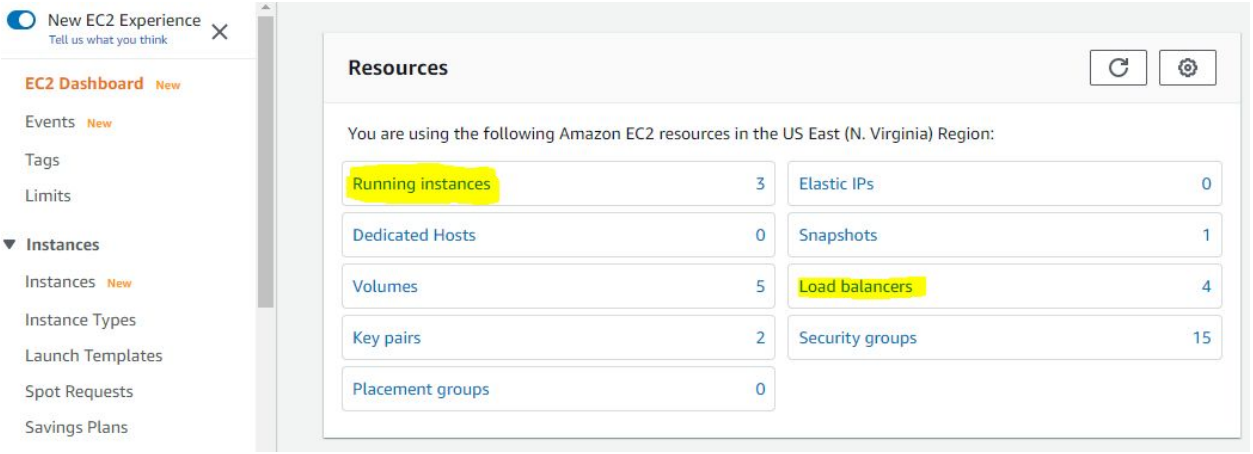


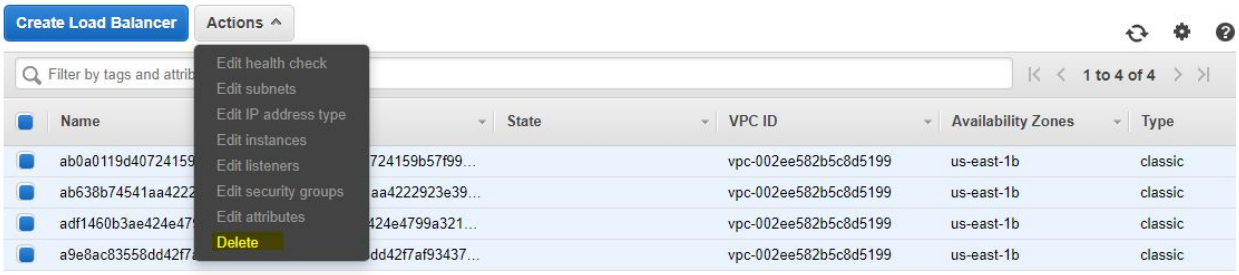
Deleting Auto Scaling Group:

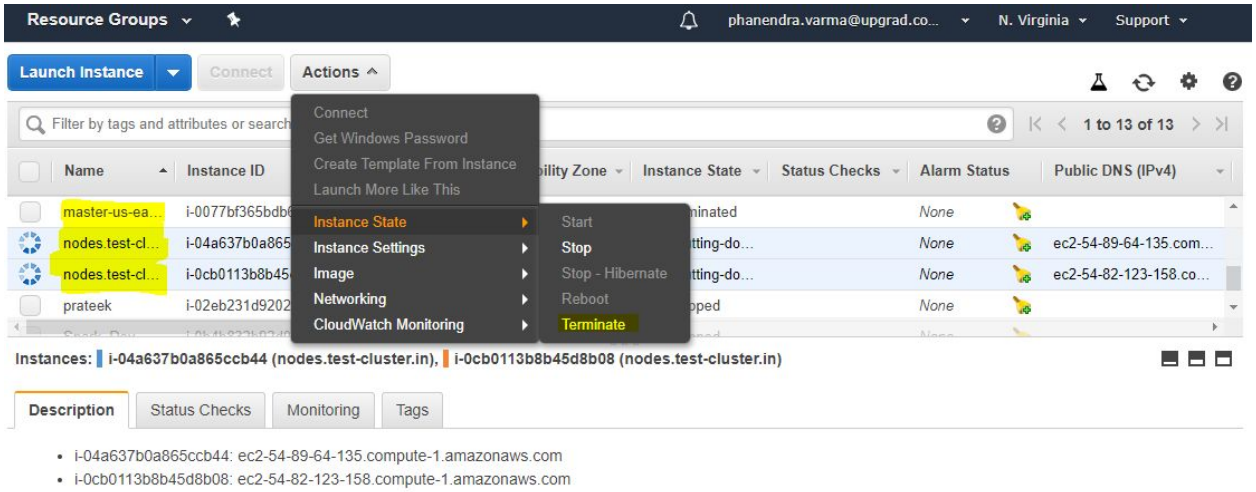




Deleting the load balancer:






Resource Groups
phanendra.varma@upgrad.co...
N. Virginia
Support
Launch Instance
Connect
Actions
Connect
Get Windows Password
Create Template From Instance
Launch More Like This
Instance State
Instance Settings
Image
Networking
CloudWatch Monitoring
Start
Stop
Stop - Hibernate
Reboot
Terminate
Filter by tags and attributes or search
1 to 13 of 13
Name
Instance ID
Instance State
Status Checks
Alarm Status
Public DNS (IPv4)
master-us-ea...
nodes.test-cl...
nodes.test-cl...
prateek
None
ec2-54-89-64-135.com...
ec2-54-82-123-158.co...
Instances: i-04a637b0a865ccb44 (nodes.test-cluster.in), i-0cb0113b8b45d8b08 (nodes.test-cluster.in)
Description
Status Checks
Monitoring
Tags
i-04a637b0a865ccb44: ec2-54-89-64-135.compute-1.amazonaws.com
i-0cb0113b8b45d8b08: ec2-54-82-123-158.compute-1.amazonaws.com