Lab Report 5 - 9

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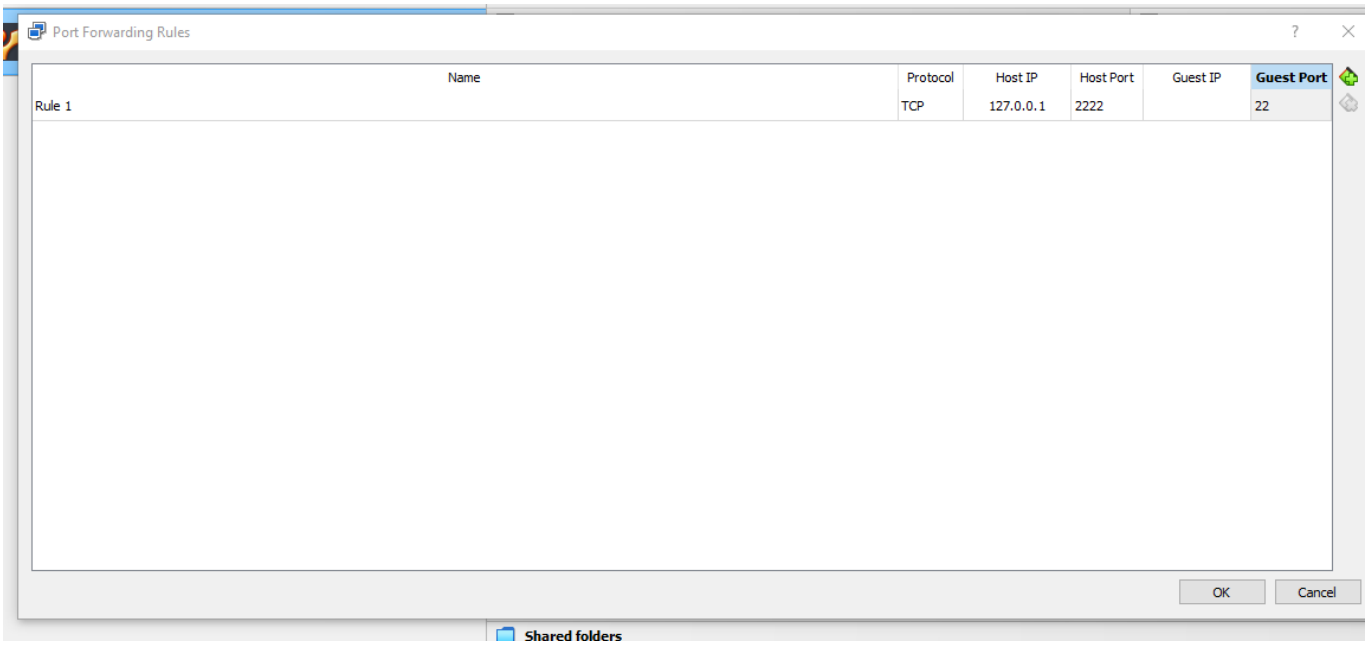
Lab 5: Networking

Section 1: Configure inbound IP on VM

1. Configure the network adapted in VirtualBox Manager using the rule: host IP 127.0.0.1 and host port 2222 mapped to Guest Port 22



2. Install tasksel and openssh-server

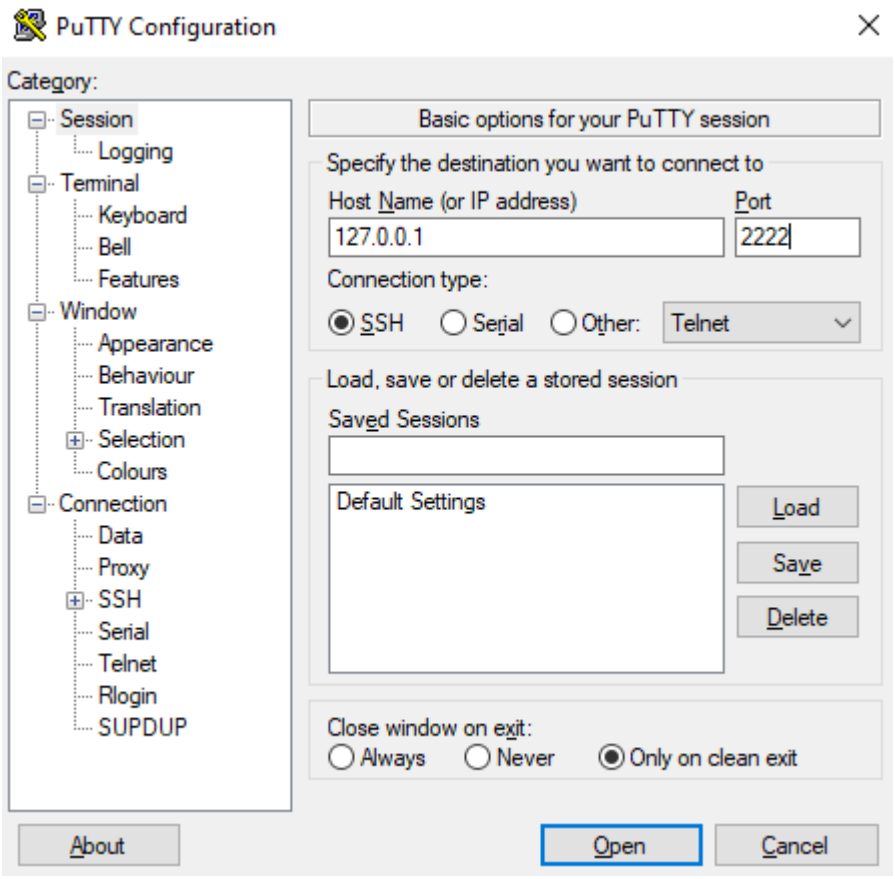
```
jookai@jookai:~$ sudo apt install tasksel
```

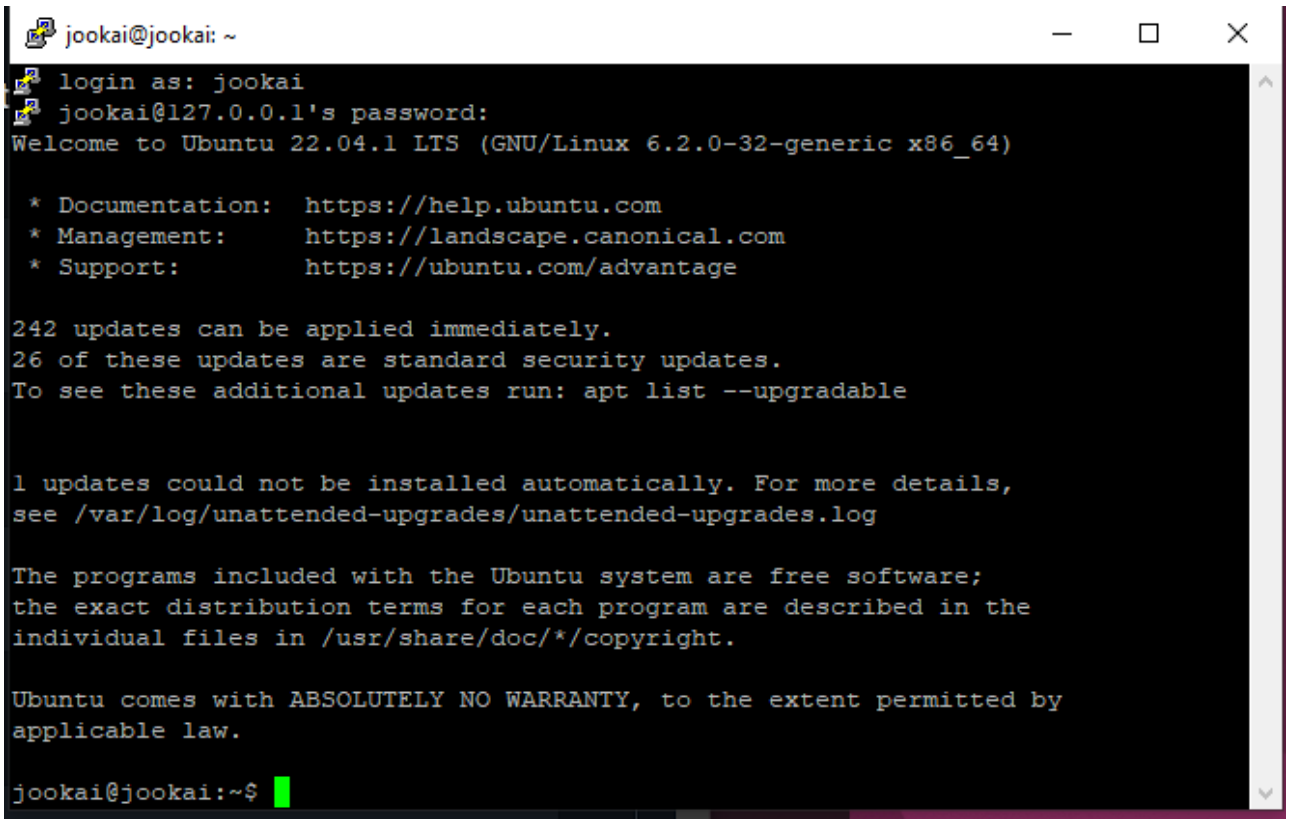
```
jookai@jookai:~$ sudo tasksel install openssh-server
```

3. Starting the ssh service on the ubuntu VM

```
jookai@jookai:~$ sudo service ssh start
```

4. SSH into the Ubuntu VM from the hostOS using Putty:





5. Terminate the SSH service:

```
jookai@jookai:~$ sudo service ssh stop
```

Section 2: Setting up an Application Load Balancer

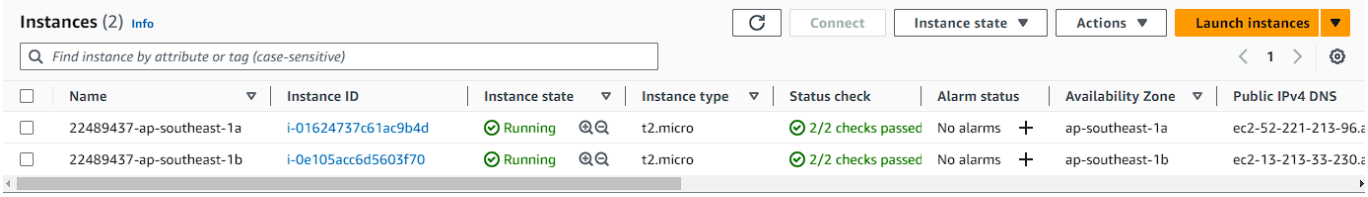
1. The following function is used to create 2 EC2 instances in two different availability zones of ap-southeast-1. The reason ap-southeast-1 was used instead of ap-southeast-2 was due to the limit in VPCUs on ap-southeast-2 which did not allow for any new EC2 instances to be created on the region at the time of attempting this lab.

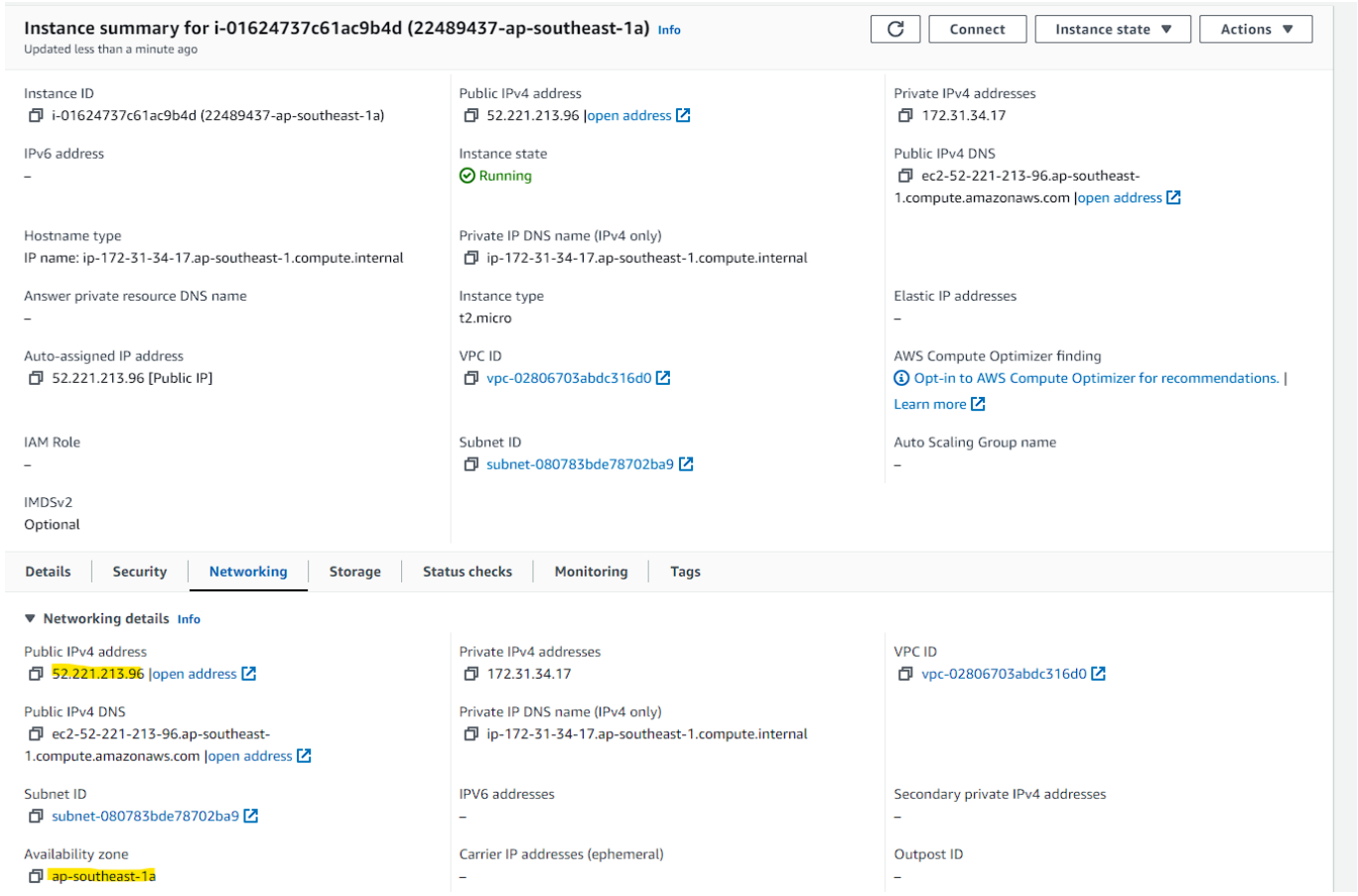
```
def launch_ec2_instances():
    # Create a security group
    response = ec2.create_security_group(
        GroupName=f"{student_number}-sg",
        Description="security group for development environment"
    )
    security_group_id = response['GroupId']

    # Authorize inbound SSH traffic for the security group
    ec2.authorize_security_group_ingress(
        GroupId=security_group_id,
        IpProtocol="tcp",
        FromPort=22,
        ToPort=22,
        CidrIp="0.0.0.0/0"
    )

    # Create a key pair and save the private key to a file
    response = ec2.create_key_pair(KeyName=f"{student_number}-key")
    private_key = response['KeyMaterial']
    private_key_file = f"{student_number}-key.pem"

    # Allow writing to the private key file
    os.chmod(private_key_file, 0o666)
    with open(private_key_file, 'w') as key_file:
        key_file.write(private_key)
    # Set the correct permissions for the private key file
    os.chmod(private_key_file, 0o400)
    # Copy the private key file to ~/.ssh directory
    ssh_directory = os.path.expanduser("~/.ssh")
    if not os.path.exists(ssh_directory):
        os.makedirs(ssh_directory)

    shutil.copy(private_key_file, ssh_directory)

    availability_zones = ["ap-southeast-1a", "ap-southeast-1b"]

    for i, az in enumerate(availability_zones):
        instance_name = f"{student_number}-{az}"

        instance_params = {
            'ImageId': 'ami-0df7a207adb9748c7',
            'InstanceType': 't2.micro',
            'KeyName': f"{student_number}-key",
            'SecurityGroupIds' : [security_group_id],
            'MinCount': 1,
            'MaxCount': 1,
```

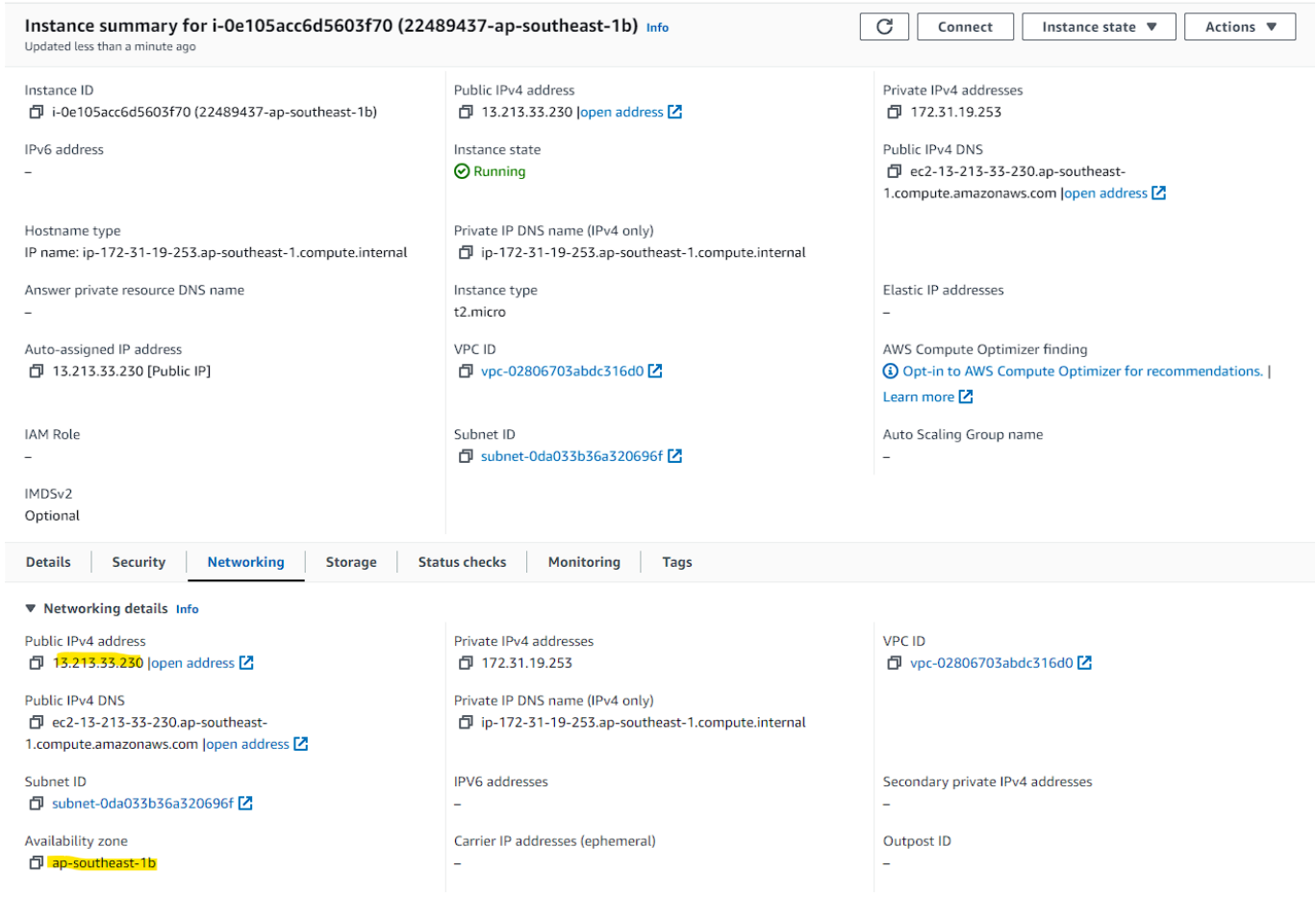
```
            'Placement': {'AvailabilityZone': az},
            'TagSpecifications': [
                {
                    'ResourceType': 'instance',
                    'Tags': [{'Key': 'Name', 'Value': instance_name}]
                }
            ]
        }

        # Launch an EC2 instance
        response = ec2.run_instances(**instance_params)

        instance_id = response['Instances'][0]['InstanceId']

        # Wait for the instance to be up and running
        ec2.get_waiter('instance_running').wait(InstanceIds=[instance_id])

        # Describe the instance to get its public IP address
        response = ec2.describe_instances(InstanceIds=[instance_id])
        public_ip_address = response['Reservations'][0]['Instances'][0]
['PublicIpAddress']

        print(f"Instance {i+1} created successfully in Availability Zone {az} with
Public IP: {public_ip_address}")
```

The created EC2 instances can be observed below. Note that the highlighted public IP addresses and availability zones in the AWS console correspond to the terminal output.

```
jookai@jookai:~/Desktop/cits5503/lab5$ python3 lab5.py -i
Instance 1 created successfully in Availability Zone ap-southeast-1a with Public
 IP: 52.221.213.96
Instance 2 created successfully in Availability Zone ap-southeast-1b with Public
 IP: 13.213.33.230
```







2. The code below creates an application load balancer. a. The code creates the load balancer and specifies the two region subnets retreived from step 1. b. The code creates a listener with a default rule

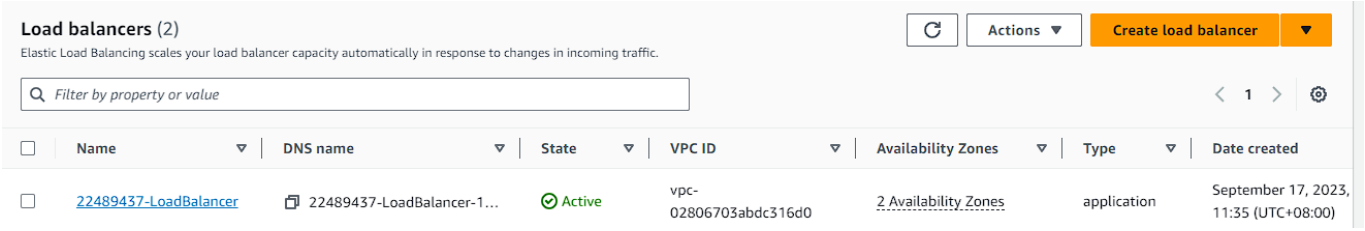
Protocol: HTTP and Port 80 forwarding on to the target group c. The code creates a target group using the VPC from step 1 d. The code registers the two EC2 instances from step 1 as targets

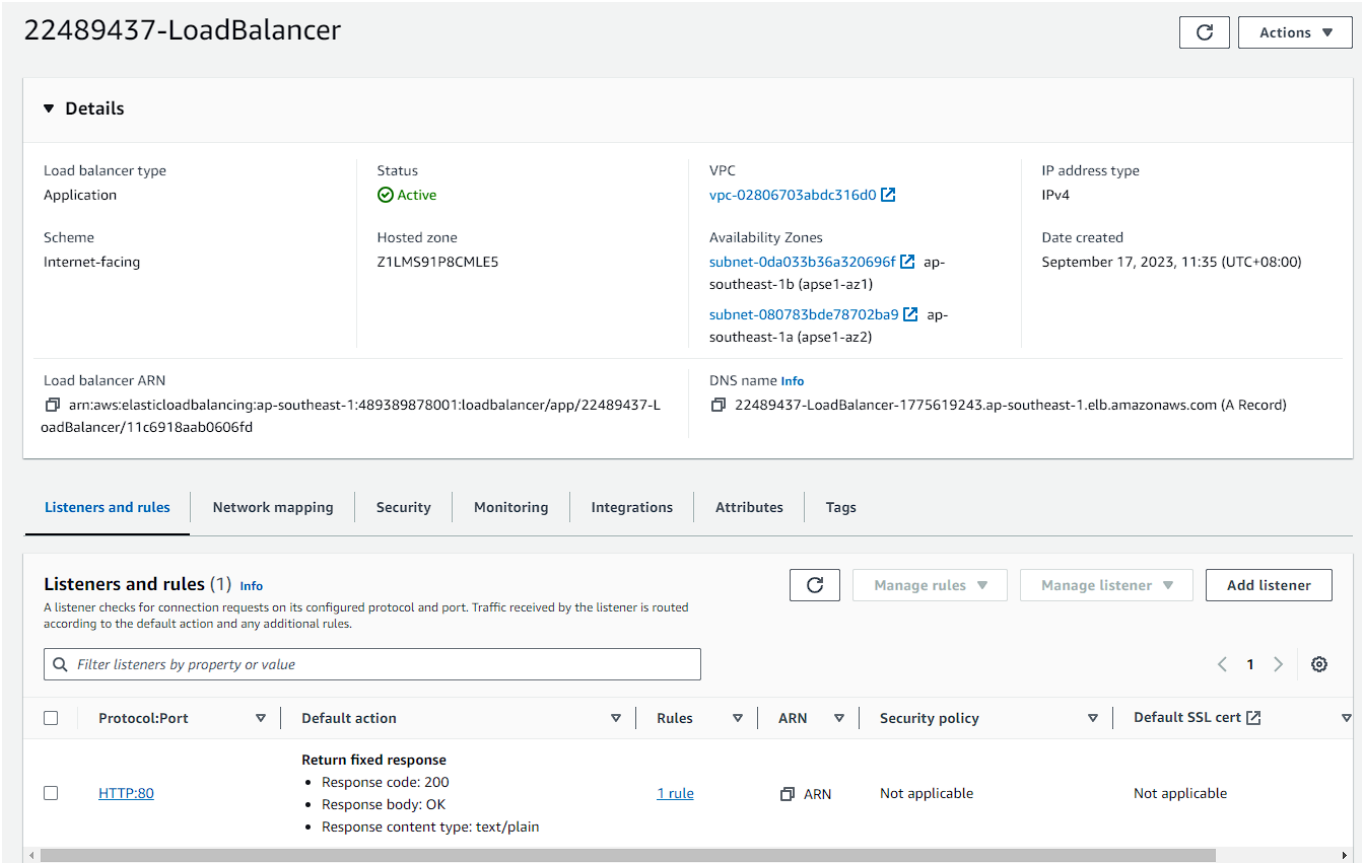
```
def create_load_balancer():
    vpc_id = 'vpc-02806703abdc316d0'
    security_group_id = 'sg-0021774194b407020'
    subnet_ids = ['subnet-080783bde78702ba9', 'subnet-0da033b36a320696f']

    response = elb.create_load_balancer(
        Name='22489437-LoadBalancer',
        Subnets=subnet_ids,
        SecurityGroups=[security_group_id],
        Scheme='internet-facing',
        Tags=[
            {
                'Key': 'Name',
                'Value': '22489437-LoadBalancer'
            },
        ]
    )

    load_balancer_arn = response['LoadBalancers'][0]['LoadBalancerArn']
    print(f"Load Balancer ARN: {load_balancer_arn}")

    # Create a target group
    response = elb.create_target_group(
        Name='22489437-target-group',
        Protocol='HTTP',
        Port=80,
        VpcId=vpc_id,
        TargetType='instance'
    )

    # Get the ARN of the target group
    target_group_arn = response['TargetGroups'][0]['TargetGroupArn']
    print(f"Target Group ARN: {target_group_arn}")

    # Create a listener for HTTP traffic (Port 80)
    response = elb.create_listener(
        DefaultActions=[
            {
                'Type': 'forward',
                'TargetGroupArn': target_group_arn,
            },
        ],
        LoadBalancerArn=load_balancer_arn,
        Port=80,
        Protocol='HTTP',
    )

    listener_arn = response['Listeners'][0]['ListenerArn']
    print(f"Listener ARN: {listener_arn}")
```

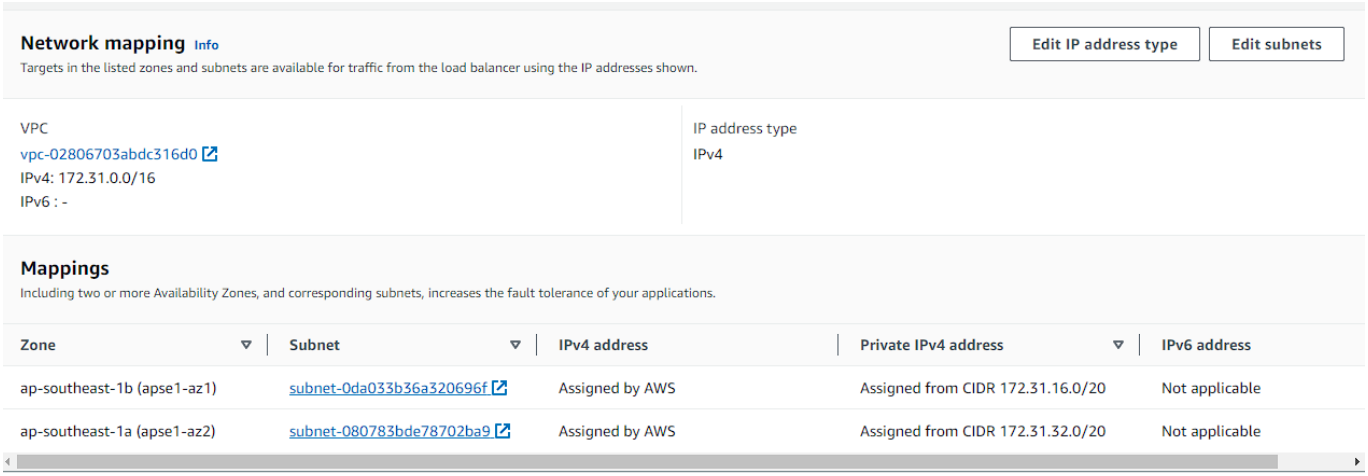
```
    instance_1_id = 'i-01624737c61ac9b4d'
    instance_2_id = 'i-0e105acc6d5603f70'

    # Register the instances in the target group
    elb.register_targets(
        TargetGroupArn=target_group_arn,
        Targets=[
            {'Id': instance_1_id},
            {'Id': instance_2_id},
        ]
    )

    # Print registration status
    print("Targets registered successfully.")
```

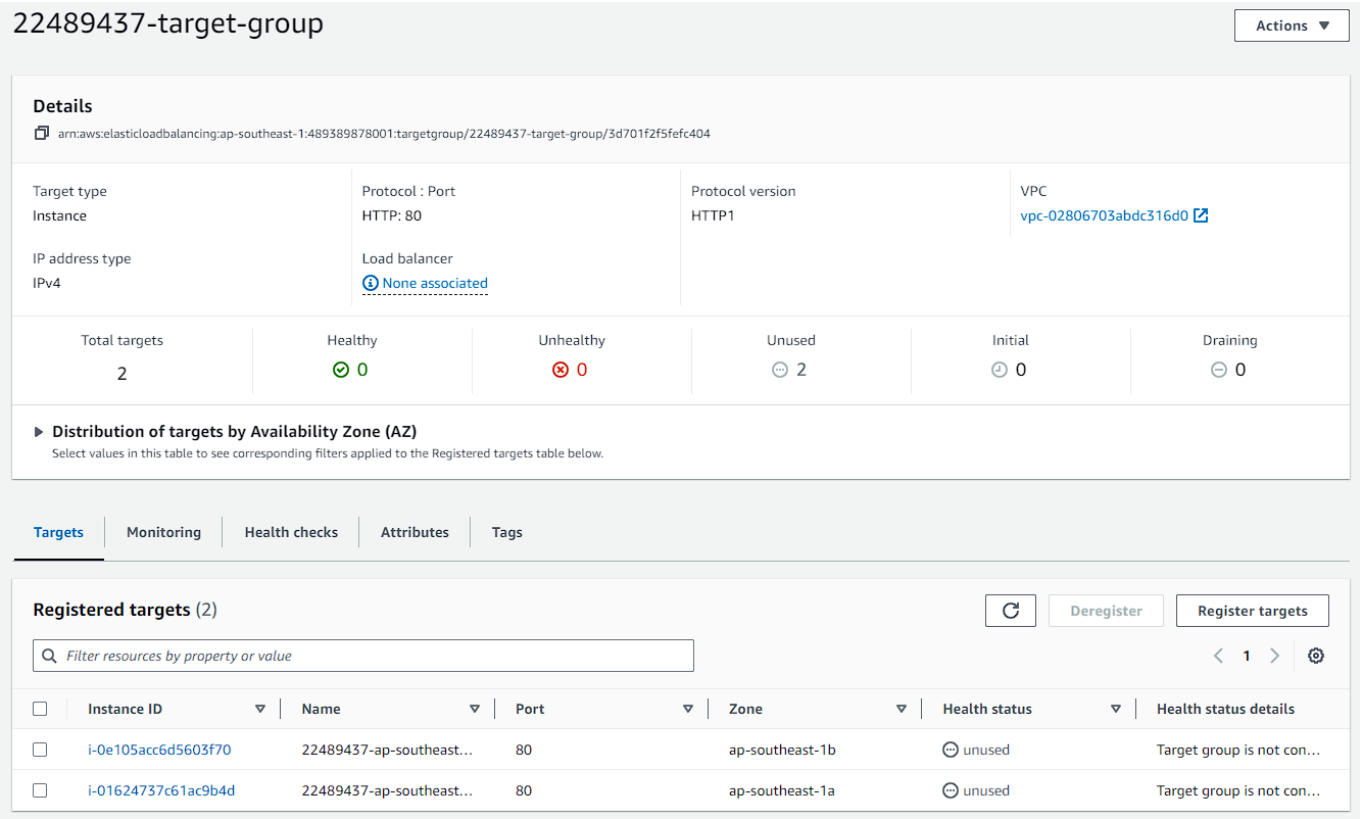
The following screenshots show the output of running the code as well as the results in the AWS terminal.

```
jookai@jookai:~/Desktop/cits5503/lab5$ python3 lab5.py -lb
Load Balancer ARN: arn:aws:elasticloadbalancing:ap-southeast-1:489389878001:load
balancer/app/22489437-LoadBalancer/11c6918aab0606fd
Listener ARN: arn:aws:elasticloadbalancing:ap-southeast-1:489389878001:listener/
app/22489437-LoadBalancer/11c6918aab0606fd/913934794eb2c296
Target Group ARN: arn:aws:elasticloadbalancing:ap-southeast-1:489389878001:targe
tgroup/22489437-target-group/3d701f2f5fefc404
Targets registered successfully.
```




22489437-LoadBalancer
Actions
Details
Load balancer type
Application
Status
Active
VPC
vpc-02806703abdc316d0
IP address type
IPv4
Scheme
Internet-facing
Hosted zone
Z1LMS91P8CMLE5
Availability Zones
subnet-0da033b36a320696f ap-southeast-1b (apse1-az1)
subnet-080783bde78702ba9 ap-southeast-1a (apse1-az2)
Date created
September 17, 2023, 11:35 (UTC+08:00)
Load balancer ARN
arn:aws:elasticloadbalancing:ap-southeast-1:489389878001:loadbalancer/app/22489437-LoadBalancer/11c6918aab0606fd
DNS name Info
22489437-LoadBalancer-1775619243.ap-southeast-1.elb.amazonaws.com (A Record)
Listeners and rules
Network mapping
Security
Monitoring
Integrations
Attributes
Tags
Listeners and rules (1) Info
A listener checks for connection requests on its configured protocol and port. Traffic received by the listener is routed according to the default action and any additional rules.
Manage rules
Manage listener
Add listener
Filter listeners by property or value
Protocol:Port
Default action
Rules
ARN
Security policy
Default SSL cert
HTTP:80
Return fixed response
Response code: 200
Response body: OK
Response content type: text/plain
1 rule
ARN
Not applicable
Not applicable

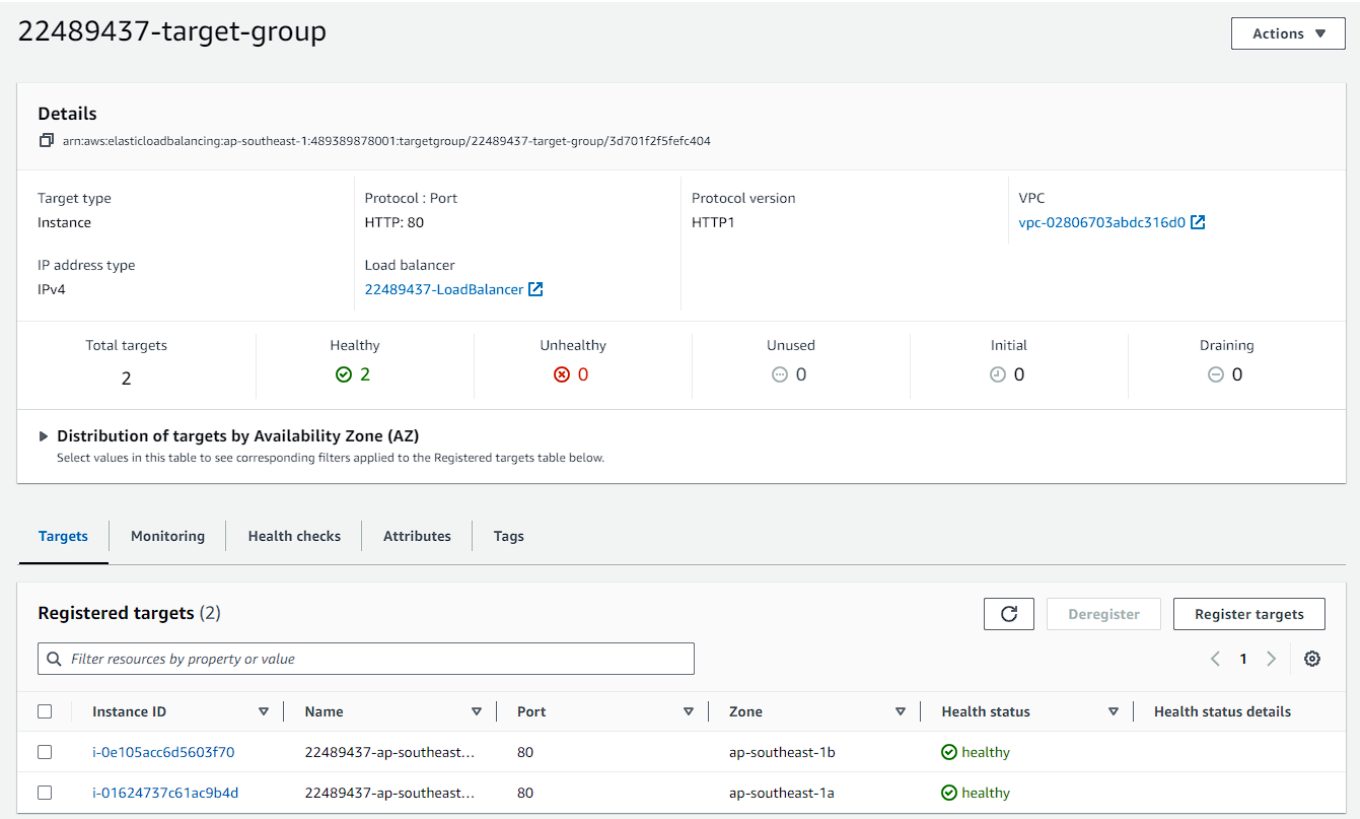

Network mapping Info
Targets in the listed zones and subnets are available for traffic from the load balancer using the IP addresses shown.
Edit IP address type
Edit subnets
VPC
vpc-02806703abdc316d0
IPv4: 172.31.0.0/16
IPv6 : -
IP address type
IPv4
Mappings
Including two or more Availability Zones, and corresponding subnets, increases the fault tolerance of your applications.
Zone
Subnet
IPv4 address
Private IPv4 address
IPv6 address
ap-southeast-1b (apse1-az1)
subnet-0da033b36a320696f
Assigned by AWS
Assigned from CIDR 172.31.16.0/20
Not applicable
ap-southeast-1a (apse1-az2)
subnet-080783bde78702ba9
Assigned by AWS
Assigned from CIDR 172.31.32.0/20
Not applicable



3. In this step, we will SSH into each of the instances created in step 1 and install Apache2. Screenshots showing this process for one of the EC2 instances have been attached:

```
jookai@jookai:~/.ssh$ ssh -i 22489437-key.pem ubuntu@52.221.213.96
The authenticity of host '52.221.213.96 (52.221.213.96)' can't be established.
ED25519 key fingerprint is SHA256:PHQL/z7oZ1klTmFoiao+rOjS708r4bLdfADQwiAlBIg.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '52.221.213.96' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.19.0-1025-aws x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Sun Sep 17 03:50:30 UTC 2023

  System load:  0.0               Processes:             96
  Usage of /:   20.6% of 7.57GB   Users logged in:       0
  Memory usage: 24%               IPv4 address for eth0: 172.31.34.17
  Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status


The list of available updates is more than a week old.
To check for new updates run: sudo apt update


The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-34-17:~$ S
```

```
ubuntu@ip-172-31-34-17:~$ sudo apt install apache2
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  apache2-bin apache2-data apache2-utils bzip2 libapr1 libaprutil1
  libaprutil1-dbd-sqlite3 libaprutil1-ldap liblua5.3-0 mailcap mime-support
  ssl-cert
Suggested packages:
  apache2-doc apache2-suexec-pristine | apache2-suexec-custom www-browser
  bzip2-doc
The following NEW packages will be installed:
  apache2 apache2-bin apache2-data apache2-utils bzip2 libapr1 libaprutil1
  libaprutil1-dbd-sqlite3 libaprutil1-ldap liblua5.3-0 mailcap mime-support
  ssl-cert
0 upgraded, 13 newly installed, 0 to remove and 127 not upgraded.
Need to get 2137 kB of archives.
After this operation, 8505 kB of additional disk space will be used.
Do you want to continue? [Y/n]
```



4. In this step we will edit the `/var/www/html/index.html` file to report the instance name and availability zone.

```
<!DOCTYPE html>
<html>
<body>
<h1>This is Instance 1 from availability zone ap-southeast-1a</h1>
</body>
</html>
```

```
<!DOCTYPE html>
<html>
<body>

<h1>This is instance 2 from availability zone ap-southeast-1b</h1>

</body>
</html>
```

5. By refreshing the page repeatedly, we can access both EC2 instances

Lab 6: Networking

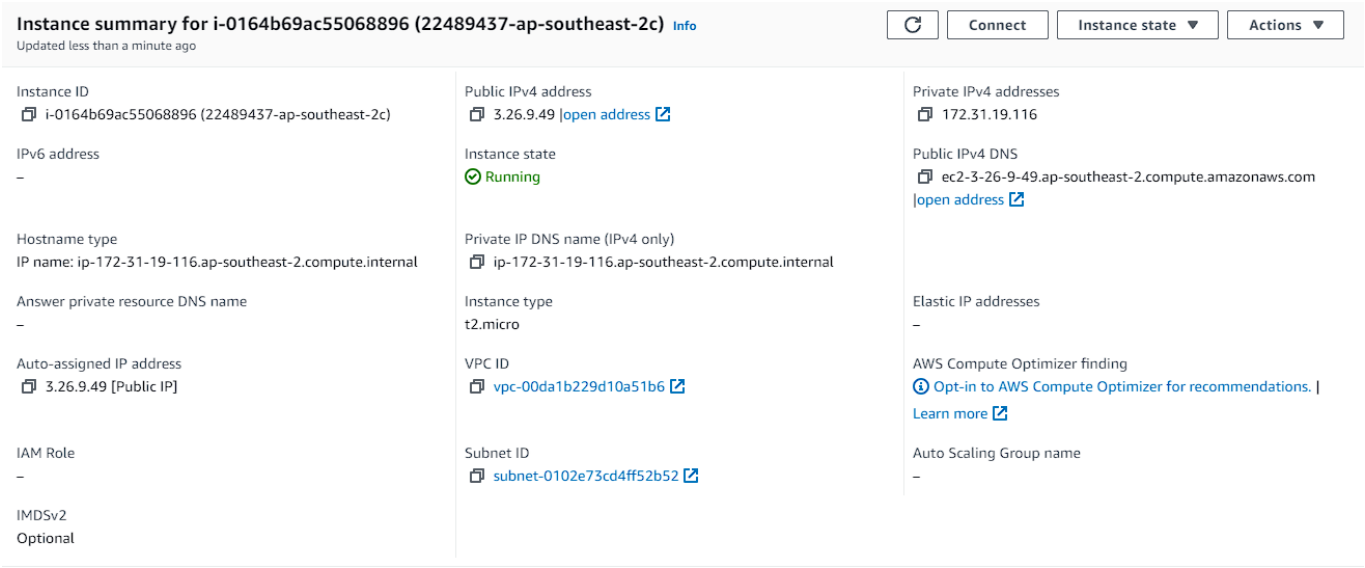
Section 1: Create an EC2 Instance

1. The code below was used to create an EC2 instance on ap-southeast-2c. For the lab this week, there was available capacity on ap-southeast-2 so there was no need to create the instance on another region. The AMI provided in lab 2 `ami-d38a4ab1` had a heavily outdated version of python and other utilities that are not compatible with modern programs, therefore an updated AMI was selected instead `ami-0310483fb2b488153`.

```
jookai@jookai:~/Desktop/cits5503/lab6$ python3 lab6.py -i
Instance 1 created successfully in Availability Zone ap-southeast-2c with Public
 IP: 3.26.9.49
```

```
def launch_ec2_instances():
    # Create a security group
    response = ec2.create_security_group(
        GroupName=f"{student_number}-sg",
        Description="security group for development environment"
    )
    security_group_id = response['GroupId']

    # Authorize inbound SSH traffic for the security group
    ec2.authorize_security_group_ingress(
        GroupId=security_group_id,
        IpProtocol="tcp",
        FromPort=22,
        ToPort=22,
        CidrIp="0.0.0.0/0"
    )

    ec2.authorize_security_group_ingress(
        GroupId=security_group_id,
        IpProtocol="tcp",
        FromPort=80,
        ToPort=80,
        CidrIp="0.0.0.0/0"
    )

    # Create a key pair and save the private key to a file
    response = ec2.create_key_pair(KeyName=f"{student_number}-key")
    private_key = response['KeyMaterial']
    private_key_file = f"{student_number}-key.pem"

    # Allow writing to the private key file
    os.chmod(private_key_file, 0o666)
    with open(private_key_file, 'w') as key_file:
        key_file.write(private_key)
    # Set the correct permissions for the private key file
    os.chmod(private_key_file, 0o400)
    # Copy the private key file to ~/.ssh directory
    ssh_directory = os.path.expanduser("~/.ssh")
    if not os.path.exists(ssh_directory):
        os.makedirs(ssh_directory)
```

```
    shutil.copy(private_key_file, ssh_directory)

    availability_zones = ["ap-southeast-2b", "ap-southeast-2c"]

    for i, az in enumerate(availability_zones):
        instance_name = f"{student_number}-{az}"

        instance_params = {
            'ImageId': 'ami-0310483fb2b488153',
            'InstanceType': 't2.micro',
            'KeyName': f"{student_number}-key",
            'SecurityGroupIds' : [security_group_id],
            'MinCount': 1,
            'MaxCount': 1,
            'Placement': {'AvailabilityZone': az},
            'TagSpecifications': [
                {
                    'ResourceType': 'instance',
                    'Tags': [{'Key': 'Name', 'Value': instance_name}]
                }
            ]
        }

        # Launch an EC2 instance
        response = ec2.run_instances(**instance_params)

        instance_id = response['Instances'][0]['InstanceId']

        # Wait for the instance to be up and running
        ec2.get_waiter('instance_running').wait(InstanceIds=[instance_id])

        # Describe the instance to get its public IP address
        response = ec2.describe_instances(InstanceIds=[instance_id])
        public_ip_address = response['Reservations'][0]['Instances'][0]
['PublicIpAddress']

        print(f"Instance {i+1} created successfully in Availability Zone {az} with
Public IP: {public_ip_address}")
```



2. Using the private key obtained and public IP address obtained from step 1, SSH into the EC2 instance and install the Python 3 virtual environment package.

```
jookai@jookai:~/.ssh$ ssh -i 22489437-key.pem ubuntu@3.26.9.49
The authenticity of host '3.26.9.49 (3.26.9.49)' can't be established.
ED25519 key fingerprint is SHA256:U83QWvm3/tMOx/A5pm0k9WqrPlr0CgYxUyQjKTAFdys.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '3.26.9.49' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.19.0-1025-aws x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Sat Sep 23 00:47:17 UTC 2023

  System load:  0.20166015625     Processes:             99
  Usage of /:   20.6% of 7.57GB   Users logged in:       0
  Memory usage: 24%               IPv4 address for eth0: 172.31.19.116
  Swap usage:   0%
```

```
ubuntu@ip-172-31-19-116:~$ sudo apt-get update
```

```
ubuntu@ip-172-31-19-116:~$ sudo apt-get upgrade
```

```
ubuntu@ip-172-31-19-116:~$ sudo apt-get install python3-venv
```

3. Creating a directory with path `/opt/wwc/mysites` and setting up the virtual environment.

```
root@ip-172-31-19-116:/home/ubuntu# sudo mkdir -p /opt/wwc/mysites
```

```
root@ip-172-31-19-116:/home/ubuntu# cd /opt/wwc/mysites
root@ip-172-31-19-116:/opt/wwc/mysites# python3 -m venv myvenv
root@ip-172-31-19-116:/opt/wwc/mysites# source myvenv/bin/activate
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites#
```

4. A Django project is a collection of configurations and apps for a particular website. In this step we install Django and create a new Django app named polls.
    - `lab`: The configuration directory
    - `polls`: The directory containing the app
    - `manage.py`: The command line utility that lets us interact with the new app

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites# pip install django
Collecting django
```

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites# django-admin startproject lab
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites# cd lab
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# python3 manage.py startapp
polls
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# ls
lab  manage.py  polls
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab#
```

Section 2: Install and Congigure Nginx

1. Installing and configuring nginx:
    - Nginx is a popular open-source web server software that can also be used as a reverse proxy, load balancer, mail proxy, and HTTP cache.
    - The configuration file is edited to tell Nginx to pass requests to the backend server running on the same machine 127.0.0.1 at port 8000.

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# apt install nginx
```

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# vi /etc/nginx/sites-enabled
/default
```

```
server {
  listen 80 default_server;
  listen [::]:80 default_server;

  location / {
    proxy_set_header X-Forwarded-Host $host;
    proxy_set_header X-Real-IP $remote_addr;

    proxy_pass http://127.0.0.1:8000;
  }
}
```

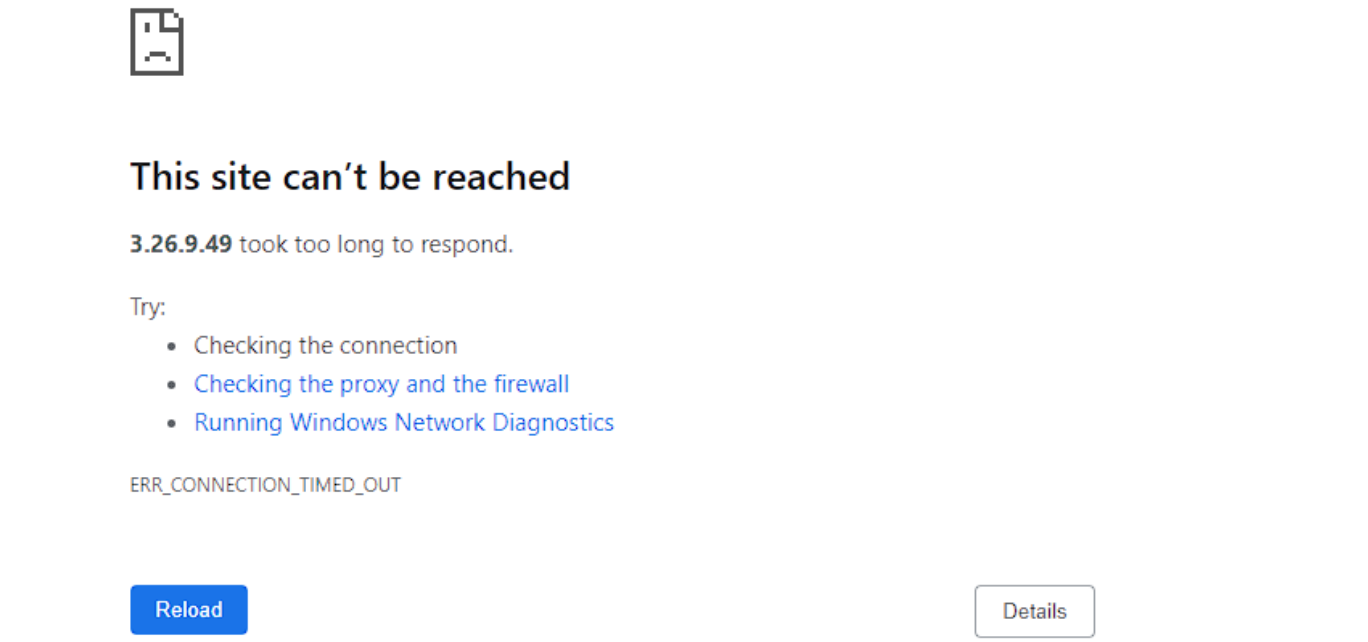
2. Restarting Nginx so that the changes from step 1 take effect:

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# service nginx restart
```

3. Using the command `python3 manage.py runserver 8000` to start Django's development web server at port 8000.

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# python3 manage.py runserver
 8000
Watching for file changes with StatReloader
Performing system checks...

System check identified no issues (0 silenced).

You have 18 unapplied migration(s). Your project may not work properly until you
 apply the migrations for app(s): admin, auth, contenttypes, sessions.
Run 'python manage.py migrate' to apply them.
September 23, 2023 - 01:07:45
Django version 4.2.5, using settings 'lab.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

4. Trying the access the public IP address of the EC2 instance results in an error:




```
Not Found: /polls/
[23/Sep/2023 08:14:39] "GET /polls/ HTTP/1.0" 404 2092
Not Found: /polls/
[23/Sep/2023 08:14:56] "GET /polls/ HTTP/1.0" 404 2092
```

Section 3: Change the code

1. Editing `polls/views.py`
    - Thsi code creates a simple view that returns an HTTP response with the text "Hello, world." when it's called.

```
from django.shortcuts import render
from django.http import HttpResponse

def index(request):
    return HttpResponse("Hello, world.")
~
```

2. Edit `polls/urls.py`
    - This code defines a URL pattern for this view in the urls.py file, so that Django knows which view to call for a given URL.

```
from django.urls import path
from . import views

urlpatterns = [
    path('', views.index, name='index'),
]
```

3. Edit `lab/urls.py`
    - The code configures the URL patterns for the Django project.

```
URL configuration for lab project.

The `urlpatterns` list routes URLs to views. For more information please see:
    https://docs.djangoproject.com/en/4.2/topics/http/urls/
Examples:
Function views
    1. Add an import:  from my_app import views
    2. Add a URL to urlpatterns:  path('', views.home, name='home')
Class-based views
    1. Add an import:  from other_app.views import Home
    2. Add a URL to urlpatterns:  path('', Home.as_view(), name='home')
Including another URLconf
    1. Import the include() function: from django.urls import include, path
    2. Add a URL to urlpatterns:  path('blog/', include('blog.urls'))
"""
from django.contrib import admin
from django.urls import include, path
from django.contrib import admin

urlpatterns = [
    path('polls/', include('polls.urls')),
    path('admin/', admin.site.urls),
]
-- INSERT --                                                    24,2          Bot
```

4. Running the application and getting `Hello, world`

```
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# vi polls/views.py
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# vi polls/urls.py
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# vi lab/urls.py
(myvenv) root@ip-172-31-19-116:/opt/wwc/mysites/lab# python3 manage.py runserver
 8000
Watching for file changes with StatReloader
Performing system checks...

System check identified no issues (0 silenced).

You have 18 unapplied migration(s). Your project may not work properly until you
 apply the migrations for app(s): admin, auth, contenttypes, sessions.
Run 'python manage.py migrate' to apply them.
September 23, 2023 - 01:31:53
Django version 4.2.5, using settings 'lab.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

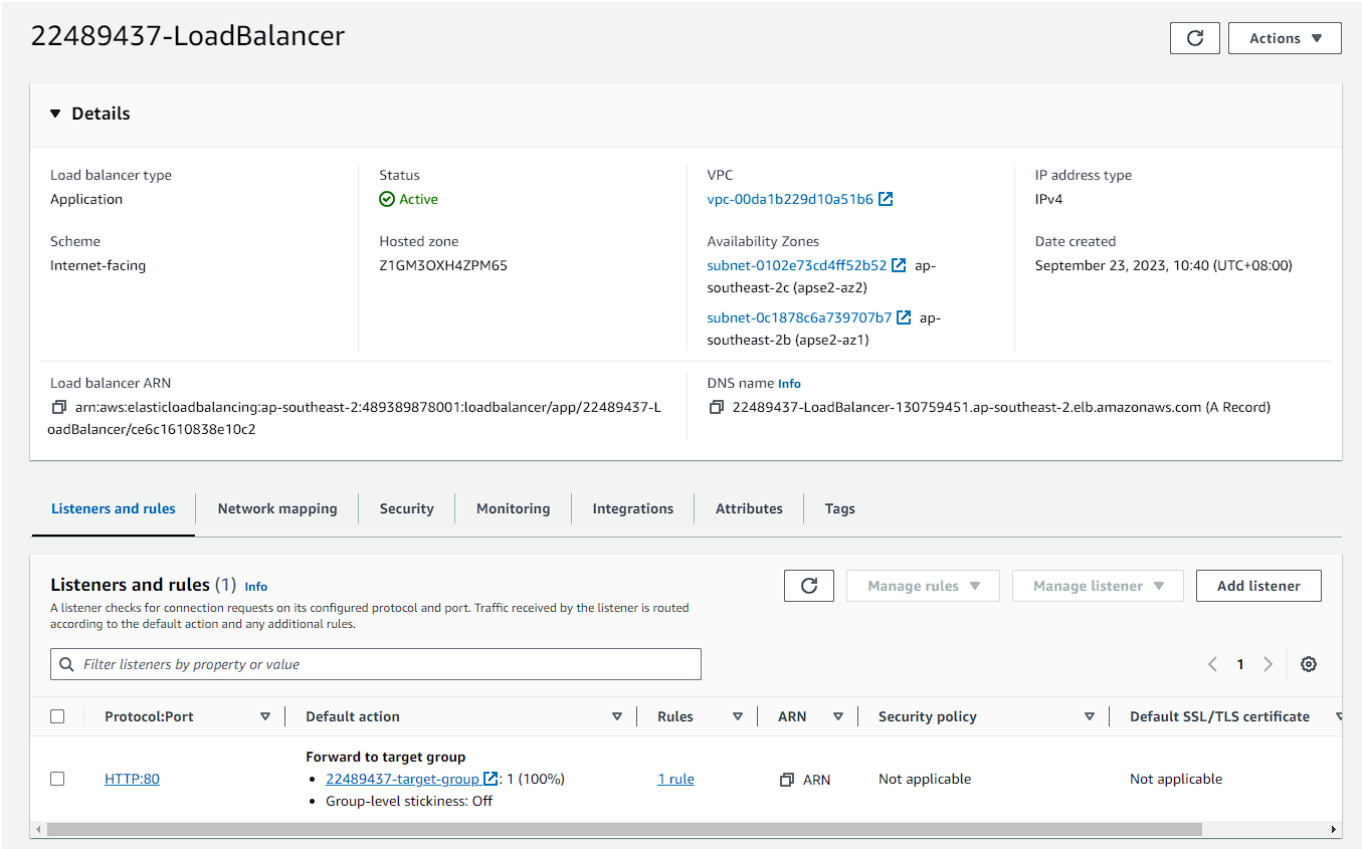
Section 4: Adding an application load balance (ALB)

1. The code below creates an application load balancer, specifies the region subnet where the EC2 instance resides, creates a listener with a default rule Protocol: HTTP and Port 80 forwarding.

```
def create_load_balancer():
    vpc_id = 'vpc-00da1b229d10a51b6'
    security_group_id = 'sg-0fb8992bd2473b7bc'
    subnet_ids = ['subnet-0c1878c6a739707b7', 'subnet-0102e73cd4ff52b52']

    response = elb.create_load_balancer(
        Name='22489437-LoadBalancer',
        Subnets=subnet_ids,
        SecurityGroups=[security_group_id],
        Scheme='internet-facing',
        Tags=[
            {
                'Key': 'Name',
                'Value': '22489437-LoadBalancer'
            },
        ]
    )

    load_balancer_arn = response['LoadBalancers'][0]['LoadBalancerArn']
    print(f"Load Balancer ARN: {load_balancer_arn}")

    # Create a target group
    response = elb.create_target_group(
        Name='22489437-target-group',
        Protocol='HTTP',
        Port=80,
        VpcId=vpc_id,
        HealthCheckProtocol='HTTP',
```

```
        HealthCheckPort='80',
        HealthCheckPath='/polls/',
        HealthCheckIntervalSeconds=30,
        HealthCheckTimeoutSeconds=5,
        HealthyThresholdCount=5,
        UnhealthyThresholdCount=2,
        Matcher={
            'HttpCode': '200'
        },
        TargetType='instance'
    )

    # Get the ARN of the target group
    target_group_arn = response['TargetGroups'][0]['TargetGroupArn']
    print(f"Target Group ARN: {target_group_arn}")

    # Create a listener for HTTP traffic (Port 80)
    response = elb.create_listener(
        DefaultActions=[
            {
                'Type': 'forward',
                'TargetGroupArn': target_group_arn,
            },
        ],
        LoadBalancerArn=load_balancer_arn,
        Port=80,
        Protocol='HTTP',
    )

    listener_arn = response['Listeners'][0]['ListenerArn']
    print(f"Listener ARN: {listener_arn}")


    instance_1_id = 'i-0164b69ac55068896'

    # Register the instances in the target group
    elb.register_targets(
        TargetGroupArn=target_group_arn,
        Targets=[
            {'Id': instance_1_id},
        ]
    )

    # Print registration status
    print("Targets registered successfully.")
```

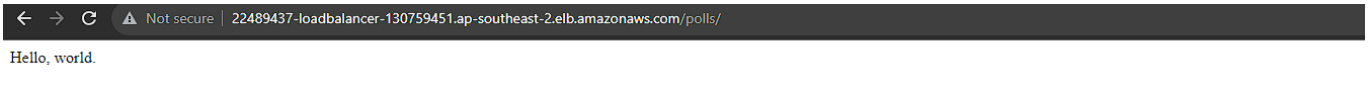
```
jookai@jookai:~/Desktop/cits5503/lab6$ python3 lab6.py -lb
Load Balancer ARN: arn:aws:elasticloadbalancing:ap-southeast-2:489389878001:load
balancer/app/22489437-LoadBalancer/ce6c1610838e10c2
Target Group ARN: arn:aws:elasticloadbalancing:ap-southeast-2:489389878001:targe
tgroup/22489437-target-group/1448f7d6495f1fac
Listener ARN: arn:aws:elasticloadbalancing:ap-southeast-2:489389878001:listener/
app/22489437-LoadBalancer/ce6c1610838e10c2/e43f09b70777fe3d
Targets registered successfully.
```



2. Viewing the health check on the `/polls/` page

```
[23/Sep/2023 08:09:55] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:10:08] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:10:25] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:10:39] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:10:55] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:11:09] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:11:26] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:11:39] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:11:56] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:12:09] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:12:26] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:12:39] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:12:56] "GET /polls/ HTTP/1.0" 200 13
[23/Sep/2023 08:13:09] "GET /polls/ HTTP/1.0" 200 13
```

3. Accessing the site using the url:



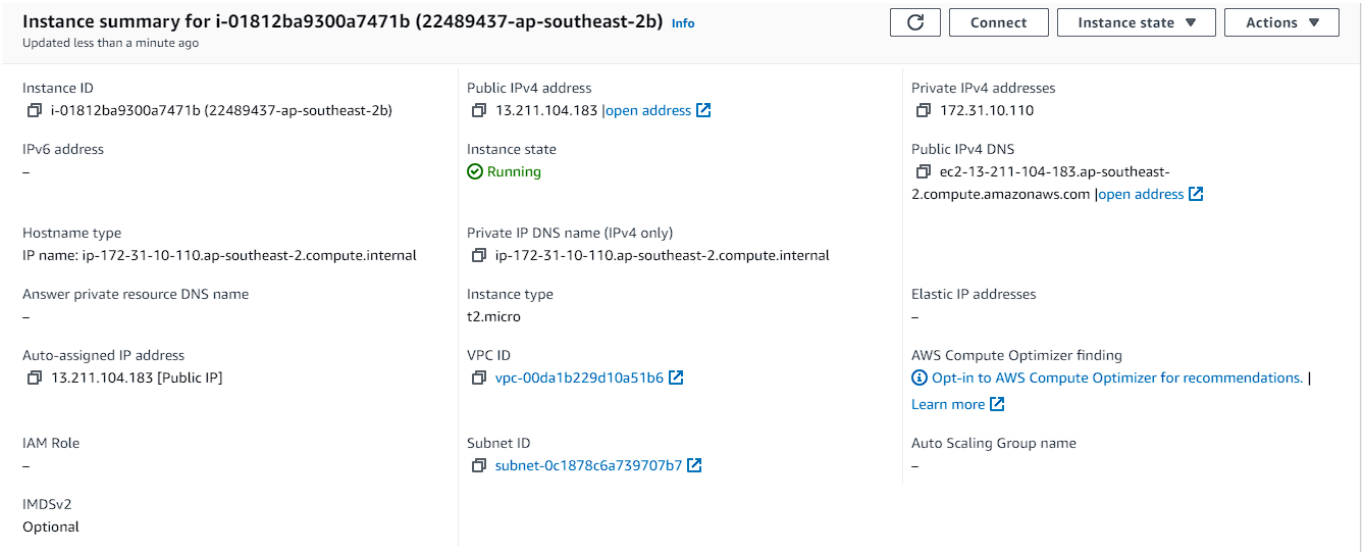
Hello, world.

Lab 7: DevOps

Step 1: Create an EC2 Instance

1. The code used in Labs 5 and 6 was used to create an EC2 instance in availability zone ap-southeast-2b

```
jookai@jookai:~/Desktop/cits5503/lab7$ python3 lab7.py -i
Instance 1 created successfully in Availability Zone ap-southeast-2b with Public
 IP: 13.211.104.183
```



Step 2: Install Fabric

1. Fabric is a Python library used to perform Linux shell commands remotely over SSH. It is a command-line tool that uses SSH for application deployment or for administration tasks. In this lab we will be using fabric to automate the deployment of a django app on the remote EC2 instance.

```
jookai@jookai:~/Desktop/cits5503/lab7$ pip install fabric
Defaulting to user installation because normal site-packages is not writeable
Collecting fabric
  Downloading fabric-3.2.2-py3-none-any.whl (59 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 59.4/59.4 KB 2.0 MB/s eta 0:00:00
Requirement already satisfied: paramiko>=2.4 in /usr/lib/python3/dist-packages (
from fabric) (2.9.3)
Collecting invoke>=2.0
  Downloading invoke-2.2.0-py3-none-any.whl (160 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 160.3/160.3 KB 5.0 MB/s eta 0:00:00
Collecting deprecated>=1.2
  Downloading Deprecated-1.2.14-py2.py3-none-any.whl (9.6 kB)
Collecting decorator>=5
  Downloading decorator-5.1.1-py3-none-any.whl (9.1 kB)
Collecting wrapt<2,>=1.10
  Downloading wrapt-1.15.0-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.ma
nylinux_2_17_x86_64.manylinux2014_x86_64.whl (78 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 78.4/78.4 KB 5.2 MB/s eta 0:00:00
Installing collected packages: wrapt, invoke, decorator, deprecated, fabric
Successfully installed decorator-5.1.1 deprecated-1.2.14 fabric-3.2.2 invoke-2.2
.0 wrapt-1.15.0
```

The configuration file located in `~/.ssh` contains the IPV4 DNS of the EC2 instance and the path of the private key file on the local VM to allow SSH access into the EC2 instance.

```
Host <ec2instance>
        Hostname ec2-13-211-104-183.ap-southeast-2.compute.amazonaws.com
        User ubuntu
        UserKnownHostsFile /dev/null
        StrictHostKeyChecking no
        PasswordAuthentication no
        IdentityFile ~/.ssh/22489437-key.pem
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"config" [New File]
```

2. Testing Fabric

```
jookai@jookai:~/.ssh$ python3
Python 3.10.12 (main, Jun 11 2023, 05:26:28) [GCC 11.4.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> from fabric import Connection
>>> c = Connection('<ec2instance>')
>>> result = c.run('uname -s')
Linux
>>>
```

Step 3: Python Script to automate installation of nginx

1. The following script is used to automate the instllation of nginx on the EC2 instance.

```
def create_nginx():
    with Connection('<ec2instance>') as c:
        c.sudo('apt update -y')
        c.sudo('apt upgrade -y')
        c.sudo('apt install nginx -y')
        c.sudo('rm /etc/nginx/sites-enabled/default')
        os.system('scp -i ~/.ssh/22489437-key.pem default ubuntu@ec2-13-211-104-
183.ap-southeast-2.compute.amazonaws.com:/home/ubuntu')
        c.sudo('mv /home/ubuntu/default /etc/nginx/sites-enabled/')
        c.sudo('service nginx restart')
```

The script is run on the local VM:

```
jookai@jookai:~/Desktop/cits5503/lab7$ python3 lab7.py -n

WARNING: apt does not have a stable CLI interface. Use with caution in scripts.
```

Checking if nginx is installed on the EC2 instance:

```
ubuntu@ip-172-31-10-110:~$ nginx -v
nginx version: nginx/1.18.0 (Ubuntu)
```

Step 4: Python script to install Django app

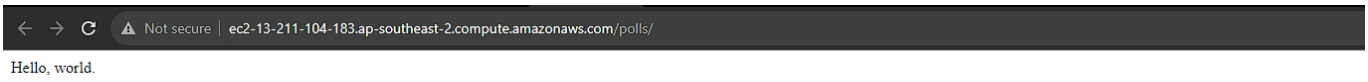
1. The following script is used to automate the installation of the Django app on the EC2 instanc:

```
def create_django_app():
    with Connection('<ec2instance>') as c:
        c.sudo('mkdir -p /opt/wwc/mysites')
        c.sudo('apt-get install python3-pip -y')
        c.sudo('apt install python3-django -y')
        c.sudo('pip3 install django')
        c.run('django-admin startproject lab')
        c.sudo('chmod 777 ./lab')
        c.run('cd ./lab && python3 manage.py startapp polls')
        c.sudo('mv ./lab /opt/wwc/mysites')
        c.sudo('rm /opt/wwc/mysites/lab/polls/views.py')
        c.sudo('rm /opt/wwc/mysites/lab/lab/urls.py')
        os.system('scp -i ~/.ssh/22489437-key.pem ./polls/views.py ubuntu@ec2-13-
211-104-183.ap-southeast-2.compute.amazonaws.com:/opt/wwc/mysites/lab/polls')
        os.system('scp -i ~/.ssh/22489437-key.pem ./polls/urls.py ubuntu@ec2-13-
211-104-183.ap-southeast-2.compute.amazonaws.com:/opt/wwc/mysites/lab/polls')
        os.system('scp -i ~/.ssh/22489437-key.pem ./lab/urls.py ubuntu@ec2-13-211-
104-183.ap-southeast-2.compute.amazonaws.com:/opt/wwc/mysites/lab/lab')
        c.run('cd /opt/wwc/mysites/lab && python3 manage.py runserver 8000')
```

The script is run on the local VM:

```
jookai@jookai:~/Desktop/cits5503/lab7$ python3 lab7.py -d
views.py                                      100%   98     1.8KB/s   00:00
urls.py                                       100%  108     2.0KB/s   00:00
urls.py                                       100%  169     2.8KB/s   00:00
Watching for file changes with StatReloader
Performing system checks...

System check identified no issues (0 silenced).

You have 18 unapplied migration(s). Your project may not work properly until you
 apply the migrations for app(s): admin, auth, contenttypes, sessions.
Run 'python manage.py migrate' to apply them.
September 29, 2023 - 14:07:35
Django version 3.2.12, using settings 'lab.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

Checking to see if `Hello world` is displayed when visiting the Public IPv4 DNS of the EC2 instance:



Hello, world.

Lab 8: AI

Step 1: Install and run jupyter notebooks

1. Jupyter notebook was already installed on this machine for CITS5508 machine learning. Therefore, only the command to launch it was needed.

```
jookai@jookai:~/Desktop/cits5503/lab8$ jupyter notebook
```

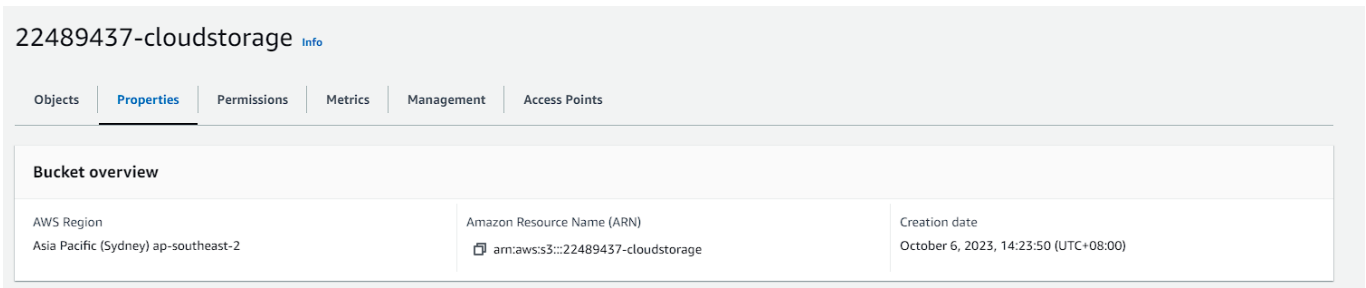
2. This brings up Jupyter notebook in the browser where we can create a notebook for this lab named `lab8.ipynb` which is an Interactive Python Notebook.

Step 2: Setup Python Environment

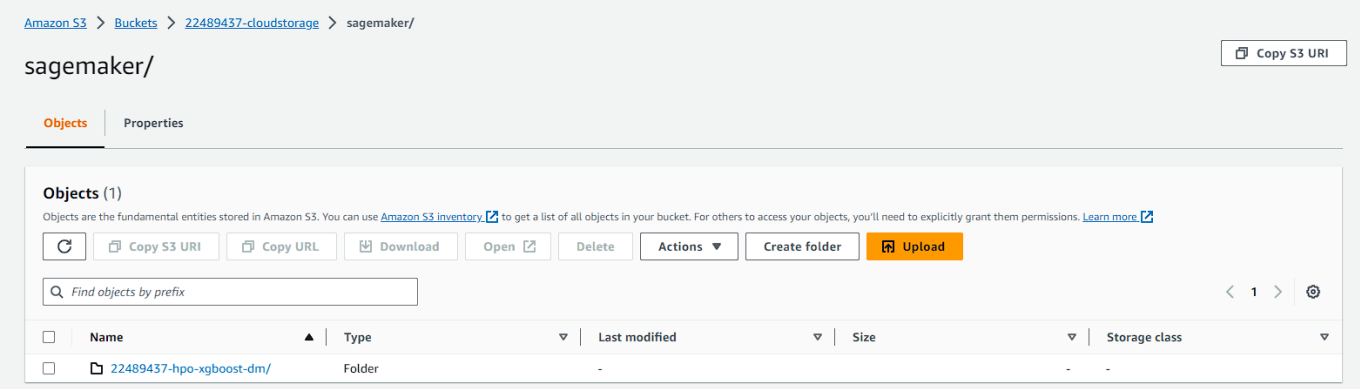
1. The following command is run `pip3 install sagemaker pandas ipykernel`.
    - This installs sagemaker, which is the Python SDK for Amazon SageMaker, that allows us to build, train, and deploy machine learning models. By installing this SDK, we can interact with the SageMaker service directly from the Python environment on the virtual machine.
    - Pandas is a popular data manipulation and analysis library for Python.
    - Ipykernel allows the python environment to interface with Jupyrer.

Step 3: Create Role and Bucket

1. Creating a S3 bucket to store the files generated in the later parts of the machine learning process:



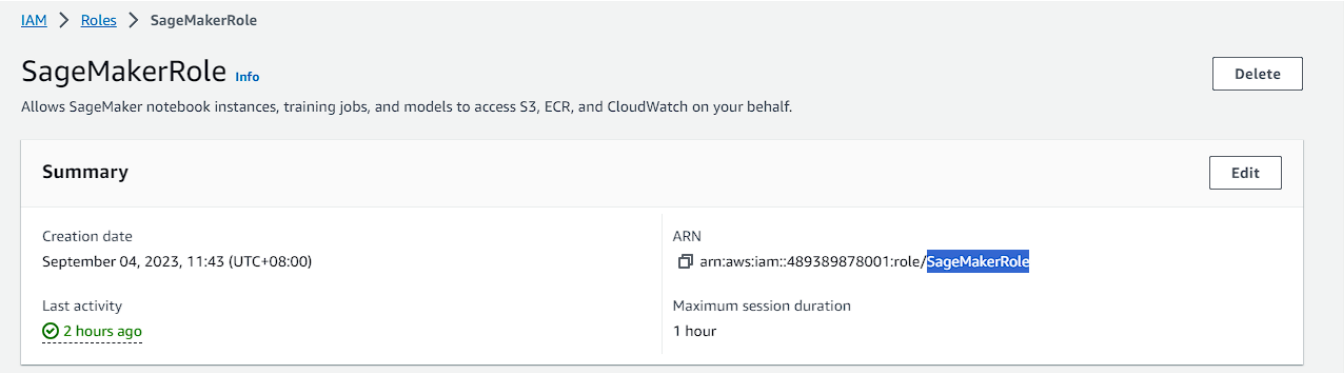
2. Creating the folders `sagemaker/22489437-hpo-xgboost-dm`



3. Due to security reasons, students are not allowed to directly create IAM roles. Therefore, we will use the code provided in the labsheet to use the already created IAM role.
    - `smclient = boto3.Session().client("sagemaker")`: This initializes a low-level client representing Amazon SageMaker. So, smclient will be used to make requests to the SageMaker service.
    - `sagemaker_role = iam.get_role(RoleName='Role_AWS_SageMaker')['Role']['Arn']`: This uses the IAM client to retrieve the ARN of a specific IAM role named 'Role_AWS_SageMaker'. This ARN can later be used to grant permissions or interact with the role in various ways within AWS.

```
region = 'ap-southeast-2'
smclient = boto3.Session().client("sagemaker")

iam = boto3.client('iam')
sagemaker_role = iam.get_role(RoleName='Role_AWS_SageMaker')['Role']['Arn']

student_id = "STUDENTID"
bucket = 'YOUR_BUCKET_NAME_HERE'
prefix = f"sagemaker/{student_id}-hpo-xgboost-dm"
```

4. The code provided fails to execute as the role `Role_AWS_SageMaker` does not exist. Therefore, we log into the IAM system in the AWS console and find that the actual name of the created roles is `SageMakerRole`. When using the actual name of the role, the code executes and we can proceed to the next step.



Step 4: Download Dataset

1. We download and extract the direct marketing dataset from UCI's ML Repository.

```
jookai@jookai:~/Desktop/cits5503/lab8$ wget -N https://archive.ics.uci.edu/ml/mac
hine-learning-databases/00222/bank-additional.zip
--2023-10-06 14:54:17--  https://archive.ics.uci.edu/ml/machine-learning-database
s/00222/bank-additional.zip
Resolving archive.ics.uci.edu (archive.ics.uci.edu)... 128.195.10.252
Connecting to archive.ics.uci.edu (archive.ics.uci.edu)|128.195.10.252|:443... co
nnected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified
Saving to: ‘bank-additional.zip’

bank-additional.zip     [      <=>           ] 434.15K   419KB/s    in 1.0s

Last-modified header missing -- time-stamps turned off.
2023-10-06 14:54:19 (419 KB/s) - ‘bank-additional.zip’ saved [444572]

jookai@jookai:~/Desktop/cits5503/lab8$ unzip -o bank-additional.zip
Archive:  bank-additional.zip
   creating: bank-additional/
  inflating: bank-additional/.DS_Store
   creating: __MACOSX/
   creating: __MACOSX/bank-additional/
  inflating: __MACOSX/bank-additional/._.DS_Store
  inflating: bank-additional/.Rhistory
  inflating: bank-additional/bank-additional-full.csv
  inflating: bank-additional/bank-additional-names.txt
  inflating: bank-additional/bank-additional.csv
  inflating: __MACOSX/._bank-additional
```

The dataset is related with direct marketing campaigns of a Portuguese banking institution. The marketing campaigns were based on phone calls. Often, more than one contact to the same client was required, in order to access if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

2. We read the dataset into a Pandas dataframe and inspect the contents:
    - We see that the data fame has 41188 rows and 21 columns

```
data = pd.read_csv("./bank-additional/bank-additional-full.csv", sep=";")
pd.set_option("display.max_columns", 500)  # Make sure we can see all of the
columns
pd.set_option("display.max_rows", 50)  # Keep the output on one page
data
```

```
data = pd.read_csv("./bank-additional/bank-additional-full.csv", sep=";")
pd.set_option("display.max_columns", 500)  # Make sure we can see all of the columns
pd.set_option("display.max_rows", 50)  # Keep the output on one page
data
```

	age	job	marital	education	default	housing	loan	contact	month	day_of_week	duration	campaign	pdays	previous	poutcome	emp.v
0	56	housemaid	married	basic.4y	no	no	no	telephone	may	mon	261	1	999	0	nonexistent	
1	57	services	married	high.school	unknown	no	no	telephone	may	mon	149	1	999	0	nonexistent	
2	37	services	married	high.school	no	yes	no	telephone	may	mon	226	1	999	0	nonexistent	
3	40	admin.	married	basic.6y	no	no	no	telephone	may	mon	151	1	999	0	nonexistent	
4	56	services	married	high.school	no	no	yes	telephone	may	mon	307	1	999	0	nonexistent	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
41183	73	retired	married	professional.course	no	yes	no	cellular	nov	fri	334	1	999	0	nonexistent	
41184	46	blue-collar	married	professional.course	no	no	no	cellular	nov	fri	383	1	999	0	nonexistent	
41185	56	retired	married	university.degree	no	yes	no	cellular	nov	fri	189	2	999	0	nonexistent	
41186	44	technician	married	professional.course	no	no	no	cellular	nov	fri	442	1	999	0	nonexistent	
41187	74	retired	married	professional.course	no	yes	no	cellular	nov	fri	239	3	999	1	failure	

41188 rows × 21 columns

3. In order to answer which variables are categorical and numerical, the following function was used:
    - This makes use of the `select_dtypes` method to filter out the categorical and numeric columns

```
# numeric columns
numeric_cols = data.select_dtypes(include=['number']).columns.tolist()
print("Numeric columns:", numeric_cols)

# categorical columns
categorical_cols = data.select_dtypes(include=['object']).columns.tolist()
print("Categorical columns:", categorical_cols)
```

```
# numeric columns
numeric_cols = data.select_dtypes(include=['number']).columns.tolist()
print("Numeric columns:", numeric_cols)

# categorical columns
categorical_cols = data.select_dtypes(include=['object']).columns.tolist()
print("Categorical columns:", categorical_cols)
```

```
Numeric columns: ['age', 'duration', 'campaign', 'pdays', 'previous', 'emp.var.rate', 'cons.price.idx', 'cons.conf.idx', 'euribor3m', 'nr.emp
loyed']
Categorical columns: ['job', 'marital', 'education', 'default', 'housing', 'loan', 'contact', 'month', 'day_of_week', 'poutcome', 'y']
```

4. The following code performs some transformations on the data:
    - `data["no_previous_contact"] = np.where(data["pdays"] == 999, 1, 0)`: This line creates a new column in the DataFrame data named "no_previous_contact". The values in this column are determined by the values in the "pdays" column. If a value in "pdays" is 999, the new column gets a value of 1; otherwise, it gets 0.
    - `data["not_working"] = np.where(np.in1d(data["job"], ["student", "retired", "unemployed"]), 1, 0)`: This line creates another new column named "not_working". It checks the "job" column of the DataFrame. If the job description is either "student", "retired", or "unemployed", the new column gets a value of 1, indicating the person is not actively employed. Otherwise, it gets 0.
    - `model_data = pd.get_dummies(data)`: This line creates a new DataFrame, model_data, by converting the categorical variables in data into "indicator" variables. For each level in a categorical variable, a new column will be created to indicate if it is present or not.

```
data["no_previous_contact"] = np.where(
    data["pdays"] == 999, 1, 0
)  # Indicator variable to capture when pdays takes a value of 999
data["not_working"] = np.where(
    np.in1d(data["job"], ["student", "retired", "unemployed"]), 1, 0
)  # Indicator for individuals not actively employed
model_data = pd.get_dummies(data)  # Convert categorical variables to sets of
indicators
model_data
```

This creates the `model_data` dataframe that has 67 columns.

[40]:

	age	duration	campaign	pdays	previous	emp.var.rate	cons.price.idx	cons.conf.idx	euribor3m	nr.employed	no_previous_contact	not_working	job_admin.	job
0	56	261	1	999	0	1.1	93.994	-36.4	4.857	5191.0	1	0	0	
1	57	149	1	999	0	1.1	93.994	-36.4	4.857	5191.0	1	0	0	
2	37	226	1	999	0	1.1	93.994	-36.4	4.857	5191.0	1	0	0	
3	40	151	1	999	0	1.1	93.994	-36.4	4.857	5191.0	1	0	1	
4	56	307	1	999	0	1.1	93.994	-36.4	4.857	5191.0	1	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
41183	73	334	1	999	0	-1.1	94.767	-50.8	1.028	4963.6	1	1	0	
41184	46	383	1	999	0	-1.1	94.767	-50.8	1.028	4963.6	1	0	0	
41185	56	189	2	999	0	-1.1	94.767	-50.8	1.028	4963.6	1	1	0	
41186	44	442	1	999	0	-1.1	94.767	-50.8	1.028	4963.6	1	0	0	
41187	74	239	3	999	1	-1.1	94.767	-50.8	1.028	4963.6	1	1	0	

41188 rows × 67 columns

5. The following code removes the the economic features and duration from the data as they would need to be forecasted with high precision to use as inputs in future predictions.

```
model_data = model_data.drop(
    ["duration", "emp.var.rate", "cons.price.idx", "cons.conf.idx", "euribor3m",
"nr.employed"],
    axis=1,
)
```

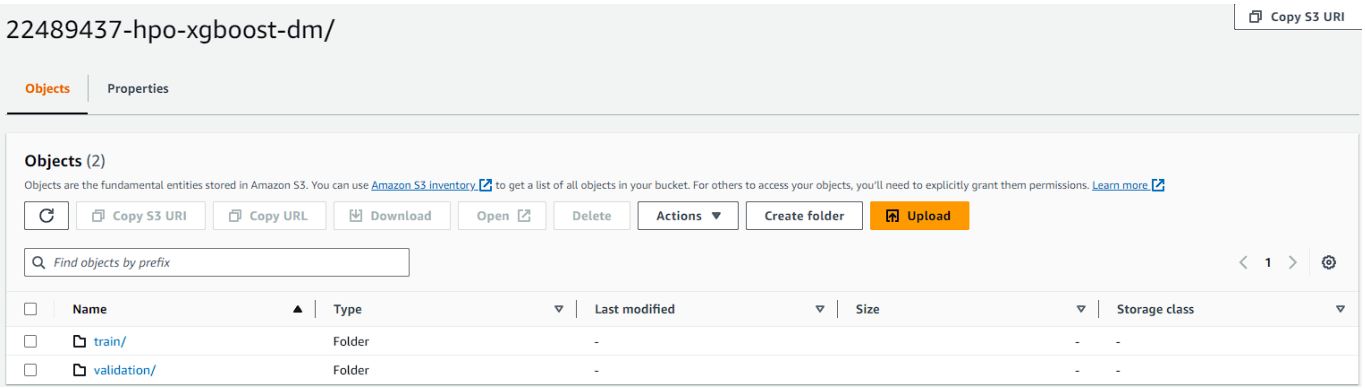
Step 5: Split Data into training, validation and test

1. The following code splits the dataset into training (70%), validation (20%), and test (10%).
    - The first block of code shuffles model_data using the sample method with frac=1 (which means to sample the whole dataset) and a random seed of 1729. The shuffled data is then split into three segments.
    - For each of the datasets (train, validation, and test), the code reorders the columns so that the target column y_yes is the first column, and then it drops the y_no and y_yes columns from the rest. It then saves the reordered data to a CSV file. This is done for compatibility reasons as Amazon SageMaker's XGBoost algorithm expects the first column to be the target variable and the CSV should not include headers.

```
train_data, validation_data, test_data = np.split(
    model_data.sample(frac=1, random_state=1729),
    [int(0.7 * len(model_data)), int(0.9 * len(model_data))],
)

pd.concat([train_data["y_yes"], train_data.drop(["y_no", "y_yes"], axis=1)],
axis=1).to_csv(
    "train.csv", index=False, header=False
)
pd.concat(
    [validation_data["y_yes"], validation_data.drop(["y_no", "y_yes"], axis=1)],
axis=1
).to_csv("validation.csv", index=False, header=False)

pd.concat([test_data["y_yes"], test_data.drop(["y_no", "y_yes"], axis=1)],
axis=1).to_csv(
    "test.csv", index=False, header=False
)
```

2. The newly created data is the uploaded to the S3 bucket we created earlier.

```
boto3.Session().resource("s3").Bucket(bucket).Object(
    os.path.join(prefix, "train/train.csv")
).upload_file("train.csv")
boto3.Session().resource("s3").Bucket(bucket).Object(
    os.path.join(prefix, "validation/validation.csv")
).upload_file("validation.csv")
```



Step 6: Setup Hyperparameter Optimization

1. The following code sets up a configuration for a hyperparameter tuning job:
    - ParameterRanges: This specifies the hyperparameters you want to tune and their possible values.
    - CategoricalParameterRanges: This would contain parameters that have categorical values, but it's empty as we have transformed all the categorical variables into indicator variables in the previous steps.
    - ContinuousParameterRanges: This contains hyperparameters that can take any real value within a range.

- ResourceLimits: This part specifies how many training jobs can be created in total (MaxNumberOfTrainingJobs) and how many of them can run in parallel (MaxParallelTrainingJobs).
- Strategy: The strategy used for the tuning job. In this case, the "Bayesian" strategy is used, which is a popular method for hyperparameter optimization. It builds a probability model of the objective function and uses it to select the most promising hyperparameters to evaluate in the true objective function.
- HyperParameterTuningJobObjective: This is where you define the metric you want to optimize. The goal here is to maximize the "validation:auc" (Area Under the Curve for the validation set).

```
tuning_job_name = f"{student_id}-xgboost-tuningjob-01"

print(tuning_job_name)

tuning_job_config = {
    "ParameterRanges": {
        "CategoricalParameterRanges": [],
        "ContinuousParameterRanges": [
            {
                "MaxValue": "1",
                "MinValue": "0",
                "Name": "eta",
            },
            {
                "MaxValue": "10",
                "MinValue": "1",
                "Name": "min_child_weight",
            },
            {
                "MaxValue": "2",
                "MinValue": "0",
                "Name": "alpha",
            },
        ],
        "IntegerParameterRanges": [
            {
                "MaxValue": "10",
                "MinValue": "1",
                "Name": "max_depth",
            }
        ],
    },
    "ResourceLimits": {"MaxNumberOfTrainingJobs": 2, "MaxParallelTrainingJobs":
2},
    "Strategy": "Bayesian",
    "HyperParameterTuningJobObjective": {"MetricName": "validation:auc", "Type":
"Maximize"},
}
```

2. The hyperparameter tuning job will launch training jobs to find an optimal configuration of hyperparameters. These training jobs should be configured using the SageMaker

CreateHyperParameterTuningJob API. To configure the training jobs, we define a JSON object and pass it as the value of the TrainingJobDefinition parameter inside CreateHyperParameterTuningJob.

- AlgorithmSpecification – The registry path of the Docker image containing the training algorithm and related metadata. We fetch the XGboost Docker image for our specic usecase.
- InputDataConfig: This specifies where SageMaker should fetch the training and validation data from. For both data sources, the content type is CSV and data distribution is "FullyReplicated", which means each training instance will get the full dataset.
- OutputDataConfig: This defines where SageMaker should store the output of the training job (e.g., model artifacts). The output will be stored in the specified S3 bucket under an "output" prefix.
- ResourceConfig: Specifies the infrastructure to be used for the training job. In this case, a single ml.m5.xlarge instance with a volume size of 10GB.
- RoleArn: This is the Amazon Resource Name (ARN) of the IAM role that SageMaker can assume to perform tasks on your behalf. We make use of the ARN of the SageMakerRole that we retreived earlier.
- StaticHyperParameters: These are hyperparameters specific to the XGBoost algorithm that will remain fixed during training. For instance, objective is set to "binary:logistic", which is suitable for binary classification problems.
- StoppingCondition: This specifies that the training job should be terminated if it runs for more than 43200 seconds (or 12 hours).

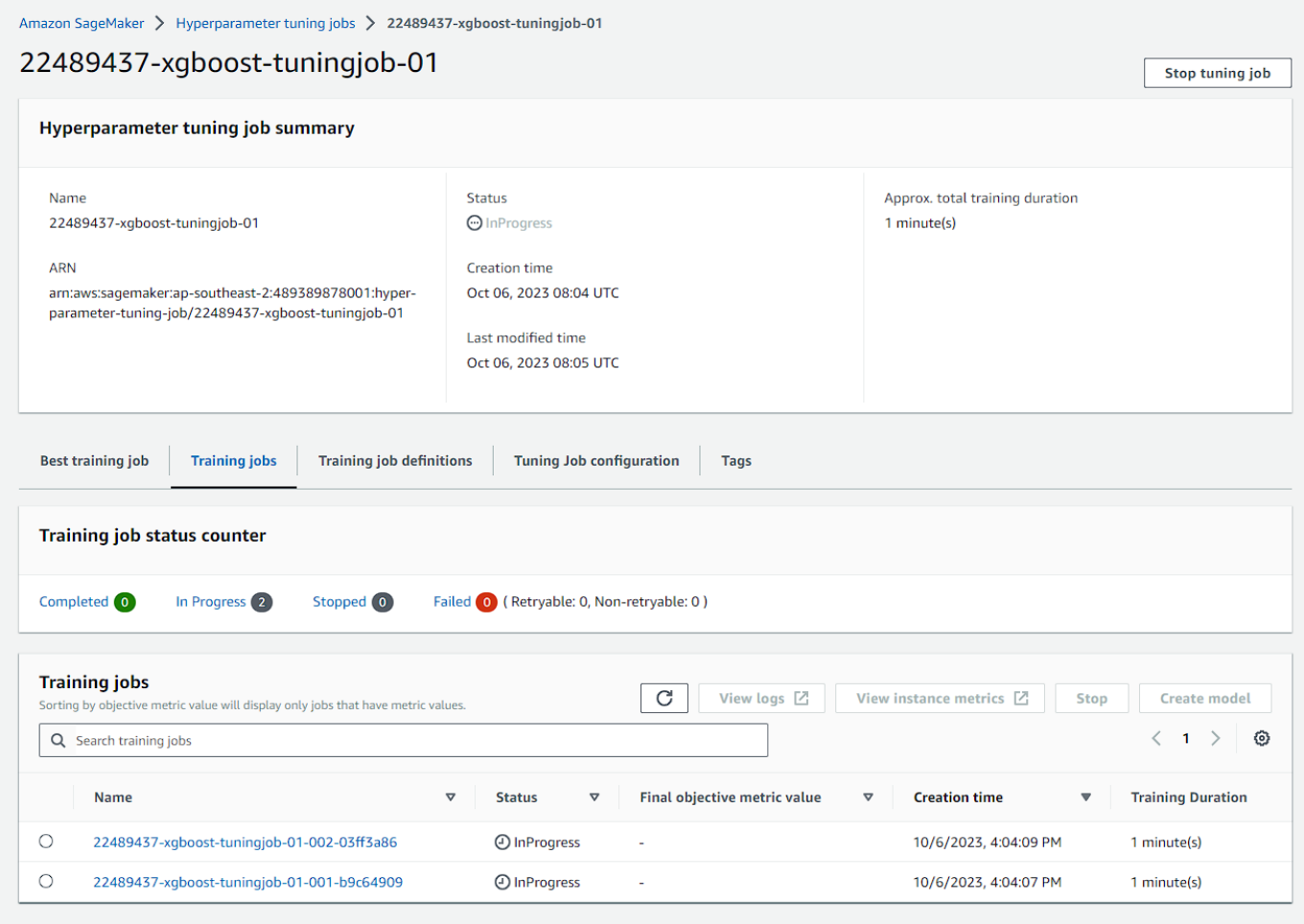
```
from sagemaker.image_uris import retrieve
# Use XGBoost algorithm for training
training_image = retrieve(framework="xgboost", region=region, version="latest")

s3_input_train = "s3://{}/{}/train".format(bucket, prefix)
s3_input_validation = "s3://{}/{}/validation/".format(bucket, prefix)

training_job_definition = {
    "AlgorithmSpecification": {"TrainingImage": training_image,
"TrainingInputMode": "File"},
    "InputDataConfig": [
        {
            "ChannelName": "train",
            "CompressionType": "None",
            "ContentType": "csv",
            "DataSource": {
                "S3DataSource": {
                    "S3DataDistributionType": "FullyReplicated",
                    "S3DataType": "S3Prefix",
                    "S3Uri": s3_input_train,
                }
            },
        },
        {
            "ChannelName": "validation",
            "CompressionType": "None",
            "ContentType": "csv",
            "DataSource": {
                "S3DataSource": {
```

```
                    "S3DataDistributionType": "FullyReplicated",
                    "S3DataType": "S3Prefix",
                    "S3Uri": s3_input_validation,
                }
            },
        },
    ],
    "OutputDataConfig": {"S3OutputPath": "s3://{}/{}/output".format(bucket,
prefix)},
    "ResourceConfig": {"InstanceCount": 1, "InstanceType": "ml.m5.xlarge",
"VolumeSizeInGB": 10},
    "RoleArn": sagemaker_role,
    "StaticHyperParameters": {
        "eval_metric": "auc",
        "num_round": "1",
        "objective": "binary:logistic",
        "rate_drop": "0.3",
        "tweedie_variance_power": "1.4",
    },
    "StoppingCondition": {"MaxRuntimeInSeconds": 43200},
}
```

3. This code snippet is launching a hyperparameter tuning job on Amazon SageMaker.

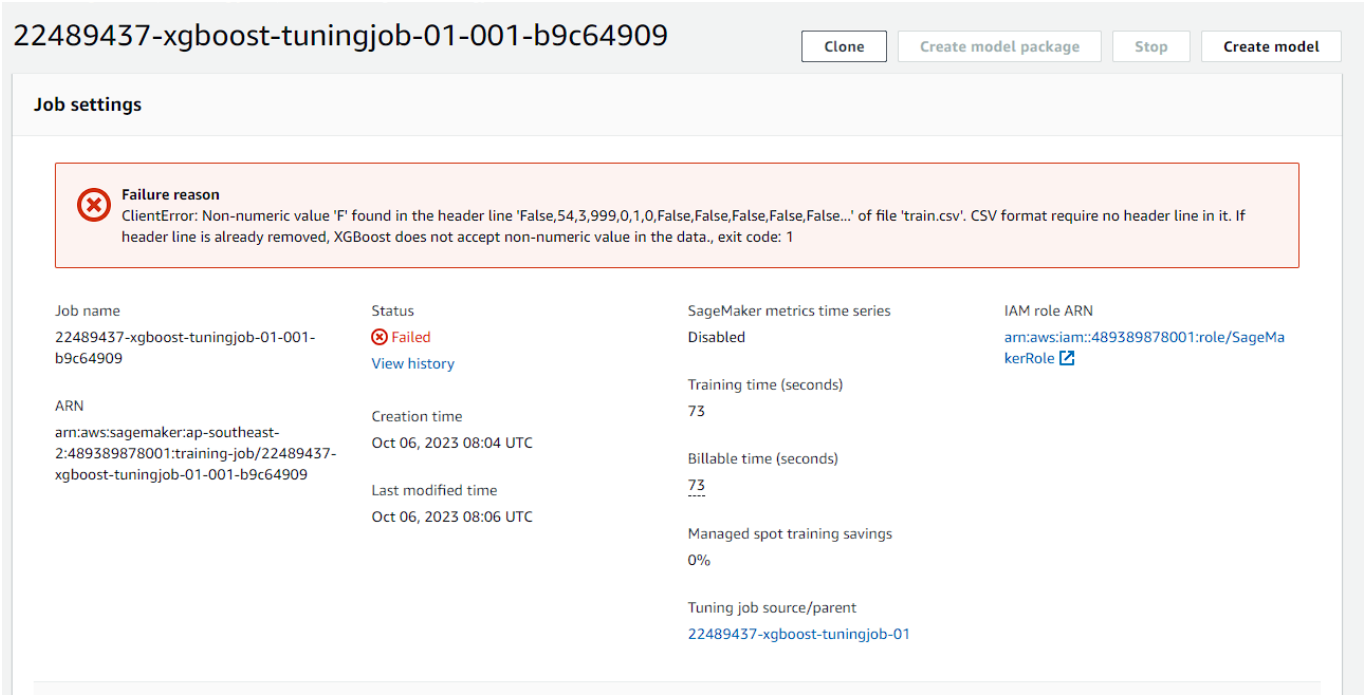
```
#Launch Hyperparameter Tuning Job
smclient.create_hyper_parameter_tuning_job(
    HyperParameterTuningJobName=tuning_job_name,
    HyperParameterTuningJobConfig=tuning_job_config,
    TrainingJobDefinition=training_job_definition,
)
```

4. We can log into the sagemaker service on the AWS console. Here we can see all the running training instances.



5. The hyperparameter optimization failed and we got the message "ClientError: Non-numeric value 'F' found in the header line 'False,54,3,999,0,1,0,False,False,False,False,False...' of file 'train.csv'". In order to resolve this, we convert all the True/False in the dataset to 1/0 using the following code.

```
bool_cols = model_data.select_dtypes(include=['bool']).columns
model_data[bool_cols] = model_data[bool_cols].astype(int)
```



6. Running the code again, we succeed this time and we can view the best training job hyperparaneters either in the AWS console or in the s3://YOUR_BUCKET/sagemaker/22489437-hpo-xgboost-dm/output.

Hyperparameter tuning job summary

Name 22489437-xgboost-tuningjob-03	Status Completed	Approx. total training duration 2 minute(s)
ARN arn:aws:sagemaker:ap-southeast-2:489389878001:hyper-parameter-tuning-job/22489437-xgboost-tuningjob-03	Creation time Oct 06, 2023 08:58 UTC	
	Last modified time Oct 06, 2023 09:01 UTC	

Best training job | Training jobs | Training job definitions | Tuning Job configuration | Tags

Best training job summary

This training job is the best training job for only this hyperparameter tuning job.

Create model

Name	Status	Objective metric	Value
22489437-xgboost-tuningjob-03-002-3f6015b6	Completed	validation:auc	0.743582010269165

Best training job hyperparameters

Name	Type	Value
_tuning_objective_metric	FreeText	validation:auc
alpha	Continuous	0.4685534350209817
eta	Continuous	0.5805843363954292
eval_metric	FreeText	auc
max_depth	Integer	8
min_child_weight	Continuous	5.24747070786632
num_round	FreeText	1
objective	FreeText	binary:logistic
rate_drop	FreeText	0.3
tweedie_variance_power	FreeText	1.4

output/

Copy S3 URI

Objects | Properties

Objects (1)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

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Find objects by prefix

1

Name	Type	Last modified	Size	Storage class
model.tar.gz	gz	October 6, 2023, 17:01:05 (UTC+08:00)	2.7 KB	Standard