Getting Started with the Cloud

Software Architecture

March 17, 2026

Brae Webb & Richard Thomas & Evan Hughes

Aside

Github Classroom links for this practical can be found on Edstem `https://edstem.org/au/courses/21491/discussion/2429006`

Before Class

Install Terraform[1] *before* your practical class. Also install the Terraform plugin for your IDE.

[1]`https://developer.hashicorp.com/terraform/tutorials/aws-get-started/install-cli`

1 This Week

Our goal is to get acquainted with AWS Academy Learner Lab. We use the lab to learn how to deploy and manage infrastructure with AWS. Additionally, Learner Lab will be used to develop the Cloud Infrastructure assignment. If you have not already enrolled in the AWS Academy courses, you need to do so now.

- Introduction to AWS Academy notes[2] describes how to accept your invitation to enrol and login to AWS Academy.
- Introduction to AWS Academy: Learner Lab notes[3] describes how to access and use Learner Lab.

You will learn how to:

- Enter the AWS Console from a Learner Lab.
- Provision an EC2 instance that deploys a simple static website.

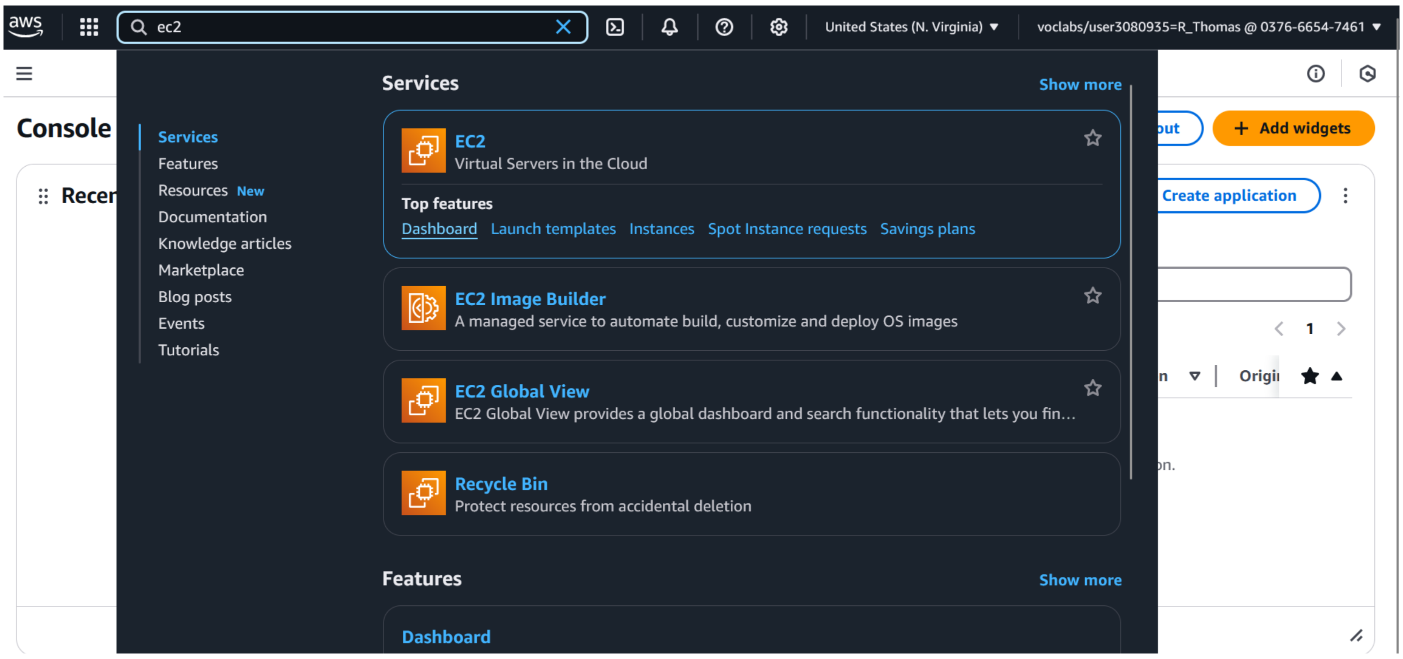
We will then start using an Infrastructure as Code tool (Terraform) to deploy the static website instead of using the AWS Console. You will also learn how to:

- Authenticate Terraform to use the AWS Learner Lab.
- Configure a single server website in Terraform and deploy.
- Create a Terraform module for deploying arbitrary single server websites.

2 AWS EC2

Today we are focussing on using AWS's EC2 service. Elastic Compute Cloud (EC2) is the primary compute service offered by AWS. It allows you to create virtual machines on Amazon's infrastructure. You have full control over this machine and can configure it for whatever purpose you need.

Navigate to the search bar in the top left and find the EC2 service. You might find this interface overwhelming. It is important to note that since EC2 is one of the primary services offered by AWS, many smaller services we do not need are bundled into this service.



Services

EC2
Virtual Servers in the Cloud

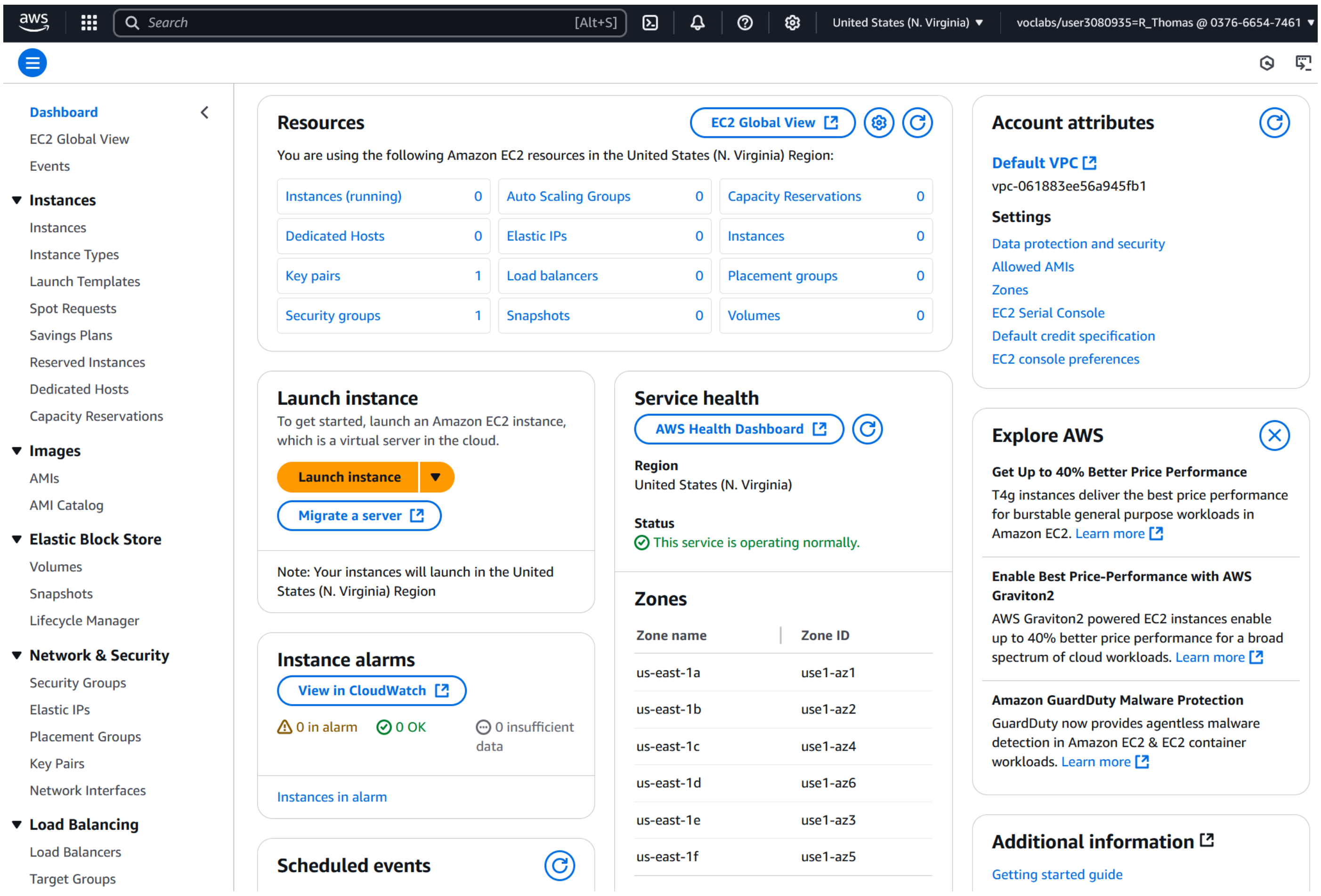
EC2 Image Builder
A managed service to automate build, customize and deploy OS images

EC2 Global View
EC2 Global View provides a global dashboard and search functionality that lets you fin…

Recycle Bin
Protect resources from accidental deletion

[2] https://csse6400.uqcloud.net/handouts/aws-academy.pdf
[3] https://csse6400.uqcloud.net/handouts/learner-lab.pdf

Today, we only need the `Instances` dashboard. Navigate to there and select "Launch instance".


aws
Search [Alt+S]
United States (N. Virginia) ▼
voclabs/user3080935=R_Thomas @ 0376-6654-7461 ▼

Dashboard
EC2 Global View
Events

▼ Instances
Instances
Instance Types
Launch Templates
Spot Requests
Savings Plans
Reserved Instances
Dedicated Hosts
Capacity Reservations

▼ Images
AMIs
AMI Catalog

▼ Elastic Block Store
Volumes
Snapshots
Lifecycle Manager

▼ Network & Security
Security Groups
Elastic IPs
Placement Groups
Key Pairs
Network Interfaces

▼ Load Balancing
Load Balancers
Target Groups

Resources EC2 Global View

You are using the following Amazon EC2 resources in the United States (N. Virginia) Region:

Instances (running)	0	Auto Scaling Groups	0	Capacity Reservations	0
Dedicated Hosts	0	Elastic IPs	0	Instances	0
Key pairs	1	Load balancers	0	Placement groups	0
Security groups	1	Snapshots	0	Volumes	0

Launch instance

To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Launch instance ▼

Migrate a server

Note: Your instances will launch in the United States (N. Virginia) Region

Instance alarms

View in CloudWatch

0 in alarm 0 OK 0 insufficient data

Instances in alarm

Scheduled events

Service health

AWS Health Dashboard

Region
United States (N. Virginia)

Status
This service is operating normally.

Zones

Zone name	Zone ID
us-east-1a	use1-az1
us-east-1b	use1-az2
us-east-1c	use1-az4
us-east-1d	use1-az6
us-east-1e	use1-az3
us-east-1f	use1-az5

Account attributes

Default VPC
vpc-061883ee56a945fb1

Settings
Data protection and security
Allowed AMIs
Zones
EC2 Serial Console
Default credit specification
EC2 console preferences

Explore AWS

Get Up to 40% Better Price Performance
T4g instances deliver the best price performance for burstable general purpose workloads in Amazon EC2. Learn more

Enable Best Price-Performance with AWS Graviton2
AWS Graviton2 powered EC2 instances enable up to 40% better price performance for a broad spectrum of cloud workloads. Learn more

Amazon GuardDuty Malware Protection
GuardDuty now provides agentless malware detection in Amazon EC2 & EC2 container workloads. Learn more

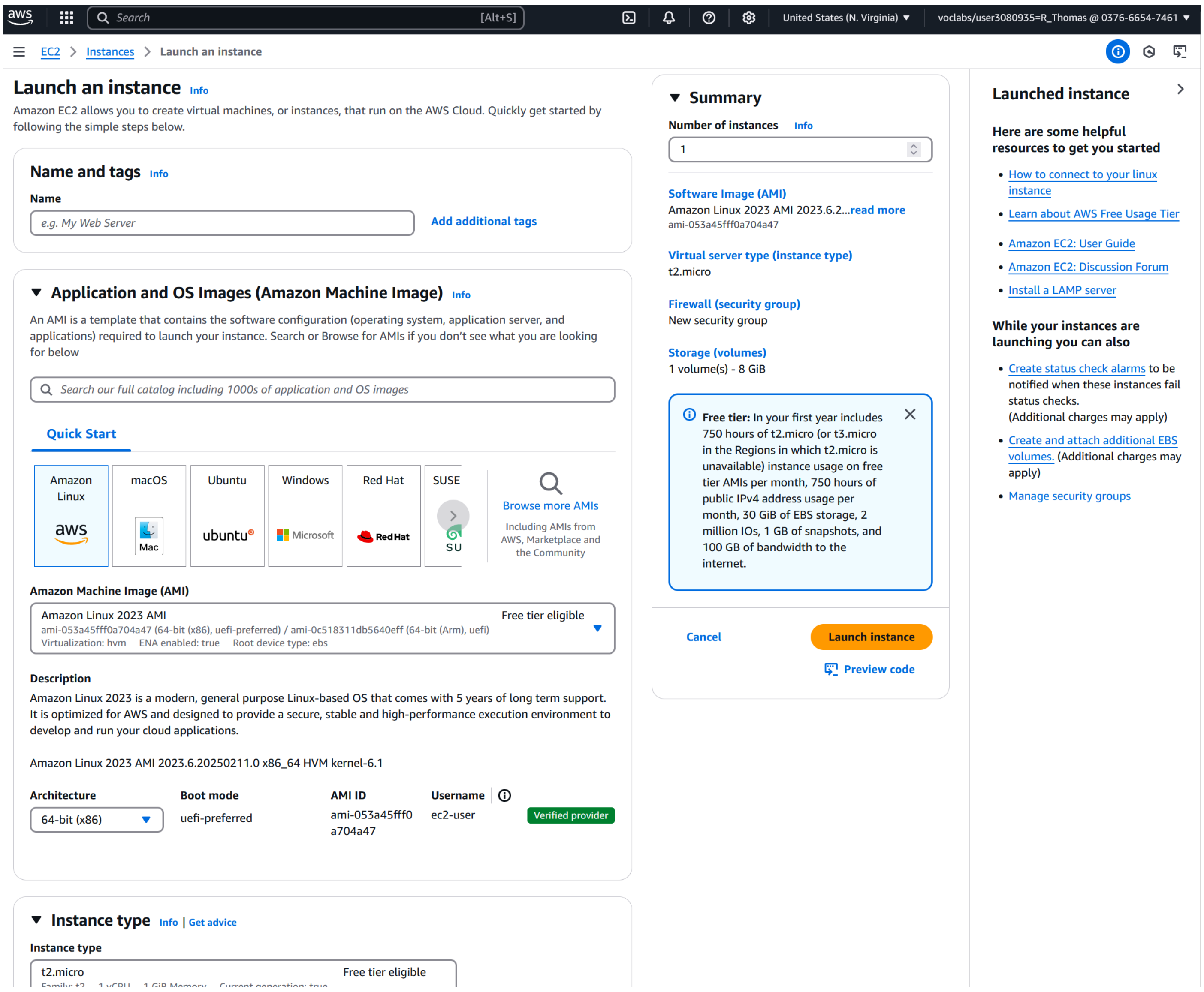
Additional information

Getting started guide

2.1 EC2 AMI

First we need to select an Amazon Machine Image (AMI). An AMI is the template that provides instructions on how an instance should be provisioned. Amazon offers a range of built-in AMIs. There are also community AMIs or you can create your own. As we just want a simple server today, we will use one of the built-in AMIs.

We will use the Amazon Linux 2023 AMI today, it is considered one of the fundamental images. Every AMI has a unique AMI code, which is `ami-08b5b3a93ed654d19` for the Amazon Linux 2023 AMI.


aws
Search [Alt+S]
United States (N. Virginia) ▼
voclabs/user3080935=R_Thomas @ 0376-6654-7461 ▼
EC2 > Instances > Launch an instance

Launch an instance Info

Amazon EC2 allows you to create virtual machines, or instances, that run on the AWS Cloud. Quickly get started by following the simple steps below.

Name and tags Info

Name

e.g. My Web Server

Add additional tags

▼ Application and OS Images (Amazon Machine Image) Info

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. Search or Browse for AMIs if you don't see what you are looking for below

Search our full catalog including 1000s of application and OS images

Quick Start

Amazon Linux | macOS | Ubuntu | Windows | Red Hat | SUSE

Browse more AMIs

Including AMIs from AWS, Marketplace and the Community

Amazon Machine Image (AMI)

Amazon Linux 2023 AMI — Free tier eligible
ami-053a45fff0a704a47 (64-bit (x86), uefi-preferred) / ami-0c518311db5640eff (64-bit (Arm), uefi)
Virtualization: hvm ENA enabled: true Root device type: ebs

Description

Amazon Linux 2023 is a modern, general purpose Linux-based OS that comes with 5 years of long term support. It is optimized for AWS and designed to provide a secure, stable and high-performance execution environment to develop and run your cloud applications.

Amazon Linux 2023 AMI 2023.6.20250211.0 x86_64 HVM kernel-6.1

Architecture	Boot mode	AMI ID	Username	
64-bit (x86)	uefi-preferred	ami-053a45fff0a704a47	ec2-user	Verified provider

▼ Instance type Info | Get advice

Instance type

t2.micro — Free tier eligible
Family: t2 1 vCPU 1 GiB Memory Current generation: true

▼ Summary

Number of instances Info

1

Software Image (AMI)
Amazon Linux 2023 AMI 2023.6.2...read more
ami-053a45fff0a704a47

Virtual server type (instance type)
t2.micro

Firewall (security group)
New security group

Storage (volumes)
1 volume(s) - 8 GiB

Free tier: In your first year includes 750 hours of t2.micro (or t3.micro in the Regions in which t2.micro is unavailable) instance usage on free tier AMIs per month, 750 hours of public IPv4 address usage per month, 30 GiB of EBS storage, 2 million IOs, 1 GB of snapshots, and 100 GB of bandwidth to the internet.

Cancel | Launch instance | Preview code

Launched instance

Here are some helpful resources to get you started

- How to connect to your linux instance
- Learn about AWS Free Usage Tier
- Amazon EC2: User Guide
- Amazon EC2: Discussion Forum
- Install a LAMP server

While your instances are launching you can also

- Create status check alarms to be notified when these instances fail status checks. (Additional charges may apply)
- Create and attach additional EBS volumes. (Additional charges may apply)
- Manage security groups

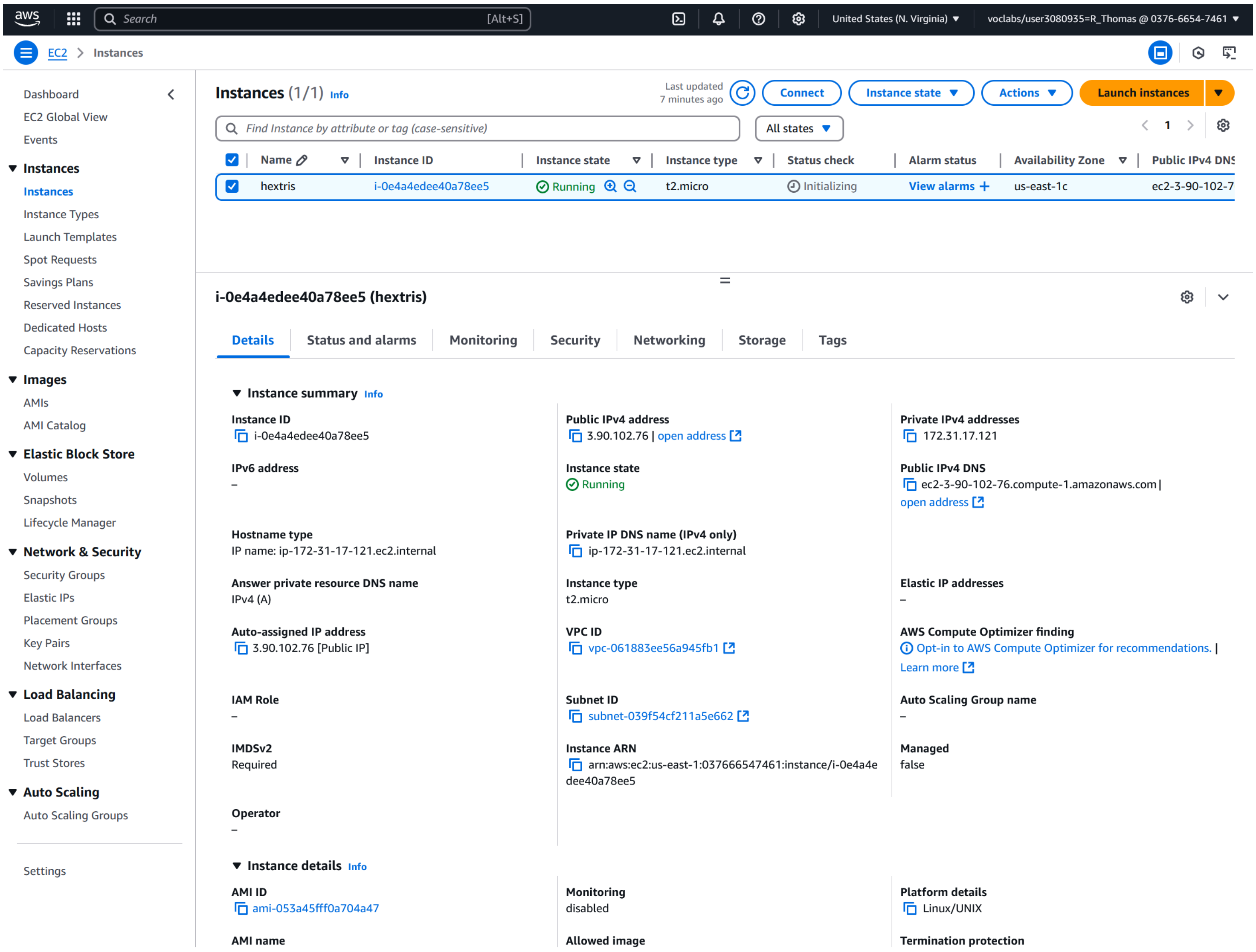
2.2 Instance Settings

The settings to configure your instance are:

1. Add a 'Name' tag. Call it the name of your website, e.g. `hextris`.
2. Select an appropriate AMI, i.e. Amazon Linux 2023 AMI, `ami-053a45fff0a704a47`.
3. Select a 64-bit (x86) architecture.
4. The instance type defines the computing, memory, networking and storage capabilities of your instance. We do not need a large server, choose `t2.micro`.
5. Select the existing `vockey` (Type: RSA) key pair option.
6. In network settings, choose 'Create security group' and select to allow SSH traffic from anywhere, and HTTPS and HTTP access from the internet.
7. Keep the 'Configure storage' settings as default.
8. Do not worry about the 'Advanced details' options for now.
9. You can now launch the instance to start your server.

3 Accessing the Instance

Return to the `Instances` dashboard. You should see that a new instance has been created. Its instance state might not yet be `Running`, if not, wait.



✓	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS
✓	hextris	i-0e4a4edee40a78ee5	✓ Running	t2.micro	Initializing	View alarms +	us-east-1c	ec2-3-90-102-7

i-0e4a4edee40a78ee5 (hextris)

▾ Instance summary Info

Instance ID i-0e4a4edee40a78ee5	**Public IPv4 address** 3.90.102.76 | open address	**Private IPv4 addresses** 172.31.17.121
IPv6 address –	**Instance state** ✓ Running	**Public IPv4 DNS** ec2-3-90-102-76.compute-1.amazonaws.com | open address
Hostname type IP name: ip-172-31-17-121.ec2.internal	**Private IP DNS name (IPv4 only)** ip-172-31-17-121.ec2.internal	
Answer private resource DNS name IPv4 (A)	**Instance type** t2.micro	**Elastic IP addresses** –
Auto-assigned IP address 3.90.102.76 [Public IP]	**VPC ID** vpc-061883ee56a945fb1	**AWS Compute Optimizer finding** Opt-in to AWS Compute Optimizer for recommendations. | Learn more
IAM Role –	**Subnet ID** subnet-039f54cf211a5e662	**Auto Scaling Group name** –
IMDSv2 Required	**Instance ARN** arn:aws:ec2:us-east-1:037666547461:instance/i-0e4a4e dee40a78ee5	**Managed** false
Operator –		

▾ Instance details Info

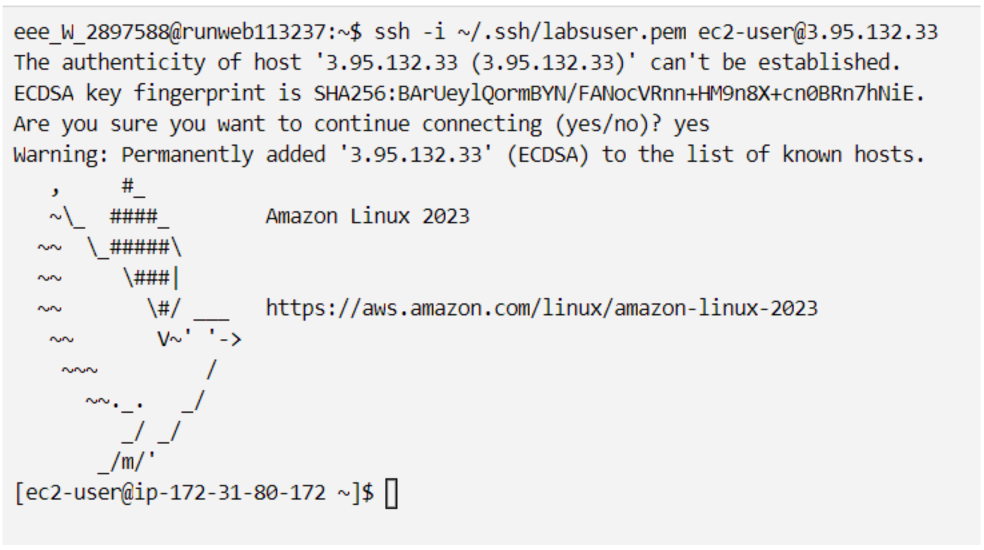
AMI ID ami-053a45fff0a704a47	**Monitoring** disabled	**Platform details** Linux/UNIX
AMI name	**Allowed image**	**Termination protection**

Note the public IPv4 address, as we will need to use this to connect to the server. You will also need this address to test that installation of Hextris in section 4 worked.

1. Return to the AWS Learner Lab interface.
2. In the terminal window run the following, replacing `127.0.0.1` with the public IP address of your instance. This command uses the `vockey | RSA` key pair to gain SSH access to the machine.

```
$ ssh -i ~/.ssh/labsuser.pem ec2-user@127.0.0.1
```

For example:



```
eee_W_2897588@runweb113237:~$ ssh -i ~/.ssh/labsuser.pem ec2-user@3.95.132.33
The authenticity of host '3.95.132.33 (3.95.132.33)' can't be established.
ECDSA key fingerprint is SHA256:BArUeylQormBYN/FANocVRnn+HM9n8X+cn0BRn7hNiE.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '3.95.132.33' (ECDSA) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
[ec2-user@ip-172-31-80-172 ~]$ 
```

You can also access the instance by selecting it from the list of instances in the dashboard and clicking the "Connect" button. This will open a new tab in your browser with terminal access to your instance.

4 Installing Hextris

Hextris [1] is very simple to install. Using an EC2 interface is perhaps overkill for it. It is an entirely client-side/static web application, which means we just have to serve the static files.

First, we will need to enable serving of static files. We can install and start the `httpd` service to do this. The AMI we have picked uses the `yum` package manager, so to install `httpd` we run:

```
> sudo yum install httpd
Last metadata expiration check: ...
Dependencies resolved
.....
.....
Total download size: 2.3 M
Installed size: 6.9 M
Is this ok [y/N]:

# enter y to install
.....
.....
Complete!
> sudo systemctl enable httpd
Created symlink from /etc/systemd/system/multi-user.target.wants/httpd.service to /
    usr/lib/systemd/system/httpd.service.
> sudo systemctl start httpd
```

All files in the `/var/www/html` directory will now be served when accessed via **HTTP**. Navigate to the public IP address of your EC2 instance in the browser. You should see an "It works!" landing page.

Change to the `/var/www/html` directory and notice that it is currently empty. We need to download the static files to this directory so that they can be served. We can use `git` for this (though it is not the most suited tool), but first `git` needs to be installed on the machine.

```
$ sudo yum install git
```

Finally, confirm that we are in the `/var/www/html` directory.

```
$ cd /var/www/html
```

And clone the repository into that directory.

```
$ sudo git clone https://github.com/Hextris/hextris .
```

Now if you navigate to the **http** address of the public IP address (e.g. `http://18.208.165.253`), you should be able to see your newly deployed website. Congratulations!

Notice

If you are having timeout issues, one problem could be using `https` to connect rather than `http`.

5 Switching to Terraform

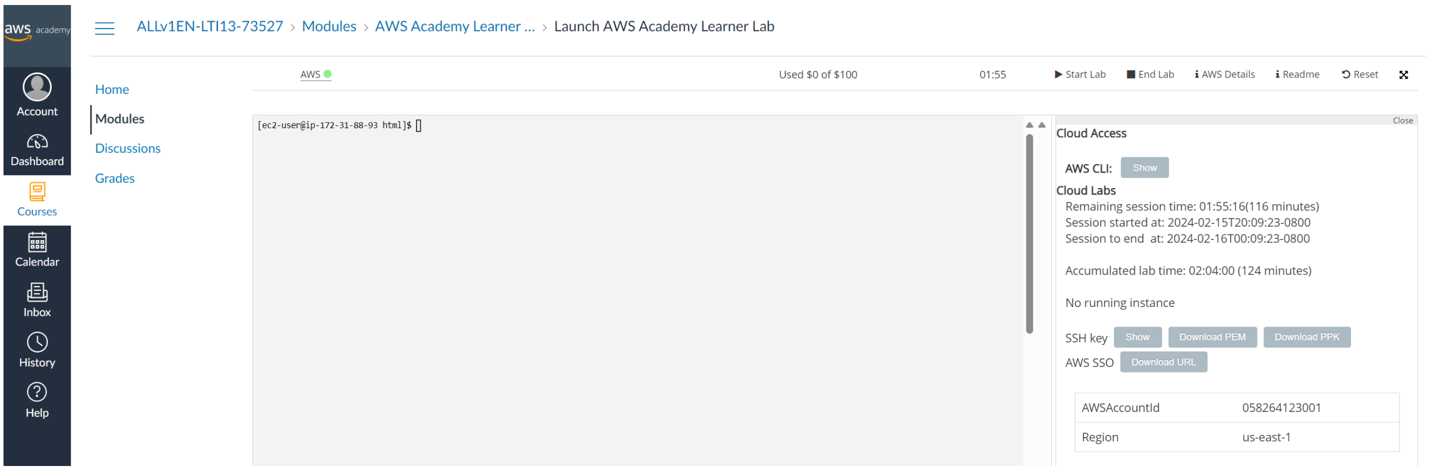
For the remainder of the practical we will use Terraform to provision the same instance we just created.

1. First, delete any running instances in your AWS account using the AWS Console.
2. Next, navigate to the GitHub Classroom link for this practical provided at the start of this document. This will create a new repository where we can work with Terraform.

6 Using Terraform in AWS Learner Labs

We will redeploy our Hextris application using Infrastructure as Code (IaC). You will need to keep your lab running for the next steps. (Now is a good time to click start to refresh your 4 hour time limit.)

1. Click on "AWS Details" to display information about the lab.



Used $0 of $100 01:55

```
[ec2-user@ip-172-31-88-93 html]$ 
```

Cloud Access

AWS CLI: Show

Cloud Labs
Remaining session time: 01:55:16(116 minutes)
Session started at: 2024-02-15T20:09:23-0800
Session to end at: 2024-02-16T00:09:23-0800

Accumulated lab time: 02:04:00 (124 minutes)

No running instance

SSH key Show Download PEM Download PPK
AWS SSO Download URL

AWSAccountId	058264123001
Region	us-east-1

2. Click on the first 'Show' button next to 'AWS CLI'. This will display a text block starting with `[default]`.
3. Within your repository create a `credentials` file and copy the contents of the text block into the file. **Do not share this file contents — do not commit it**. This file is added to the `.gitignore` of your repository by default.
4. Create a `main.tf` file in the same directory with the following contents:

```
» cat main.tf
terraform {
    required_providers {
        aws = {
            source = "hashicorp/aws"
            version = "~> 5.0"
        }
    }
}

provider "aws" {
    region = "us-east-1"
    shared_credentials_files = ["./credentials"]
    default_tags {
        tags = {
            Environment = "Dev"
            Course = "CSSE6400"
            StudentID = "<Your Student ID>"
        }
  }
}
```

The `terraform` block specifies the required external dependencies, here we need to use the AWS provider above version 5.0. The `provider` block configures the AWS provider, instructing it which region to use and how to authenticate (using the credentials file we created). We also include some `tags` to add to any resource made by this provider, these are useful for keeping track of resources in the console.

5. We need to initialise Terraform, which will download the required dependencies. This is done with the `terraform init` command.

```
$ terraform init
```

This command will create a `.terraform` directory which stores providers and a provider lock file, `.terraform.lock.hcl`.

6. To verify that we have setup Terraform correctly, use `terraform plan`.

```
$ terraform plan
```

As we currently have no resources configured, it should find that no changes are required. Note that this does not ensure our credentials are correctly configured, as Terraform has no reason to try authenticating yet.

7 Deploying Hextris

First, we will need to create an EC2 instance resource. The AWS provider calls this resource an `aws_instance`[4]. Get familiar with the documentation page. Most Terraform providers have reasonable documentation. Reading the argument reference section helps to understand what a resource is capable of doing.

We will start off with the basic information for the resource. Configure it to use a specific Amazon Machine Instance (AMI), and chose the `t2.micro` size. We will also give it a name so that it is easy to find. Add the following basic `resource` block to `main.tf`:

```
» cat main.tf
resource "aws_instance" "hextris-server" {
    ami = "ami-08b5b3a93ed654d19"
    instance_type = "t2.micro"
    key_name = "vockey"

    tags = {
        Name = "hextris"
    }
}
```

To create the server, invoke `terraform apply`, which will first do `terraform plan` and prompt us to confirm if we want to apply the changes.

```
$ terraform apply
```

You should be prompted with something similar to the output below.

```
Terraform used the selected providers to generate the following execution plan.
   Resource actions are indicated with the following symbols:
  + create

Terraform will perform the following actions:

  # aws_instance.hextris-server will be created
  + resource "aws_instance" "hextris-server" {
      + ami = "ami-08b5b3a93ed654d19"
      (omitted)
      + instance_type = "t2.micro"
      (omitted)
      + tags = {
```

[4]https://registry.terraform.io/providers/hashicorp/aws/latest/docs/resources/instance

```
          + "Name" = "hextris"
        }
      (omitted)
    }

Plan: 1 to add, 0 to change, 0 to destroy.

Do you want to perform these actions?
  Terraform will perform the actions described above.
  Only 'yes' will be accepted to approve.

  Enter a value:
```

If the plan looks sensible enter `yes` to enact the changes.

```
  Enter a value: yes

aws_instance.hextris-server: Creating...
aws_instance.hextris-server: Still creating... [10s elapsed]
aws_instance.hextris-server: Still creating... [20s elapsed]
aws_instance.hextris-server: Still creating... [30s elapsed]
aws_instance.hextris-server: Still creating... [40s elapsed]
aws_instance.hextris-server: Creation complete after 47s [id=i-08c92a097ae7c5b18]

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

You can now check in the AWS Console that another EC2 instance with the name `hextris` has been created. Now that we have a server, we should try to configure it to serve Hextris. We will use the `user_data` field, which configures commands to run when launching the instance. First we need a script to provision the server, if we combine all our commands from section 4, we will produce this script:

```
   » cat serve-hextris.sh

#!/bin/bash
yum install -y httpd
systemctl enable httpd
systemctl start httpd

yum install -y git
cd /var/www/html
git clone https://github.com/Hextris/hextris .
```

Now we can add the following field to our Terraform resource. It uses the Terraform `file` function to load the contents of a file named `serve-hextris.sh`, relative to the Terraform directory. The contents of that file is passed to the `user_data` field.

```
user_data = file("./serve-hextris.sh")
```

If you run the `terraform plan` command now, you will notice that Terraform has identified that this change will require creating a new EC2 instance. Where possible, Terraform will try to update a resource in-place but since this changes how an instance is started, it needs to be replaced. Go ahead and apply the changes.

Now, in theory, we should have deployed Hextris to an EC2 instance. But how do we access that instance? We *could* go to the AWS Console and find the public IP address. However, it turns out that Terraform already knows the public IP address. In fact, if you open the Terraform state file (`terraform.tfstate`), you should be able to find it hidden away in there. But, we do not want to go hunting through this file all the time. Instead we will use the `output` keyword.

We can specify certain attributes as 'output' attributes. Output attributes are printed to the terminal when the module is invoked directly but as we will see later, they can also be used by other Terraform configuration files.

```
   » cat main.tf

output "hextris-url" {
  value = aws_instance.hextris-server.public_ip
}
```

This creates a new output attribute, `hextris-url`, which references the `public_ip` attribute of our `hextris-server` resource. Note that resources in Terraform are addressed by the resource type (`aws_instance`) followed by the name of the resource (`hextris-server`).

If you `apply` the changes, it should tell you the public IP address of the instance resource.

```
$ terraform apply
```

```
aws_instance.hextris-server: Refreshing state... [id=i-043a61ff86aa272e0]

Outputs:
hextris-url = "3.82.225.65"
```

You can apply this plan to save these new output values to the Terraform state, without changing any real infrastructure.

So let's try and access that URL, hmm. That is strange. Something has gone wrong.

8 Security Groups

When we setup our EC2 instance using the AWS Console, it helpfully created a new security group for us. We specified that this security group should allow SSH, HTTP, and HTTPS traffic by allowing traffic from ports 22, 80, and 443 respectively. When configuring with Terraform, security groups and their attachment to EC2 instances are separate resources. Refer back to the Terraform documentation for details or, as is normally quicker, Google "terraform aws security group".

First, let us create an appropriate security group. Recall that in the AWS Console configuration, ingress SSH access (port 22) and all egress[5] traffic were automatically configured and we just added ingress port 80. In Terraform the whole state must be configured so we specify two `ingress` blocks, one for HTTP (port 80) and one for SSH access (port 22).[6] Additionally, we will create egress for all outgoing traffic.

```
resource "aws_security_group" "hextris-server" {
  name = "hextris-server"
  description = "Hextris HTTP and SSH access"

  ingress {
    from_port = 80
    to_port = 80
    protocol = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  ingress {
    from_port = 22
    to_port = 22
    protocol = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }

  egress {
    from_port = 0
    to_port = 0
    protocol = "-1"
    cidr_blocks = ["0.0.0.0/0"]
  }
}
```

Note the following:

- `from_port` and `to_port` are the start and end of a range of ports rather than incoming or outgoing. In this example our range is 80-80.
- `protocol` set to "-1" is a special flag to indicate all protocols.
- Explaining `cidr` is outside the scope of the course, but the specified block above means to apply to all IP addresses.

You may now `apply` the changes to create this new security group resource.

Next, we will attach the security group to the EC2 instance. Return to the `aws_instance.hextrix-server` resource and include the following line:

```
security_groups = [aws_security_group.hextris-server.name]
```

[5]Ingress and egress in networking just means incoming and outgoing respectively.

[6]We do not actually need SSH access as all the server configuration is done when the machine is provisioned, thanks to the `user_data`, but we are trying to create a new instance that is identical to the original AWS Console in section 4.

Note that EC2 instances can have multiple security groups. Once again notice the structure of resource identifiers in AWS.

Now `apply` the changes. If you now try to access via the IP address (the IP address may have changed), you should be able to view the Hextris website.

9 Tearing Down

One of the important features of Infrastructure as Code (IaC) is all the configuration we just did is stored in a file. This file can, and should be, version controlled and subject to the same quality rules of code files. It also means that if we want to redeploy Hextris at any point, we can easily just run the IaC to deploy it.

To try this out, let us first take everything down. We can do this with:

```
$ terraform destroy
```

You should be prompted to confirm that you want to destroy all of the resources in the state. Once Terraform has finished taking everything down, confirm that you can no longer access the website and that the AWS console says the instances have been destroyed.

Now go ahead and apply the changes to bring everything back:

```
$ terraform apply
```

Confirm that this brings the website back exactly as before (with a different IP address). You can now start any lab you want and almost instantly spin back up the website you have configured. That is the beauty of Infrastructure as Code!

Hint: Destroy everything again before you finish.

10 Automated Testing

A quick note about automated testing. As with all the practicals thus far, this practical has automated tests enabled on your repository.

From within your repository, you can run the tests locally with:

```
$ .csse6400/bin/unittest.sh
```

While the emails saying that the tests failed can be annoying, these automated tests allow us to ensure that everyone is keeping up with the practical content.

If fixing the test failures is not too hard, please try to do so. If you are repeatedly not passing the practicals, we may reach out to ensure that you are not being left behind in the content.

11 Extension

Info

This section is for students who have completed the practical and want to extend their knowledge.

Since CSSE6400 runs this practical every year, sometimes the AMI that we were using is out of date or does not exist any more. For this practical, we could instead query AWS for the latest AMI and use that in our Terraform.

To do this we introduce a new data source, `aws_ami`. Data sources fetch or query data from the provider, rather than creating something.

Add the following to your `main.tf` file:

```
data "aws_ami" "latest" {
  most_recent = true
  owners = ["amazon"]

  filter {
    name = "name"
    values = ["al2023-ami-2023*"]
  }

  filter {
    name = "root-device-type"
    values = ["ebs"]
  }

  filter {
    name = "virtualization-type"
    values = ["hvm"]
  }

  filter {
    name = "architecture"
    values = ["x86_64"]
  }
}
```

The `aws_ami` data source will find the latest Amazon Linux 2023 AMI for 64 bit x86, which is what is running on our EC2 instance.

To use the data source we need to change the `ami` attribute of the `aws_instance` resource to use the data source. This is done as so:

```
resource "aws_instance" "hextris-server" {
  ami = data.aws_ami.latest.id
  instance_type = "t2.micro"
  key_name = "vockey"
  security_groups = [aws_security_group.hextris-server.name]
  user_data = file("./serve-hextris.sh")
  tags = {
    Name = "hextris"
  }
}
```

And now, if we run `terraform plan`, we will see that it wants to destroy and recreate the EC2 instance. This is because the AMI has changed since this practical was first updated for this year.

References

[1] L. Engstrom, G. Finucane, N. Moroze, and M. Yang, "Hextris." https://github.com/hextris/hextris/, 2014.

[2] "Aws global infrastructure." https://aws.amazon.com/about-aws/global-infrastructure/, March 2025.

A AWS Networking Terminology

AWS Regions Regions are the physical locations of AWS data centres. When applying Terraform, the changes are made to one region at a time. In our case we specified the region `us-east-1`. Often you do not need to deploy to more than one region, however, it can help decrease latency and reduce risk from a major disaster. Generally, pick a region and stick with it. We have picked `us-east-1` because it is the least expensive.

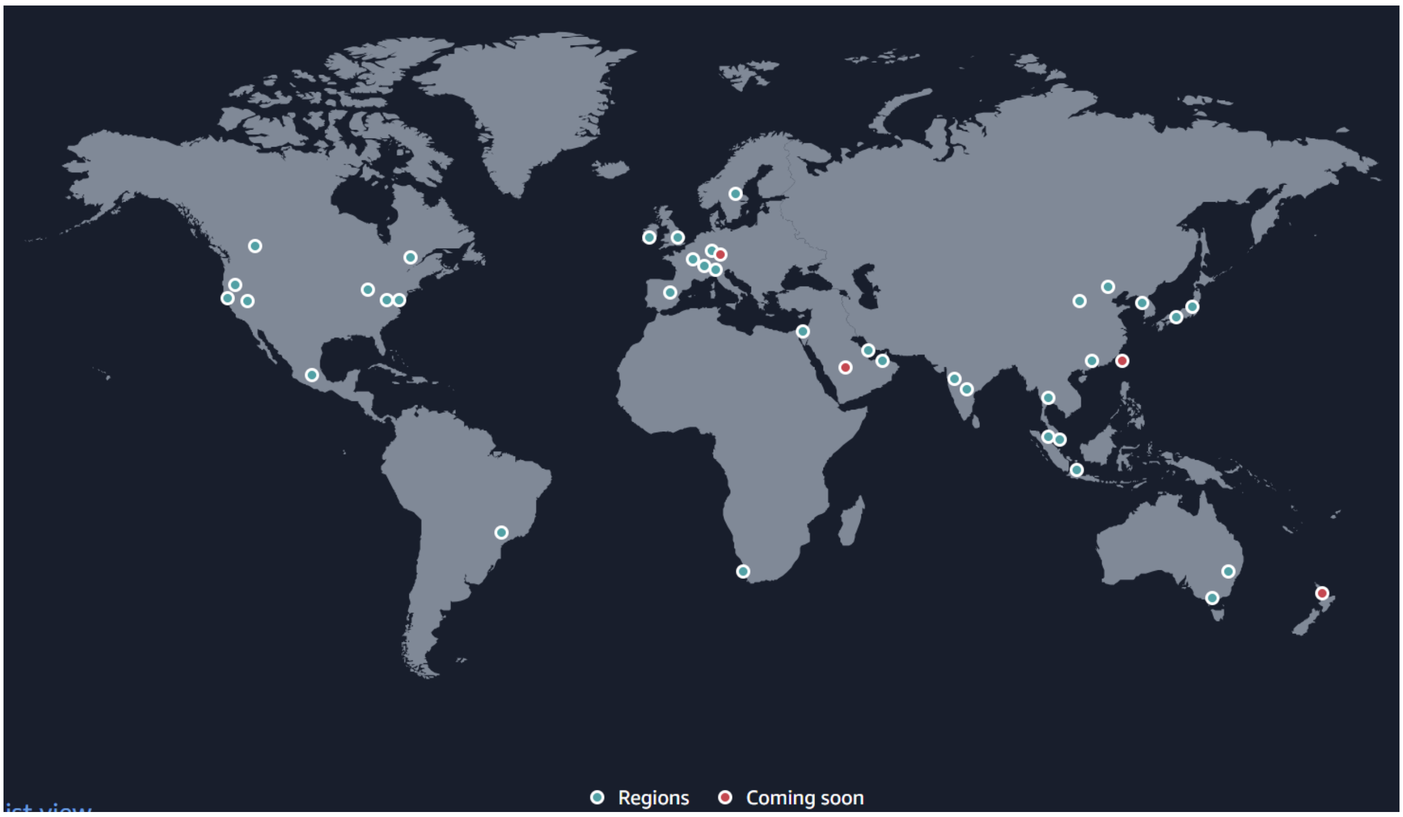


Figure 1: AWS Regions as of March 2025 [2]

Availability Zones An AWS Region will consist of availability zones, normally named with letters. For example, the AWS Region located in Sydney, `ap-southeast-2` has three availability zones: `ap-southeast-2a`, `ap-southeast-2b`, and `ap-southeast-2c`. An availability zone is a collection of resources which run on separate power supplies and networks. Reducing the risk that multiple availability zones would fail at once.

VPC Virtual Private Clouds, or VPCs, are virtual networks under your control, if you have managed a regular network before it should be familiar. VPCs are contained within one region but are spread across multiple availability zones.