Deploying with Terraform

Software Architecture

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1 Before Class

Ensure you've had practice using the AWS Academy learner lab. It's preferable if you already have terraform installed[1]. Please also have one of IntelliJ IDEA, PyCharm, or VSCode with the terraform plugin installed.

2 This Week

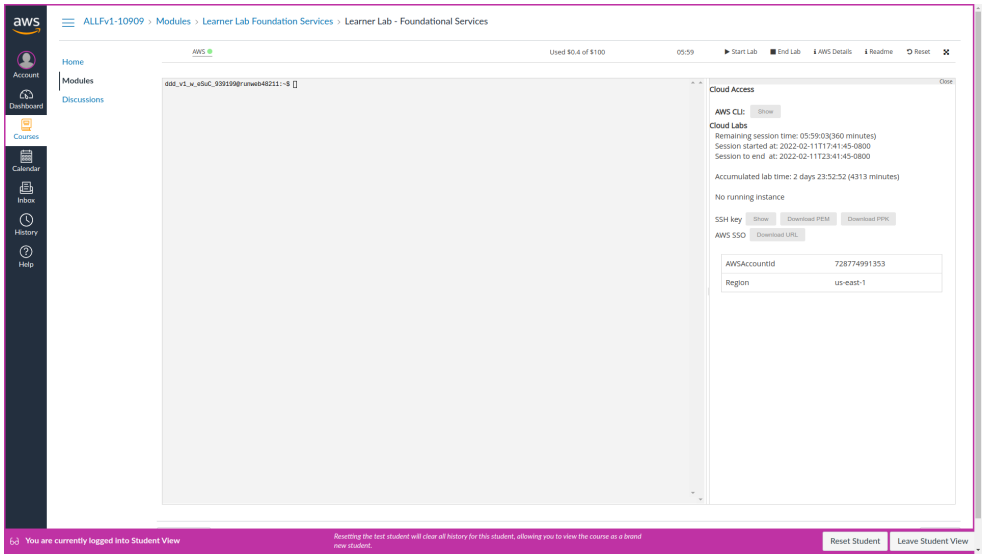
This week our goal is to get experience using an Infrastructure as Code tool, specifically, Terraform, to deploy a service to AWS. Specifically, this week you need to:

- 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.

3 Using Terraform in AWS Learner Labs

Following the steps from the week one practical, start a learner lab in AWS Academy. For this practical, you do not need to create any resources in the AWS Console. The console can be used to verify that Terraform has correctly provisioned resources.

1. Once the learner lab has started, click on 'AWS Details' to display information about the lab.



2. Click on the first 'Show' button next to 'AWS CLI' which will display a text block starting with `[default]`.
3. Create a directory for this week's practical.

[1] https://learn.hashicorp.com/tutorials/terraform/install-cli

4. Within that directory 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.**

5. Create a `main.tf` file in the same directory with the following contents:

```
» cat main.tf
terraform {
    required_providers {
        aws = {
            source = "hashicorp/aws"
            version = "~> 3.0"
        }
    }
}

provider "aws" {
    region = "us-east-1"
    shared_credentials_file = "./credentials"
}
```

   The `terraform` block specifies the required external dependencies, here we need to use the AWS provider. The `provider` clock configures the AWS provider, instructing it which region to use and how to authenticate (using the credentials file we created).

6. We need to initialise terraform which will fetch 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`.

7. 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.

4 Deploying Hextris

If you followed the default instructions in the week one practical, you would have manually deployed the hextris game. Now we'll try to deploy hextris using terraform.

First, we will need to create an EC2 instance resource. The AWS provider calls this resource an `aws_instance`[2]. 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.

We will start off with the basic information for the resource. We configured it to use a specific Amazon Machine Instance (AMI) and chose the `t2.micro` size. Refer back to the week one practical sheet for a refresher. Add the following basic resource to `main.tf`:

```
   » cat main.tf
resource "aws_instance" "hextris-server" {
    ami = "ami-0a8b4cd432b1c3063"
    instance_type = "t2.micro"

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

To create the server, invoke `terraform apply` will first do `terraform plan` and prompt us to confirm if we want to apply 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-0a8b4cd432b1c3063"
      (omitted)
      + instance_type = "t2.micro"
      (omitted)
      + tags = {
          + "Name" = "hextris"
        }
    }

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

Do you want to perform these actions?
  Terraform will perform the actions described above.
```

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

```
  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 an EC2 instance with the name `hextris` has been created. Now we have got a server, we should try to configure it to contain 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 the last practical, we will produce this script:

```
   » cat deploy.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 `deploy.sh` relative to the Terraform directory. The contents of that file is passed to the `user_data` field.

```
user_data = file("${path.module}/deploy.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[3], 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`),

[3] hint

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 plan or apply the changes, it should tell you the public IP address of the instance resource.

```
  $ terraform plan
```

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

Changes to 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's strange. Something has gone wrong.

5 Security Groups

As you will recall from the practical in week one. An important part of setting up the EC2 instance was configuring the security group to allow traffic from port 80 to reach the instance. Configuring the security group was built into the process with the GUI configuration. 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 GUI configuration, ingress SSH access (port 22) and all egress[4] traffic was 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).[5] Additionally, we will create egress for all outgoing traffic.

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

[5] 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 will try to recreate the instance from the week one practical exactly.

```
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]
```

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.

6 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 leave.

References

[1] D. Poccia, "Now open — third availability zone in the aws canada (central) region." https://aws.amazon.com/blogs/aws/now-open-third-availability-zone-in-the-aws-canada-central-region/, March 2020.

A AWS Networking Terminology

AWS Regions Regions are the physical locations of AWS data centres. When applying Terraform, the changes are being 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.

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. Essentially minimising 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.

Figure 1: AWS Regions as of March 2020 [1]