Deploying with Terraform

Teacher Version

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 we are going to deploy TaskOverflow our Todo Application to AWS using a hosted database and a single server website.

Specifically, this week you need to:

- Authenticate Terraform to use the AWS learner lab.
- Configure an RDS database.

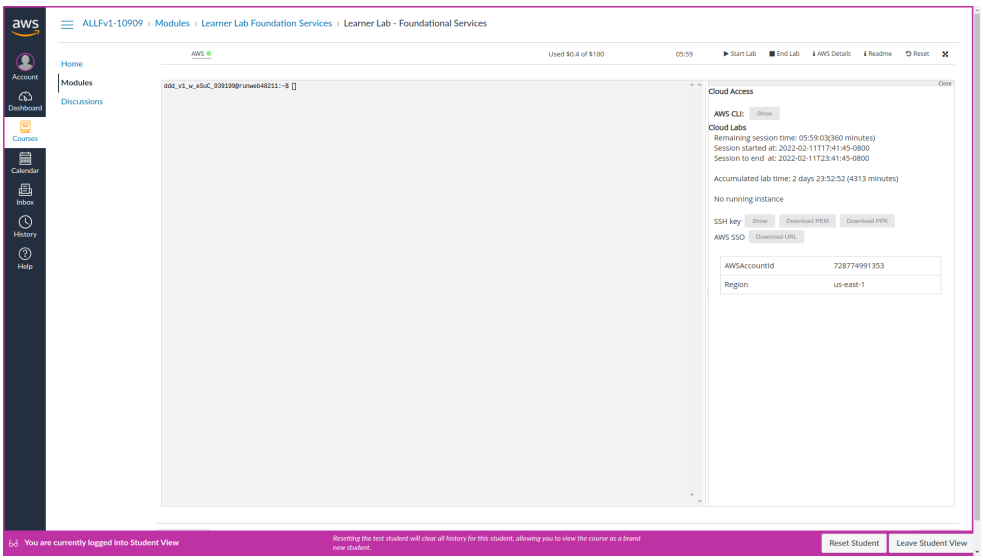
Path A Configure a single server and deploy the container.

Path B Configure a ECS cluster and deploy the container.

3 Using Terraform in AWS Learner Labs

Following the steps from the week four 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.



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

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.
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 = "~> 4.0"
        }
    }
}

provider "aws" {
    region = "us-east-1"
    shared_credentials_files = ["./credentials"]
}
```

The `terraform` block specifies the required external dependencies, here we need to use the AWS provider. The `provider` block 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 a Database in AWS

Info

This section manually deploys a Postgresql RDS instance, which is not the courses end goals but is a good way to get started with AWS. Latter this practical we will use terraform to create the database, so this section is optional and is better to be observed rather than actioned.

For the teacher

Instruct the class to observe you making the database and not to follow along.

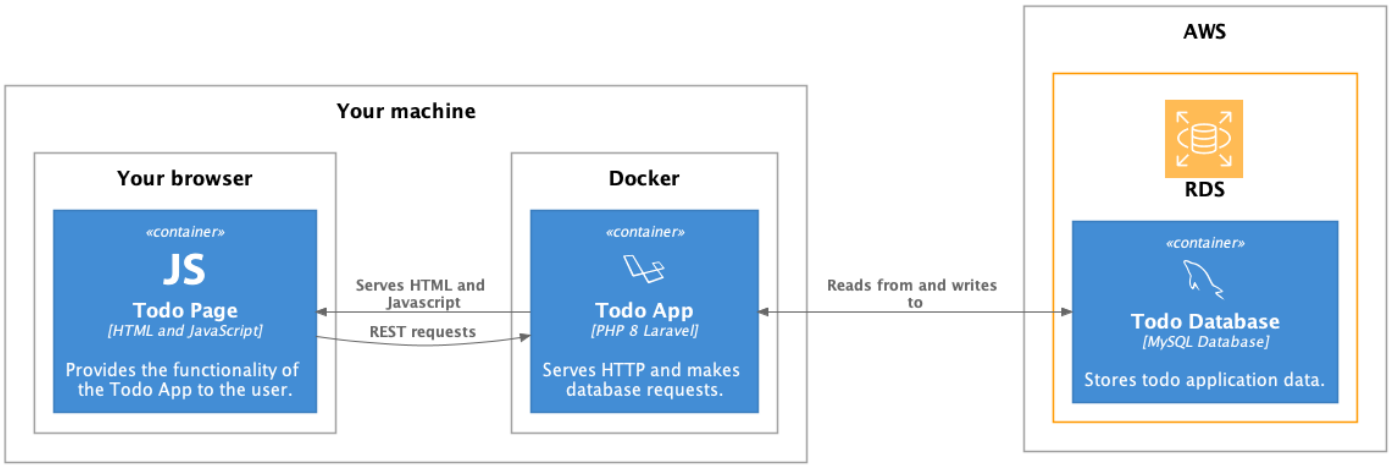


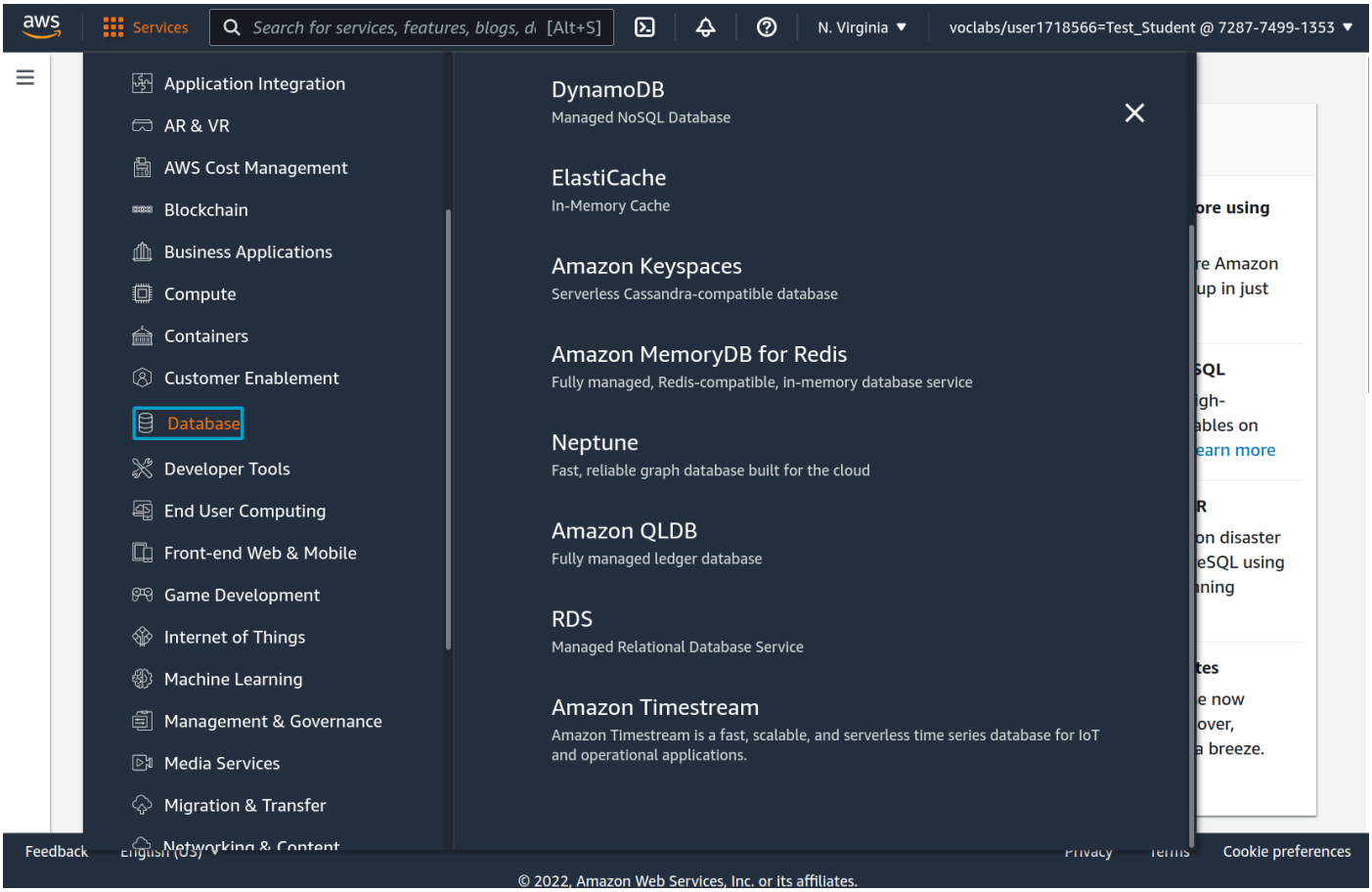
Figure 1: Remote database deployment diagram

This is the last time we will heavily use the AWS user interface in the practicals. If you already feel confident in the AWS environment skip this section and move on to the next one.

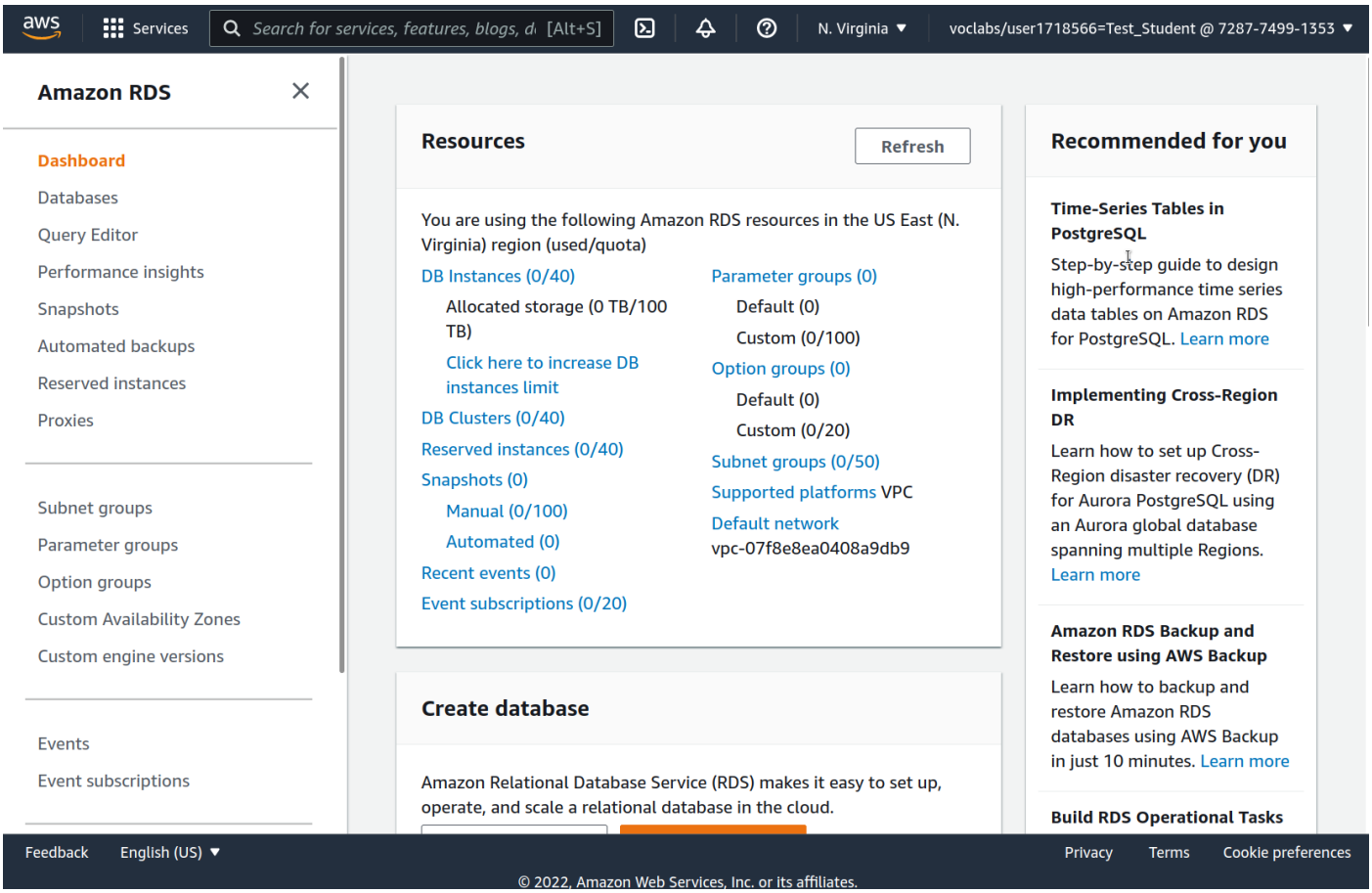
For the teacher

Give students time to start the labs, could take up to 10 minutes.

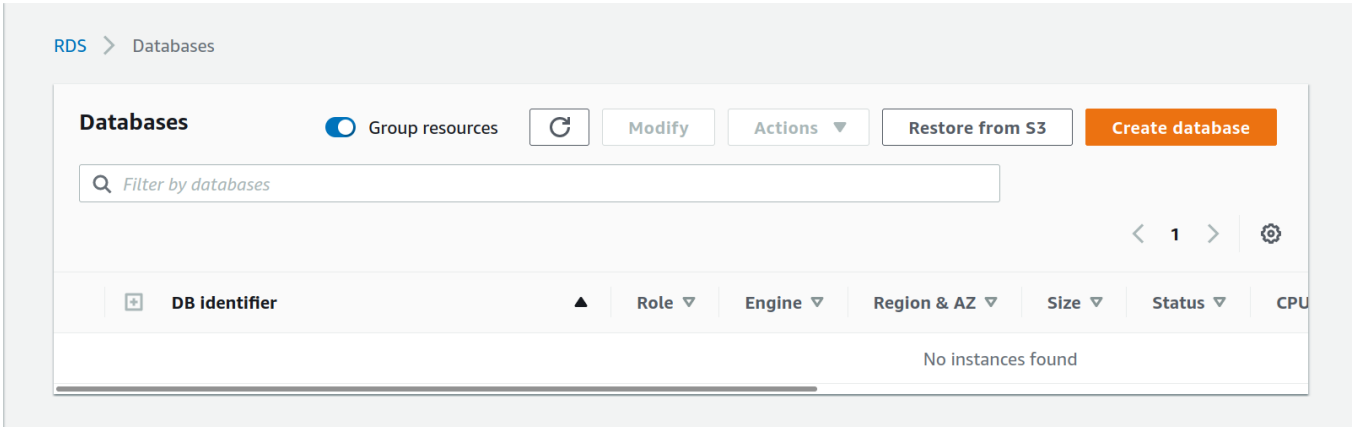
To get started let's jump into the lab environment and have a look at AWS RDS which is an AWS managed database service. To get to the RDS service either search it or browse Services -> Database -> RDS as shown below.



Now we are in the management page for all our database instances, for today we just want to get a small instance running to explore the service. Head to “DB Instances (0/40)”.



This page should appear familar as it's very similar to the AWS EC2 instance page. Let us create a new database by hitting the "Create Database" button.



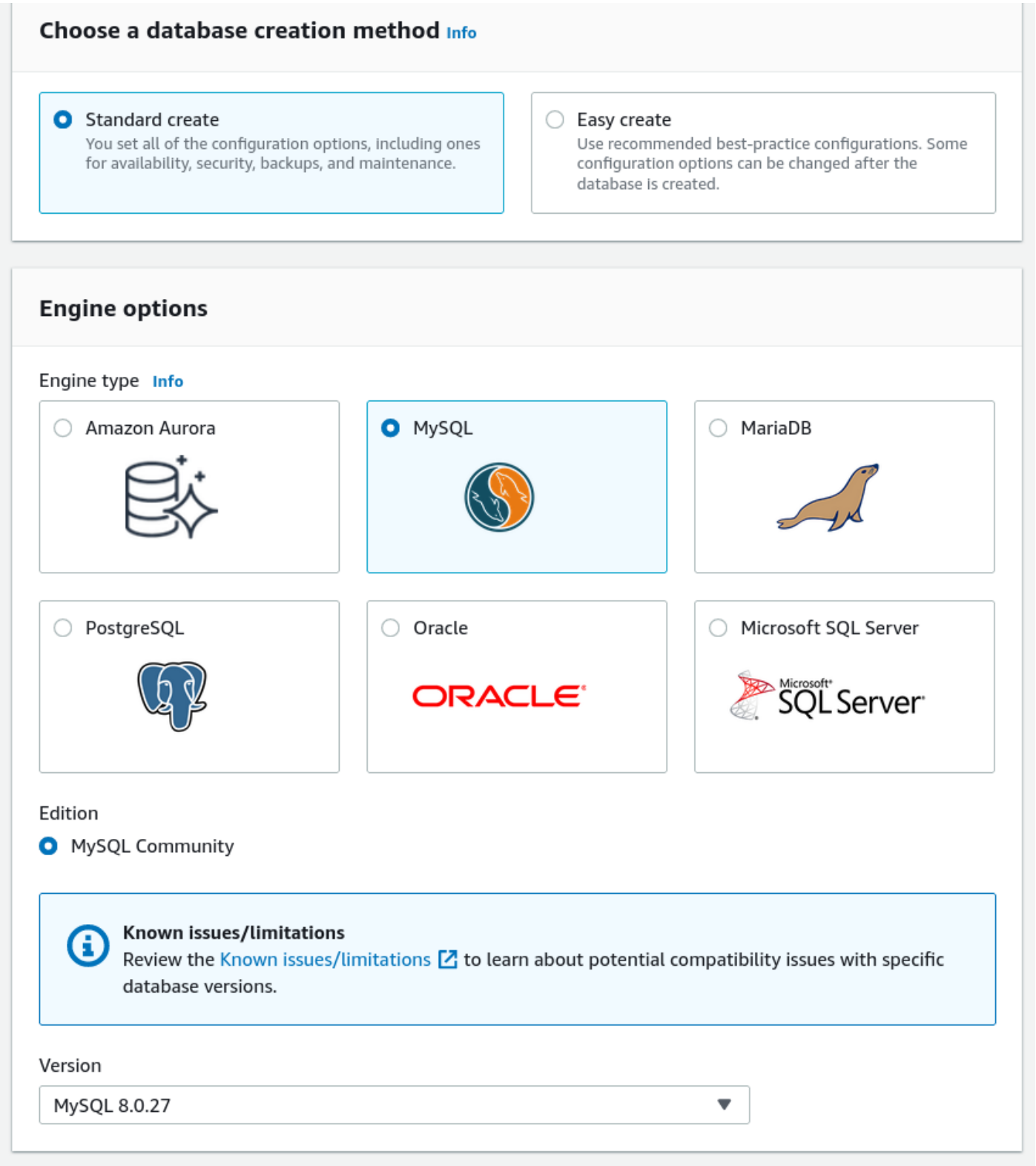
Warning

In the next section we cannot use the Easy Create method as it tries to create a IAM account which is not allowed in the labs. Going forward we would typically do this using Terraform so we can easily avoid these restrictions.

For the teacher

Feel free to talk about the other offerings here, but make sure to flame Oracle and Microsoft SQL Server. A good thing to point out is the Amazon Aurora which is the serverless version of RDS.

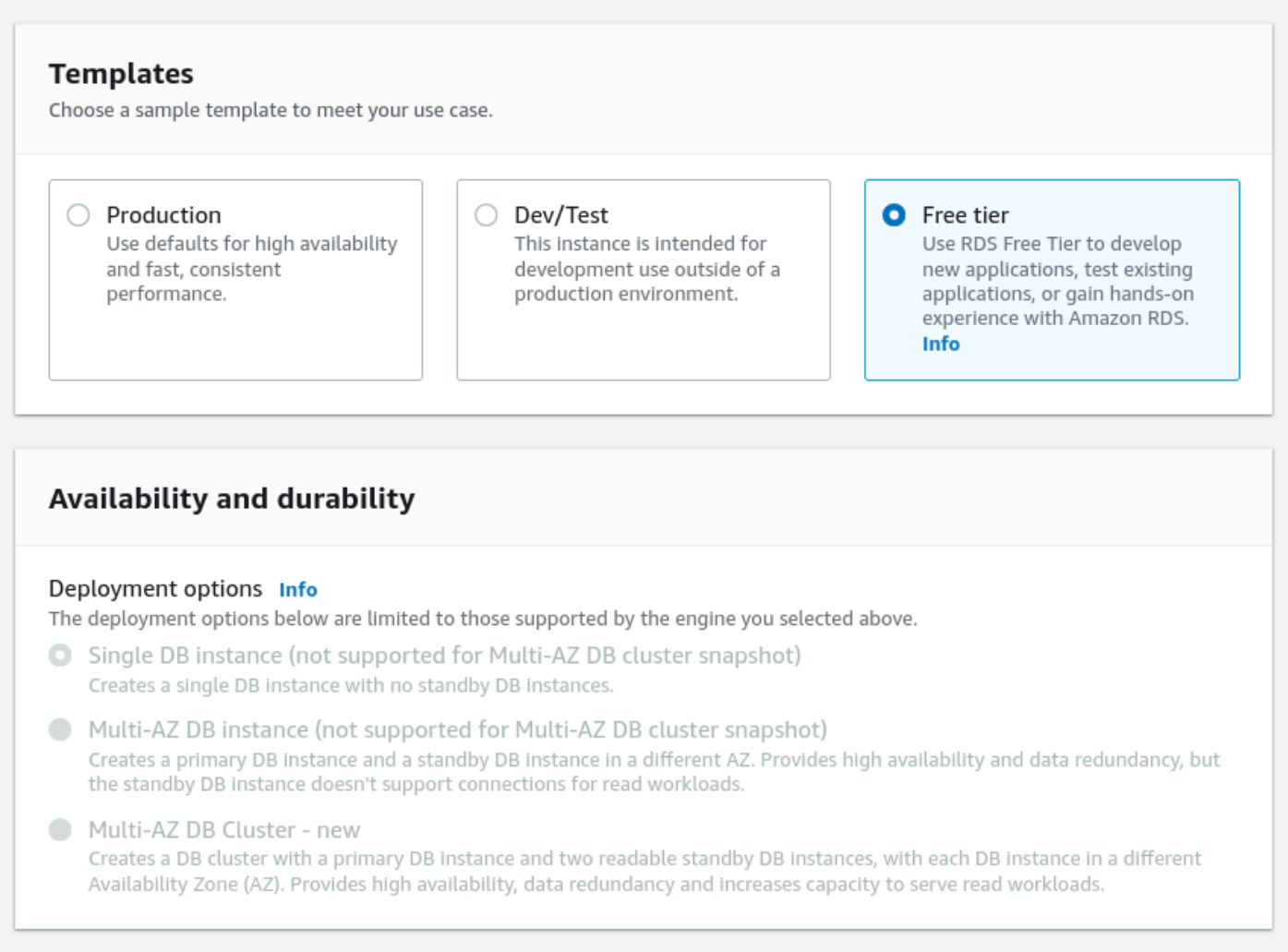
We will be creating a standard database so select standard and Postgresql. We will use version 14 which is a fairly recent release.



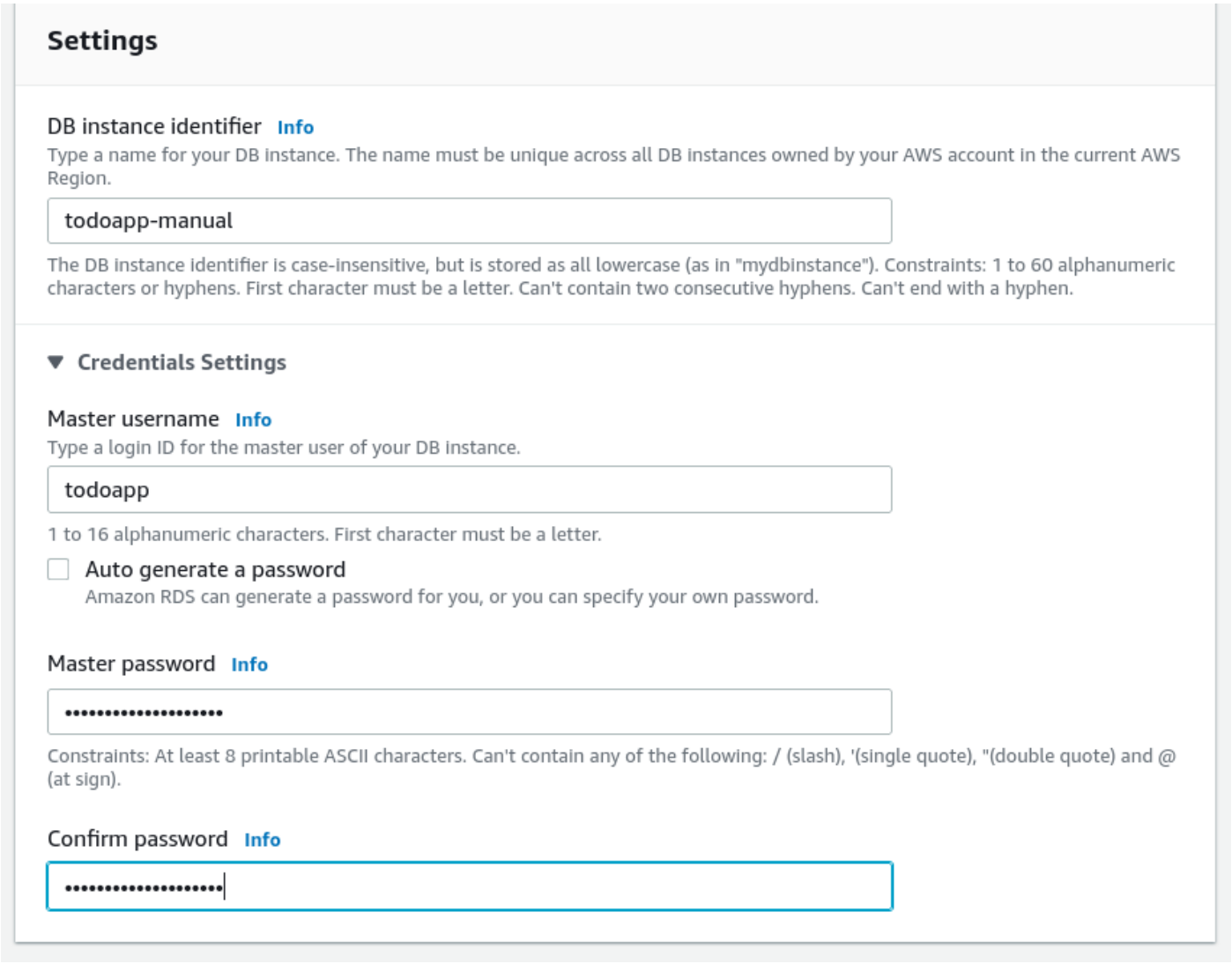
For today we are going to use “Free Tier” but in the future, you may wish to explore the different deployment options. Please peruse the available different options.

For the teacher

Walk through what Multi-AZ means aka Multiple Availability Zones.



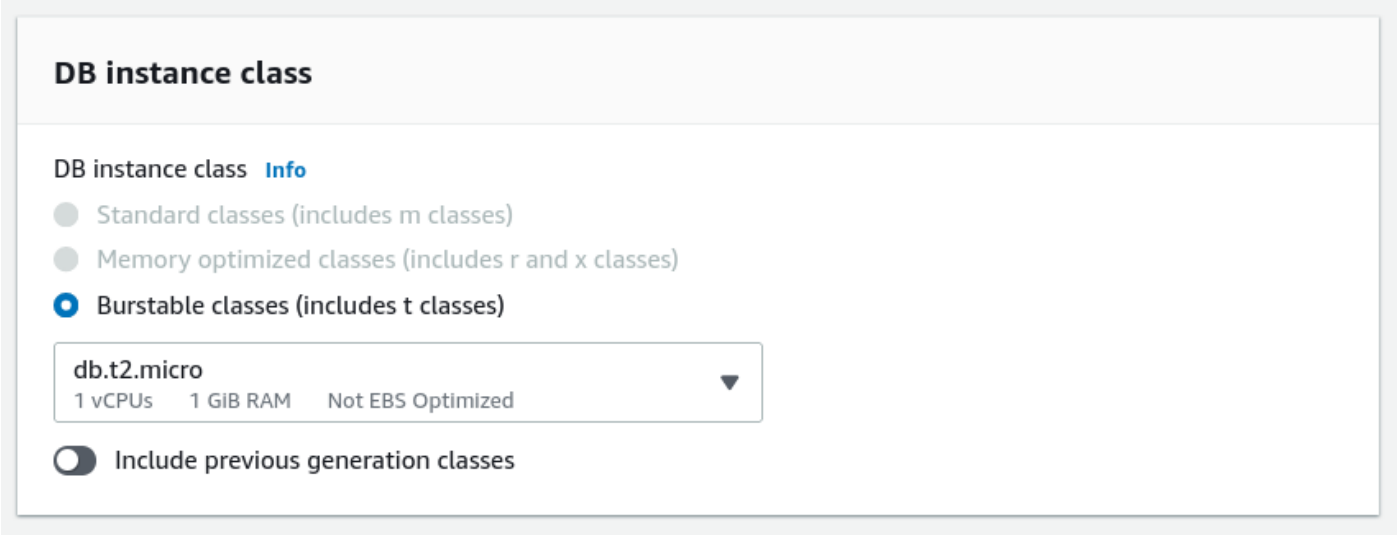
Now we need to name our database and create credentials to connect via. Here is where you can enter in credentials for the main account of the database.



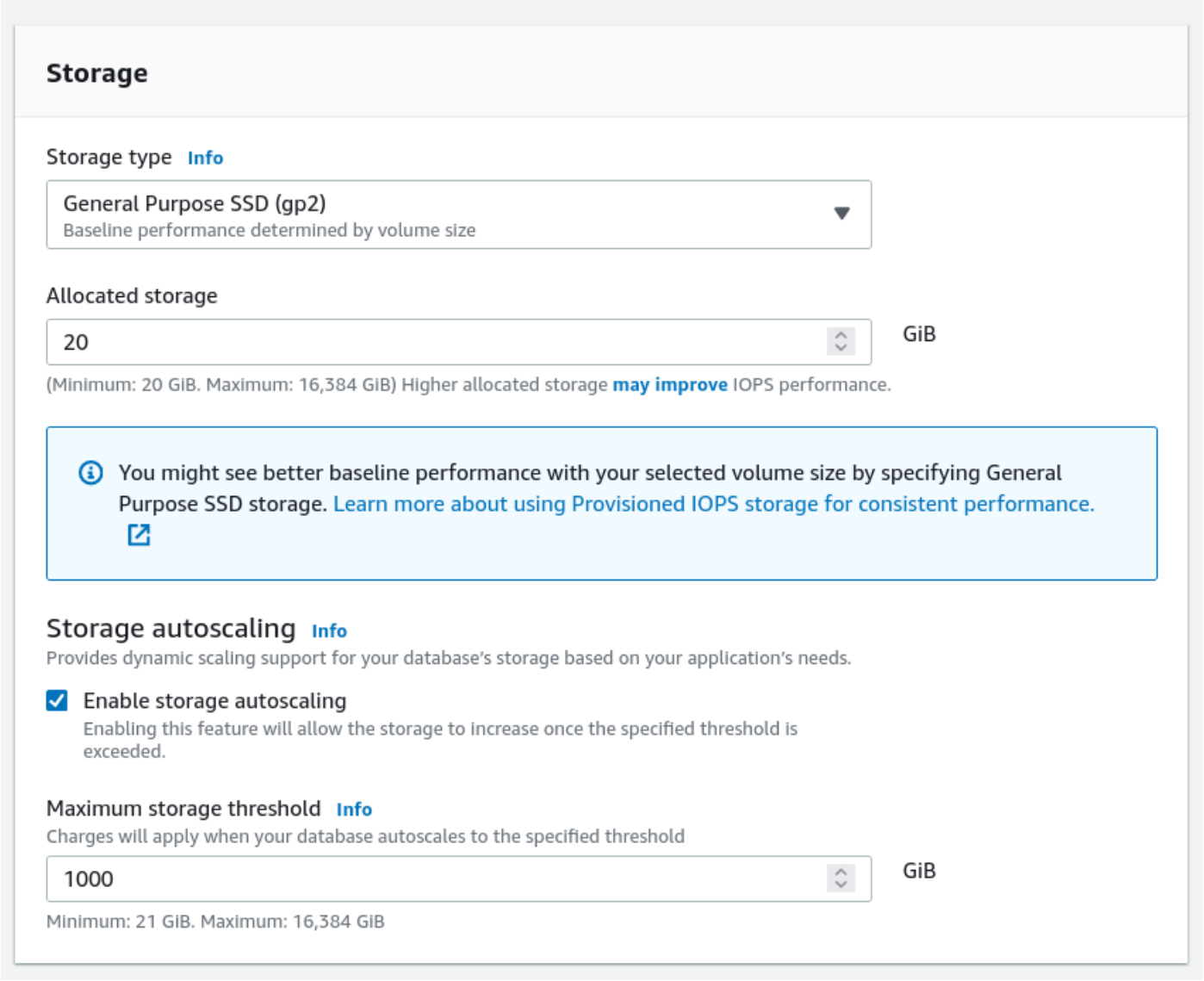
For exploring the process select t2.micro, which should be adaquite for our needs.

For the teacher

May want to mention that burstable is not recommended for consistantly used databases. Usually DBs are memory focused and thus the standard or memory optimised are used.

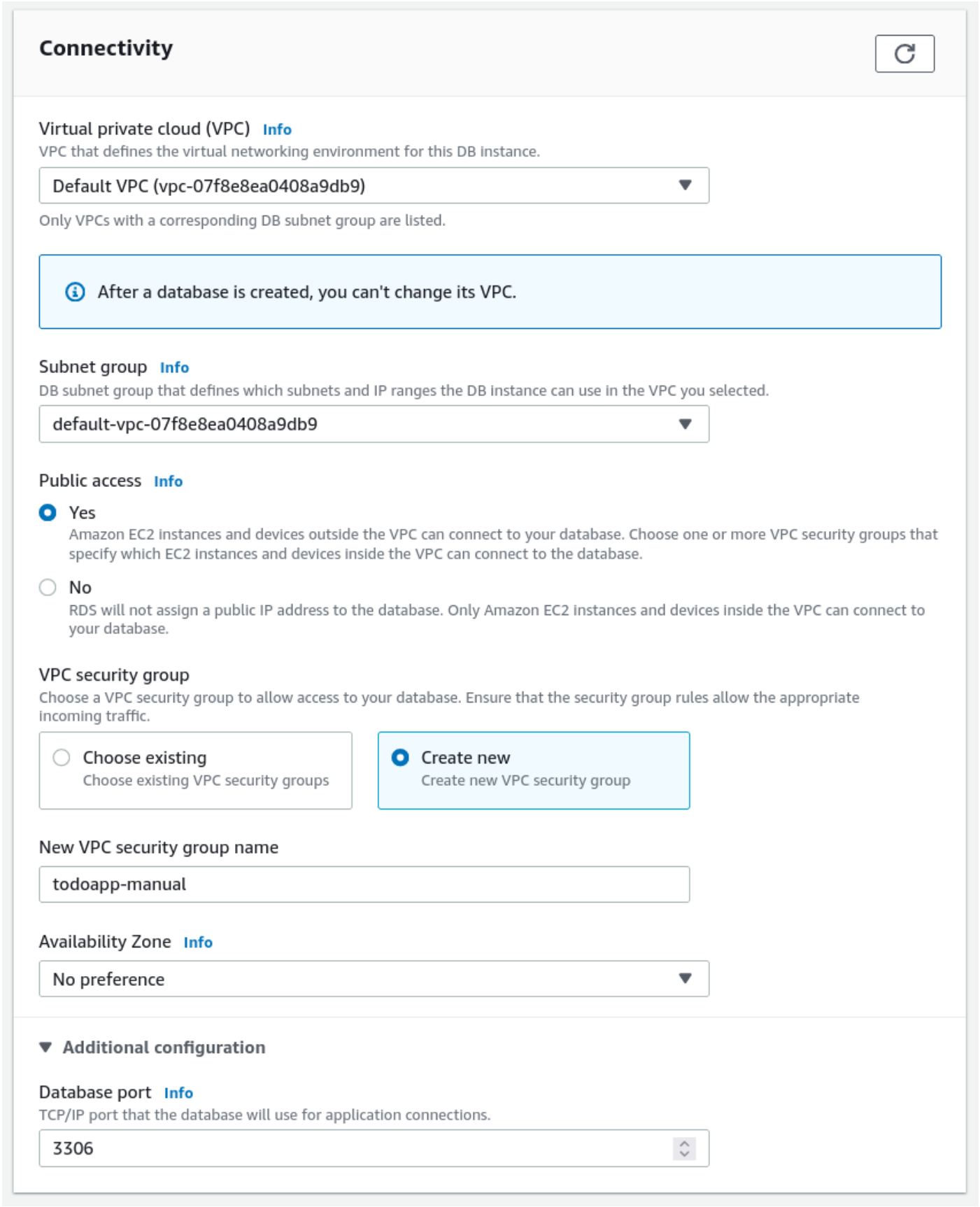


For storage we will leave all the default options.



In connectivity we need to make sure our instance is publicly available. Usually you don't want to expose your databases publicly and, would instead, have a web server sitting in-front. For our learning purposes though we are gonna expose it directly just like we did with our EC2 instances early in the course.

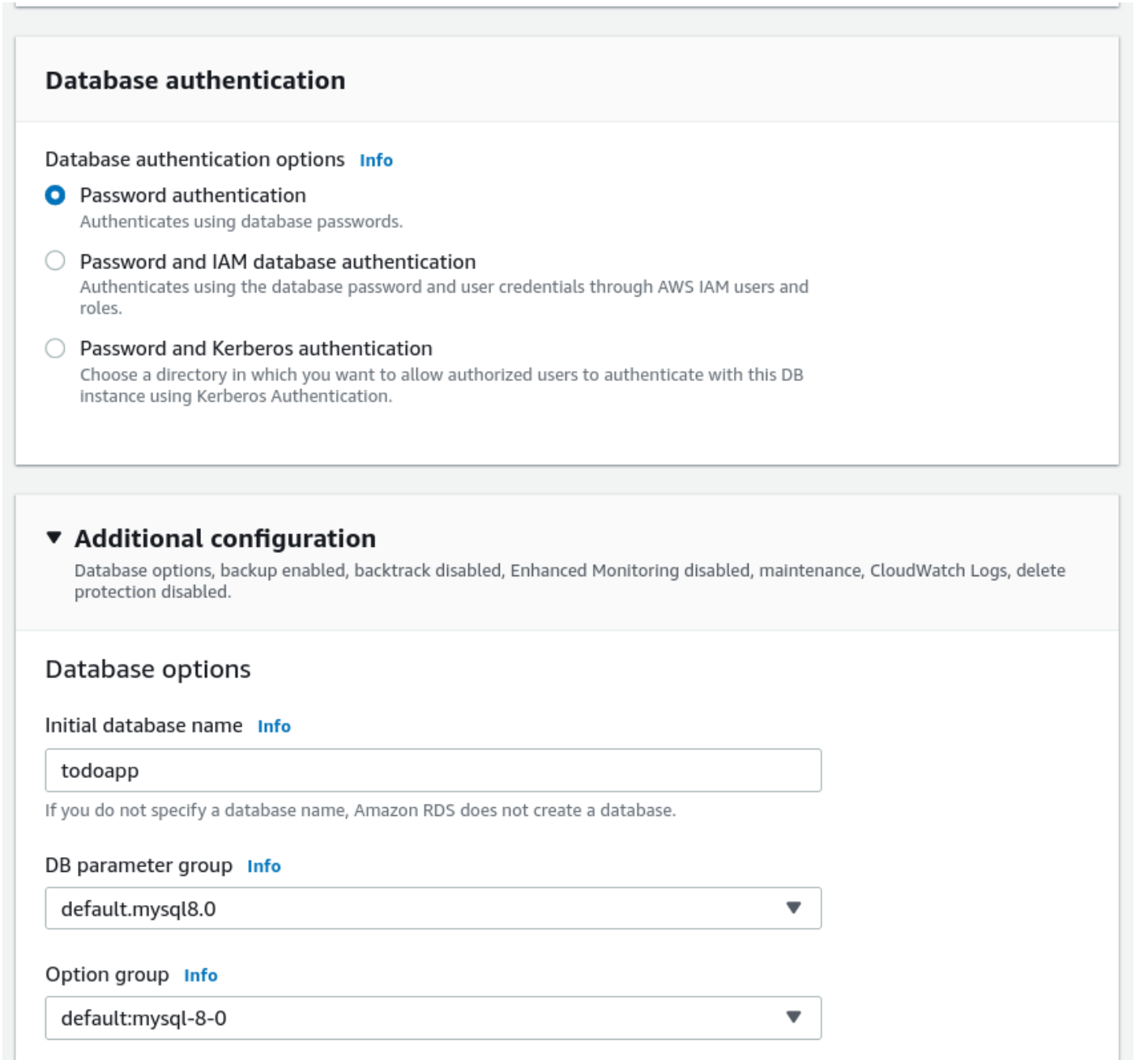
When selecting public access as yes we have to create a new Security Group, give this Security Group a sensible name.



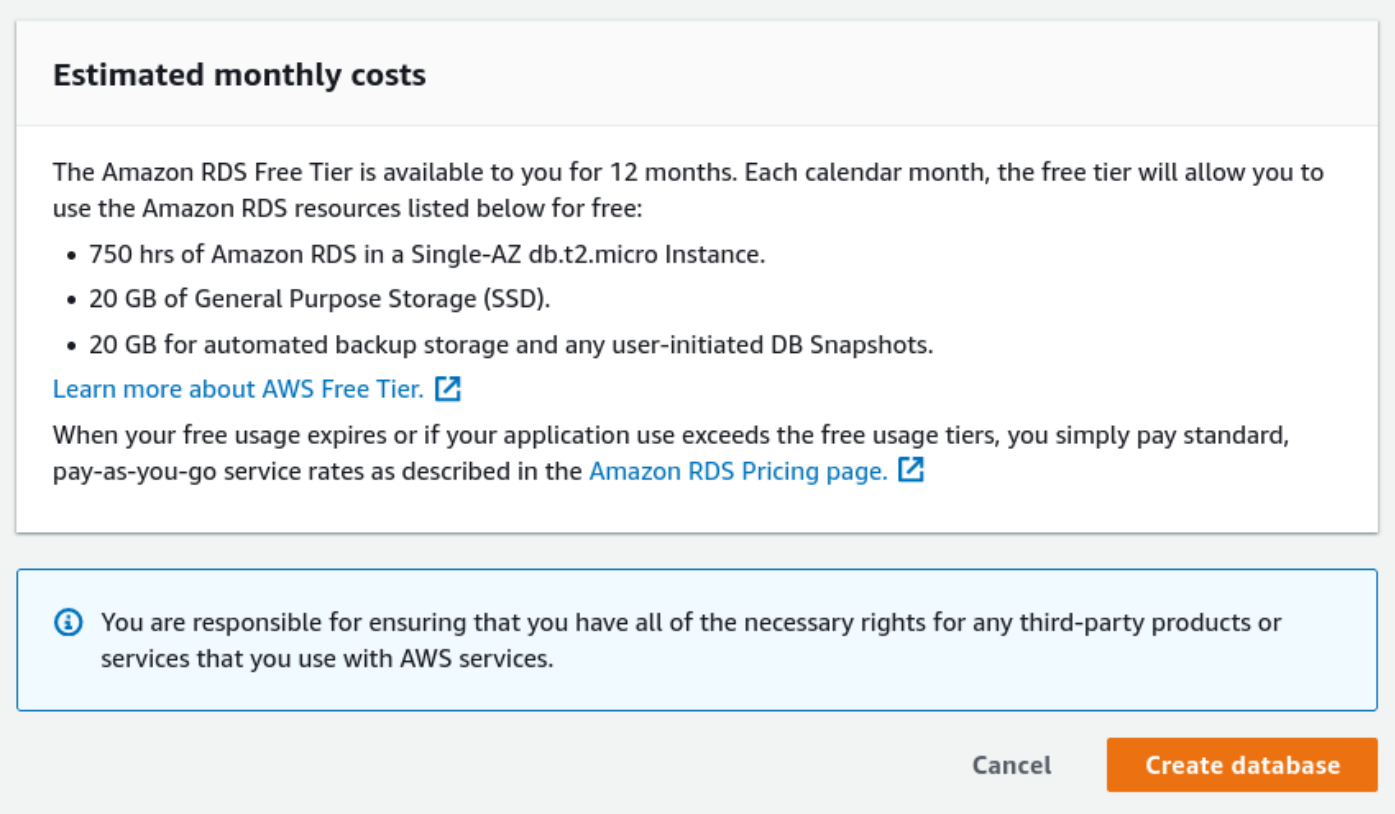
We will leave the authentication as password based but we need to expand the “Additional configuration”. Fill in the “Initial Database Name” section to be “todo”, this is similar to what we had in the Docker Composes environment variable.

For the teacher

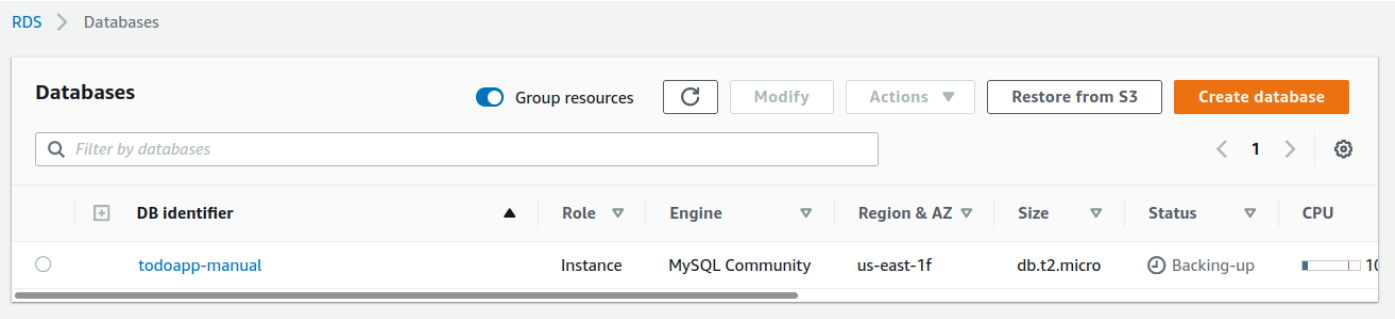
The other options here are to do with the parameters used to start the database, it is uncommon to have to change these but this is where any settings you would pass in via cli to the db would be set.



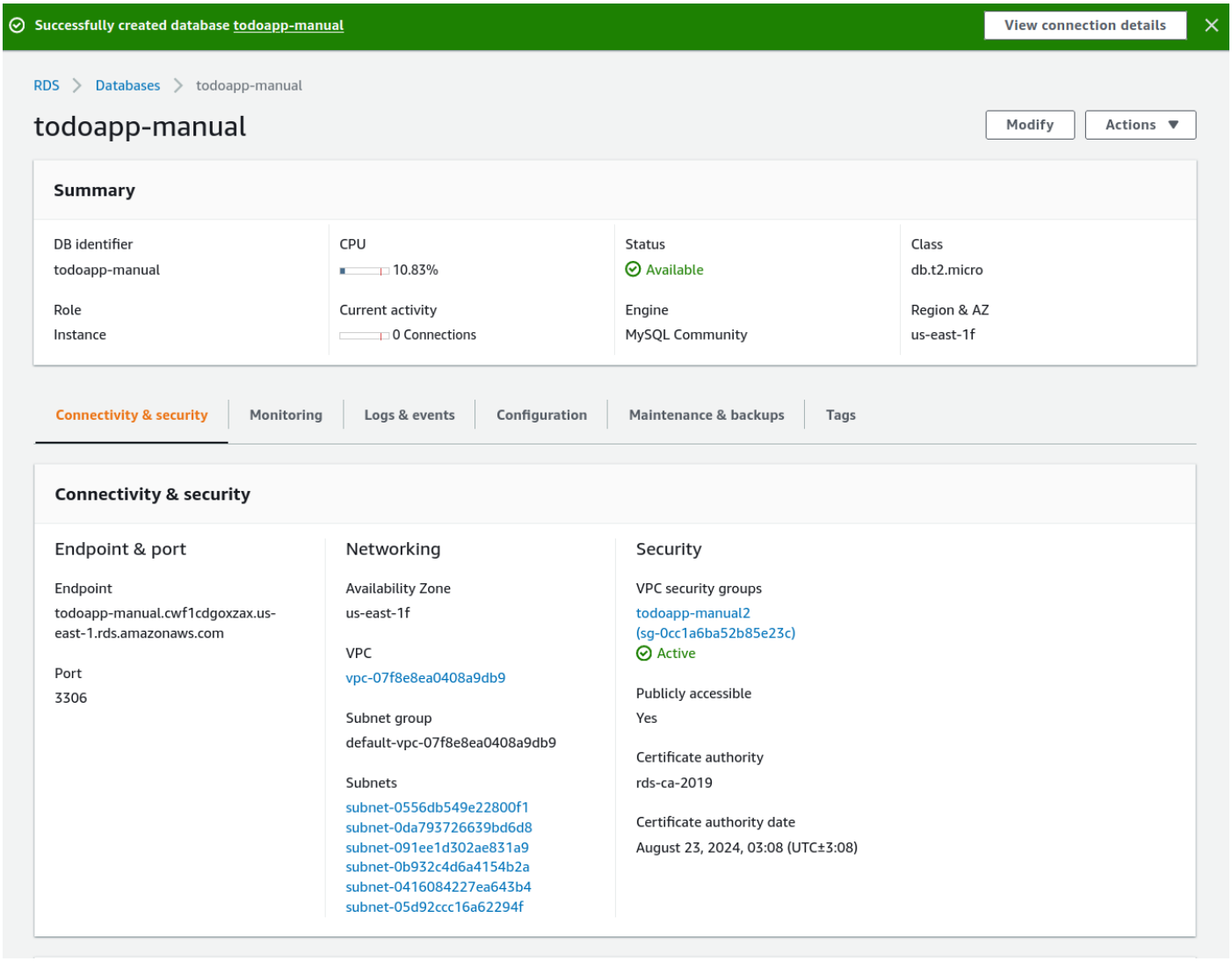
Now we can click create which will take some time.



Depending on your database it may take 10 to 30minutes to create, the larger and more complicated the setup the longer it usually takes. The database will also do a initial backup when its created.



When the database has finished being created you can select it to view the configuration and details. In this menu we also see the endpoint address which we will need to copy into our docker compose file.



5 RDS Database with Terraform

Now would be a good time to browse the documentation for the RDS database in Terraform: https://registry.terraform.io/providers/hashicorp/aws/latest/docs/resources/db_instance. Using our manual configuration, we can come up with a resource with the appropriate parameters as below:

```
   » cat main.tf
locals {
  password = "foobarbaz" # this is bad
}

resource "aws_db_instance" "todoapp-database" {
  allocated_storage = 20
  max_allocated_storage = 1000
  engine = "postgresql"
  engine_version = "14"
  instance_class = "db.t2.micro"
  name = "todo"
  username = "todo"
```

```
  password = local.password
  parameter_group_name = "default.postgresql14"
  skip_final_snapshot = true
  vpc_security_group_ids = [aws_security_group.todo-database.id]
  publicly_accessible = true

  tags = {
    Name = "todo-database"
  }
}
```

Remember to create an appropriate security group as we did through the user interface.

```
resource "aws_security_group" "todo-database" {
  name = "todo-database"
  description = "Allow inbound Postgresql traffic"

  ingress {
    from_port = 5432
    to_port = 5432
    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"]
    ipv6_cidr_blocks = ["::/0"]
  }

  tags = {
    Name = "todo-database"
  }
}
```

6 Container on AWS

As we mentioned in the Infrastructure as Code notes [1], in this course we will use Docker to configure machines and Terraform to configure infrastructure. AWS has the ability to deploy Docker containers using a service known as Elastic Container Service (ECS). We will cover ECS and deploying maunally via EC2 so you can use the method you feel most confortable with.

For this practical we have made available a docker container running the todo application which you can use to deploy to AWS. This container is available on Github under the CSSE6400 organisation `https://ghcr.io/csse6400/taskoverflow:latest`. This container is very similar to what you have been building in the practicals but contains a simple UI and some extra features for the future practicals.

6.1 Setup

All of the differnt ways that we can deploy our application we have already decided that we are gonna offload the database to AWS. This means that we can move all the "state" of our application away from our containerised environment.

To start off we are gonna use what we had above to create a database and the default terraform. Edit your files so that they match whats provided below:

6.2 [Path A] EC2

Congrats you have chosen to go down the EC2 path which builds on what we experienced in the previouse practicals.

6.2.1 Finished Terraform

```
» cat main.tf
terraform {
  required_providers {
      aws = {
          source = "hashicorp/aws"
          version = "~> 4.0"
      }
  }
}

provider "aws" {
  region = "us-east-1"
  shared_credentials_files = ["./credentials"]
  default_tags {
      tags = {
          Course = "CSSE6400"
          Name = "TaskOverflow"
          Automation = "Terraform"
      }
  }
}

locals {
  image = "ghcr.io/csse6400/taskoverflow:latest"
  database_username = "administrator"
  database_password = "VerySecurePasswordByYourBoiEvan"
}

resource "aws_db_instance" "database" {
  allocated_storage = 20
  max_allocated_storage = 1000
  engine = "postgres"
  engine_version = "14"
```

```
  instance_class = "db.t4g.micro"
  db_name = "todo"
  username = local.database_username
  password = local.database_password
  parameter_group_name = "default.postgres14"
  skip_final_snapshot = true
  vpc_security_group_ids = [aws_security_group.database.id]
  publicly_accessible = true
}

resource "aws_security_group" "database" {
  name = "todo-database"
  description = "Allow inbound Postgres traffic"

  ingress {
    from_port = 5432
    to_port = 5432
    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"]
    ipv6_cidr_blocks = ["::/0"]
  }
}

resource "aws_instance" "todo" {
  ami = "ami-005f9685cb30f234b"
  instance_type = "t2.micro"
  key_name = "vockey"

  user_data_replace_on_change = true
  user_data = <<-EOT
#!/bin/bash
yum update -y
yum install -y docker
service docker start
systemctl enable docker
usermod -a -G docker ec2-user
docker run --restart always -e SQLALCHEMY_DATABASE_URI=postgresql://${local.
    database_username}:${local.database_password}@${aws_db_instance.database.address
    }:${aws_db_instance.database.port}/${aws_db_instance.database.db_name} -p
    6400:6400 ${local.image}
  EOT

  security_groups = [aws_security_group.todo.name]
```

```
}

resource "aws_security_group" "todo" {
  name = "todo"
  description = "TaskOverflow Security Group"

  ingress {
    from_port = 6400
    to_port = 6400
    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"]
  }
}

output "url" {
  value = "http://${aws_instance.todo.public_ip}:6400/"
}
```

6.3 [Path B] ECS

Congrats you have choosen to go down the ECS path which mimics the same environment that you have via Docker Compose but as a service on AWS. This path is new for the course this year so please let your tutors know any particular issues you have.

6.3.1 Finished Terraform

```
  ➜ cat main.tf
  terraform {
    required_providers {
        aws = {
            source = "hashicorp/aws"
            version = "~> 4.0"
        }
```

```
    }
}

provider "aws" {
    region = "us-east-1"
    shared_credentials_files = ["./credentials"]
    default_tags {
        tags = {
            Course = "CSSE6400"
            Name = "TaskOverflow"
            Automation = "Terraform"
        }
    }
}

locals {
    image = "ghcr.io/csse6400/taskoverflow:latest"
    database_username = "administrator"
    database_password = "VerySecurePasswordByYourBoiEvan"
}

resource "aws_db_instance" "database" {
  allocated_storage = 20
  max_allocated_storage = 1000
  engine = "postgres"
  engine_version = "14"
  instance_class = "db.t4g.micro"
  db_name = "todo"
  username = local.database_username
  password = local.database_password
  parameter_group_name = "default.postgres14"
  skip_final_snapshot = true
  vpc_security_group_ids = [aws_security_group.database.id]
  publicly_accessible = true
}

resource "aws_security_group" "database" {
  name = "todo-database"
  description = "Allow inbound Postgres traffic"

  ingress {
    from_port = 5432
    to_port = 5432
    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"]
    ipv6_cidr_blocks = ["::/0"]
  }
}

data "aws_iam_role" "lab" {
  name = "LabRole"
}

resource "aws_ecs_cluster" "taskoverflow" {
  name = "taskoverflow"
}

resource "aws_ecs_task_definition" "todo" {
  family = "todo"
  network_mode = "awsvpc"
  requires_compatibilities = ["FARGATE"]
  cpu = 1024
  memory = 2048
  execution_role_arn = data.aws_iam_role.lab.arn

  container_definitions = <<DEFINITION
[
  {
    "image": "${local.image}",
    "cpu": 1024,
    "memory": 2048,
    "name": "todo",
    "networkMode": "awsvpc",
    "portMappings": [
      {
        "containerPort": 6400,
        "hostPort": 6400
      }
    ],
    "environment": [
      {
        "name": "SQLALCHEMY_DATABASE_URI",
        "value": "postgresql://${local.database_username}:${local.database_password}
           @${aws_db_instance.database.address}:${aws_db_instance.database.port}/${
           aws_db_instance.database.db_name}"
      }
    ],
    "logConfiguration": {
      "logDriver": "awslogs",
      "options": {
        "awslogs-group": "/taskoverflow/todo",
        "awslogs-region": "us-east-1",
        "awslogs-stream-prefix": "ecs",
```

```
        "awslogs-create-group": "true"
      }
    }
  }
]
DEFINITION
}

data "aws_vpc" "default" {
    default = true
}

data "aws_subnets" "private" {
  filter {
    name = "vpc-id"
    values = [data.aws_vpc.default.id]
  }
}

resource "aws_ecs_service" "taskoverflow" {
  name = "taskoverflow"
  cluster = aws_ecs_cluster.taskoverflow.id
  task_definition = aws_ecs_task_definition.todo.arn
  desired_count = 1
  launch_type = "FARGATE"

  network_configuration {
    subnets = data.aws_subnets.private.ids
    security_groups = [aws_security_group.todo.id]
    assign_public_ip = true
  }
}

resource "aws_security_group" "todo" {
  name = "todo"
  description = "TaskOverflow Security Group"

  ingress {
    from_port = 6400
    to_port = 6400
    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"]
  }
}
```

6.4 [Path C] EKS / K8S

This path is not available in the course yet but we recommend that if you liked the course to have a look at Kubernetes as it is widly used in industry.

References

[1] B. Webb, "Infrastructure as code," March 2022. https://csse6400.uqcloud.net/handouts/iac.pdf.