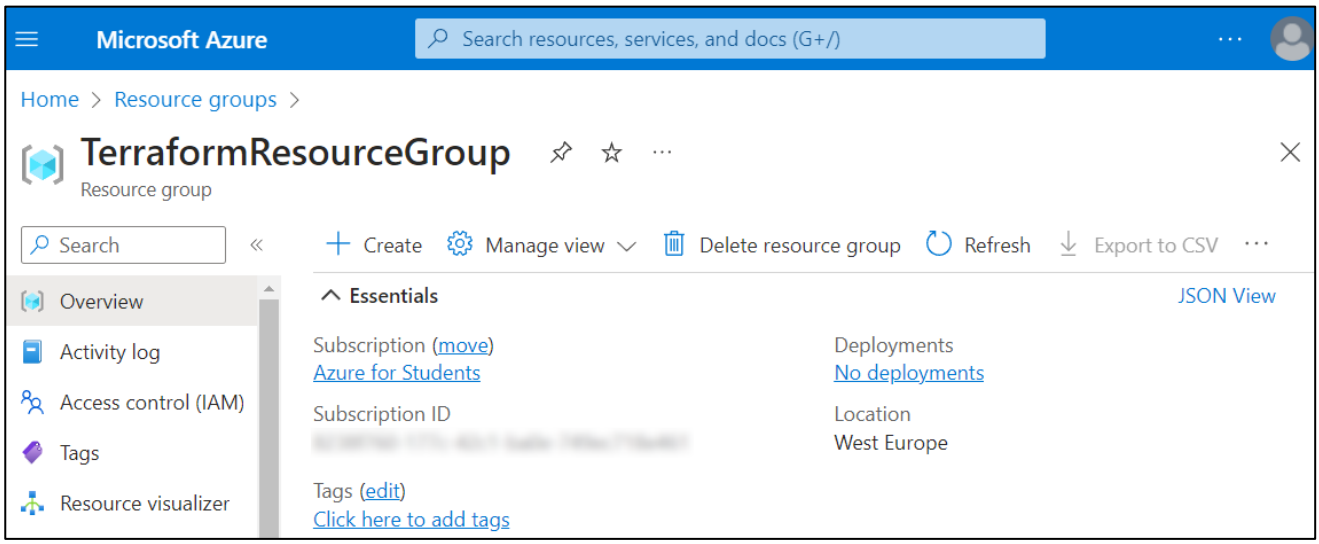
Exercise: IaC and Monitoring

Exercise assignment for the "Containers and Clouds" course @ SoftUni.

1. Azure Resource Group

Now you have a task to **create a `Terraform` configuration** to **deploy an `Azure` resource group**.

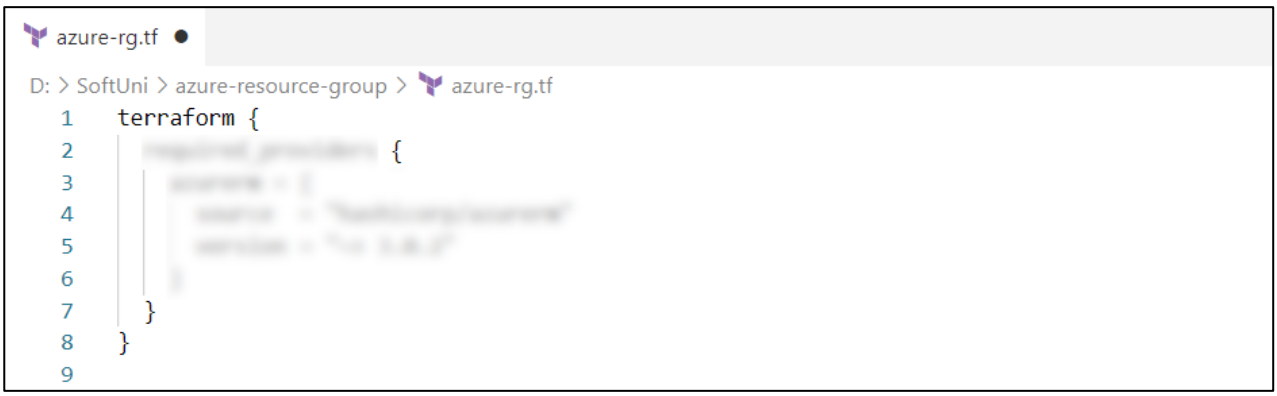


Hints

Open a **terminal** (for example PowerShell), **create a Terraform configuration folder** with an **empty configuration file** and **follow the steps below** to fulfill the task:

1. **Authenticate** using the **`Azure CLI`**, i.e. **log in to `Azure`**, as **`Terraform` must authenticate** to create infrastructure
2. **Write the configuration** for creating an **`Azure` resource group**
    - You need an **`Azure` provider**, available here: https://registry.terraform.io/providers/hashicorp/azurerm/latest
    - The **`Azure` provider** needs a **`feature {}` block** in the **configuration**
    - At the end, the **resource group** should be created using the "**`azurerm_resource_group`**" **`Terraform` resource**, whose **required arguments** can be seen here: https://registry.terraform.io/providers/hashicorp/azurerm/latest/docs/resources/resource_group

    The **configuration file** looks like shown below. The **resource group name and location** are for you to choose:



```
10  [redacted] {
11    features {}
12  }
13
14  resource [redacted] {
15    [redacted]
16    [redacted]
17  }
```

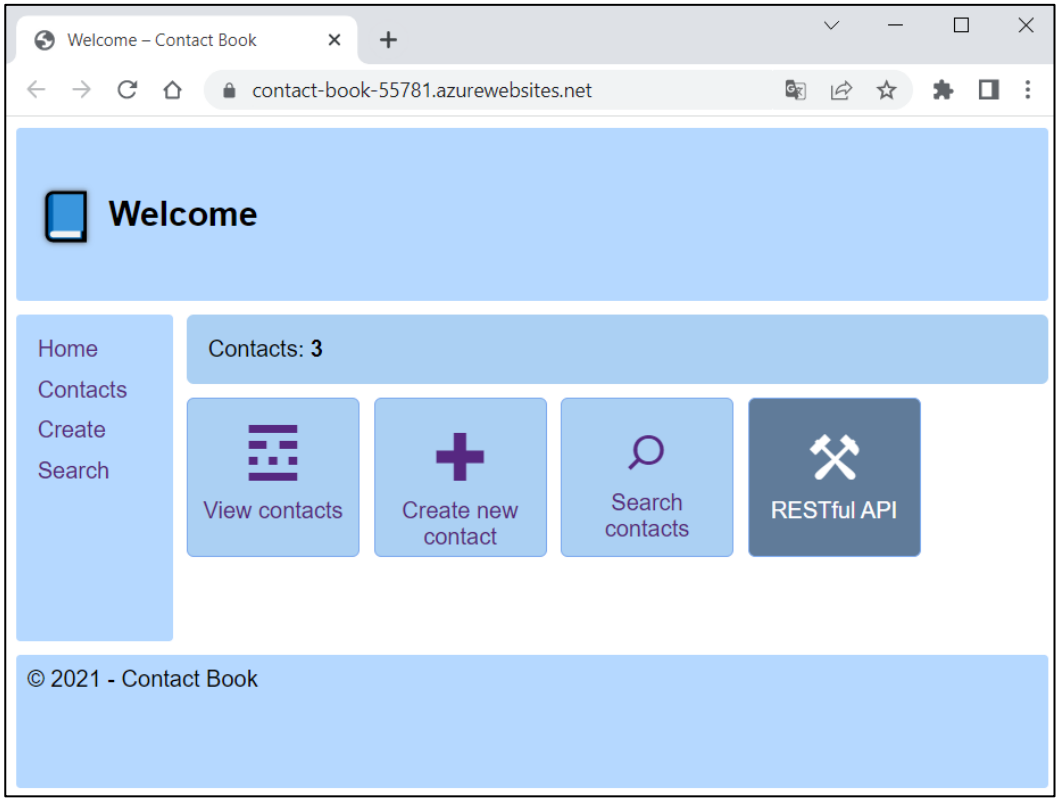
3. **Initialize**, **format**, **validate** and **apply your `Terraform` configuration**
4. **Navigate to `Azure Portal`** in the browser and validate that a **resource group was created**

Later you can **delete the resource group** from **`Azure`** again **using `Terraform`**.

As we know how to **create an `Azure` resource group with `Terraform`**, let's see how this would be **useful for us in the next task**.

2. Azure Web App

You are already **familiar with `Azure Web Apps`** and now you should **use `Terraform`** to **create a resource group**, then **create an App `Service Plan`** and finally **deploy the "`Contact` Book" app to `Azure`** from a **`GitHub` repo**.



"**`Contact` Book**" is a **Node.js app without a database**, available here: https://github.com/nakov/ContactBook.

Hints

To **fulfill your task**, you need to **create a `Terraform` configuration file**. Find the **`Terraform` resources** you need in the **`Terraform Registry`** and use them: https://registry.terraform.io.

The **configuration** you should write:

- Uses and configures an **Azure provider** (as in the previous exercise)

azure-app.tf

D: > SoftUni > azure-app-deploy > azure-app.tf

```
# Configure the Azure provider
terraform {
  required_providers {
    azurerm = {
      source  = "hashicorp/azurerm"
      version = "~> 3.0.2"
    }
  }
}

provider "azurerm" {
  features {}
}

```

- **Generates a random integer** with **minimum and maximum number range** to be used for **creating unique resource names**

```
# Generate a random integer to create a globally unique name
resource "random_integer" "ri" {
  min = 10000
  max = 99999
}

```

- Creates a **resource group**, whose name **uses the randomly-generated integer** by a **reference to the above resource**

```
# Create the resource group
resource "azurerm_resource_group" "rg" {
  name     = "ContactBookRG${random_integer.ri.result}"
  location = "West Europe"
}

```

- Creates an **App `Service Plan`** with **name**, **location** (**reference the location** from the **resource group**), **resource group name** (reference the **name of the resource group**), **operating system** (set to "**`Linux`**") and **type of SKU** (set to "**`F1`**")

```
# Create the Linux App Service Plan
resource "azurerm_app_service_plan" "appserviceplan" {
  name                = "contact-book-${random_integer.ri.result}"
  location            = azurerm_resource_group.rg.location
  resource_group_name = azurerm_resource_group.rg.name
  os_type             = "Linux"
  sku_name            = "F1"
}

```

- Creates an **`Azure` Linux Web app** with **name**, **location**, **resource group name** and the **id of the service plan** (use **references** to the above resources)

```
# Create the web app, pass in the App Service Plan ID
resource "azurerm_linux_web_app" "webapp" {
  name                = "contact-book-${random_integer.ri.result}"
  location            = azurerm_resource_group.rg.location
```

```
40
41
42
```

- In addition, you should **add site configurations** including the **app's Node.js version** and a restriction for the **app to not always be on** (as we use the **free pricing plan**)

```
43    site_config {
44      application_stack {
45        node_version = "16-lts"
46      }
47      always_on = false
48    }
49  }
50
```

- **Deploys code** from the https://github.com/nakov/ContactBook **repo**, providing the **Web app id**, the **URL of the repo** and the **main branch name**

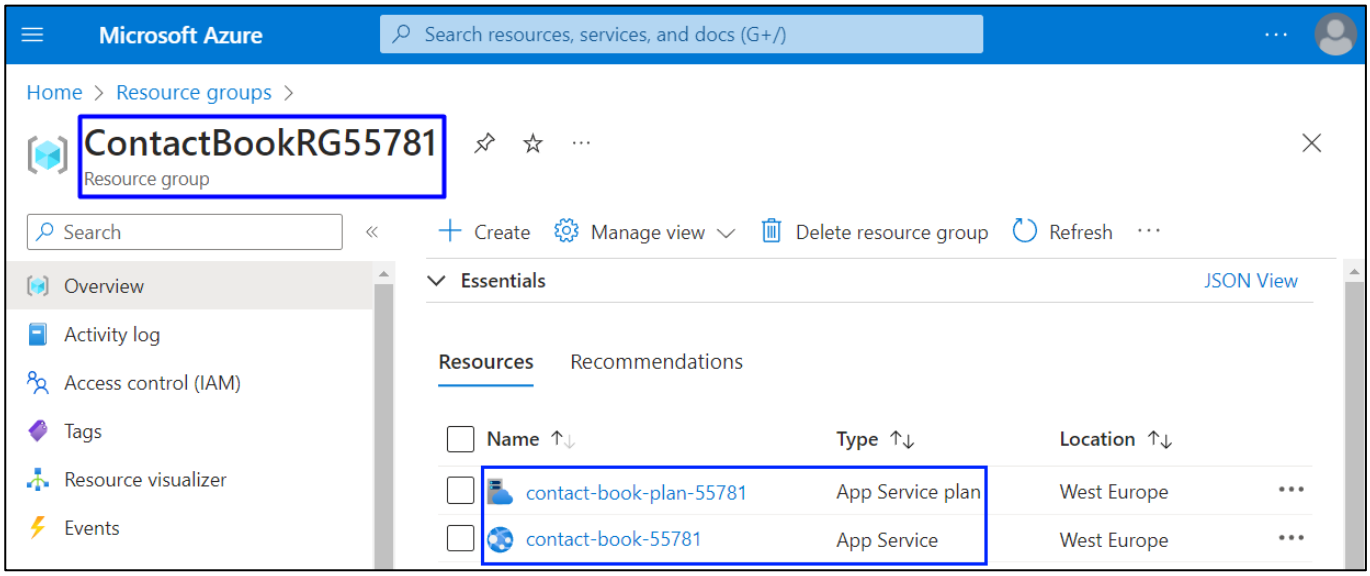
```
51  #  Deploy code from a public GitHub repo
52
53
54
55
56  use_manual_integration = true
57
```

- Moreover, we should set the **`use_manual_integration` argument** to **`true`**, so that we **agree to deploy the app and its updates manually** when we use an **external Git** (a public GitHub repo, which is not our own and we cannot run CI/CD in GitHub Actions)

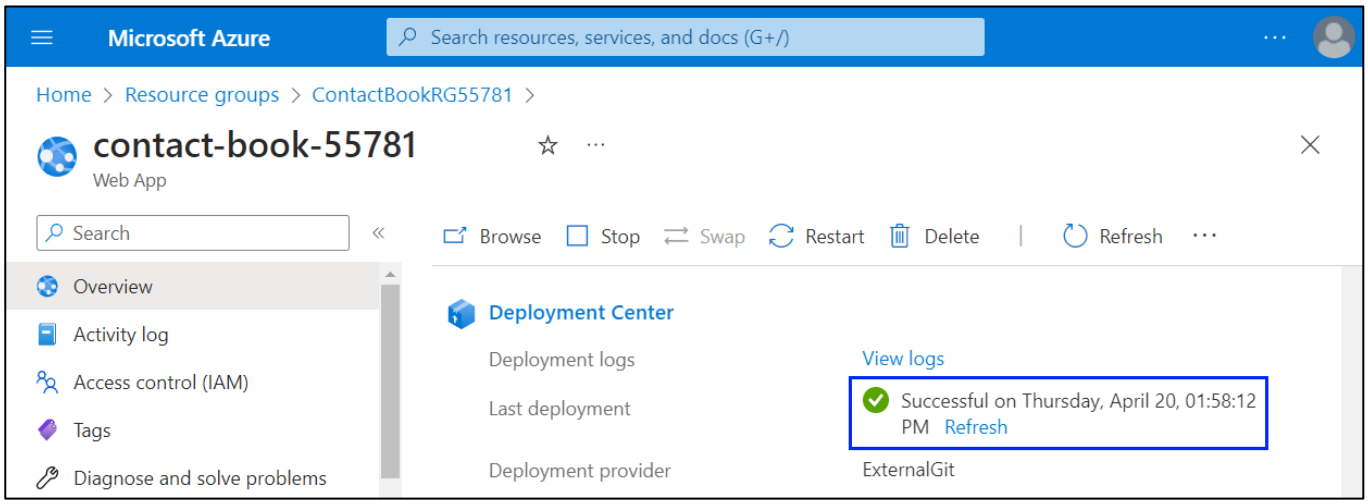
When **ready with the configuration file**, **initialize `Terraform`**, **format and validate the configuration** and **provision the resources** from the file. Know that this may **take a while**. It should be **successful** at the end:

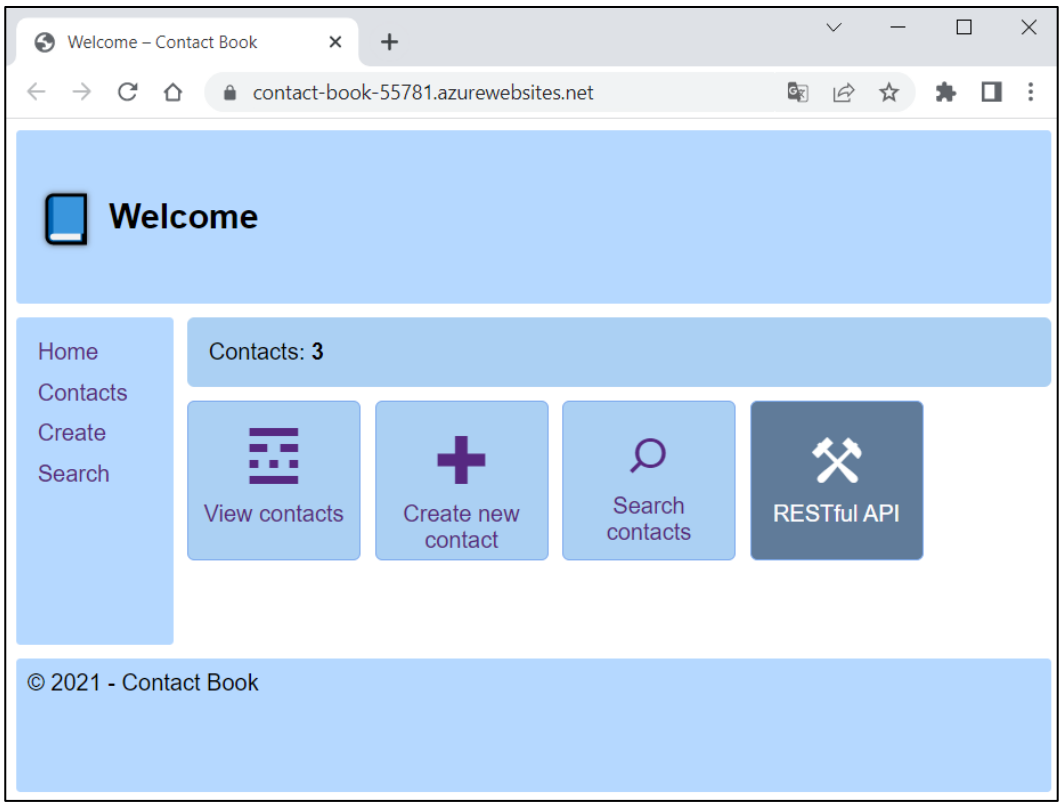
```
Apply complete! Resources: 5 added, 0 changed, 0 destroyed.
```

When **done**, make sure that you **have a resource group**, an **app service plan** and a **Web app** in **`Azure`**:



Also, make sure that the "**`Contact` Book**" **app is up and working** on the **provided domain URL** in Azure. First, however, you should **wait a bit** and make sure that the **deployment is successful**:



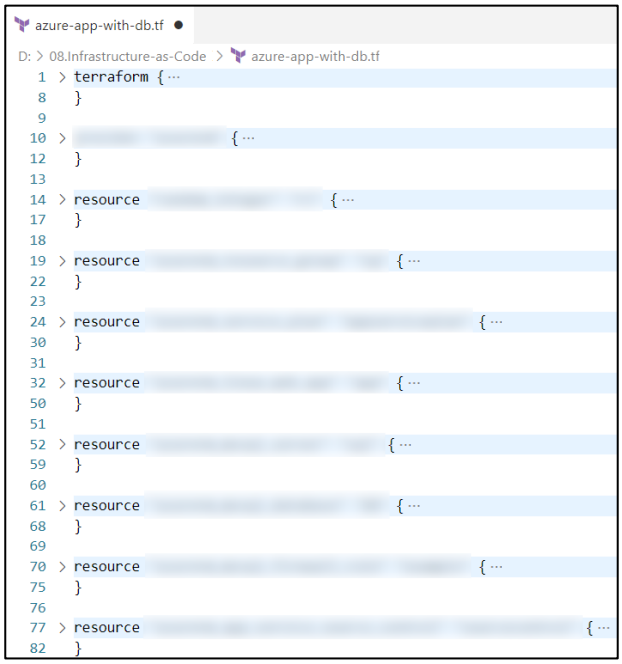


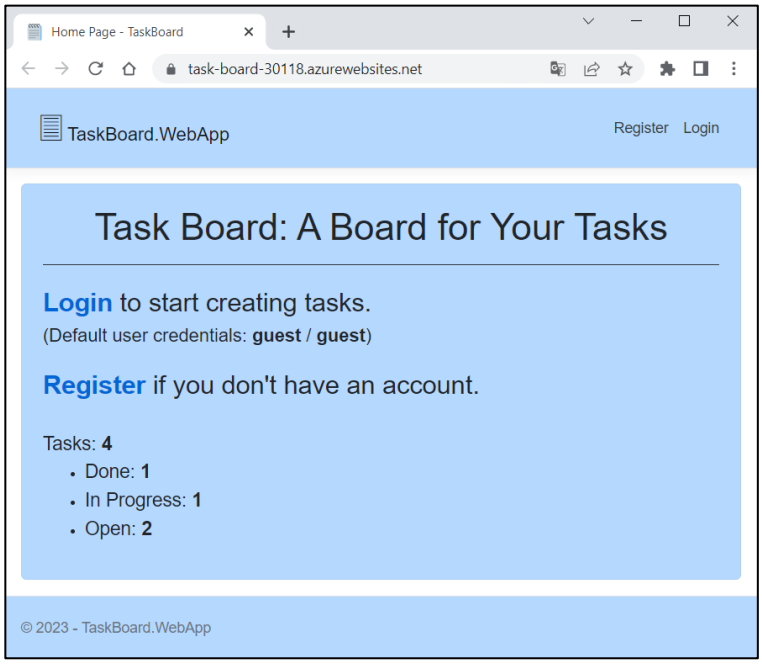
Finally, you can **destroy the created Azure resources** using the **well-known `Terraform` command**.

And this is how you can **deploy an app to Azure** with some easy steps, using **`Terraform`**.

3. Azure Web App with Database

Create a **`Terraform` configuration** to **create and deploy the "`TaskBoard`" Web app** from the **resources** to **`Azure Web Apps`**. It is an **ASP.NET Core Web app** with a **SQL Server database**, which you should **upload to a GitHub repo** before you start.





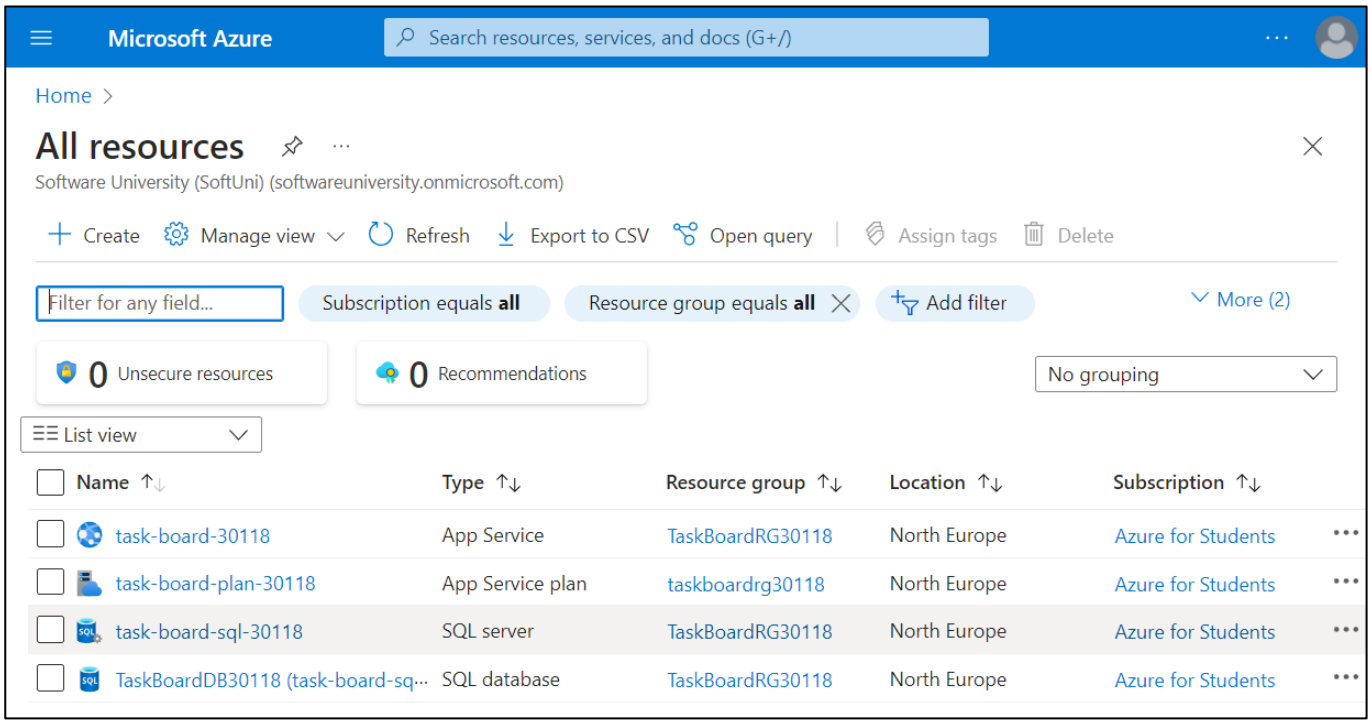
Write and Apply a Terraform Configuration

In this task, you can use the **Terraform configuration from the previous task** but you should make the following **modifications and additions**:

- Create a **server resource in Azure** with **name**, **resource group name**, **location**, **version**, **administrator username** and **administrator password** arguments
- Create a **database resource in Azure** with **name**, **server ID**, **collation**, **license type**, **SKU name** and **zone redundancy** arguments
- Create a **firewall rule for the Azure server**, which has a **name** and **server ID** and sets "**`0.0.0.0`**" as **start and end IP addresses** (this means that it allows other **Azure resources to access the server**)
- **Application stack** should be set to **`dotnet_version = "6.0"`**
- The **Linux Web app** should contain a **`connection_string` block** with:
  - Name: "**`DefaultConnection`**"
  - Type: "**`SQLAzure`**"
  - Value: "**`Data Source=tcp:${`*`fully qualified domain name of the MSSQL server`*`},1433;Initial Catalog=${`*`name of the SQL database`*`};User ID=${`*`username of the MSSQL server administrator`*`};Password=${`*`password of the MSSQL server administrator`*`};Trusted_Connection=False; MultipleActiveResultSets=True;`**"
- The **GitHub repo URL** should be changed to point out a **repo with the source code** of the "**`TaskBoard`**" **app**

Find the **Terraform resources** you need and **how to configure them** by yourself. Also, use the **random integer** you have created as a resource to **generate unique names**, as well as **resource references** where possible.

When your **configuration is written**, use the well-known **`Terraform` commands** to **apply it**. After a while, your **declared resources should be provisioned in `Azure`**:



And then, when the **app is deployed from the GitHub repo**, your **app should be up and working**.

Separate Configuration to Multiple Files

What we should do now is **separate our Terraform configuration to multiple files**, as it is **good practice** that allows **configuration modularity**, **reusability**, etc.

When done, we will have the **following files** (not necessary with the same file names):

- **`main.tf`** – the main Terraform configuration file
- **`variables.tf`** – contains variable declarations
- **`values.tfvars`** – contains values for the variables
- **`outputs.tf`** – contains outputs declarations

Let's see how to **separate our configuration**.

Step 1: Define Input Variables

You have the **configuration for provisioning and deploying a Web app with database** but it is all in one **`.tf` file** – including resource names, administrator credentials, etc. There are quite a **few hard coded values** that would make sense to have as **input parameters instead**, as this would allow us to **re-use the same template** to create multiple environments with a slightly different configuration.

In our **configuration**, we have the following **values** that can be turned into **input parameters**:

- Resource group name
- Resource group location
- App service plan name
- App service name
- SQL server name
- SQL database name
- SQL administrator login username
- SQL administrator password
- Firewall rule name

- GitHub repo URL

Create a **new `.tf` file** in the **Terraform configuration directory** and let's **define the input variables**. Each **variable** will have a **name**, **type** and **description**. In addition, it can have a **default value** that you can add if you want.

Define each variable from the above list in this way:

variables.tf

D: > SoftUni > azure-app-deploy-asp-sql > variables.tf

```
variable "resource_group_name" {
  type        = string
  description = "Resource group name in Azure"
}
```

You can go on with the **rest of the variables' definition by yourself**, following the **syntax** shown. At the end, you should have **10 variables**:

variables.tf

D: > SoftUni > azure-app-deploy-asp-sql > variables.tf

```
variable "resource_group_name" { ···
}

variable "resource_group_location" { ···
}

variable "app_service_plan_name" { ···
}

variable "app_service_name" { ···
}

variable "sql_server_name" { ···
}

variable "sql_database_name" { ···
}

variable "sql_admin_login" { ···
}

variable "sql_admin_password" { ···
}

variable "firewall_rule_name" { ···
}

variable "repo_URL" { ···
}
```

Now let's **use these variables** in the **main Terraform configuration file** we have. To do this, use the following **syntax**: **`var.{variable name}`**. Do it like this for **all input variables** you defined:

```
main.tf
D: > SoftUni > azure-app-deploy-asp-sql > main.tf
  1 > terraform {···
  8   }
  9
 10 > provider "azurerm" {···
 12   }
 13
 14   resource "azurerm_resource_group" "rg" {
 15     name     = var.resource_group_name
 16     location = var.resource_group_location
 17   }
```

In addition, you can still use the **randomly generated integer value** as **part of the resource names** or you can **remove this resource** if you don't need it. However, make sure that your **resource names are unique enough** or **errors may appear**.

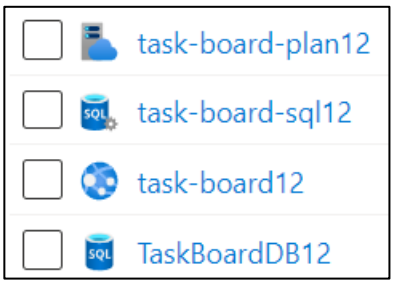
Now let's try to **apply the Terraform configuration** we have and see what will happen:

```
PS D:\SoftUni\azure-app-deploy-asp-sql> terraform apply
var.app_service_name
  App Service name in Azure

  Enter a value: _
```

As you can see, you are **prompted to enter an app service name** for the **app_service_name input variable**. You should **add values for all variables** and then they will be **used in your configuration**. All of them are **required** as we didn't put default values.

```
PS D:\SoftUni\azure-app-deploy-asp-sql> terraform apply
var.app_service_name
  App Service name in Azure

  Enter a value: task-board12

var.app_service_plan_name
  App Service Plan name in Azure

  Enter a value: task-board-plan12

...
var.sql_database_name
  SQL Database name in Azure

  Enter a value: TaskBoardDB12

var.sql_server_name
  SQL Server instance name in Azure

  Enter a value: task-board-sql12
```

→



Now we have **input variables for our configuration**, which is nice. However, if we run **`terraform destroy`**, we should **enter the same values again**, which is not pleasant.

Step 2: Create File with Variable Values

If we **don't want to enter values for the input variables**, we can **create a file** for them. Create a **file** with the **`.tfvars` extension** and **add value for each variable** using this syntax: **`{variable name} = "{variable value}"`**.

values.tfvars

```
resource_group_name      = "TaskBoardRG12"
resource_group_location  = "North Europe"
app_service_plan_name    = "task-board-plan12"
app_service_name         = "task-board12"
sql_server_name          = "task-board-sql12"
sql_database_name        = "TaskBoardDB12"
sql_admin_login          = "user01"
sql_admin_password       = "@Aa123456789!"
firewall_rule_name       = "TaskBoardFirewallRule12"
repo_URL                 = "https://github.com/
```

Now we can **apply our configuration** again, using the **`.tfvars` file** we created:

```
PS D:\SoftUni\azure-app-deploy-asp-sql> terraform apply -var-file="values.tfvars"
```

The **file should be found** and **values used** – you should **not be prompted** to add any value manually.

Step 3: Define Outputs

At the end, we can **add outputs** that will **print us the URL of the Azure Web app** that will be created and its **outbound IP addresses**. **Outputs** are basically just pieces **state information** that you want to have available for different purposes.

You should create **a new `.tf` file** and **define the outputs** with **name** and **value** using the following syntax:

outputs.tf

```
output "webapp_url" {
  value = azurerm_linux_web_app.app.default_hostname
}

output "webapp_ips" {
  value = azurerm_linux_web_app.app.outbound_ip_addresses
}
```

When you **apply the configuration**, the **values of the outputs** should be **printed in the terminal**:

```
PS D:\SoftUni\azure-app-deploy-asp-sql> terraform apply -var-file="values.tfvars"
...
Plan: 7 to add, 0 to change, 0 to destroy.

Changes to Outputs:
  + webapp_ips = (known after apply)
  + webapp_url = (known after apply)

Do you want to perform these actions?

...
Apply complete! Resources: 7 added, 0 changed, 0 destroyed.

Outputs:

webapp_ips = "4.231.131.239,4.231.131.181,4.231.132.10,4.231.132.14,4.231.132.30,
4.231.132.34,20.107.224.7"
webapp_url = "task-board12.azurewebsites.net"
```

After all this separation of the **Terraform configuration to files**, it should still be **working** and **provision the resources in Azure** successfully.

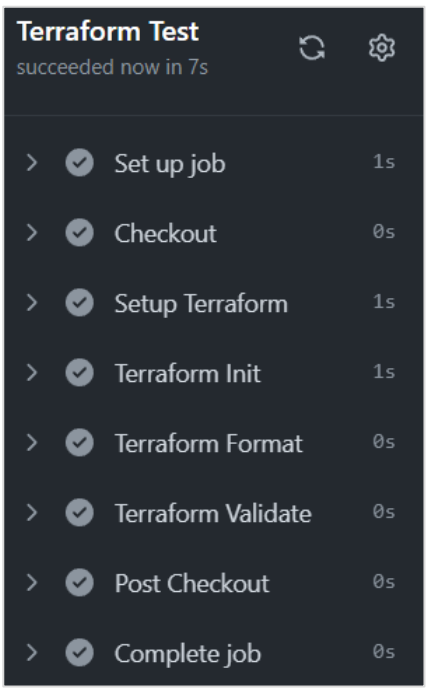
Now your **configuration follows good practices**. However, in the **next task** we will see how to **improve it** even more.

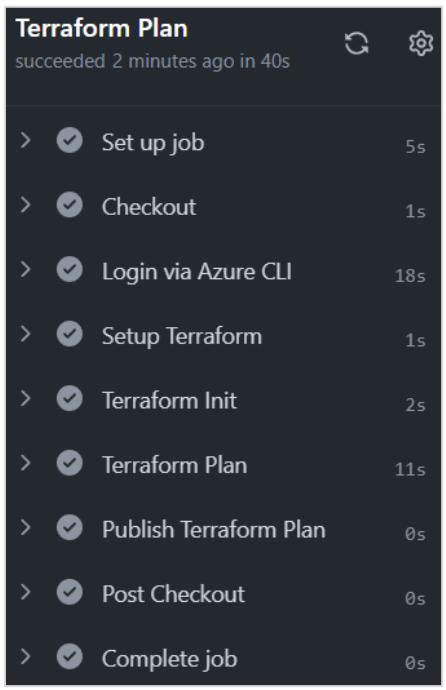
4. Terraform with CI/CD

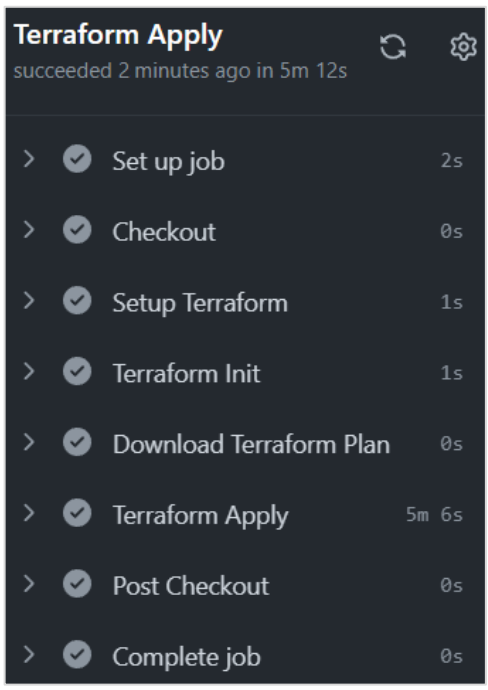
Now we will **upload the Terraform configuration from** the **previous task** (for provisioning **Azure resources** and **deploying the "TaskBoard" Web app** to Azure Web Apps) **to GitHub** and will use **GitHub Actions workflows** to **test and run the configuration**.

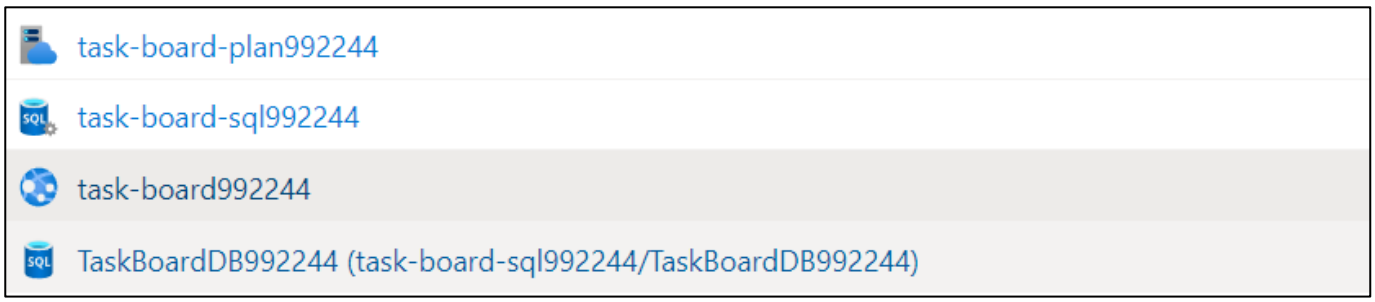
By combining **Terraform with GitHub Actions**, we can **automate the infrastructure provisioning process**, **ensure consistency**, and **integrate it into your CI/CD workflows**, promoting **efficient software delivery** and **reducing manual tasks**. It provides a streamlined and efficient **workflow for managing infrastructure as code**, making it easier to **maintain**, **test**, and **deploy your infrastructure resources**.

We will have **GitHub Actions workflows** that will provision the **Azure resources** we want:

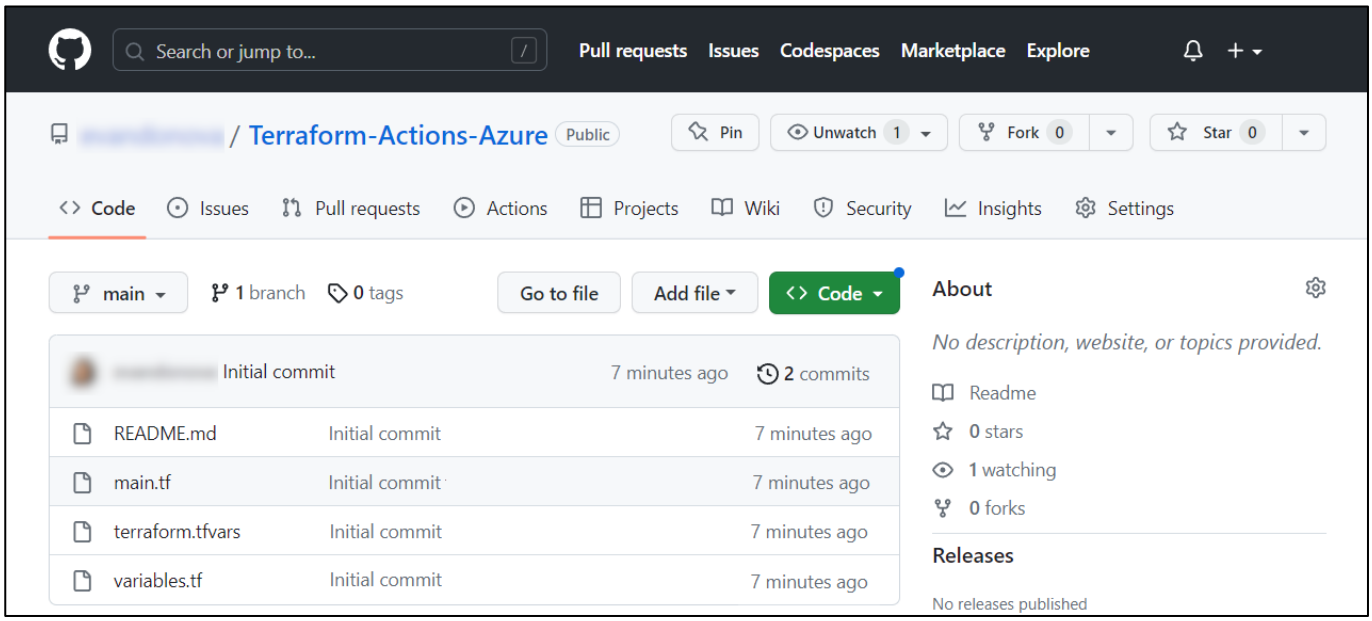








Start by creating a **GitHub repository**, which should contain your **`main.tf` Terraform configuration file** and your additional **Terraform files** – **`terraform.tfvars`** and **`variables.tf`**:



Note: when the **`.tfvars` file** with **variable values** is **named** "**`terraform`**", **Terraform finds it on its own** and you **should not point to it specifically** in the **Terraform commands you run**.

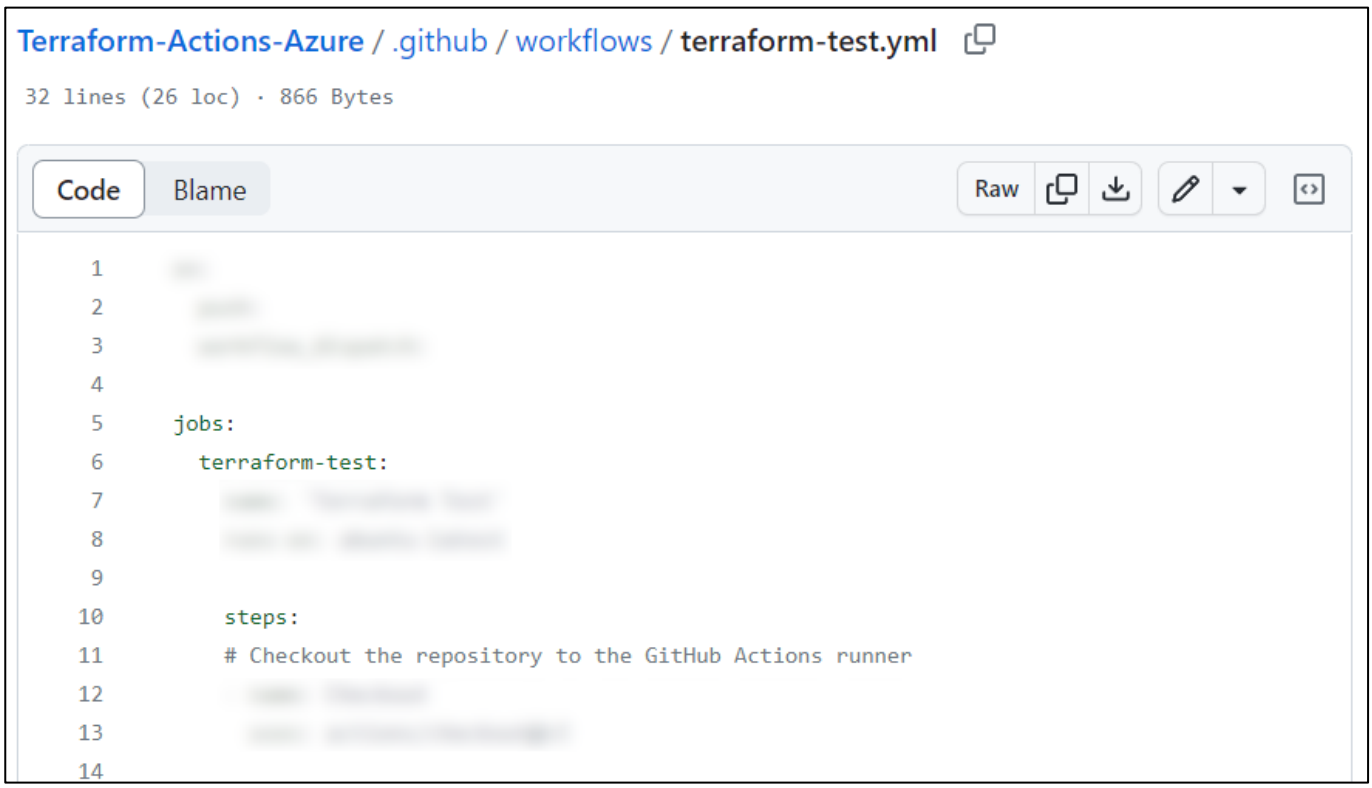
Also, you **don't need the `outputs.tf` file**, as you can use GitHub Actions to show you what you need when a workflow is run.

Now let's see how to write the **GitHub Actions workflows** we need.

Test Workflow

We will first write a **test workflow in GitHub Actions** that will try to **initialize the working directory**, **check if the configuration files are correctly formatted** and **validate the configuration**.

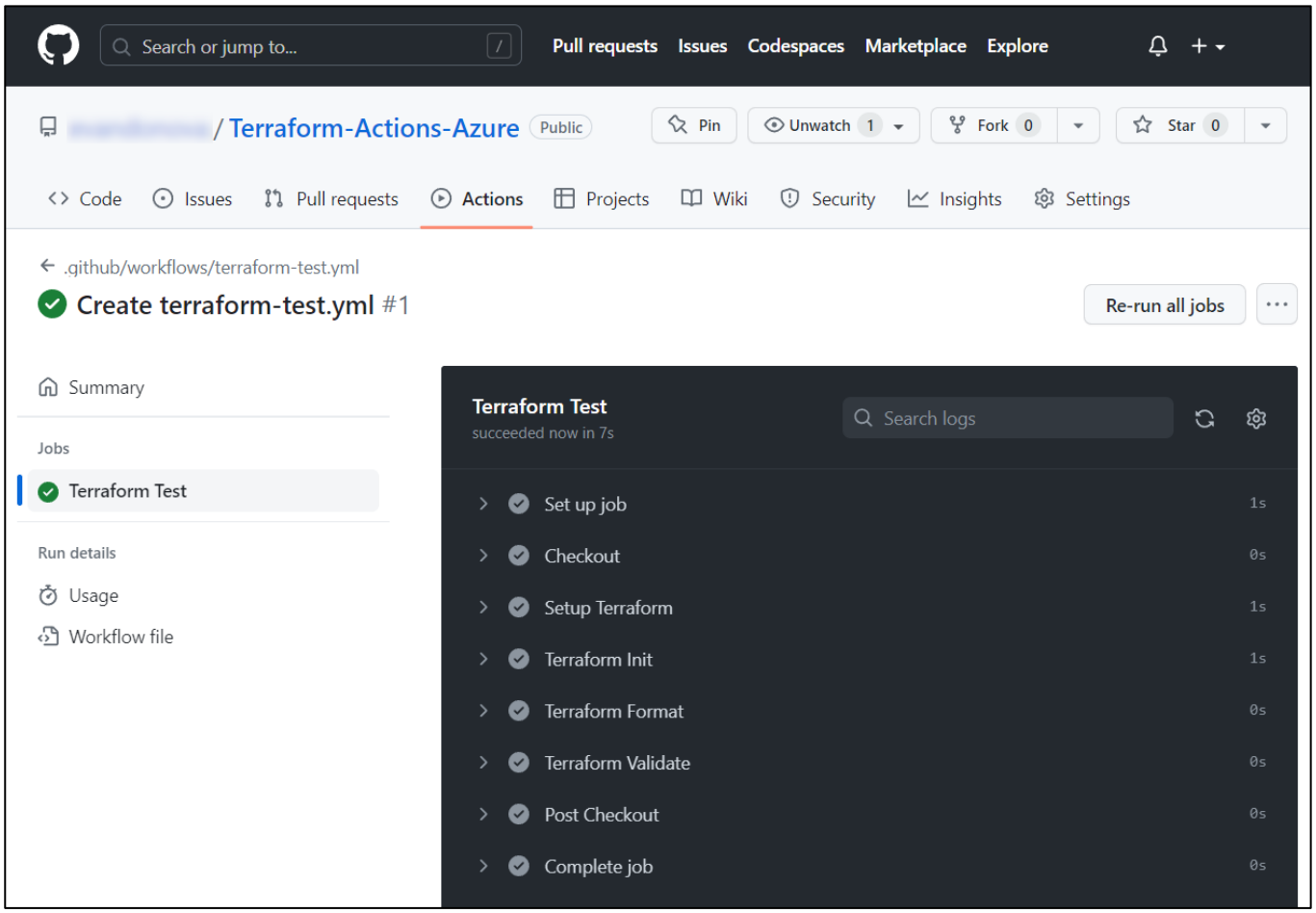
Create a **YAML file** in **GitHub Actions**. The **workflow** should look like this:



```
15        # Install the latest version of the Terraform CLI
16        - name: Setup Terraform
17          uses: hashicorp/setup-terraform@v1
18          with:
19            terraform_wrapper: false
20
21        # Initialize a new or existing Terraform working directory
22        # Creating initial files, loading any remote state, downloading modules, etc.
23        - name: Terraform Init
24          run: terraform init
25
26        # Checks that all Terraform configuration files adhere to a canonical format
27        - name: Terraform Format
28          run: terraform fmt -check -recursive
29
30        # Validate Terraform files
31        - name: Terraform Validate
32          run: terraform validate
```

Look at the **comments in the above workflow** – they **describe the steps** for **testing the Terraform configuration**.

Write the workflow and **run it**. It should be **successful**:



If you **receive any error**, **fix it** – you may have problems with your **Terraform configuration files** or the **workflow file** you have just created.

Apply Configuration Workflow

When we have a **valid configuration** with **working tests** in **GitHub Actions**, let's use a **workflow to provision resources** and **deploy the "TaskBoard" Web app** to **Azure**. You should **authenticate in Azure** using a **service principal** and then **write the workflow**.

Step 1: Create Service Principal

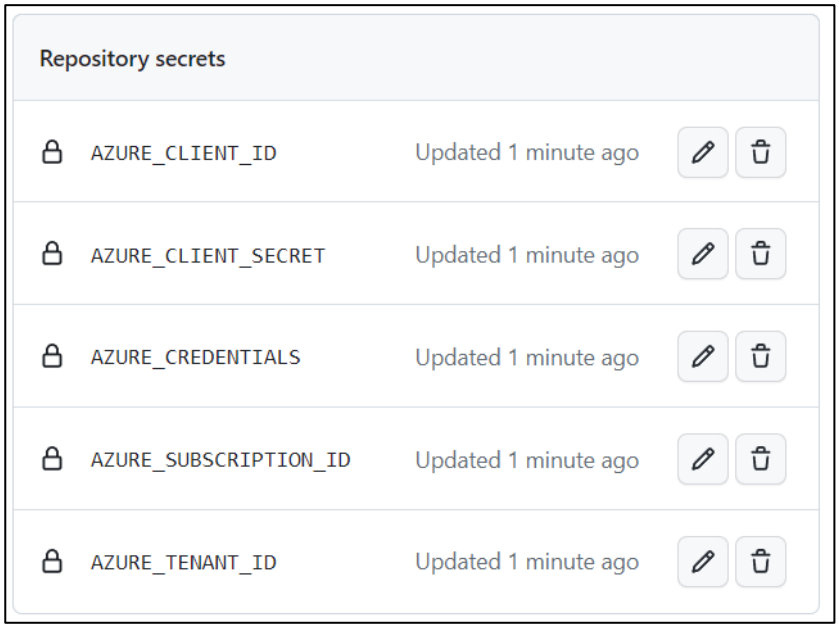
We should **create a service principal** with a "**Contributor**" **role** in **Azure** that we will use to **authenticate GitHub Actions**. Do it with the **following command locally** or **manually through Azure Portal**:

```
PS C:\Users\PC> az ad sp create-for-rbac --name "Azure-Terraform-GitHub-Actions"
--role contributor --scopes /subscriptions/[redacted] --sdk-
auth
Option '--sdk-auth' has been deprecated and will be removed in a future release.
Creating 'contributor' role assignment under scope '/subscriptions/8238f760-177c-42c1-
ba0e-749ec718e461'
The output includes credentials that you must protect. Be sure that you do not include
 these credentials in your code or check the credentials into your source control. For
 more information, see https://aka.ms/azadsp-cli
{
  "clientId": "[redacted]",
  "clientSecret": "[redacted]",
  "subscriptionId": "[redacted]",
  "tenantId": "[redacted]",
  "activeDirectoryEndpointUrl": "https://login.microsoftonline.com",
  "resourceManagerEndpointUrl": "https://management.azure.com/",
  "activeDirectoryGraphResourceId": "https://graph.windows.net/",
  "sqlManagementEndpointUrl": "https://management.core.windows.net:8443/",
  "galleryEndpointUrl": "https://gallery.azure.com/",
  "managementEndpointUrl": "https://management.core.windows.net/"
}
```

Copy the credentials JSON as you will need it for the next step.

Step 2: Create GitHub Secrets

As you know, it is **good practice** to **store your credentials** as **secrets in GitHub**. You need the following secrets:



"**AZURE_CREDENTIALS**" should **contain the whole JSON that we copied earlier** and the **rest of the variables** should contain **only the corresponding parts** of it (only the **value**, without quotes "").

Now we are ready to write the **GitHub workflow** that uses these secrets.

Step 3: Write the Workflow

Finally, let's **write the workflow** that will consist of **2 jobs** – the first one will **create the Terraform plan** and the **second one will apply it**.

Write the workflow in this way:

Terraform-Actions-Azure / .github / workflows / terraform-plan-apply.yml

76 lines (62 loc) · 2.02 KB

Code Blame Raw

```yaml
env:
  ARM_CLIENT_ID: ${{ secrets.AZURE_CLIENT_ID }}
  ARM_CLIENT_SECRET: ${{ secrets.AZURE_CLIENT_SECRET }}
  ARM_SUBSCRIPTION_ID: ${{ secrets.AZURE_SUBSCRIPTION_ID }}
  ARM_TENANT_ID: ${{ secrets.AZURE_TENANT_ID }}

jobs:
  terraform-plan:

    steps:
    # Checkout the repository to the GitHub Actions runner

    # Login to Azure via Azure CLI
      with:
        creds: ${{ secrets.AZURE_CREDENTIALS }}

    # Install the latest version of the Terraform CLI

    # Initialize a new or existing Terraform working directory
    # Creates initial files, loading any remote state, downloading modules, etc.

    # Generates an execution plan for Terraform
```

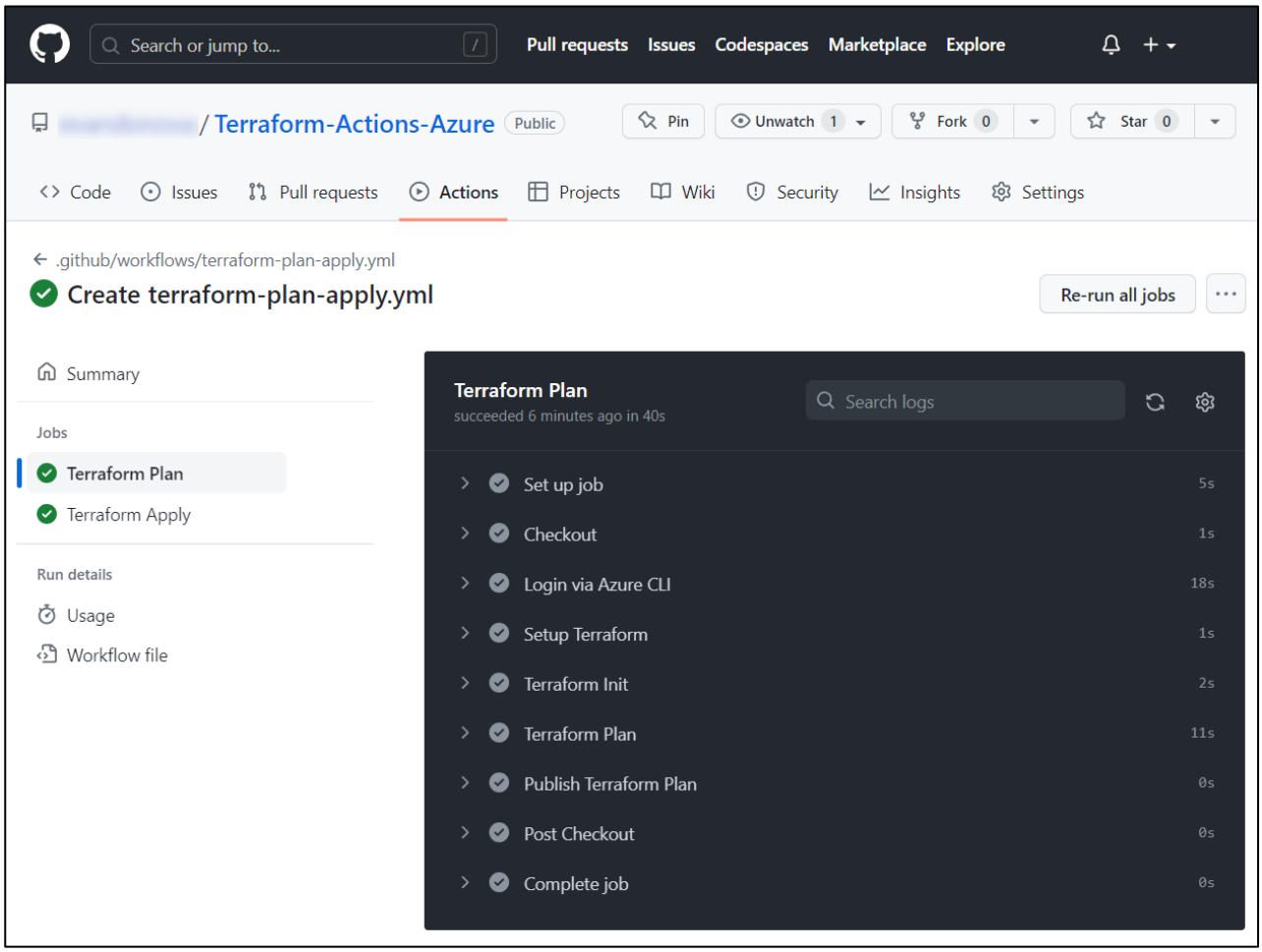
```yaml
      # Save plan to artifacts

  terraform-apply:
    needs: [terraform-plan]

    steps:
    # Checkout the repository to the GitHub Actions runner

    # Install the latest version of Terraform CLI

    # Initialize a new or existing Terraform working directory
    # Creates initial files, loading any remote state, downloading modules, etc.

    # Download saved plan from artifacts

    # Terraform Apply
        -auto-approve tfplan
```

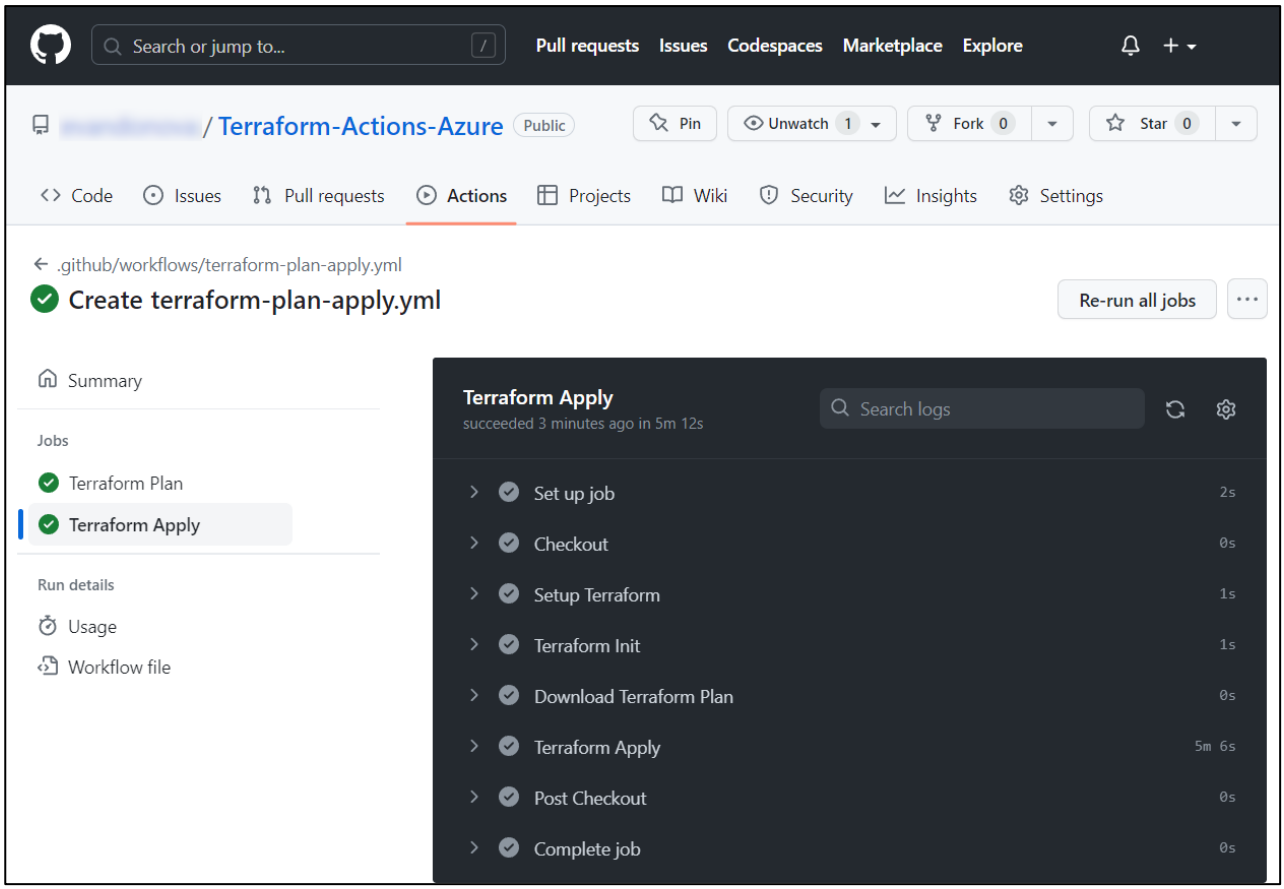
You can use the **steps from the test workflow** we created earlier as part of **this YAML file**.

Note some **specific things** about this **workflow**:

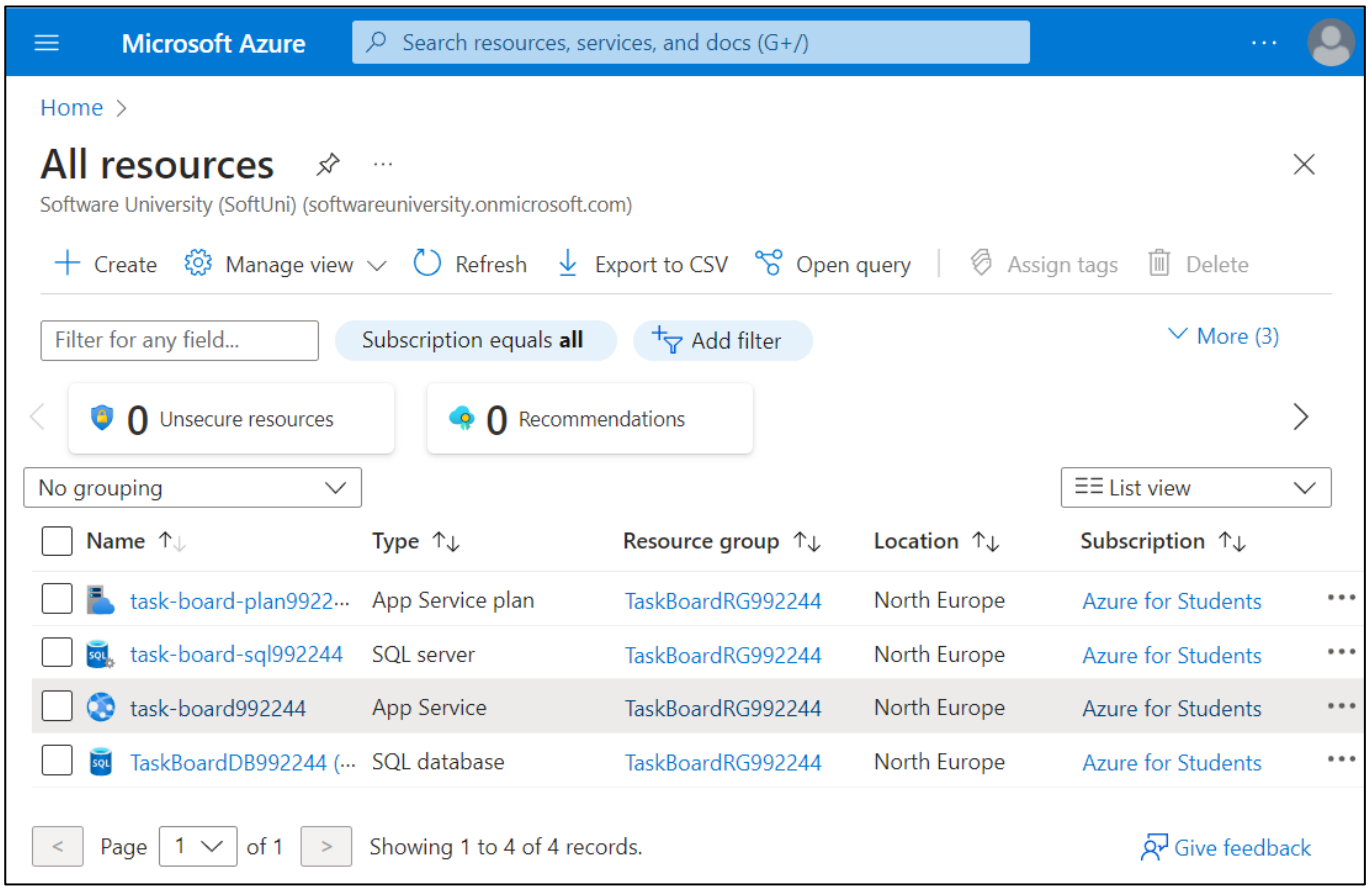
- You need some **environment variables** so that **Terraform can authenticate in Azure**.
- You should use the "**AZURE_CREDENTIALS**" **GitHub secret** to **authenticate GitHub Actions in Azure**.
- The **second job** should **depend on the execution** of the **first one**.
- You should **add the "`-auto-approve tfplan`" flag** to **automatically approve the changes** in the "**`tfplan`**" without requiring manual confirmation during the workflow run.

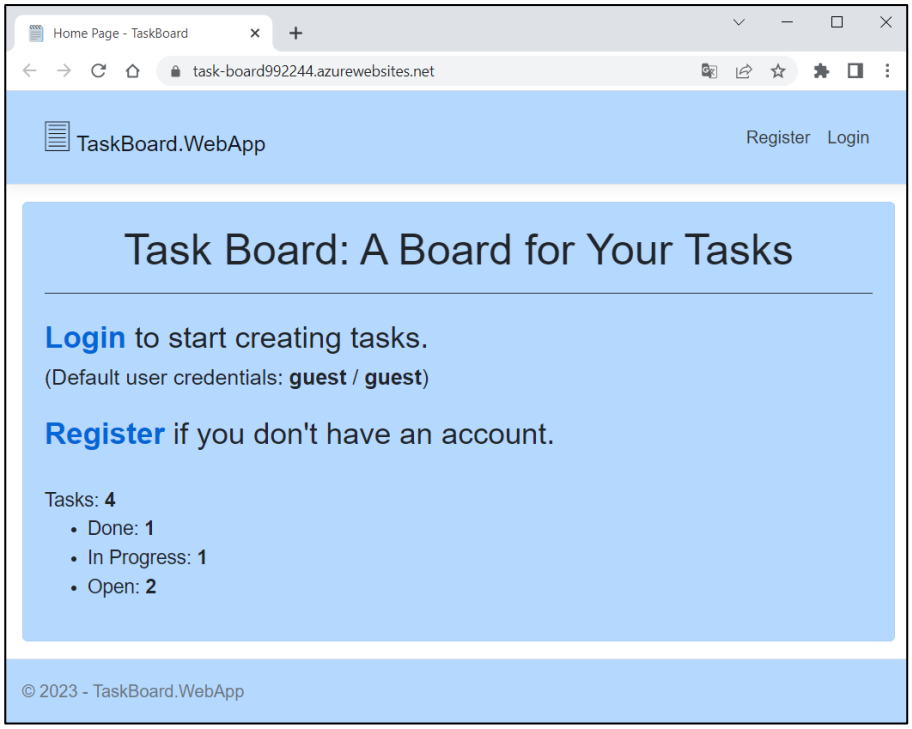
The **workflow should run successfully**:





Also, the **Azure resources** you defined in the **Terraform configuration** should be **provisioned** and the "**TaskBoard**" **app deployed and working**:





We successfully used **GitHub Actions** to **run a Terraform configuration** that **provisions resources in Azure**. However, if we **change the configuration** and **run the workflow again**, an **error will occur**. This happens because we **don't save the Terraform configuration state file**.

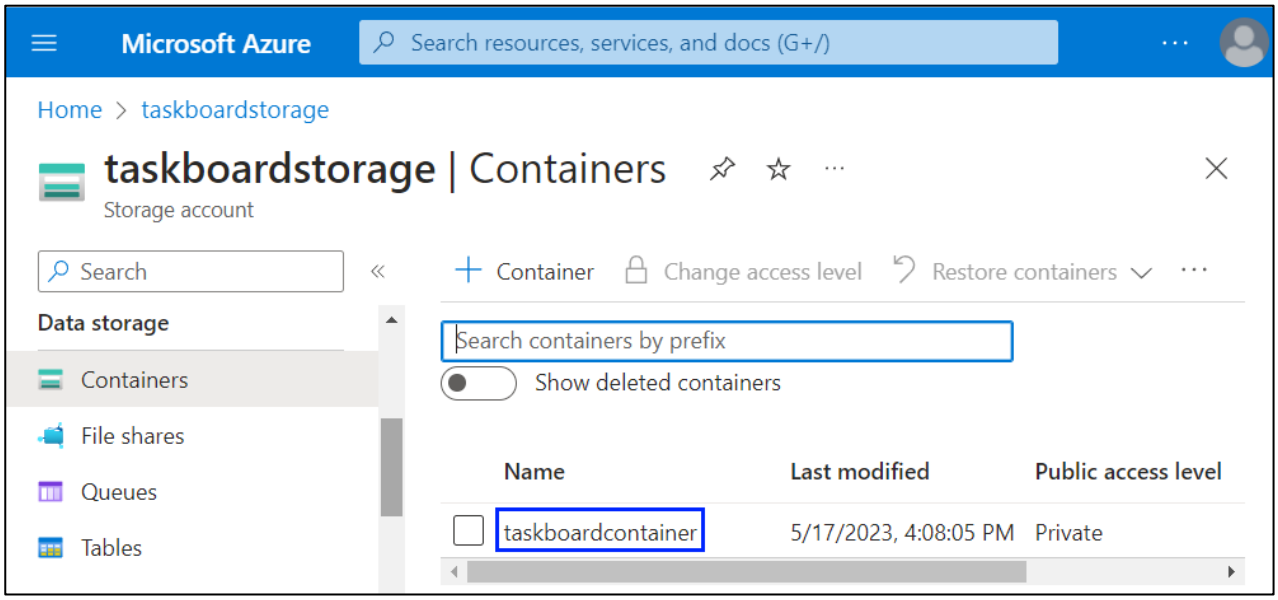
Store State File in Azure Storage Account

Terraform utilizes a **state file** to **store information** about the **current state of your managed infrastructure** and associated configuration. This file will need to be **persisted between different runs of the workflow**.

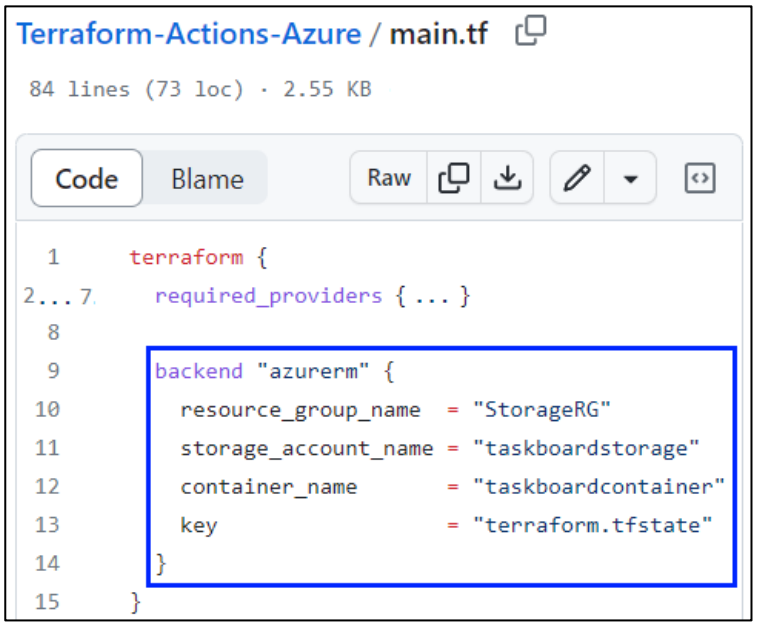
The recommended approach is to **store this file** within an **`Azure Storage Account`** and this is what we will do now. First, you should **create an Azure storage account** with a **container** to **store the state file**:

```
PS C:\Users\PC> az storage account create
>> --name taskboardstorage
>> --resource-group StorageRG
>> --location northeurope
>> --sku Standard_LRS
>> --kind StorageV2
```

```
PS C:\Users\PC>az storage container create -n taskboardcontainer --account-name taskboardstoraget
```



Then, to **use this storage in Terraform**, you should **add a `backend` block** in the **`main.tf` configuration file**:



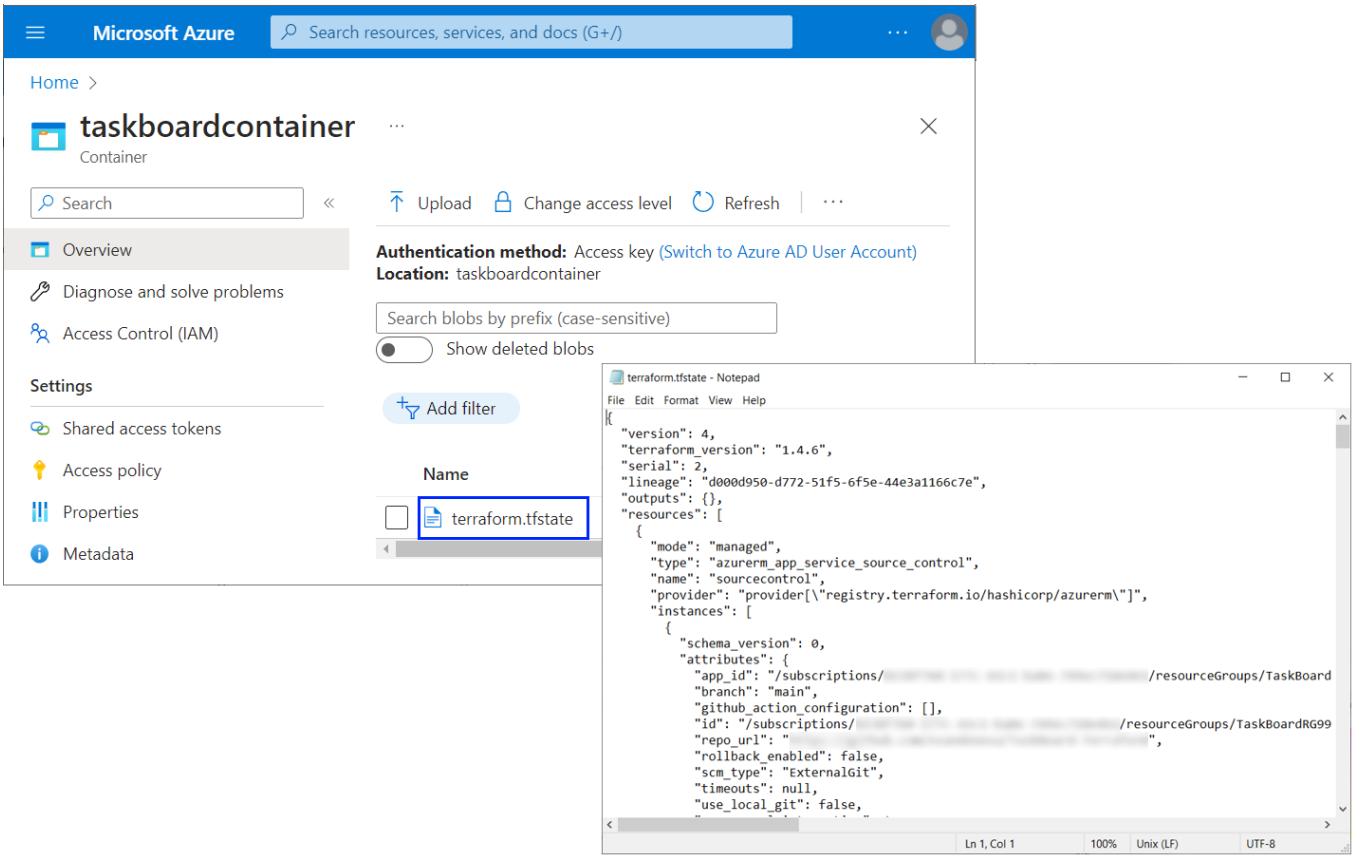

```
1     terraform {
2...7   required_providers { ... }
8
9     backend "azurerm" {
10      resource_group_name  = "StorageRG"
11      storage_account_name = "taskboardstorage"
12      container_name       = "taskboardcontainer"
13      key                  = "terraform.tfstate"
14    }
15  }
```

A **`backend` block** defines where **Terraform stores its state data files**. You should provide the **names of your resource group**, **storage account** and **container**, as well as to set a **name of the state file** that will be created.

Commit the changed file to GitHub and wait for **GitHub Actions to run the workflow**.

Note: you **should not have your resources in Azure now** or the **GitHub Actions workflow will still give you an error** when **trying to create them**, as they are **not defined in the state file**. **Delete the resources** you created previously with your Terraform configuration from **Azure**.

The **workflow should be successful** and you should see that a **`terraform.tfstate` file** was created in your **Azure storage container**:



Go and **make a change in your Terraform configuration in GitHub** and **run the workflow again** – the **modified resources** should be **updated successfully in Azure**.

Now you have a **fully working `GitHub Actions` + `Terraform` + `Azure` configuration** to create and manage resources.

* More Configuration Improvements

We have a **good Terraform configuration** and **GitHub Actions workflows** created during the previous tasks but here are some **additional challenges for you** to overcome to **improve your Terraform skills** even more:

- You can **create a Terraform configuration file** to **provision an Azure storage account and container** for the **Terraform backend**, instead of doing it with commands like we did previously. Then, you can use a **GitHub Actions workflow** to **run that configuration** and **provision the resources in Azure**.
- You can **create a Terraform configuration file** to **create the service principal** and **assign the "`Contributor`" role to it** instead of doing it manually or with commands through Azure CLI. You can again try to **run the configuration in GitHub Actions**, not only locally.

By **fulfilling these additional tasks**, you would have **fully explored** and used the **integration between `Terraform`, `GitHub Actions`** and **`Azure`**.