What Why and How Terraform

Before getting into the Tutorial, we should understand Why Terraform is needed in the first place. Creating and managing application instances in Datacenters is a really crucial job and it cannot even afford a small mistake or misconfiguration. Wait! even application developers do mistakes with their application codes but how they are managing it to avoid big downtime or issue? Yes, They have everything coded and everyone has their own versions of code which can be reviewed and approved!. Likewise, creating code for Infrastructure will help misconfiguration, and most importantly, it will automate the way long infrastructure processes. Now, Terraform provide such a platform that will store the configuration of infrastructure with configuration, provision, and manage feature as code. We call that Infrastructure as Code (IaC).

Terraform is an infrastructure as code (IaC) tool that allows you to build, change, and version infrastructure safely and efficiently. This includes low-level components such as compute instances, storage, and networking, as well as high-level components such as DNS entries, SaaS features, etc. Terraform can manage both existing service providers and custom in-house solutions.

Terraform's configuration language is declarative, meaning that it describes the desired end-state for your infrastructure, in contrast to procedural programming languages that require step-by-step instructions to perform tasks. Terraform providers automatically calculate dependencies between resources to create or destroy them in the correct order.

Terraform is HashiCorp's infrastructure as a code tool. It lets you define resources and infrastructure in human-readable, declarative configuration files, and manages your infrastructure's lifecycle. Using Terraform has several advantages over manually managing your infrastructure.

Terraform is an orchestration engine and language that enables you to safely and predictably create, change, and improve production infrastructure. It is an open-source tool that codifies APIs into declarative configuration files that can be shared amongst team members, treated as code, edited, reviewed, and versioned.

What is Terraform used for?

* External resource management -- Terraform supports public and private cloud infrastructure, as well as network appliances and software as a service (SaaS) deployments.
* Multi-cloud deployment -- the software tool's native ability to support multiple cloud services helps increase fault tolerance.
* Multi-tier applications -- Terraform allows each resource collection to easily be scaled up or down as needed.
* Self-service clusters -- the registries make it easy for users to find prepackaged configurations that can be used as is or modified to meet a particular need.
* Software-defined networking (SDN) -- Terraform's readability makes it easy for network engineers to codify the configuration for an SDN.
* Resource scheduler -- Terraform modules can stop and start resources on AWS and allow Kubernetes to schedule Docker containers.
* Disposable environments -- modules can be used to create an ad hoc, throwaway test environment for code before it's put into production.

How does Terraform work?

Terraform allows users to define their entire infrastructure simply by using configuration files and version control. When a command is given to deploy and run a server, database or load balancer, Terraform parses the code and translates it into an application programming interface (API) call to the resource provider. Because Terraform is open source, developers are always able to extend the tool's usefulness by writing new plugins or compiling different versions of existing plugins.

Terraform has two important components: **Terraform Core** and **Terraform Plugins**.

**Terraform Core** oversees the reading and interpolation of resource plan executions, resource graphs, state management features and configuration files. Core is composed of compiled binaries written in the Go programming language. Each compiled binary acts as a command-line interface (CLI) for communicating with plugins through remote procedure calls (RPC).

**Terraform Plugins** are responsible for defining resources for specific services. This includes authenticating infrastructure providers and initializing the libraries used to make API calls. Terraform Plugins are written in Go as executable binaries that can either be used as a specific service or as a provisioner. (Provisioner plugins are used to execute commands for a designated resource.)

Features of Terraform

* **Reuse**: Infrastructure as code (IaC) tools allow you to manage infrastructure with configuration files rather than through a graphical user interface. IaC allows you to build, change, and manage your infrastructure in a safe, consistent, and repeatable way by defining resource configurations that you can version, reuse, and share.
* **Execution Plans**: Terraform generates an execution plan describing what it will do and asks for your approval before making any infrastructure changes. This allows you to review changes before Terraform creates, updates, or destroys infrastructure.
* **Resource Graph**: Terraform builds a resource graph and creates or modifies non-dependent resources in parallel. This allows Terraform to build resources as efficiently as possible and gives you greater insight into your infrastructure.
* **Change Automation:** Terraform can apply complex changesets to your infrastructure with minimal human interaction. When you update configuration files, Terraform determines what changed and creates incremental execution plans that respect dependencies.
* Terraform can manage infrastructure on multiple cloud platforms.
* The human-readable configuration language helps you write infrastructure code quickly.
* Terraform's state allows you to track resource changes throughout your deployments.
* You can commit your configurations to version control to safely collaborate on infrastructure.
* **Manage any infrastructure:**Terraform plugins called providers let Terraform interact with cloud platforms and other services via their application programming interfaces (APIs). HashiCorp and the Terraform community have written over 1,000 providers to manage resources on Amazon Web Services (AWS), Azure, Google Cloud Platform (GCP), Kubernetes, Helm, GitHub, Splunk, and DataDog, just to name a few. Find providers for many of the platforms and services you already use in the Terraform Registry.
* If you don't find the provider you're looking for you can write your own provider plugin.
* make incremental changes to resources.
* Standardize your deployment workflow Providers define individual units of infrastructure, for example compute instances or private networks, as resources. You can compose resources from different providers into reusable Terraform configurations called modules, and manage them with a consistent language and workflow.
* **Track your infrastructure:**Terraform keeps track of your real infrastructure in a state file, which acts as a source of truth for your environment. Terraform uses the state file to determine the changes to make to your infrastructure so that it will match your configuration.
* **Collaborate:** Terraform allows you to collaborate on your infrastructure with its remote state backends. When you use Terraform Cloud (free for up to five users), you can securely share your state with your teammates, provide a stable environment for Terraform to run in, and prevent race conditions when multiple people make configuration changes at once.
* You can also connect Terraform Cloud to version control systems (VCSs) like GitHub, GitLab, and others, allowing it to automatically propose infrastructure changes when you commit configuration changes to VCS. This lets you manage changes to your infrastructure through version control, as you would with application code.

Benefits of Using Terraform

Manual Needs many Human Resources which can be Managed by a single Terraform Platform.

Since we need fewer human resources, the Cost of Infrastructure management can be reduced drastically.

Misconfiguration and Manual errors can be taken away by Terraform

Scaling or High Availability of the Application stack within Infrastructure can be easily achieved with Terraform.

The Infrastructure setup is available as Configuration Files, It can be Documented and Reviewed every version of the changes.

No Blame Games in Infrastructure Configurations. It can be traced back and Identified easily.

# Terraform Installations

In this blog, We are going to install terraform in the Ubuntu operating system.

Ensure that your system is up to date, and you have the gnupg, software-properties-common, and curl packages installed. You will use these packages to verify HashiCorp's GPG signature, and install HashiCorp's Debian package repository.

$ sudo apt-get update && sudo apt-get install -y gnupg software-properties-common curl

Add the HashiCorp GPG key.

$ curl -fsSL https://apt.releases.hashicorp.com/gpg | sudo apt-key add -

Add the official HashiCorp Linux repository.

$ sudo apt-add-repository "deb [arch=amd64] https://apt.releases.hashicorp.com $(lsb\_release -cs) main"

Update to add the repository, and install the Terraform CLI.

$ sudo apt-get update && sudo apt-get install terraform

## Verify the installation

Verify that the installation worked by opening a new terminal session and listing Terraform's available subcommands.

$ terraform -help

Usage: terraform [-version] [-help] <command> [args]

The available commands for execution are listed below.

The most common, useful commands are shown first, followed by

less common or more advanced commands. If you're just getting

started with Terraform, stick with the common commands. For the

other commands, please read the help and docs before usage.

##...

Add any subcommand to terraform -help to learn more about what it does and available options.

$ terraform -help

# First Terraform Configuration

## Terraform Language

The Terraform language is Terraform's primary user interface. In every edition of Terraform, a configuration written in the Terraform language is always at the heart of the workflow.

The main purpose of the Terraform language is declaring resources, which represent infrastructure objects.

## ****Terraform configuration****

A Terraform configuration is a complete document in the Terraform language that tells Terraform how to manage a given collection of infrastructure. A configuration can consist of multiple files and directories.

<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>" {

# Block body

<IDENTIFIER> = <EXPRESSION> # Argument

}

## ****File Extension****

Code in the Terraform language is stored in plain text files with the**.tf**file extension. There is also a**JSON-based variant** of the language that is named with the **.tf.json** file extension.

## ****Text Encoding****

Configuration files must always use UTF-8 encoding, and by convention usually use Unix-style line endings (LF) rather than Windows-style line endings (CRLF), though both are accepted

let's create first terraform configurations

create a file first.tf in the present working directory with the below content

// this is comment

# this is comment

output hello1 {

    value = "Hello World 1234"

}

now let's run **terraform plan** command

output

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-world]

└─$ terraform plan

Changes to Outputs:

  + hello1 = "Hello World 1234"

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

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly these actions if you run "terraform apply" now.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-world]

└─$

# Terraform Configurations As JSON File

Code in the Terraform language is stored in plain text files with the**.tf**file extension. There is also a **JSON-based variant**of the language that is named with the**.tf.json**file extension.

Terraform also supports an alternative syntax that is JSON-compatible. This syntax is useful when generating portions of a configuration programmatically, since existing JSON libraries can be used to prepare the generated configuration files.

let's create our first.tf.json file in the present working directory with the below content

{

"output" : {

  "hello1": {

      "value": "Hello Gaurav"

     }

  }

}

Run the **terraform plan**command and see the output.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-world-json]

└─$ terraform plan

Changes to Outputs:

  + hello1 = "Hello Gaurav"

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

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly these actions if you run "terraform apply" now.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-world-json]

└─$

# Multiple Block in Single Terraform File

In the previous blogs, we used single-output block in a file. in this blog, we will demonstrate that we can use multiple blocks in the same file.

let create the **first.tf** file in the present working directory with the below content. here we can see that we are using multiple blogs in the same file. make source that label must be different.

output "firstoutputblock" {

        value = " this is first hello world block"

}

output "secondoutputblock" {

        value = "this is second hello world block"

}

output "thirdoutputblock" {

        value = "this is third hello world block"

}

now run **terraform plan**and see the output.

**Output:**

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-world-multi-block]

└─$ terraform plan

Changes to Outputs:

  + firstoutputblock  = " this is first hello world block"

  + secondoutputblock = "this is second hello world block"

  + thirdoutputblock  = "this is third hello world block"

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

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly these actions if you run "terraform apply" now.

# Terraform Variables

So in last blog we see that we can put multiple files in a directory. and in this blogs we will use variables and print that variables. so let's start and create a file **first.tf** with below content and you can change the name of files as per your choice.

variable username {}

output printname {

    value = "Hello, ${var.username}"

}

In the above content we declare a variable **username** with the help of **variable block.** The label after the variable keyword is a name for the variable, which must be unique among all variables in the same module.

## Using Input Variable Values

Within the module that declared a variable, its value can be accessed from within expressions as **var.<NAME>**, where <NAME> matches the label given in the declaration block (here is username)

so if we want to use a variable in terraform then we can use it using **var.variableName**and "${var.variableName}" inside string.

now lets run the terraform plan command and see the output.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-variable]

└─$ terraform plan

var.username

  Enter a value: Learning-Ocean

Changes to Outputs:

  + printname = "Hello, Learning-Ocean"

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

real infrastructure.

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly

these actions if you run "terraform apply" now.

Terraform will take value of username as input (we give it **Learning-Ocean**) and it will return the output as **Hello, Learning-Ocean.**

## Divide Terraform files

in the previous blogs, we have seen that we can put multiple terraform configurations files in same directory. let's implement it and divide the above first.tf file.

let create a files variable.tf with the below content, in this file we will only define the variables.

variable username {}

let create one more file hello-variable.tf with below content.

output printname {

    value = "Hello, ${var.username}"

}

now lets run the terraform plan command and see the output.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-variable]

└─$ ls

hello-variable.tf  variable.tf

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-variable]

└─$ terraform plan

var.username

  Enter a value: Learning-Ocean

Changes to Outputs:

  + printname = "Hello, Learning-Ocean"

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

real infrastructure.

# Pass Variable from Command Line

In last blogs we create two files. variable.tf and hello-variable.tf with the below content.

variable.tf contains the below content.

variable username {}

hello-variable.tf with below content.

output printname {

    value = "Hello, ${var.username}"

}

then we run **terraform plan**then terraform will ask us variable value that is**not defined.**

Now we want to supply the variable value from the command line. so that we can run terraform plan command in non-interactive node.

for that we will use below.

syntex:

terraform plan -var "<VARIABLE\_NAME>=<VARIABLE\_VALUE>"

let's run the below command and see the output

$ terraform plan -var "username=Learning-Ocean"

output:

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-variable]

└─$ terraform plan -var "username=Learning-Ocean"

Changes to Outputs:

  + printname = "Hello, Learning-Ocean"

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

real infrastructure.

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly

these actions if you run "terraform apply" now.

Terraform Variable Type

The type argument in a variable block allows you to restrict the type of value that will be accepted as the value for a variable. If no type constraint is set then a value of any type is accepted.

type constraints are optional but its recommended by terraform to specifying them.

Type constraints are created from a mixture of type keywords and type constructors. The supported type keywords are:

* string
* number
* bool

The type constructors allow you to specify complex types such as collections:

* list
* map

If both the type and default arguments are specified, the given default value must be convertible to the specified type.

Variable description

Because the input variables of a module are part of its user interface, you can briefly describe the purpose of each variable using the optional description argument.

let's create a file variable.tf in your current working directory. with the below content.

variable username {

type = string

default = "world"

}

variable age {

type = number

default = 23

}

and create one more file printvariable.tf with the below content

output "printvariable" {

value = "Hello ${var.username} and your age is ${var.age}"

}

you can pass the variable value from the command line using below syntax

terraform plan -var "variablename=variablevalue" -var "variable2name=varible2value"

now lets run terraform plan command in actions.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/hello-variable]

└─$ terraform plan -var "username=Learning-Ocean" -var "age=23"

Changes to Outputs:

  + printname = "Hello, Learning-Ocean, your age is 23"

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

if we pass age as String it will give an error.

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/hello-variable]

└─$ terraform apply -var username="Gaurav" -var age=gaurav

╷

│ Error: Invalid value for input variable

│

│ The argument -var="age=..." does not contain a valid value for variable "age": a number is required.

╵

│ Error: Incorrect variable type

│

│   on variable.tf line 5:

│    5: variable "age" {

│

│ The resolved value of variable "age" is not appropriate: a number is required.

# List Variable

A **list variable** holds a list of values (for example, name of users) to be used. Each list variable specifies the order.

let see with example create a file variable.tf with below contents.

variable users {

    type = list

}

let's create one more file that will access user from the users variables. (list variable.)

output printfirst {

  value = "first user is ${(var.users[1])}"

}

in the above file we will accessing second element of the array. because indexing starting from the zero. let run the **terraform plan**and see the output.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/list-variable]

└─$ terraform plan

var.users

  Enter a value: [ "gaurav", "saurav", "ankit"]

Changes to Outputs:

  + printfirst = "first user is saurav"

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

here we can see the second element of the array in the output.

we can add the default value using the below snippet

variable users {

  type = list

  default = ["gaurav","Saurav","anKit"]

}

and we can pass the list variable from the command line using below syntax.

terraform plan -var 'variablename=["valueone","valuetwo","value3"]'

let's run terraform apply and see it in action.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/list-variable]

└─$ terraform plan -var 'users=["gaurav","saurav","ankit"]'

Changes to Outputs:

  + printfirst = "first user is saurav"

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

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly these actions if you run "terraform apply" now.

┌──(gaurav㉿learning-ocean)-[~/youtube-course/list-variable]

└─$

# Terraform Functions

The Terraform language includes a number of built-in functions that you can call from within expressions to transform and combine values. The general syntax for function calls is a function name followed by comma-separated arguments in parentheses

max(5, 12, 9)

The Terraform language**does not support user-defined functions**, and so only the functions built into the language are available for use.

## Numeric Functions

### **abs**

abs returns the absolute value of the given number. In other words, if the number is zero or positive then it is returned as-is, but if it is negative then it is multiplied by -1 to make it positive before returning it.

> abs(24)

23

> abs(0)

0

> abs(-24.4)

24.4

### **ceil**

ceil returns the closest whole number that is greater than or equal to the given value, which may be a fraction.

> ceil(5)

5

> ceil(5.1)

6

### **floor**

floor returns the closest whole number that is less than or equal to the given value, which may be a fraction.

> floor(5)

5

> floor(4.9)

4

### **log**

log returns the logarithm of a given number in a given base.

> log(50, 10)

1.6989700043360185

> log(16, 2)

4

### **max**

max takes one or more numbers and returns the greatest number from the set.

> max(12, 54, 3)

54

### **min**

min takes one or more numbers and returns the smallest number from the set.

> min(12, 54, 3)

3

### **pow**

pow calculates an exponent, by raising its first argument to the power of the second argument.

> pow(3, 2)

9

> pow(4, 0)

1

## String Functions

### **join**

join produces a string by concatenating together all elements of a given list of strings with the given delimiter.

> join(", ", ["foo", "bar", "baz"])

foo, bar, baz

> join(", ", ["foo"])

foo

### **upper**

upper converts all cased letters in the given string to uppercase.

> upper("hello")

HELLO

### **lower**

lower converts all cased letters in the given string to lowercase.

> lower("HELLO")

hello

### **title**

title converts the first letter of each word in the given string to uppercase.

> title("hello world")

Hello World

lets take an example of String functions

create a file variable.tf with below code:

variable users {

    type = list

    default = ["gaurav","Saurav","anKit"]

}

create a file first.tf (you can change the file name as per your convenient.

output printfirst {

        value = "${join("--->",var.users)}"

}

output helloworldupper {

        value = "${upper(var.users[0])}"

}

output helloworldlower {

        value = "${lower(var.users[1])}"

}

output helloworldtitle {

        value = "${title(var.users[2])}"

}

let run terraform apply and see the output:

└─$ terraform plan

No changes. Your infrastructure matches the configuration.

Terraform has compared your real infrastructure against your configuration and found no differences, so no changes are needed.

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

Outputs:

helloworldlower = "saurav"

helloworldtitle = "AnKit"

helloworldupper = "GAURAV"

printfirst = "gaurav--->Saurav--->anKit"

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/functions]

└─$

**Below are the types of other functions with function names**:

**Numeric**Functions : abs, ceil, floor, log, max, min, parseint, pow, signum

**String Functions**: chomp, format, formalist, join, lower, regex, regexall, rep[lace, split, strrev, title, trim, trimprefix, trimsuffix, trimspace, upper

**Collection Functions**: alltrue, anytrue, chunklist, coalesce, coalescelist, compact, concat, contains, distinct, element, flatten, index, keys, length, list, lookup, map, matchkeys,merge, one, range, reverse, setintersection, setproduct, setsubsctract, setunion, slice, sort, sum, transpose, values, zipmap

**Encoding Functions**: base643ncode, base64decode, base64gzip, csvdecode, jsonencode, jsondecode, urlencode, yamlencode, yamldecode

**Filesystem functions**: absath, dirname, pathexpand, basename, file, fileexists, fileset, filebase64, templatefile

**Date & Time Functions**: formade, timeadd, timestamp

**Hash and Crypto Functions**: base64sha256, base64sha512, bcrypt, filebase64sha512, filemd5, filesha1, filesha256, filesha512, md5, rsadecrypt, sha, sha256, sha512, uuid, uuidv5

**IP Network Functions**: cidrhost, cidrnetmask, cidrsubnets

**Type Conversion functions**: can, defaults, nonsensative, sensitive, tobool, tolist, tomap, tonumber, toset, tostring, try

Reference : <https://www.terraform.io/language/functions>

# Terraform Map Variable

A map value is a lookup table from string keys to string values. This is useful for selecting a value based on some other provided value.

A common use of maps is to create a table of machine images per region, as follows:

variable "images" {

  type    = "map"

  default = {

    "us-east-1" = "image-1234"

    "us-west-2" = "image-4567"

  }

}

lets take an simple example of terraform map

create a file with tf extension.

variable "usersage" {

    type = map

    default = {

        gaurav = 20

        saurav = 19

    }

}

output "userage" {

    value = "my name is gaurav and my age is ${lookup(var.usersage, "gaurav")}"

}

now let's run terraform apply and see the output

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/map-variable]

└─$ terraform plan

Changes to Outputs:

  + userage = "my name is gaurav and my age is 20"

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

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

Outputs:

userage = "my name is gaurav and my age is 20"

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/map-variable]

└─$

## How to Read values Dynamically from Map Variable:

lets create a file

variable "usersage" {

    type = map

    default = {

        gaurav = 20

        saurav = 19

    }

}

variable "username" {

  type = string

}

output "userage" {

    value = "my name is ${var.username} and my age is ${lookup(var.usersage, "${var.username}")}"

}

now lets run terraform apply

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/map-variable]

└─$ terraform plan -var username="gaurav"

No changes. Your infrastructure matches the configuration.

Terraform has compared your real infrastructure against your configuration and found no differences, so no changes are needed.

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

Outputs:

userage = "my name is gaurav and my age is 20"

## How to pass Map Variable From Command line

┌──(gaurav㉿learning-ocean)-[~/terraform/youtube-course/map-variable]

└─$ terraform plan -var username="gaurav" -var usersage="{"gaurav"=22,"saurav"=23}"                                                                       1 ⨯

Changes to Outputs:

  + userage = "my name is gaurav and my age is 22"

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

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Note: You didn't use the -out option to save this plan, so Terraform can't guarantee to take exactly these actions if you run "terraform apply" now.