

DevOps Final Project

AWS Infrastructure Deployment with Terraform, Docker, and BI Integration

Ali Muhammad – 18585

GitHub:

<https://github.com/AliMuhammadAslam/DevOpsProject-AWSInfrastructureDeployment>

Loom Video – Part 1:

<https://www.loom.com/share/3ad97a14eb81482e811e2d18e2468b6b?sid=199816a0-d06d-409a-8abd-99d6d2e8cdc1>

Loom Video – Part 2:

<https://www.loom.com/share/3ca357988b1f46c8bafacd3147dee49e?sid=c7e93728-74c4-4e8f-9a00-6ce1f9ce2cf2>

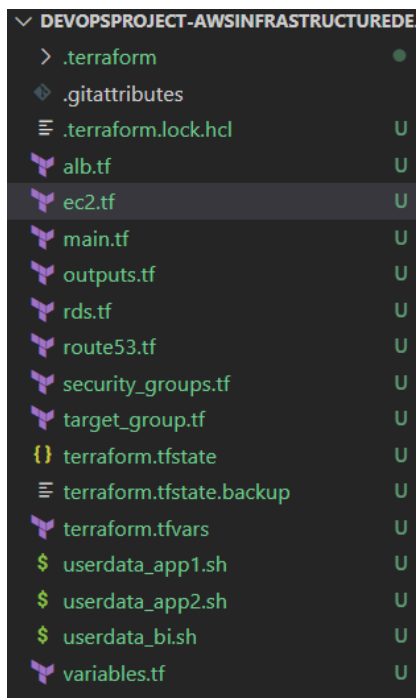


Introduction:

This project focuses on the integration of cloud-based infrastructure and data visualization tools to analyze real-time data. By utilizing AWS services, including EC2, RDS, and Application Load Balancer (ALB), we have designed and deployed a scalable architecture that securely handles data storage and retrieval. The primary objective of this project is to demonstrate the effective use of PostgreSQL for data management and Metabase for dynamic data visualization. Through the use of real-world data, this project emphasizes the value of interactive dashboards and efficient database management in driving business intelligence and informed decision-making. By implementing these systems in a cloud environment, the project highlights how modern infrastructure and visualization tools can enhance data accessibility and analysis.

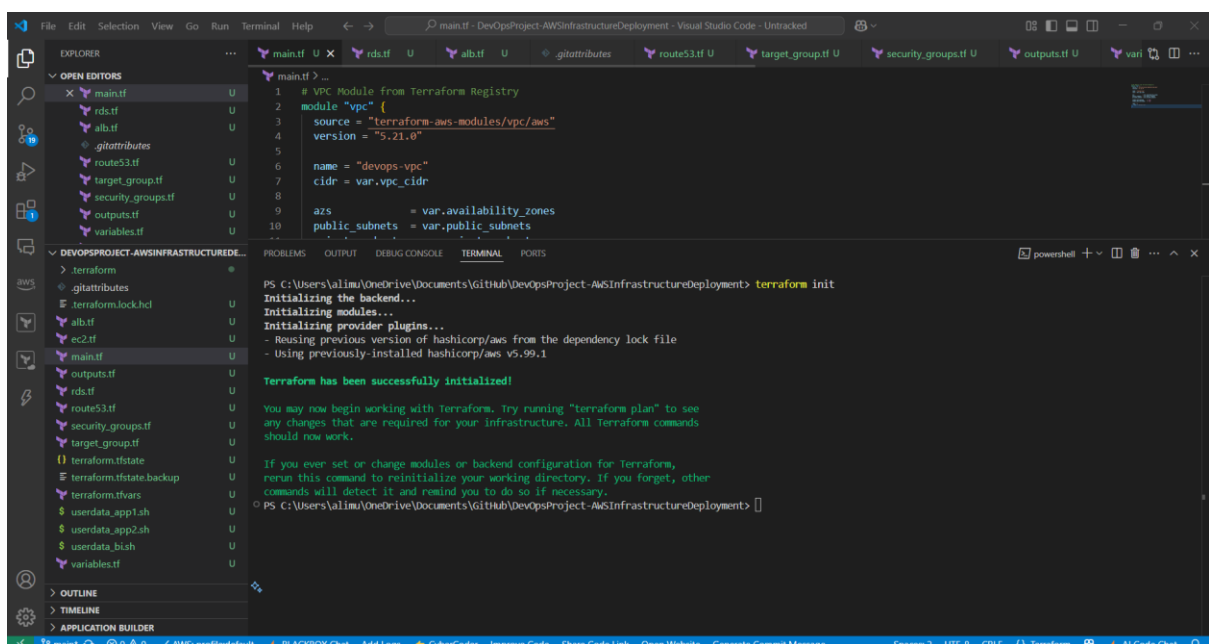
Terraform File Structure:

The Terraform project structure includes several custom files that I have created to configure the required AWS infrastructure. **alb.tf** defines the configuration for the Application Load Balancer (ALB), specifying the rules and routing for traffic. **ec2.tf** configures the EC2 instances, detailing their types, key pairs, and security groups. **outputs.tf** sets the output values to be displayed after deployment, such as IP addresses or URLs. **rds.tf** contains the configuration for the Amazon RDS database, including instance type and settings. **route53.tf** configures DNS records with Route 53 to map domain names to AWS resources. **security_groups.tf** defines the security rules for EC2 instances and other resources. **target_group.tf** defines the target groups for the load balancer, ensuring traffic is directed to healthy instances. **terraform.tfvars** holds variable values to be used across the configuration. **userdata_app1.sh** and **userdata_app2.sh** automate the setup of the respective EC2 instances, while **userdata_bi.sh** configures the BI tool instance. **variables.tf** defines the variables used throughout the configuration, allowing for easy adjustments.

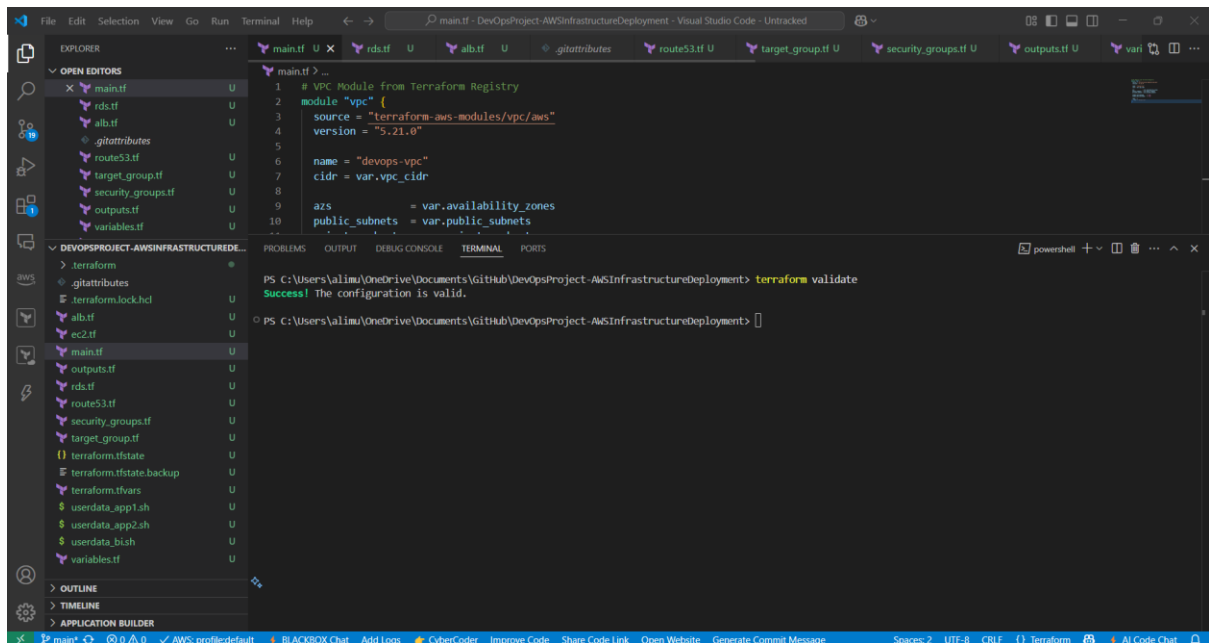


Execution of Terraform Commands:

Terraform init (Initializes the working directory by downloading necessary provider plugins and setting up the backend for Terraform):



Terraform validate (Checks the syntax and configuration of the Terraform files for correctness, ensuring no errors before applying changes):

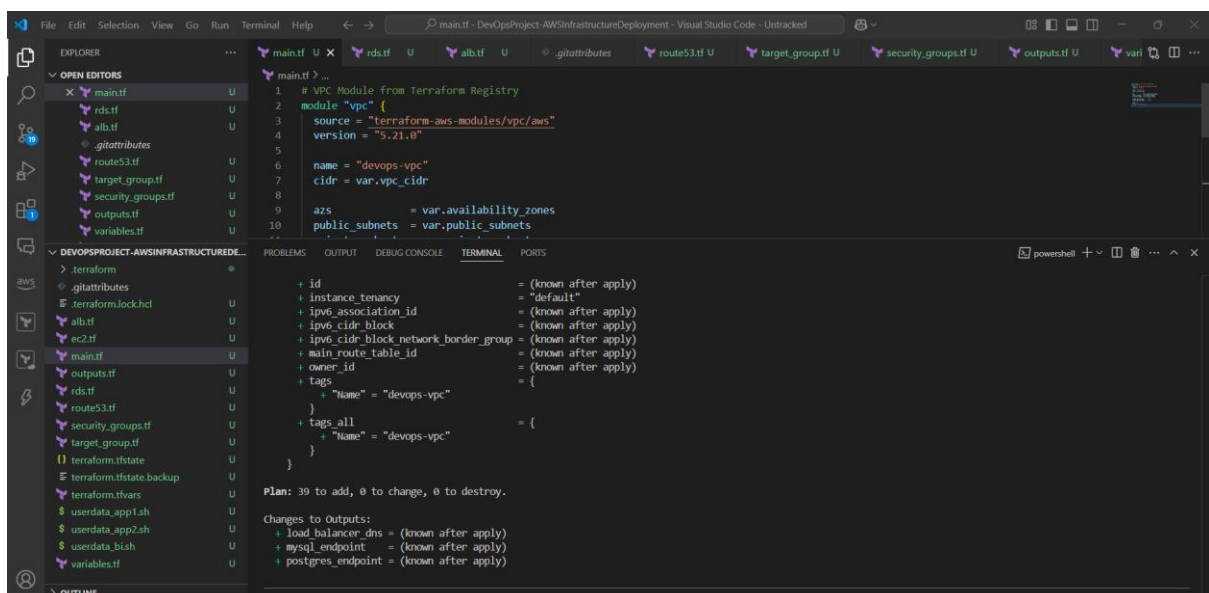


The screenshot shows the Visual Studio Code interface with the Explorer view on the left displaying a project structure for 'DEVOPSPROJECT-AWSINFRASTRUCTUREDE...'. The main editor shows the 'main.tf' file with Terraform code for a VPC module. The terminal at the bottom displays the command 'terraform validate' and its successful output: 'Success! The configuration is valid.'

```
1 # VPC Module from Terraform Registry
2 module "vpc" {
3   source = "terraform-aws-modules/vpc/aws"
4   version = "5.21.0"
5
6   name = "devops-vpc"
7   cidr = var.vpc_cidr
8
9   azs = var.availability_zones
10  public_subnets = var.public_subnets
```

```
PS C:\Users\alimu\OneDrive\Documents\Github\DevOpsProject-AWSInfrastructureDeployment> terraform validate
Success! The configuration is valid.
```

Terraform Plan (Creates an execution plan by comparing the current state of the infrastructure with the desired configuration, showing the changes that will be made):



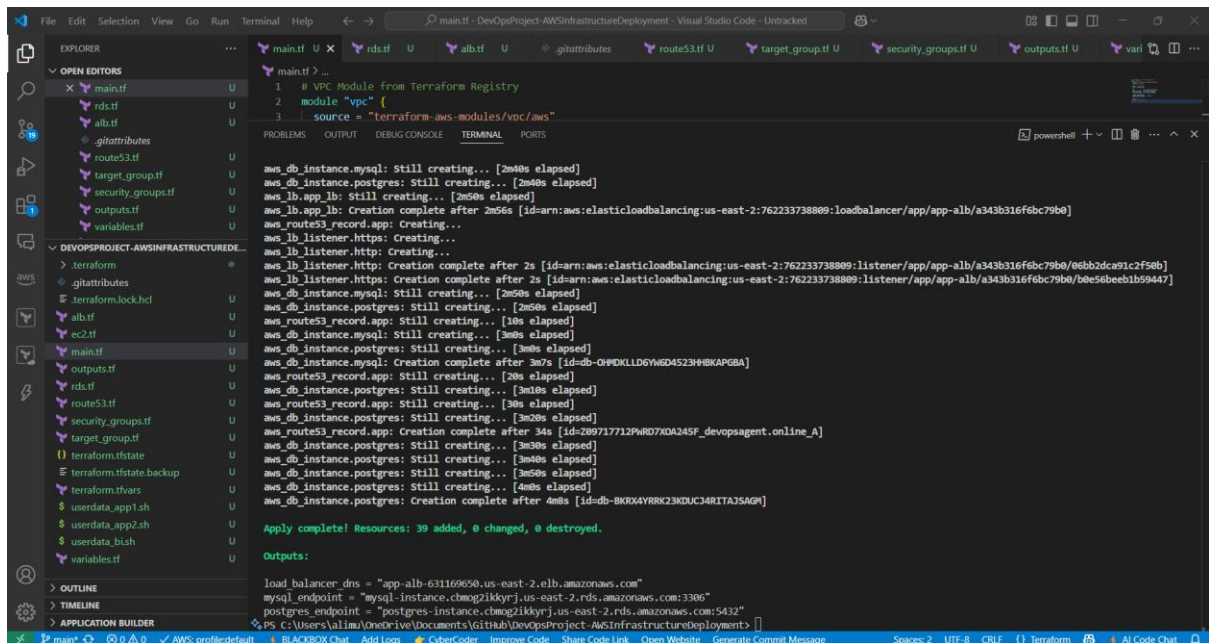
The screenshot shows the Visual Studio Code interface with the Explorer view on the left displaying the same project structure. The main editor shows the 'main.tf' file. The terminal at the bottom displays the command 'terraform plan' and its output, which lists changes to be made to the infrastructure, including adding new resources and updating existing ones.

```
+ id = (known after apply)
+ instance_tenancy = "default"
+ ipv6_association_id = (known after apply)
+ ipv6_cidr_block = (known after apply)
+ ipv6_cidr_block_network_border_group = (known after apply)
+ main_route_table_id = (known after apply)
+ owner_id = (known after apply)
+ tags = {
  + "Name" = "devops-vpc"
}
+ tags_all = {
  + "Name" = "devops-vpc"
}

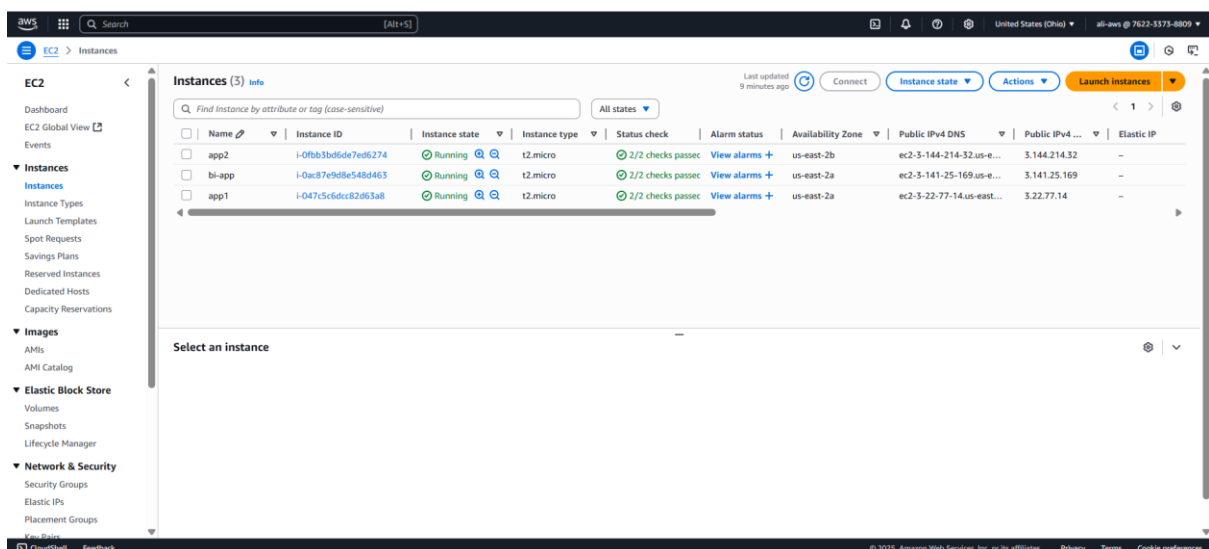
Plan: 39 to add, 0 to change, 0 to destroy.

Changes to Outputs:
+ load_balancer_dns = (known after apply)
+ mysql_endpoint = (known after apply)
+ postgres_endpoint = (known after apply)
```

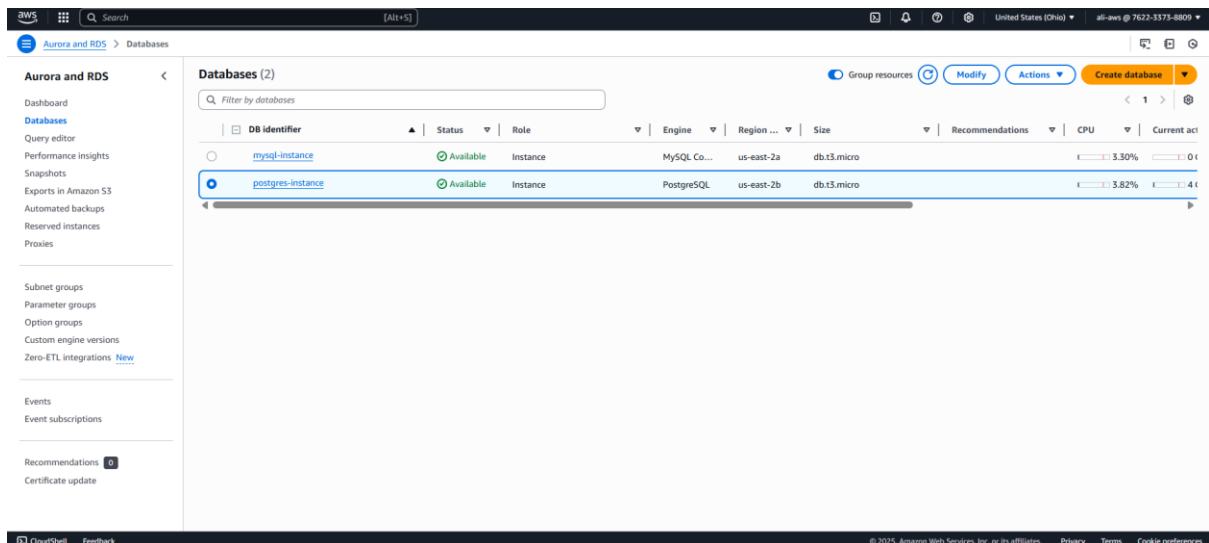
Terraform Apply (Applies the changes defined in the execution plan to the infrastructure, provisioning or modifying resources as necessary):



AWS Console – Infrastructure Provisioned:
EC 2 Instances Created:



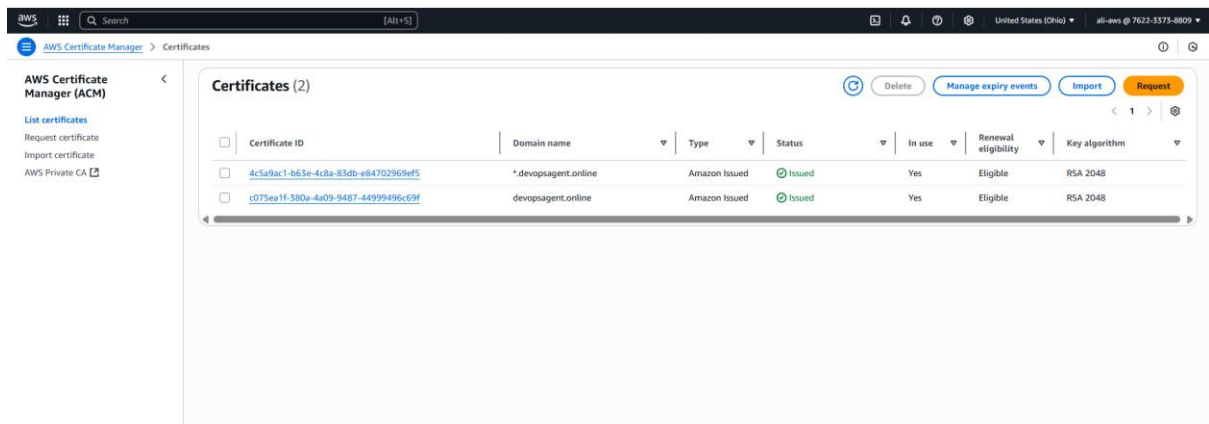
RDS Instances Created:



The screenshot shows the AWS Aurora and RDS Databases console. The left sidebar contains navigation links for Dashboard, Databases, Query editor, Performance insights, Snapshots, Exports in Amazon S3, Automated backups, Reserved instances, Proxies, Subnet groups, Parameter groups, Option groups, Custom engine versions, Zero-ETL integrations, Events, Event subscriptions, Recommendations, and Certificate update. The main content area displays a table of databases with the following columns: DB identifier, Status, Role, Engine, Region, Size, Recommendations, CPU, and Current activity. Two databases are listed: 'mysql-instance' and 'postgres-instance', both with a status of 'Available' and role of 'Instance'. The 'postgres-instance' is highlighted with a blue selection bar.

DB identifier	Status	Role	Engine	Region	Size	Recommendations	CPU	Current activity
mysql-instance	Available	Instance	MySQL Co...	us-east-2a	db.t3.micro		3.30%	0 t
postgres-instance	Available	Instance	PostgreSQL	us-east-2b	db.t3.micro		3.82%	4 t

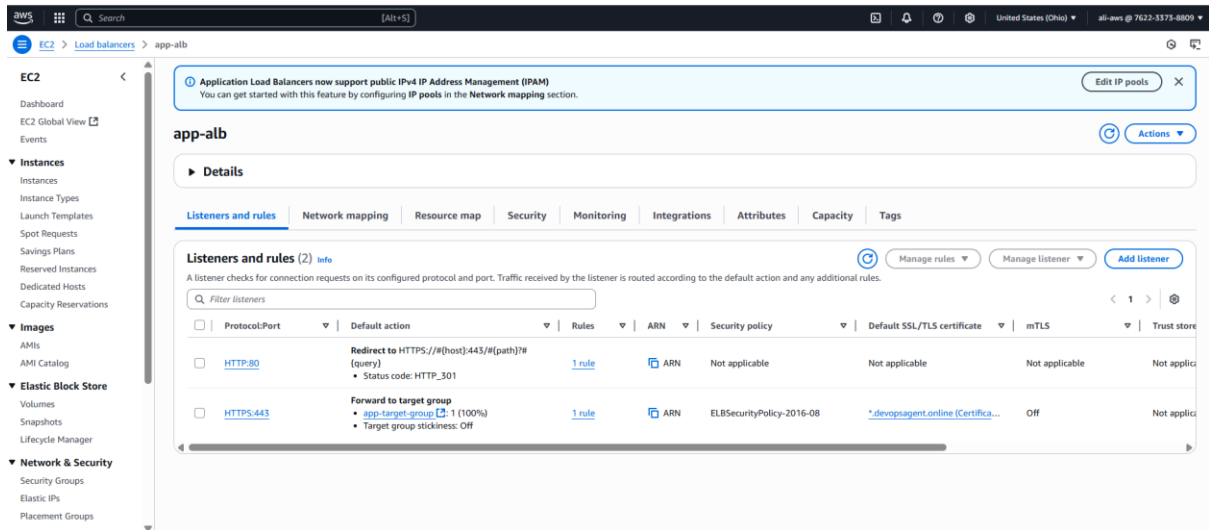
Wild card certificate issued - *.devopsagent.online:



The screenshot shows the AWS Certificate Manager console. The left sidebar contains navigation links for List certificates, Request certificate, Import certificate, and AWS Private CA. The main content area displays a table of certificates with the following columns: Certificate ID, Domain name, Type, Status, In use, Renewal eligibility, and Key algorithm. Two certificates are listed: one for '*.devopsagent.online' and another for 'devopsagent.online', both with a status of 'Issued' and key algorithm of 'RSA 2048'.

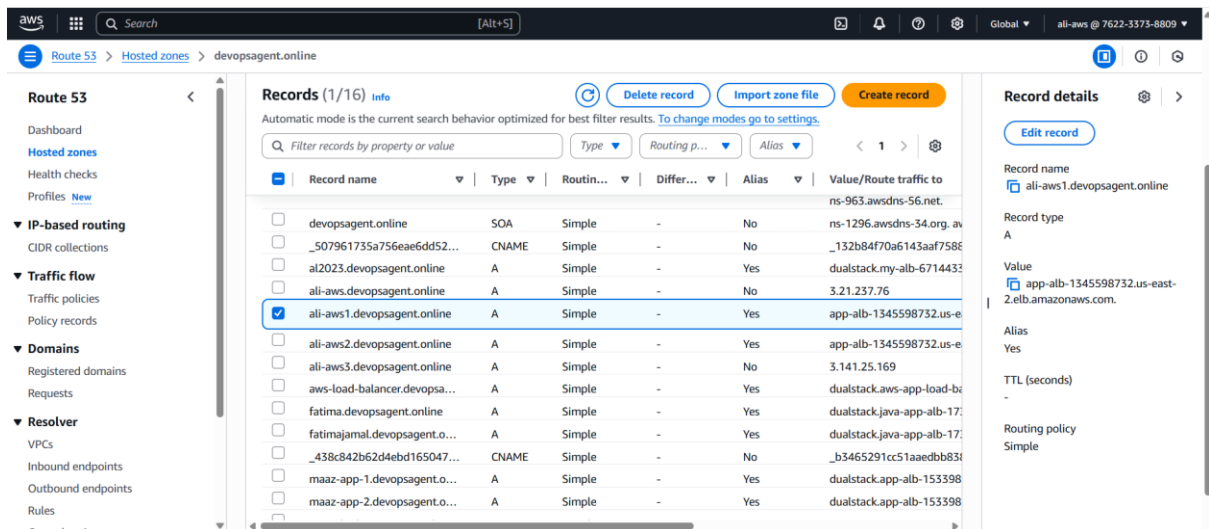
Certificate ID	Domain name	Type	Status	In use	Renewal eligibility	Key algorithm
4c5a9ac1-b63e-4c8a-83db-e84702909ef5	*.devopsagent.online	Amazon Issued	Issued	Yes	Eligible	RSA 2048
c075ea1f-380a-4a09-9487-44999496c69f	devopsagent.online	Amazon Issued	Issued	Yes	Eligible	RSA 2048

Load Balancer provisioned with required listeners and rules:



ALB and IP Values mapped with the domain names using Route 53:

App 1:



App 2:

Route 53

Dashboard
Hosted zones
Health checks
Profiles [New](#)

▼ **IP-based routing**
CIDR collections

▼ **Traffic flow**
Traffic policies
Policy records

▼ **Domains**
Registered domains
Requests

▼ **Resolver**
VPCs
Inbound endpoints
Outbound endpoints
Rules

Records (1/16) Info

Automatic mode is the current search behavior optimized for best filter results. [To change modes go to settings.](#)

Filter records by property or value

Type Routing p... Alias

< 1 >

Record name	Type	Routin...	Differ...	Alias	Value/Route traffic to
<input type="checkbox"/> devopsagent.online	SOA	Simple	-	No	ns-963.awsdns-56.net.
<input type="checkbox"/> _507961735a756eae6dd52...	CNAME	Simple	-	No	_132b84f70a6143aaf758e...
<input type="checkbox"/> al2023.devopsagent.online	A	Simple	-	Yes	dualstack.my-alb-6714433...
<input type="checkbox"/> ali-aws.devopsagent.online	A	Simple	-	No	3.21.237.76
<input type="checkbox"/> ali-aws1.devopsagent.online	A	Simple	-	Yes	app-alb-1345598732.us-e...
<input checked="" type="checkbox"/> ali-aws2.devopsagent.online	A	Simple	-	Yes	app-alb-1345598732.us-e...
<input type="checkbox"/> ali-aws3.devopsagent.online	A	Simple	-	No	3.141.25.169
<input type="checkbox"/> aws-load-balancer.devopsa...	A	Simple	-	Yes	dualstack.aws-app-load-b...
<input type="checkbox"/> fatima.devopsagent.online	A	Simple	-	Yes	dualstack.java-app-alb-17...
<input type="checkbox"/> fatimajamal.devopsagent.o...	A	Simple	-	Yes	dualstack.java-app-alb-17...
<input type="checkbox"/> _438c842b62d4ebd165047...	CNAME	Simple	-	No	_b3465291cc51aadb83f...
<input type="checkbox"/> maaz-app-1.devopsagent.o...	A	Simple	-	Yes	dualstack.app-alb-153398...
<input type="checkbox"/> maaz-app-2.devopsagent.o...	A	Simple	-	Yes	dualstack.app-alb-153398...

Record details

[Edit record](#)

Record name
ali-aws2.devopsagent.online

Record type
A

Value
app-alb-1345598732.us-east-2.elb.amazonaws.com.

Alias
Yes

TTL (seconds)
-

Routing policy
Simple

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BI-APP:

Route 53

Dashboard
Hosted zones
Health checks
Profiles [New](#)

▼ **IP-based routing**
CIDR collections

▼ **Traffic flow**
Traffic policies
Policy records

▼ **Domains**
Registered domains
Requests

▼ **Resolver**
VPCs
Inbound endpoints
Outbound endpoints
Rules

Records (1/16) Info

Automatic mode is the current search behavior optimized for best filter results. [To change modes go to settings.](#)

Filter records by property or value

Type Routing p... Alias

< 1 >

Record name	Type	Routin...	Differ...	Alias	Value/Route traffic to
<input type="checkbox"/> devopsagent.online	SOA	Simple	-	No	ns-963.awsdns-56.net.
<input type="checkbox"/> _507961735a756eae6dd52...	CNAME	Simple	-	No	_132b84f70a6143aaf758e...
<input type="checkbox"/> al2023.devopsagent.online	A	Simple	-	Yes	dualstack.my-alb-6714433...
<input type="checkbox"/> ali-aws.devopsagent.online	A	Simple	-	No	3.21.237.76
<input type="checkbox"/> ali-aws1.devopsagent.online	A	Simple	-	Yes	app-alb-1345598732.us-e...
<input type="checkbox"/> ali-aws2.devopsagent.online	A	Simple	-	Yes	app-alb-1345598732.us-e...
<input checked="" type="checkbox"/> ali-aws3.devopsagent.online	A	Simple	-	No	3.141.25.169
<input type="checkbox"/> aws-load-balancer.devopsa...	A	Simple	-	Yes	dualstack.aws-app-load-b...
<input type="checkbox"/> fatima.devopsagent.online	A	Simple	-	Yes	dualstack.java-app-alb-17...
<input type="checkbox"/> fatimajamal.devopsagent.o...	A	Simple	-	Yes	dualstack.java-app-alb-17...
<input type="checkbox"/> _438c842b62d4ebd165047...	CNAME	Simple	-	No	_b3465291cc51aadb83f...
<input type="checkbox"/> maaz-app-1.devopsagent.o...	A	Simple	-	Yes	dualstack.app-alb-153398...
<input type="checkbox"/> maaz-app-2.devopsagent.o...	A	Simple	-	Yes	dualstack.app-alb-153398...

Record details

[Edit record](#)

Record name
ali-aws3.devopsagent.online

Record type
A

Value
3.141.25.169

Alias
No

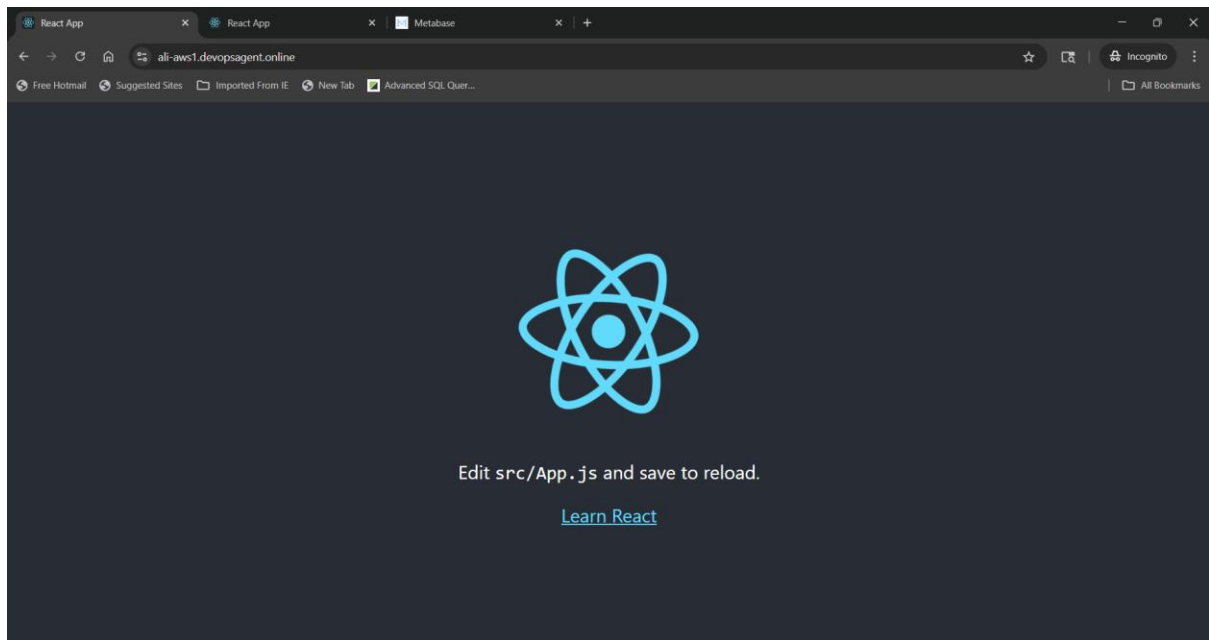
TTL (seconds)
300

Routing policy
Simple

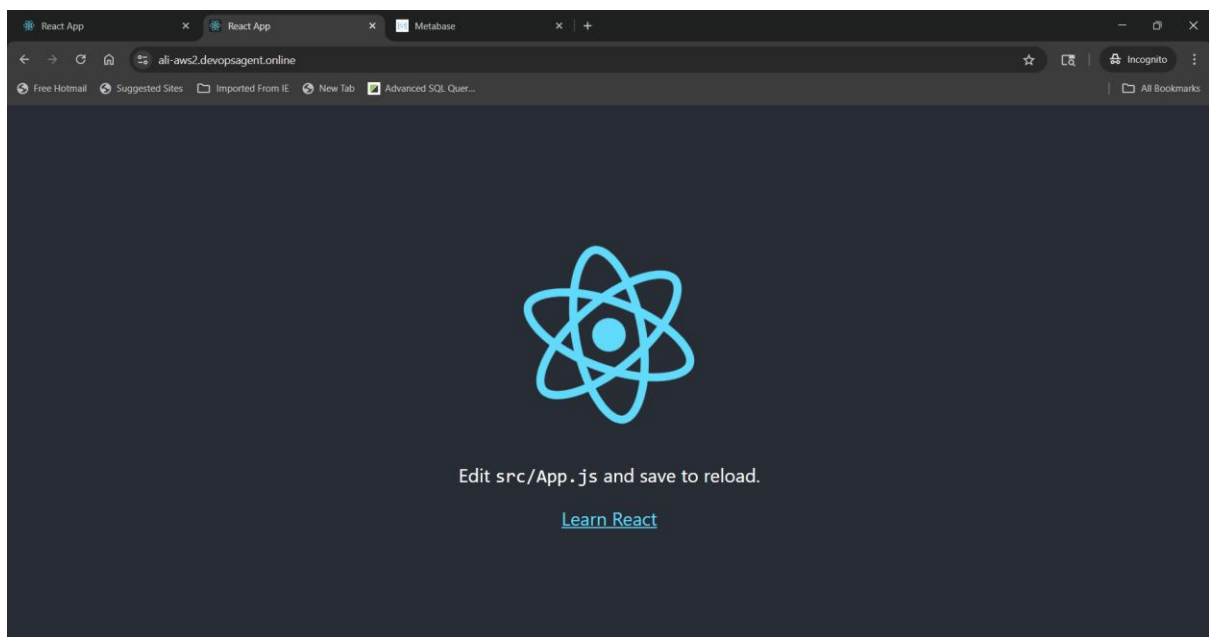
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Accessing Apps (SSL Enabled):

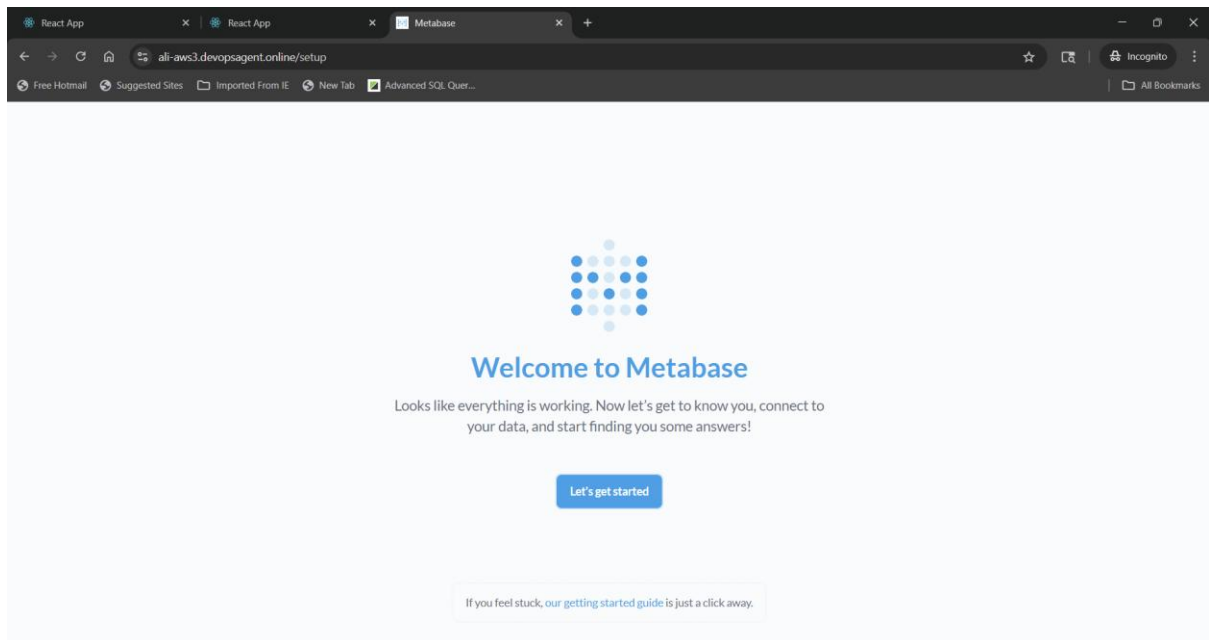
APP 1:



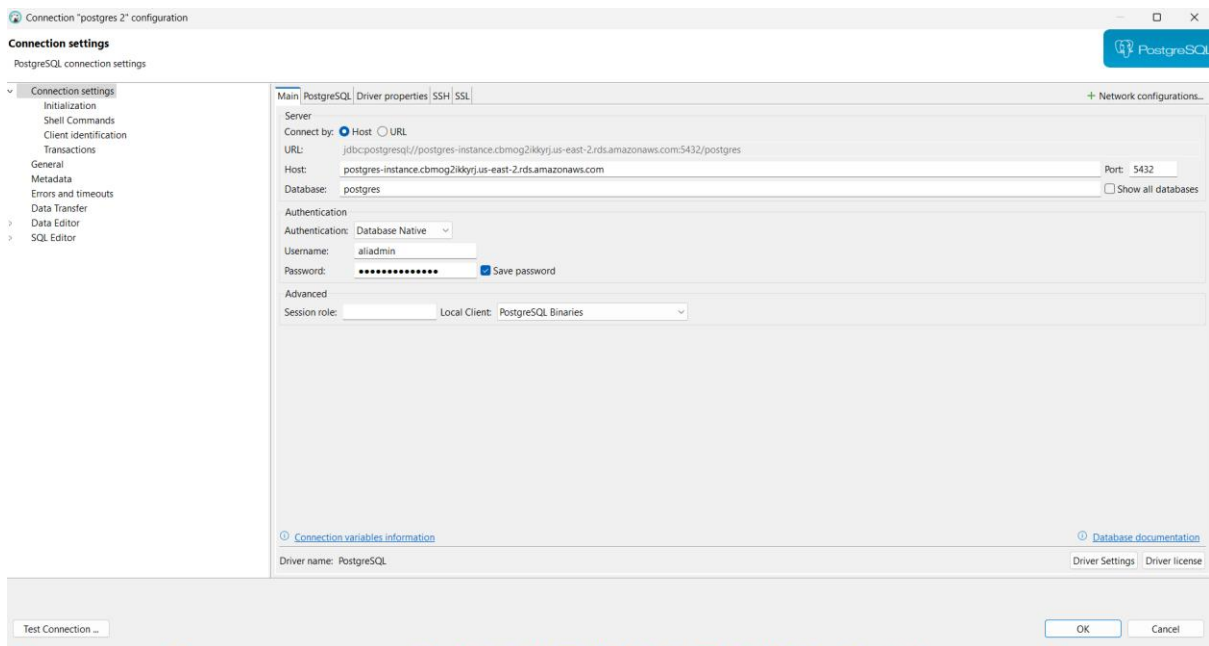
APP 2:

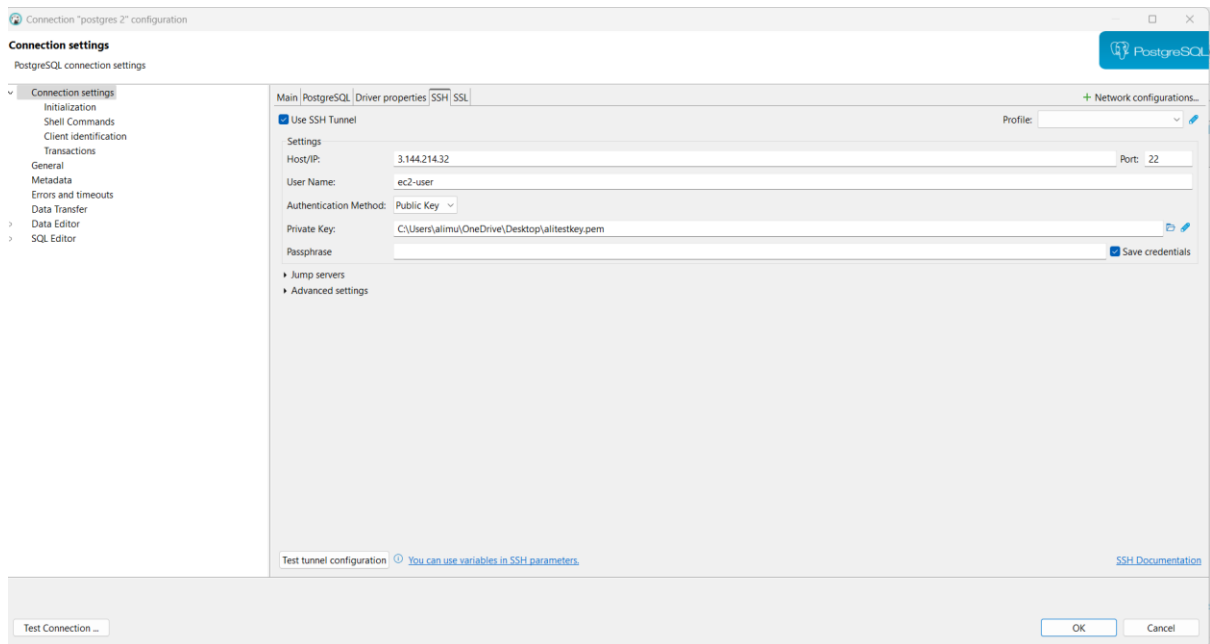


BI-APP:



D Beaver Configurations to establish Connection:





Script to create table:

```

DROP TABLE IF EXISTS employees;

CREATE TABLE employees (
    id SERIAL PRIMARY KEY,
    name VARCHAR(100),
    department VARCHAR(50),
    salary INT,
    hire_date DATE,
    location VARCHAR(100)
);

```

Script to insert record into table:

```

INSERT INTO employees (name, department, salary, hire_date, location) VALUES
('John Doe', 'Engineering', 90000, '2015-06-15', 'New York'),
('Jane Smith', 'HR', 75000, '2017-04-20', 'San Francisco'),
('Jim Brown', 'Sales', 50000, '2019-03-10', 'Chicago'),
('Emily Davis', 'Marketing', 65000, '2018-11-30', 'Austin'),
('Michael Wilson', 'Engineering', 95000, '2016-05-11', 'New York'),
('Sara Lee', 'Engineering', 85000, '2018-02-22', 'San Francisco'),
('Chris Clark', 'Sales', 45000, '2020-07-15', 'Chicago'),
('Rachel Harris', 'HR', 72000, '2019-01-30', 'San Francisco'),
('David Lewis', 'Marketing', 68000, '2017-08-19', 'Austin'),
('Sophia Walker', 'Sales', 55000, '2021-01-25', 'Chicago');

```

Employees Table Created:

[illegible]

Metabase Setup:

✓

Your language is set to English

2

What should we call you?

First name

Ali

Last name

Muhammad

Email

aaalimohdaslam@gmail.com

Company or team name

IBA

Create a password

●●●●●●●●●●

Confirm your password

●●●●●●●●●●

4

Add your data

Are you ready to start exploring your data? Add it below.
Not ready? Skip and play around with our Sample Database.

PostgreSQL



Display name

Employees DB



Host

postgres-instance.cbmog2ikkyrj.us-east-2.rds.amazonaws.com



Port

5432

Database name

postgres

Username

aliadmin

Password

●●●●●●●●●●●●●●●●

Schemas

All



Hi, Ali. Nice to meet you!



I'll do a bit of both self-service and embedding



Connecting to Employees DB

5

Usage data preferences

In order to help us improve Metabase, we'd like to collect certain data about product usage.
[Here's a full list of what we track and why.](#)



Allow Metabase to anonymously collect usage events

- Metabase **never** collects anything about your data or question results.
- All collection is completely anonymous.
- Collection can be turned off at any point in your admin settings.

Finish

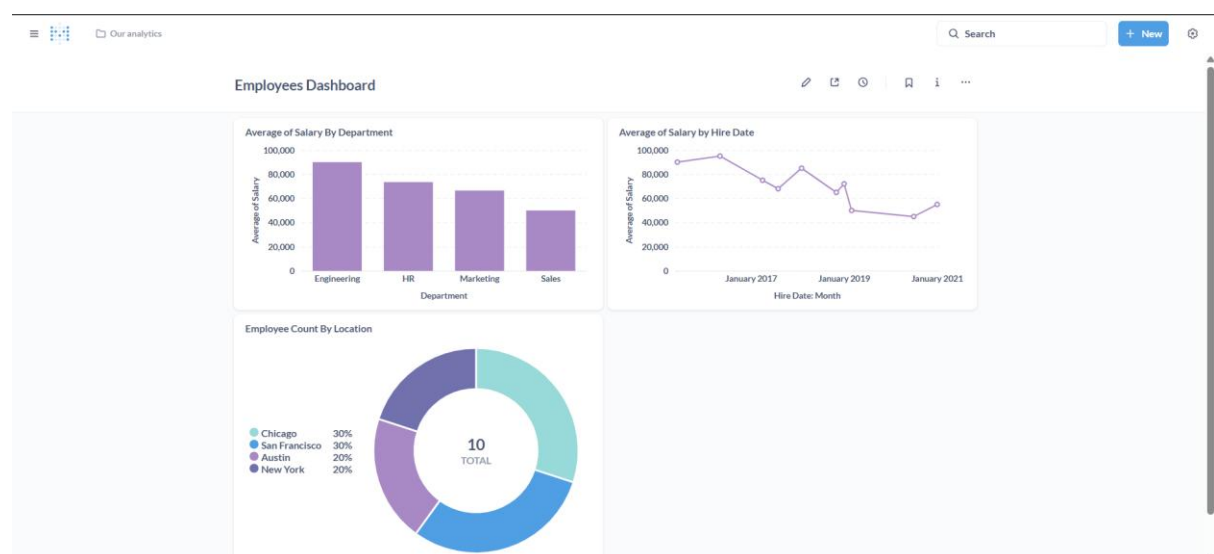
Employees Table Accessible Through Metabase:

Employees DB / Employees

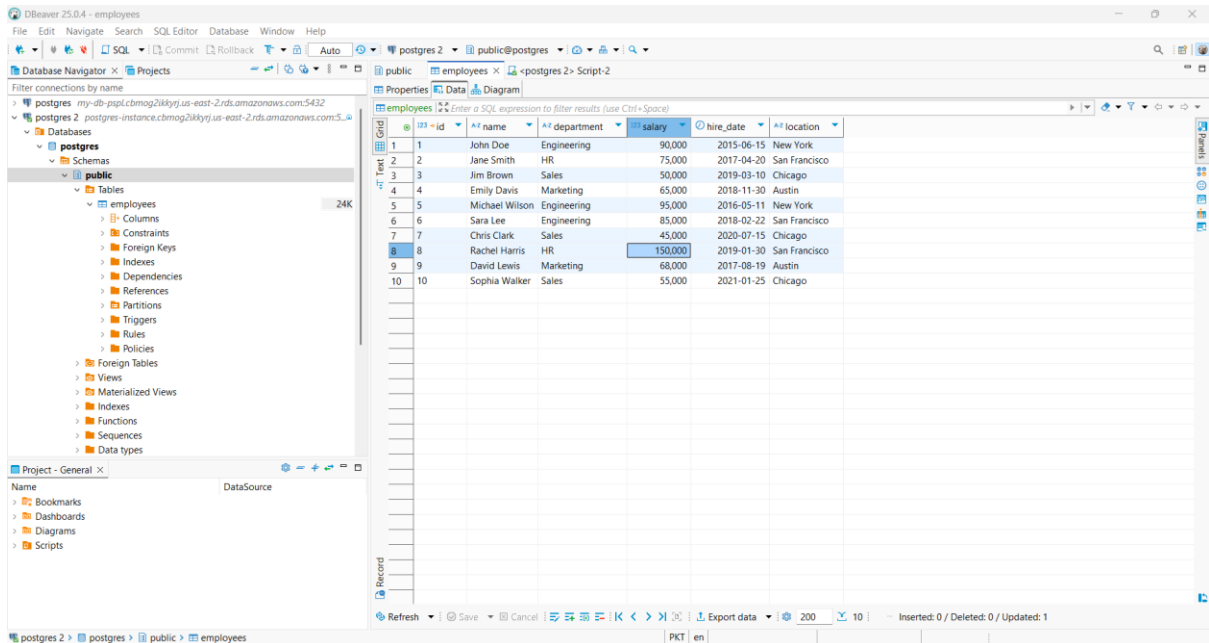
ID	Name	Department	Salary	Hire Date	Location	+
1	John Doe	Engineering	90,000	June 15, 2015	New York	
2	Jane Smith	HR	75,000	April 20, 2017	San Francisco	
3	Jim Brown	Sales	50,000	March 10, 2019	Chicago	
4	Emily Davis	Marketing	65,000	November 30, 2018	Austin	
5	Michael Wilson	Engineering	95,000	May 11, 2016	New York	
6	Sara Lee	Engineering	85,000	February 22, 2018	San Francisco	
7	Chris Clark	Sales	45,000	July 15, 2020	Chicago	
8	Rachel Harris	HR	72,000	January 30, 2019	San Francisco	
9	David Lewis	Marketing	68,000	August 19, 2017	Austin	
10	Sophia Walker	Sales	55,000	January 25, 2021	Chicago	

Visualization

Employees Dashboard Created:



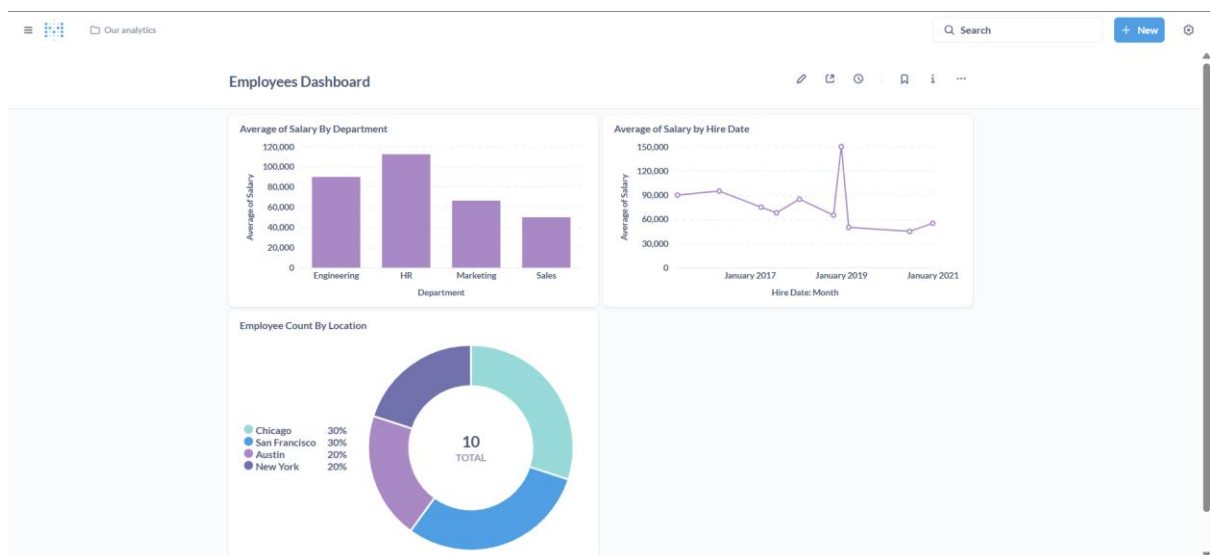
Editing a record (Rachel Harris Salary) in D Beaver:



The screenshot shows the DBeaver 25.0.4 interface. The 'employees' table is selected in the 'Database Navigator' on the left. The main window displays the table data in a grid. The record for Rachel Harris (id 8) is highlighted, and the 'salary' field is being edited, showing a value of 150,000. The table has columns: id, name, department, salary, hire_date, and location.

id	name	department	salary	hire_date	location
1	John Doe	Engineering	90,000	2015-06-15	New York
2	Jane Smith	HR	75,000	2017-04-20	San Francisco
3	Jim Brown	Sales	50,000	2019-03-10	Chicago
4	Emily Davis	Marketing	65,000	2018-11-30	Austin
5	Michael Wilson	Engineering	95,000	2016-05-11	New York
6	Sara Lee	Engineering	85,000	2018-02-22	San Francisco
7	Chris Clark	Sales	45,000	2020-07-15	Chicago
8	Rachel Harris	HR	150,000	2019-01-30	San Francisco
9	David Lewis	Marketing	68,000	2017-08-19	Austin
10	Sophia Walker	Sales	55,000	2021-01-25	Chicago

Dashboard in Metabase updated in Real Time (Average Salary of HR increased – Bar Chart):



Editing a record (Rache Harris location) in D Beaver:

DBeaver 25.0.4 - employees

File Edit Navigate Search SQL Editor Database Window Help

Database Navigator Projects

Filter connections by name

- postgres my-db-papl.cbmg2kkyj.us-east-2.rds.amazonaws.com:5432
- postgres postgres-instance.cbmg2kkyj.us-east-2.rds.amazonaws.com:5432

Databases

- postgres
 - Schemas
 - public
 - Tables
 - employees 24K
 - Columns
 - Constraints
 - Foreign Keys
 - Indexes
 - Dependencies
 - References
 - Partitions
 - Triggers
 - Rules
 - Policies
 - Foreign Tables
 - Views
 - Materialized Views
 - Indexes
 - Functions
 - Sequences
 - Data types

Project - General

Name DataSource

- Bookmarks
- Dashboards
- Diagrams
- Scripts

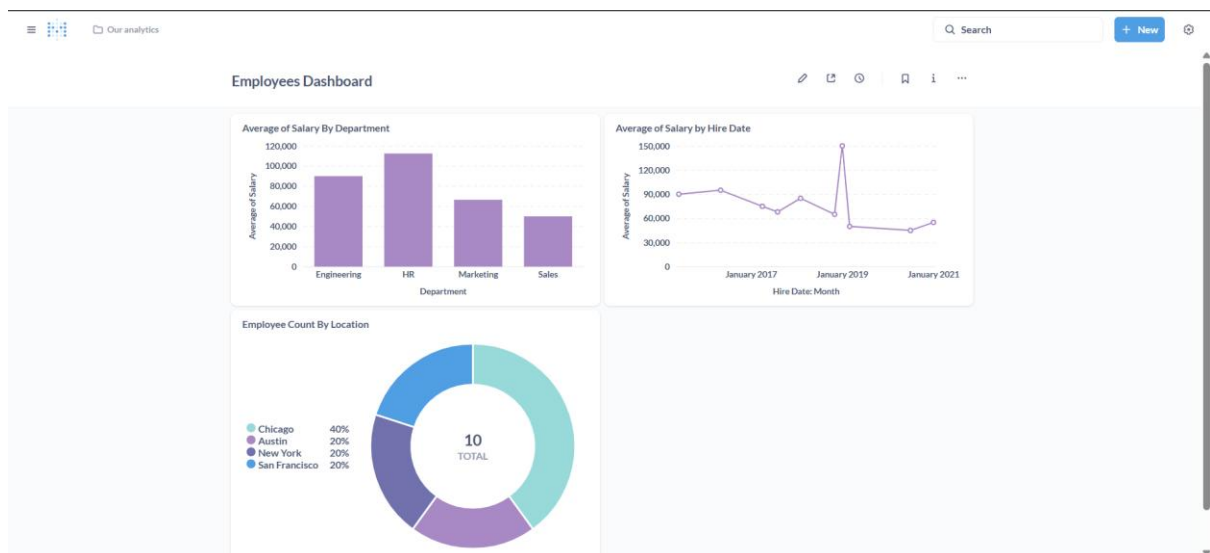
employees

Enter a SQL expression to filter results (use Ctrl+Space)

id	name	department	salary	hire_date	location
1	John Doe	Engineering	90,000	2015-06-15	New York
2	Jane Smith	HR	75,000	2017-04-20	San Francisco
3	Jim Brown	Sales	50,000	2019-03-10	Chicago
4	Emily Davis	Marketing	65,000	2018-11-30	Austin
5	Michael Wilson	Engineering	95,000	2016-05-11	New York
6	Sara Lee	Engineering	85,000	2018-02-22	San Francisco
7	Chris Clark	Sales	45,000	2020-07-15	Chicago
8	Rachel Harris	HR	150,000	2019-01-30	Chicago
9	David Lewis	Marketing	68,000	2017-08-19	Austin
10	Sophia Walker	Sales	55,000	2021-01-25	Chicago

Refresh Save Cancel Export data 200 10 Inserted: 0 / Deleted: 0 / Updated: 1

Dashboard in Metabase updated in Real Time (Count of Chicago Increased and San Francisco Decreased):



Destroyed Resources Provisioned By Terraform (Ran terraform destroy command):

