

DevOps Project - Report

Project Title

Secure and Scalable AWS Infrastructure for Java Login App with BI Integration

GitHub Repository: <https://github.com/Fatima-jamal/multi-stage-docker-app>

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1. Introduction

This project represents a comprehensive, real-world implementation of modern DevOps principles. It demonstrates the end-to-end deployment of a containerized Java Login Application on Amazon Web Services (AWS) using Terraform for infrastructure automation and Docker for containerization. The infrastructure is designed to be production-ready—ensuring scalability, security, and observability. With the integration of Metabase as a Business Intelligence (BI) tool, the project also adds real-time data analytics capabilities. The architecture leverages multiple AWS services such as EC2, RDS, ALB, Route 53, ACM, and VPC, organized through modular Terraform code to enable repeatability and maintainability. This report explains in detail the motivation, architecture, setup, and learnings derived from executing this project.

2. Problem Statement

In traditional setups, deploying scalable and secure web applications requires manual configuration of servers, databases, networking, and access controls. This approach is not only time-consuming but also highly prone to human error, lacks scalability, and increases the surface area for security vulnerabilities. Furthermore, monitoring and analytics often come as an afterthought, resulting in poor operational visibility. There is a growing need for automated, codified infrastructure that is secure, reusable, and observable. Organizations require mechanisms to provision and deprovision resources reliably, enforce security policies through code, and provide actionable business insights in real-time.

3. Objective

The goal of this project is to build and deploy a production-grade infrastructure for a Java Login Application using DevOps practices. Key objectives include:

- Deploying the application on EC2 instances managed by an Auto Scaling Group (ASG).
- Placing a PostgreSQL RDS instance in private subnets to isolate database access.
- Creating a public-facing ALB with listeners to distribute traffic to EC2 targets.
- Deploying Metabase on a separate EC2 instance to enable BI analytics.
- Using Terraform to automate the provisioning of all resources.
- Enabling Docker-based multi-stage builds for efficient application packaging.
- Preparing the system for CI/CD pipelines.
- Ensuring that all communication between components is secured and access is controlled.

4. Methodology

This project was executed using an **incremental and modular DevOps approach**, aligned with real-world cloud deployment practices. The process began with defining core infrastructure components such as VPC, subnets, route tables, and security groups. Once the network layer was in place, Terraform modules were developed for compute (EC2 + ASG), storage (RDS), and routing (ALB). Each component was tested individually before integration.

Docker was used to containerize a Java-based login application. The Docker image was pushed to DockerHub, and the EC2 instances were configured with a user data script to pull and run the latest image. CI/CD automation was implemented using GitHub Actions for build and deployment. Metabase was deployed on a dedicated EC2 instance to enable business intelligence via PostgreSQL RDS integration.

5. Technologies and Tools Used

Cloud Provider: AWS (EC2, RDS, ALB, IAM, Route 53, ACM, VPC)

IaC: Terraform (modular structure)

Containerization: Docker (multi-stage build)

Programming Language: Java (Spring Boot)

BI Tool: Metabase

Others: GitHub, PostgreSQL, Bash scripting

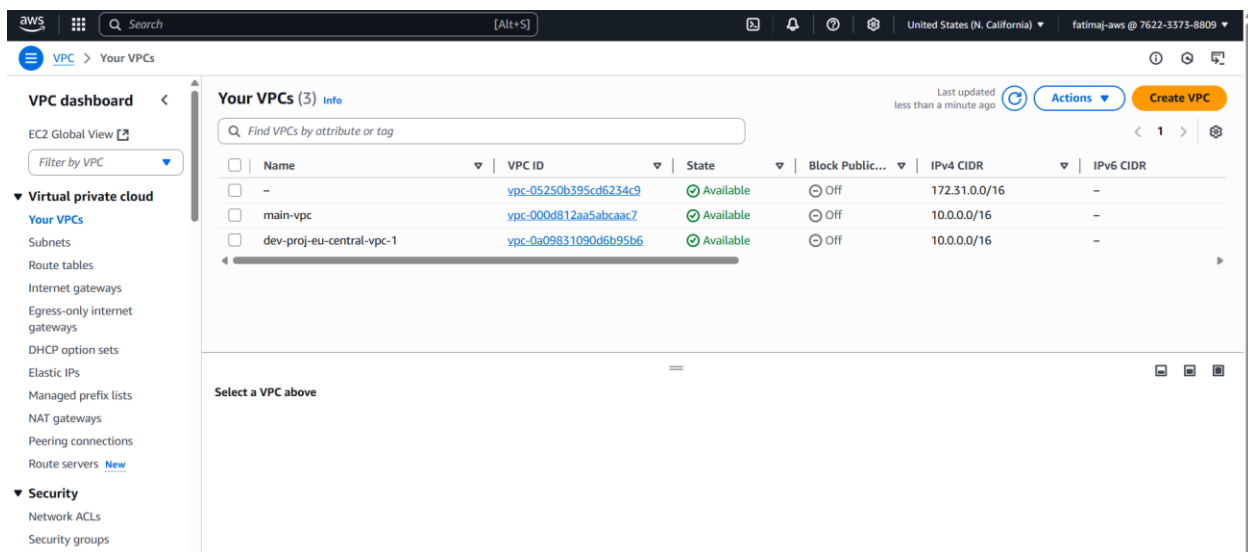
6. Architecture Overview

The project uses a 3-tier cloud architecture with strict isolation of layers for security and maintainability.

- The **networking layer** includes a custom VPC with public and private subnets across multiple Availability Zones.
- The **application layer** uses a Launch Template and Auto Scaling Group to host Dockerized Java Login App containers on EC2.
- The **data layer** consists of a PostgreSQL RDS instance deployed in private subnets to avoid public exposure.
- The **BI Layer** is Metabase, deployed on a separate EC2 instance in a public subnet, with security group rules that allow it to access the RDS internally.

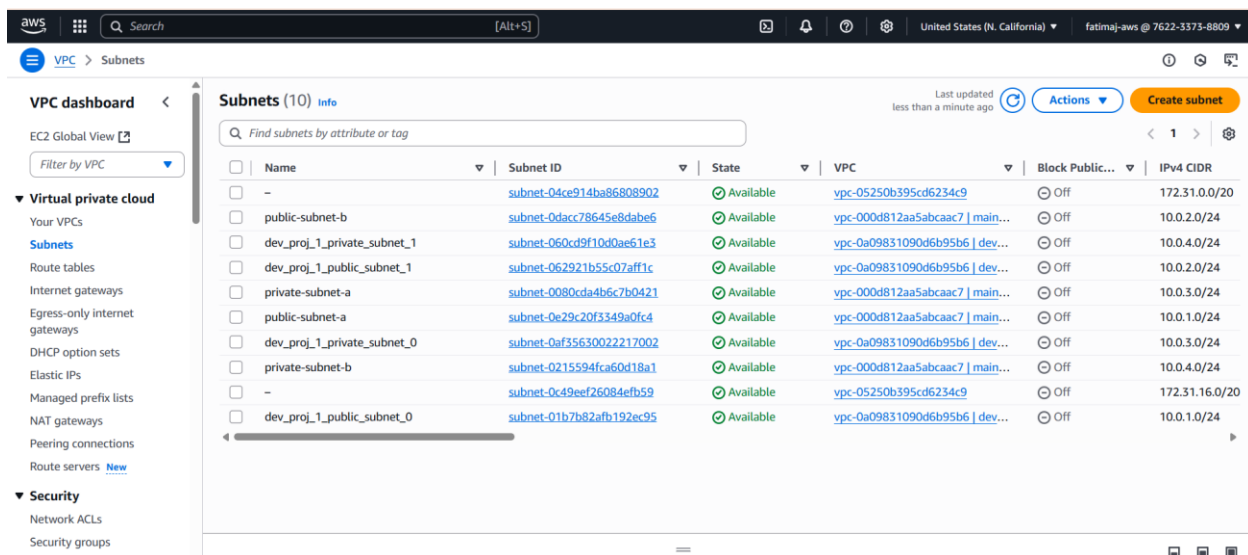
Routing is handled via an Application Load Balancer, which forwards traffic from port 80/443 to port 8080 on EC2 instances.

Screenshot: AWS VPC Configuration – main-vpc



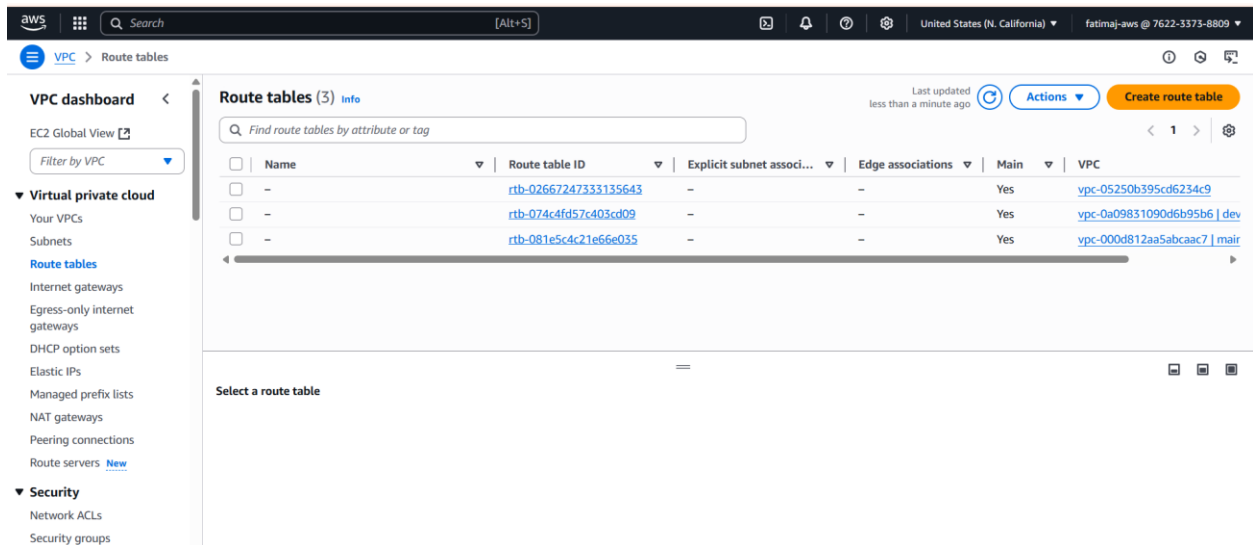
This screenshot displays the primary Virtual Private Cloud (VPC) named `main-vpc`, configured with a `10.0.0.0/16` CIDR block. It is the foundational networking layer hosting our EC2 instances, ALB, and RDS across public and private subnets.

Screenshot: AWS Subnet Configuration – Public and Private Subnets



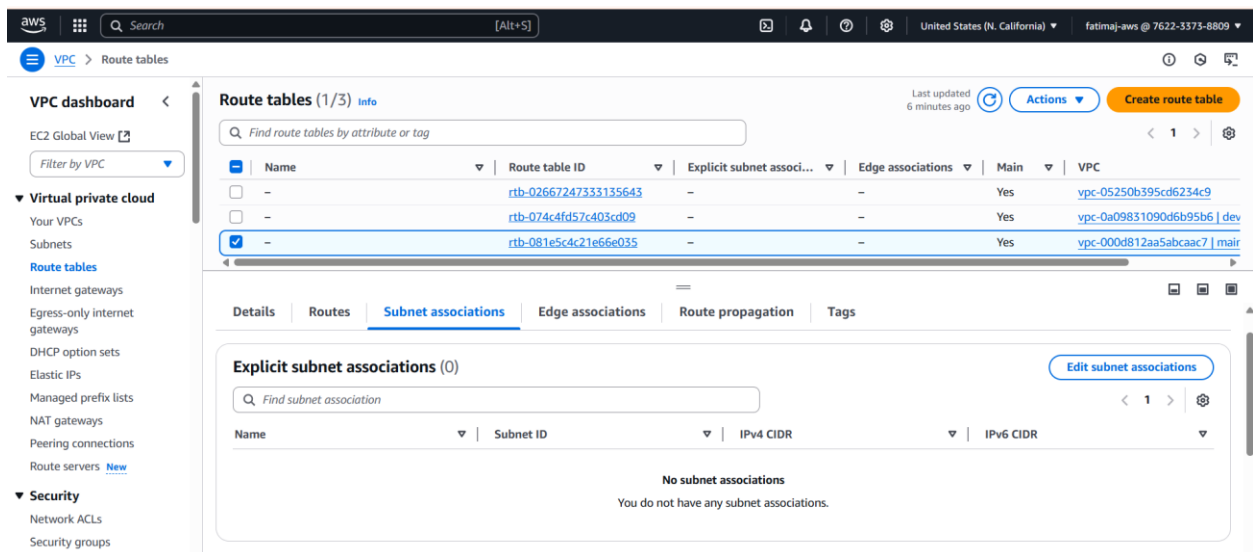
This screenshot shows the set of public and private subnets created within the `main-vpc`. These subnets are strategically divided into network isolation and scalability. Public subnets host the ALB and Metabase EC2 instances, while private subnets securely isolate the PostgreSQL RDS and application EC2 instances. Subnet naming follows a consistent convention for clarity in module referencing.

Screenshot: Route Table Configuration – Public and Private Subnets



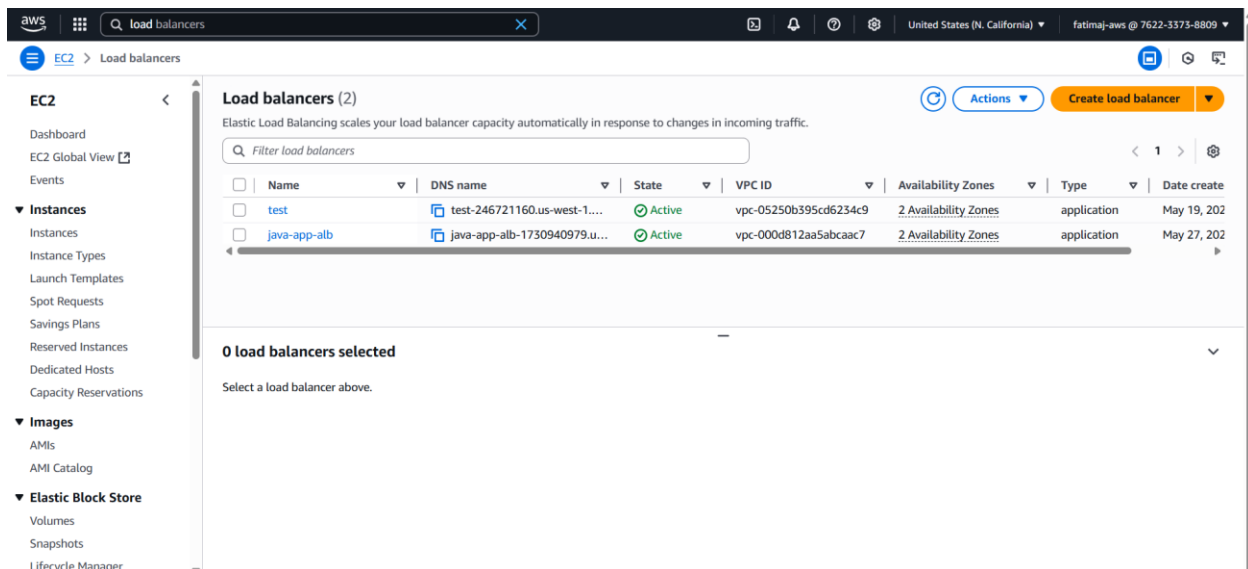
This screenshot presents the Route Tables associated with the VPC. Each table routes traffic between public and private subnets, controlling internet access. Public subnets are linked to route tables with internet gateway targets for outbound traffic (used by ALB and Metabase), whereas private subnets route only within the VPC for secure database access.

Screenshot: Route Table Subnet Associations – main-vpc



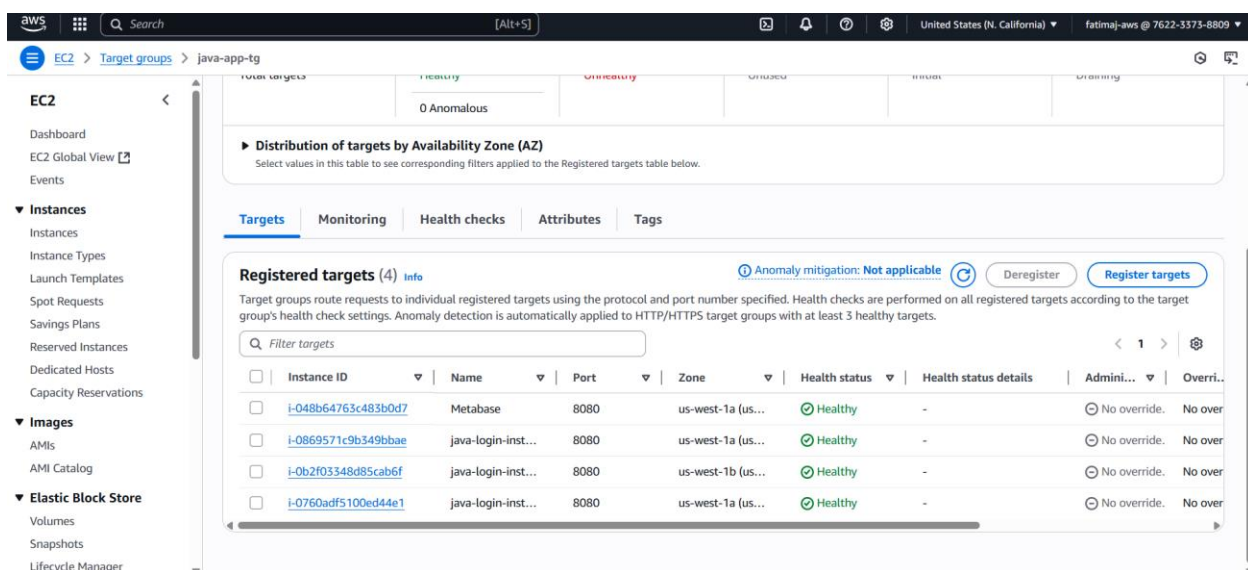
This screenshot displays the subnet association tab for the route table attached to the main-vpc. The absence of explicit subnet associations here indicates that this route table likely uses implicit or default associations, or that the mapping will be handled via Terraform. This is a common pattern when the modular Infrastructure Code separates subnet creation and routing logic.

Screenshot: ALB Overview – java-app-alb



This shows the Application Load Balancer named `java-app-alb`, configured in VPC `main-vpc` and deployed across two availability zones. It serves as the entry point for incoming user traffic, forwarding it to the EC2 Auto Scaling Group running the Java app.

Screenshot: ALB Target Group – Healthy Instances



This screenshot shows the registered targets within the Application Load Balancer's target group. All EC2 instances running the Java login app, along with the Metabase instance, show a Healthy

status, indicating successful health checks and traffic routing.

7. Project Setup & Deployment

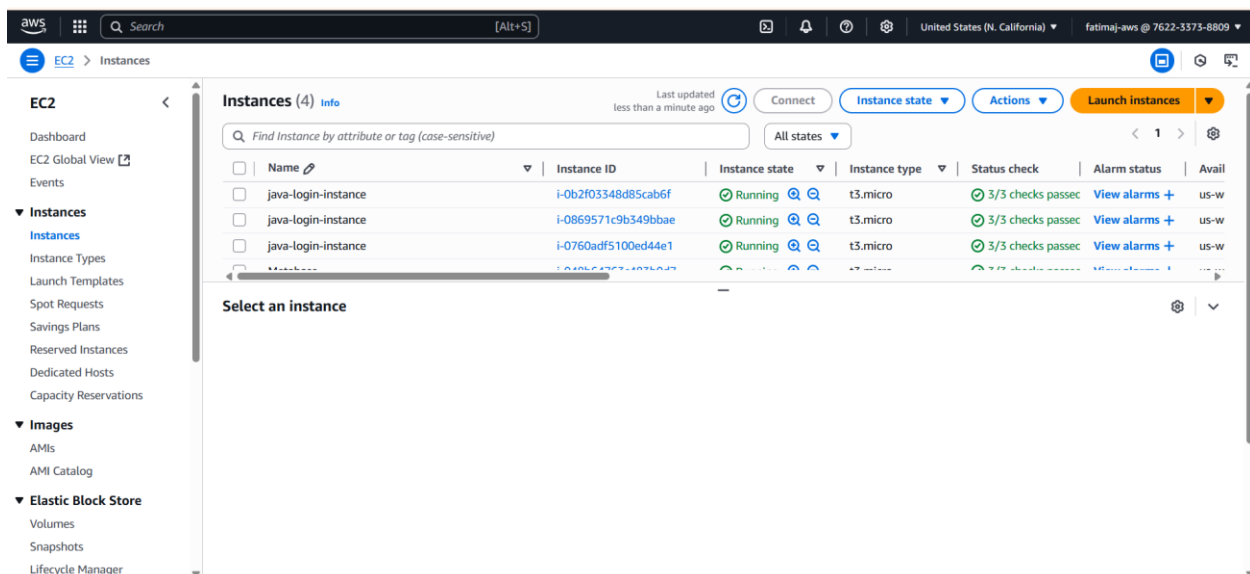
The project was structured using a modular Terraform setup with a central `main.tf` file calling individual modules. Each module—VPC, EC2, ALB, ASG, RDS, and Security Groups—was developed and tested independently. EC2 instances used launch templates with a bootstrap script (`user_data.sh`) that installed Docker and pulled the Java Login App image from the Docker Hub. The ALB was configured to direct traffic to EC2 instances on port 8080. RDS was provisioned in private subnets with no public IP, and connectivity was tested using an SSH tunnel from the EC2 instance. Metabase was deployed in a public subnet and exposed via port 3000. Post-deployment, DNS, and SSL were set up using Route 53 and ACM.

The Terraform codebase is modular, reusable, and scalable.

- `main.tf` includes all modules.
- `terraform.tfvars` injects variables across modules.
- Modules include: `vpc`, `alb`, `asg`, `ec2`, `rds`, `rds_sg`, `security_groups`, `metabase`.

This structure allowed iterative development, simplified debugging, and easier extension of infrastructure. All resources are version-controlled through GitHub.

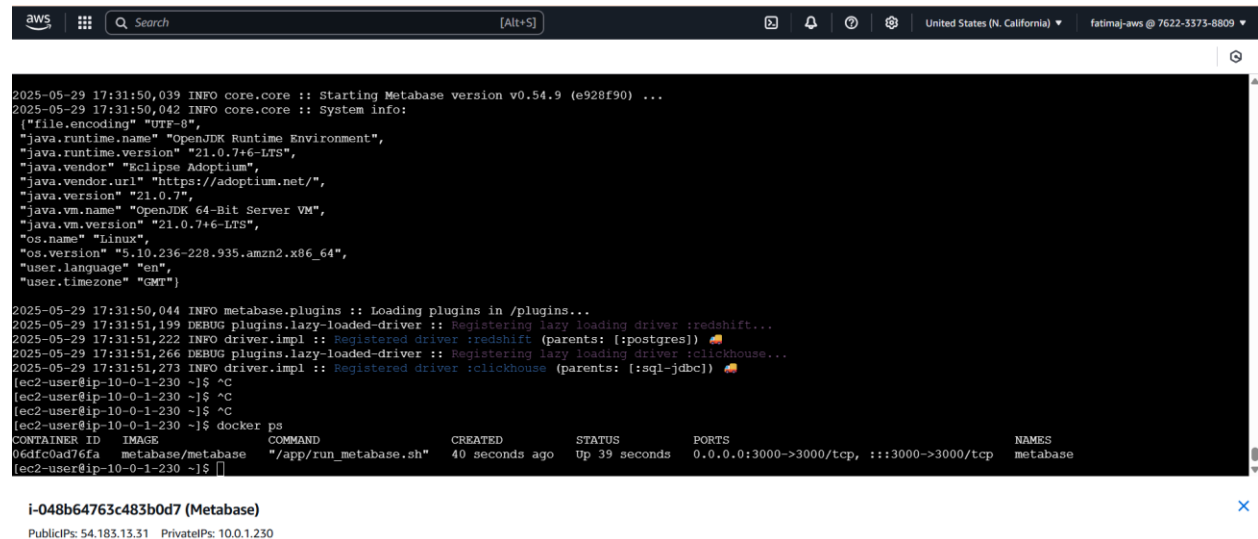
Screenshot: AWS EC2 Instances – Application and Metabase



This screenshot highlights four EC2 instances deployed as part of the project's Auto Scaling Group and BI infrastructure. The `java-login-instance` entries represent application containers

provisioned in public subnets behind an ALB, while the dedicated Metabase instance runs a containerized BI dashboard, deployed manually in a separate public subnet with SSH access enabled for Docker interaction.

Screenshot: Metabase Container Running via Docker



The screenshot shows an AWS Management Console terminal window with the following content:

```
2025-05-29 17:31:50,039 INFO core.core :: Starting Metabase version v0.54.9 (e928f90) ...
2025-05-29 17:31:50,042 INFO core.core :: System info:
{"file.encoding" "UTF-8",
 "java.runtime.name" "OpenJDK Runtime Environment",
 "java.runtime.version" "21.0.7+6-LTS",
 "java.vendor" "Eclipse Adoptium",
 "java.vendor.url" "https://adoptium.net/",
 "java.version" "21.0.7",
 "java.vm.name" "OpenJDK 64-Bit Server VM",
 "java.vm.version" "21.0.7+6-LTS",
 "os.name" "Linux",
 "os.version" "5.10.236-228.935.amzn2.x86_64",
 "user.language" "en",
 "user.timezone" "GMT"}

2025-05-29 17:31:50,044 INFO metabase.plugins :: Loading plugins in /plugins...
2025-05-29 17:31:51,199 DEBUG plugins.lazy-loaded-driver :: Registering lazy loading driver :redshift...
2025-05-29 17:31:51,222 INFO driver.impl :: Registered driver :redshift (parents: [:postgres]) 🚀
2025-05-29 17:31:51,266 DEBUG plugins.lazy-loaded-driver :: Registering lazy loading driver :clickhouse...
2025-05-29 17:31:51,273 INFO driver.impl :: Registered driver :clickhouse (parents: [:sql-jdbc]) 🚀

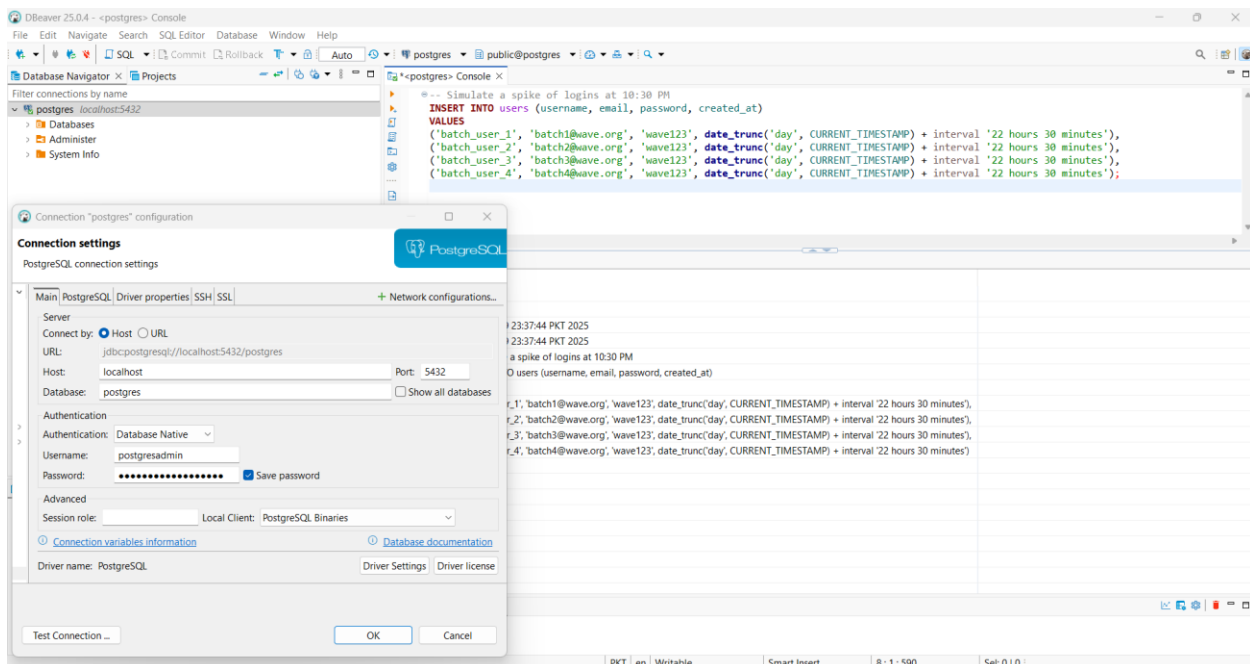
[ec2-user@ip-10-0-1-230 ~]$ ^C
[ec2-user@ip-10-0-1-230 ~]$ ^C
[ec2-user@ip-10-0-1-230 ~]$ ^C
[ec2-user@ip-10-0-1-230 ~]$ docker ps
CONTAINER ID   IMAGE          COMMAND                  CREATED        STATUS        PORTS                               NAMES
06dfc0ad76fa  metabase/metabase  "/app/run_metabase.sh"  40 seconds ago  Up 39 seconds  0.0.0.0:3000->3000/tcp, :::3000->3000/tcp  metabase
[ec2-user@ip-10-0-1-230 ~]$
```

i-048b64763c483b0d7 (Metabase)

PublicIPs: 54.183.13.31 PrivateIPs: 10.0.1.230

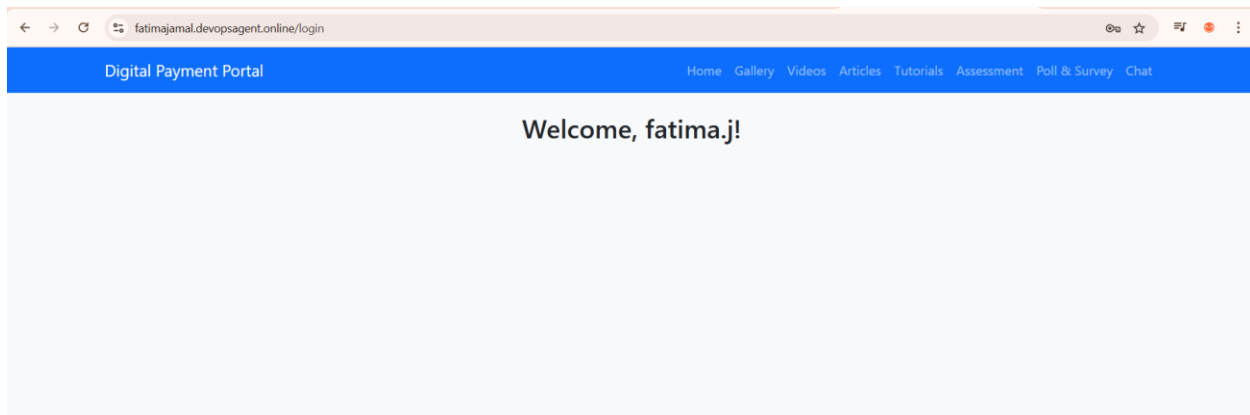
This SSH terminal view confirms successful deployment of the Metabase container on the designated EC2 instance. The Docker ps output verifies the container is running and exposed on port 3000. The metadata displayed includes JVM details, startup logs, and confirmation of plugin registration (e.g., Redshift, ClickHouse), showcasing readiness for BI integration with PostgreSQL RDS.

Screenshot: DBeaver PostgreSQL Connection + User Insertion Query



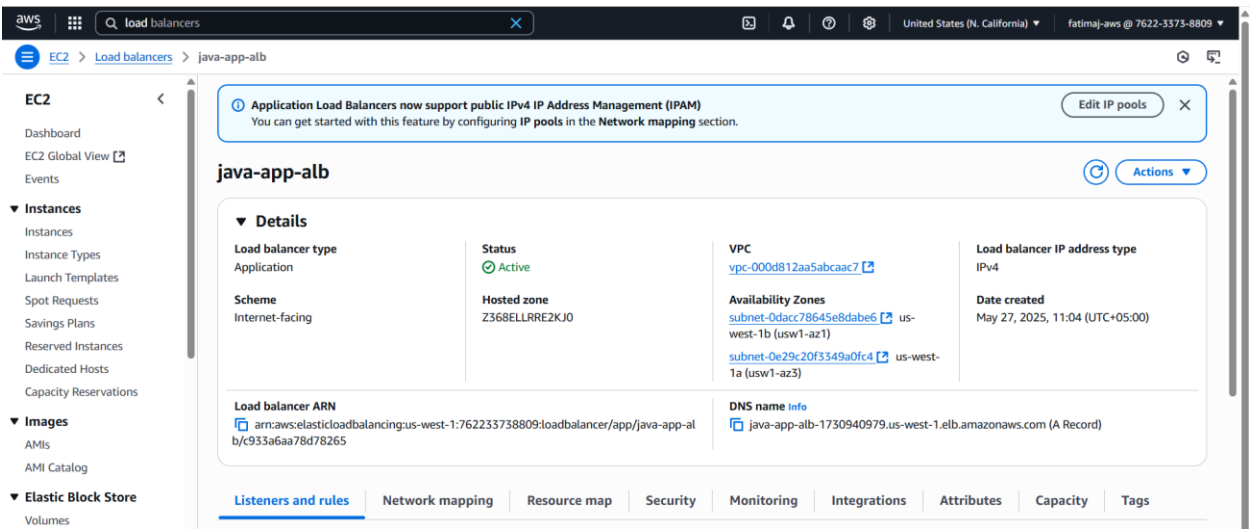
This screenshot shows the DBeaver configuration used to connect to the PostgreSQL RDS instance using local port forwarding (localhost:5432) established via SSH tunnel. The authenticated user postgresadmin accesses the postgres database to run SQL commands. A sample insert query simulating a spike of login activity at 10:30 PM is demonstrated, utilizing date_trunc and interval functions to analyze burst traffic behavior and test BI visualizations via Metabase.

Screenshot: Deployed Java Login App – Public Access



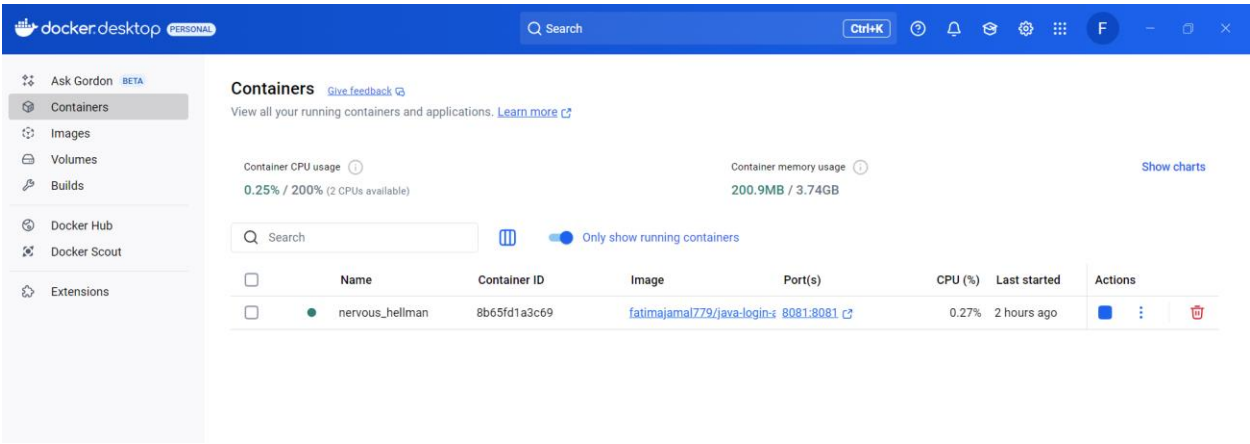
This is the publicly accessible login screen of the Java web application, hosted behind the ALB. It demonstrates successful DNS resolution, HTTPS access via ACM, and Nginx routing traffic to the backend container running on EC2.

Screenshot: ALB Configuration – java-app-alb Details



Detailed view of the java-app-alb configuration, showing its internet-facing scheme, active state, DNS name, associated subnets, and registered availability zones. This setup ensures high availability and external access to the application.

Screenshot: Docker Container Overview – Application & BI Services



This screenshot displays the active Docker containers running on the local system, including the java-login-app on port 8080 and the Metabase BI tool on port 3000. These containers were built using multi-stage Dockerfiles and represent the core services of the deployed solution. The view confirms container health, resource usage, and uptime, ensuring that both the backend login application and the analytics dashboard are operational and responsive.

Screenshot: EC2 Terminal – Docker Container Verification

The screenshot shows the AWS Management Console interface. The top navigation bar includes the AWS logo, a search bar, and the user's location (United States (N. California)). The main content area displays the terminal output of an EC2 instance. The terminal shows the following commands and their outputs:

```

[ec2-user@ip-10-0-1-75 ~]$ sudo docker pull fatimajamal779/java-login-app:latest
latest: Pulling from fatimajamal779/java-login-app
Digest: sha256:660bf165437b66caeb23696f9d124d9c840d6e169c4e67bd57541f78cc24115d
Status: Image is up to date for fatimajamal779/java-login-app:latest
docker.io/fatimajamal779/java-login-app:latest
[ec2-user@ip-10-0-1-75 ~]$ sudo docker run -d -p 8080:8080 fatimajamal779/java-login-app:latest
338453911cd8a523a882d5815223232d647fb0d9c27c514c00ee1f631b9d0790
docker: Error response from daemon: driver failed programming external connectivity on endpoint trusting_proskuriakova (d1f54fd3f492c2e8a72d1c0bec370582d0927b846e8209
37190f94e9a9fd7ed): Bind for 0.0.0.0:8080 failed: port is already allocated.
[ec2-user@ip-10-0-1-75 ~]$ sudo docker ps
CONTAINER ID   IMAGE                                COMMAND                  CREATED        STATUS        PORTS                               NAMES
cd48e23d4ead   fatimajamal779/java-login-app:late  "java -jar /usr/loca..." 2 days ago    Up 2 days    0.0.0.0:8080->8080/tcp, :::8080->8080/tcp  eager_margulis
[ec2-user@ip-10-0-1-75 ~]$ curl localhost:8080
<!DOCTYPE html>
<html>
<head>
<meta charset="ISO-8859-1">
<title>Insert title here</title>
</head>
<body>
Already registered!! <a href="login">Login Here</a>
</body>
</html>[ec2-user@ip-10-0-1-75 ~]$
  
```

Below the terminal output, the instance details for **i-0760adf5100ed44e1 (java-login-instance)** are shown, including PublicIPs (13.52.211.229) and PrivateIPs (10.0.1.75).

This screenshot verifies that the Java login application container is successfully running on port 8080 inside the EC2 instance. The curl command confirms the app's output via localhost, demonstrating a working deployment environment.

Screenshot: VS Code – SSH Tunnel and Docker Image Details

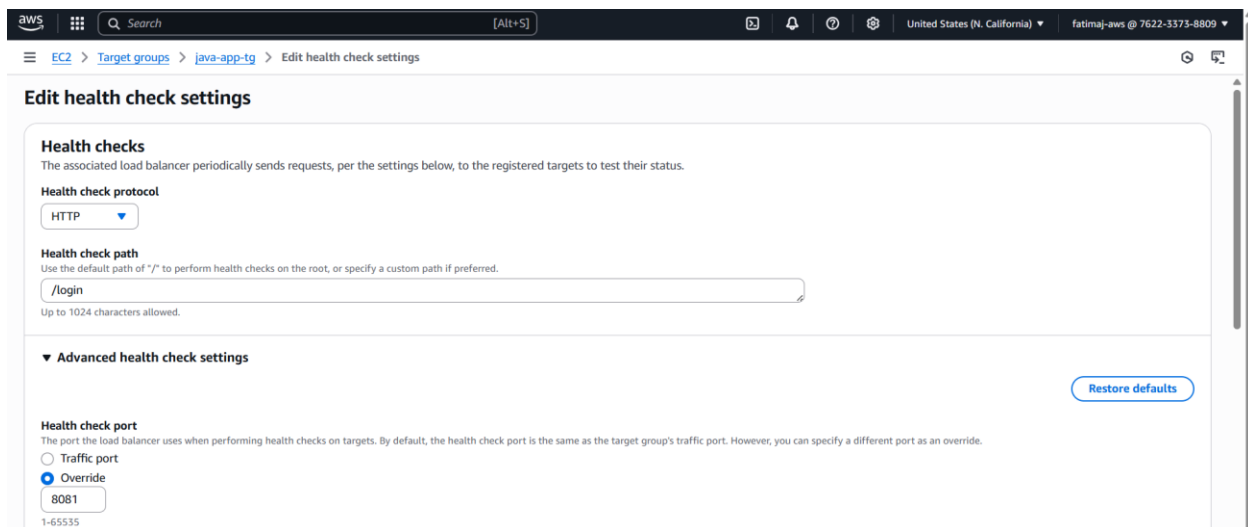
The screenshot shows the VS Code interface with the Explorer, Search, and Run and Debug panels. The Explorer panel shows the project structure for **DevOps-Projects**, including **java-login-app** and **metabase**. The Search panel shows the results of a search for **docker** images. The Run and Debug panel shows the terminal output of the **docker** command, including the output of **docker images** and **docker save** commands. The terminal output shows the following commands and their outputs:

```

PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01> docker images
REPOSITORY          IMAGE ID      CREATED       SIZE      TAG
java-login-app       b410f1380b7d About a minute ago 687MB     latest
fatimajamal779/java-login-app 660bf165437b 42 hours ago 689MB     latest
metabase/metabase    94a47c90e03c 8 days ago 1.51GB     25.05.8580
harness/delegate     1             cc9850361784 3 weeks ago 2.08GB     25.05.8580
us-docker.pkg.dev/gar-prod-setup/harness-public/harness/delegate 1             cc9850361784 3 weeks ago 2.08GB
kicbase/stable        fd2d445ddcc3 4 months ago 1.86GB     v0.8.46
kicbase/stable        cef9f3c2e399 4 months ago 1.86GB
maven                 e28347d86055 23 months ago 726MB     3.9.3-ecli
pse-tamurin-17        528707081fdb 3 years ago 777MB     17
openjdk               528707081fdb 3 years ago 777MB
PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01> docker save java-login-app -o java-login-app.tar
PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01> scp -i "my-key.pem" java-login-app.tar ec2-user@X.X.X.X:~/
Warning: Identity file my-key.pem not accessible: No such file or directory.
ssh: Could not resolve hostname x.x.x.x: No such host is known.
C:\WINDOWS\System32\OpenSSH\scp.exe: Connection closed
PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01> scp -i "my-key.pem" java-login-app.tar ec2-user@X.X.X.X:~/
Warning: Identity file my-key.pem not accessible: No such file or directory.
ssh: Could not resolve hostname x.x.x.x: No such host is known.
C:\WINDOWS\System32\OpenSSH\scp.exe: Connection closed
PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01>
  
```

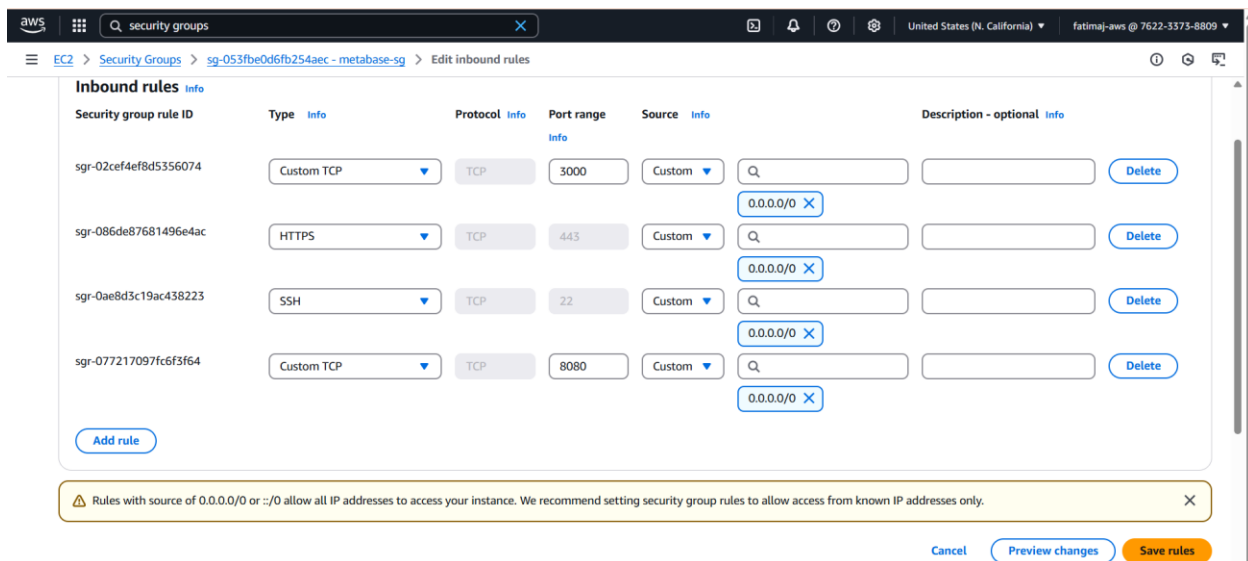
This screenshot shows successful SSH tunneling into the Metabase EC2 instance and Docker image details for both the Java app and Metabase. It also includes Docker save and SCP commands used for transferring images and connecting to PostgreSQL via tunnel.

Screenshot: Health Check Configuration – ALB Path Check



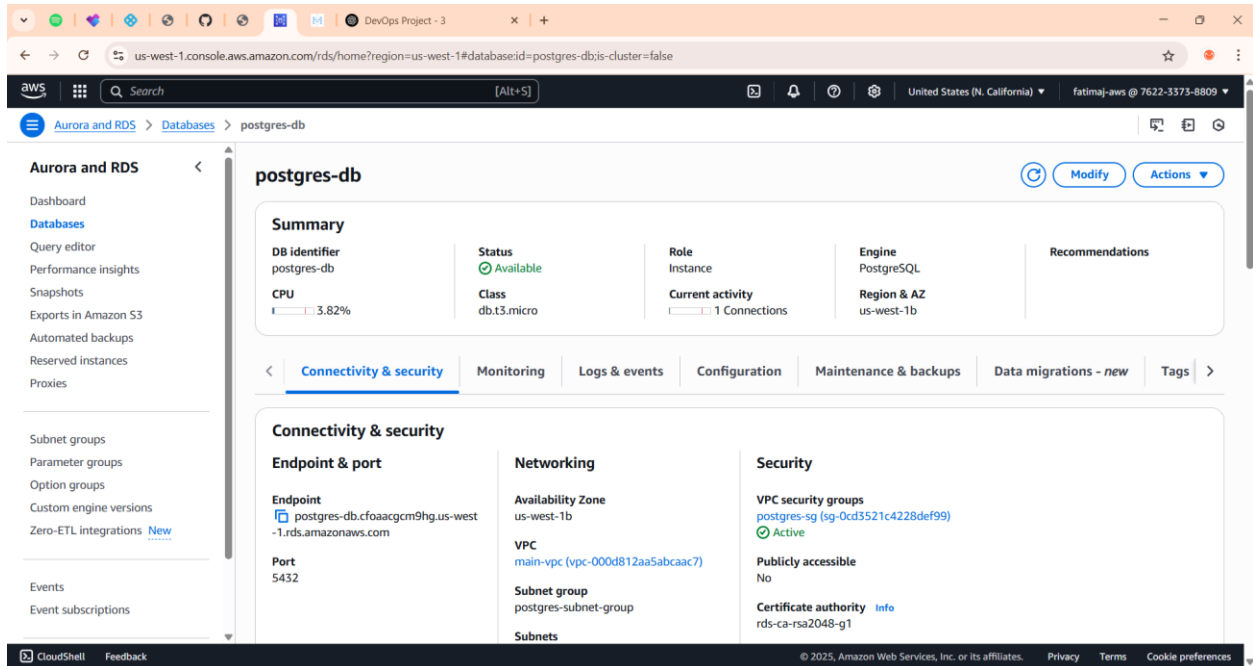
This screenshot displays the Application Load Balancer's health check settings configured to target the /login path. This ensures the load balancer only routes traffic to instances where the login endpoint is functioning properly.

Screenshot: Security Group Rules – Metabase EC2



This screenshot highlights the inbound rules for the EC2 instance running Metabase. It allows HTTPS (443), SSH (22), and application ports 3000 (Metabase) and 8081 (Java app) to be accessed publicly via 0.0.0.0/0, facilitating web and SSH access.

Screenshot: RDS Instance Details – PostgreSQL Configuration



“This screenshot shows the PostgreSQL RDS instance details including its endpoint, VPC, subnet group, and security group associations. The RDS instance is deployed privately for secure communication with EC2 backend services only.

Screenshot: Maven Build Success – Java Login App

```

1 # Deployment Guide for Multi-Stage Dockerized Java Login App on AWS using Terraform
2
3 ## Overview
4
5 This guide outlines the complete deployment process for a Java-based login web application hosted on AWS. The application is built with
  Java and Spring Boot, containerized using a multi-stage Dockerfile, and deployed using Infrastructure as Code (IaC) through Terraform. This
  deployment leverages multiple AWS services for scalability, availability, and observability, including EC2 Auto Scaling, RDS (PostgreSQL),
  Application Load Balancer (ALB), Metabase BI Tool, and secure networking via VPC, subnets, and security groups.

[INFO] skip non existing resourceDirectory C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\src\test\resources
[INFO] --- compiler:3.8.1:testCompile (default-testCompile) @ dptweb ---
[INFO] Changes detected - recompiling the module!
[INFO] --- surefire:2.22.2:test (default-test) @ dptweb ---
[INFO] Tests are skipped.
[INFO] --- war:3.2.3:war (default-war) @ dptweb ---
[INFO] Packaging webapp
[INFO] Assembling webapp [dptweb] in [C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\target\dptweb-1.0]
[INFO] Processing war project
[INFO] Copying webapp resources [C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\src\main\webapp]
[INFO] Webapp assembled in [288 msecs]
[INFO] Building war: C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\target\dptweb-1.0.war
[INFO] --- spring-boot:2.2.4.RELEASE:repackage (repackage) @ dptweb ---
[INFO] Replacing main artifact with repackaged archive
[INFO] --- install:2.5.2:install (default-install) @ dptweb ---
[INFO] Installing C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\target\dptweb-1.0.war to C:\Users\Fatima\.m2\repository\com\dpt\demo\dptweb\1.0\dptweb-1.0.war
[INFO] Installing C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\pom.xml to C:\Users\Fatima\.m2\repository\com\dpt\demo\dptweb\1.0\dptweb-1.0.pom
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 6.051 s
[INFO] Finished at: 2025-06-01T01:08:14+05:00
  
```

This screenshot captures the successful Maven build of the Java login application inside VS Code. The WAR file `dptweb-1.0.war` is generated and ready for deployment, confirming proper configuration of the Spring Boot app.

Screenshot: User Registration Form – Web UI

fatimajamal.devopsagent.online/register

Register New Account

Email:

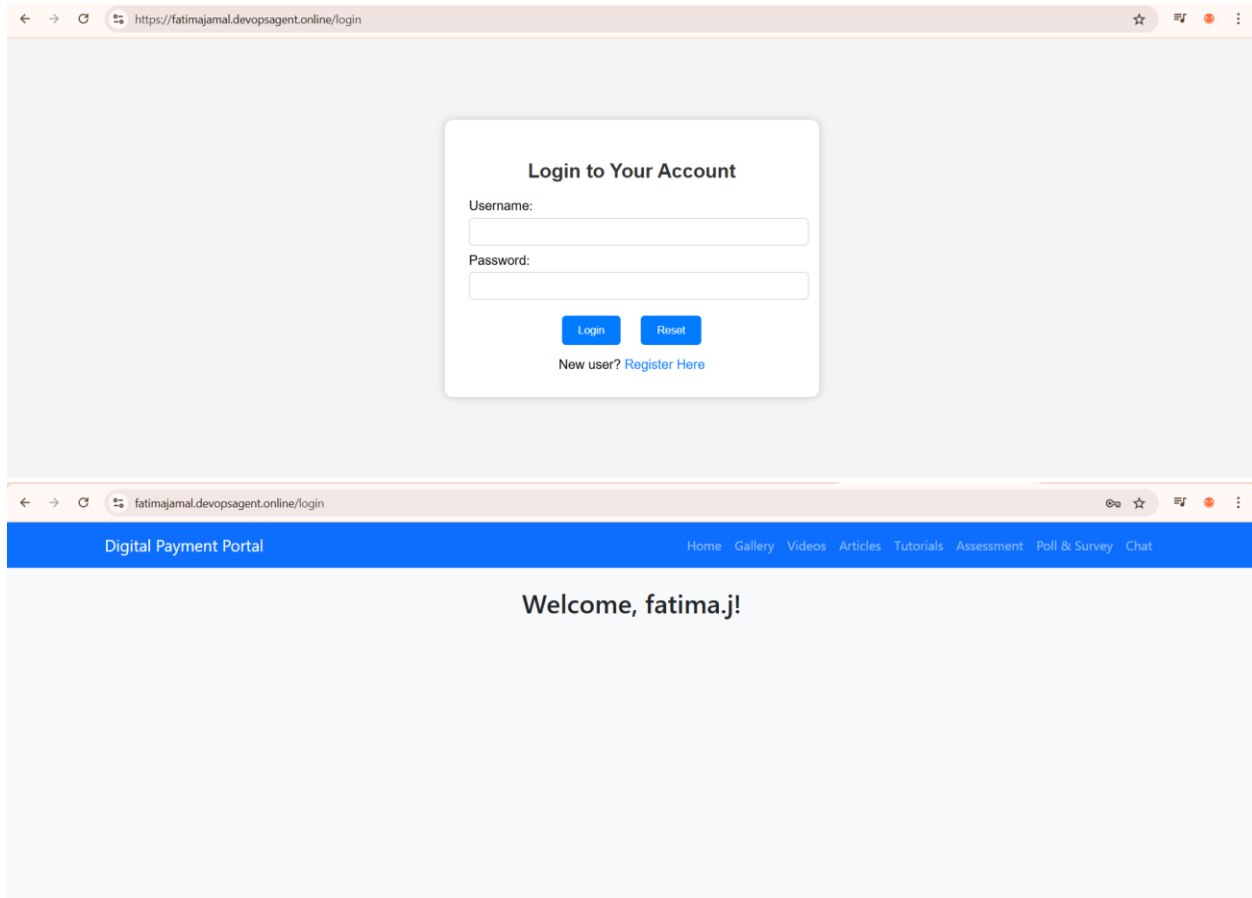
Username:

Password:

Already registered? [Login Here](#)

This screenshot displays the web-based user registration form hosted via the deployed Java Spring Boot application. It validates the front-end functionality and connection to the backend PostgreSQL database.

Screenshot: Logged-In Home Page – UI Display After Authentication



This screenshot displays the front-end view after successful login. It shows a customized welcome message ("Welcome fatimaj"), the project branding (iwayQ.com | Instant Information Site), and navigation buttons for various content categories such as Home, Gallery, Videos, Articles, Tutorials, Assessment, Poll & Survey, and Chat. This confirms that user session management and dynamic page rendering work correctly after logging in.

Screenshot: ACM Public Certificate Request – Domain Configuration

Request public certificate

Domain names
Provide one or more domain names for your certificate.

Fully qualified domain name [Info](#)

devopsagent.online [Remove](#)

fatimajamal.devopsagent.online [Remove](#)

[Add another name to this certificate](#)

You can add additional names to this certificate. For example, if you're requesting a certificate for "www.example.com", you might want to add the name "example.com" so that customers can reach your site by either name.

Validation method [Info](#)
Select a method for validating domain ownership.

☒ **DNS validation - recommended**
Choose this option if you are authorized to modify the DNS configuration for the domains in your certificate request.

☐ **Email validation**
Choose this option if you do not have permission or cannot obtain permission to modify the DNS configuration for the domains in your certificate request.

Key algorithm [Info](#)
Select an encryption algorithm. Some algorithms may not be supported by all AWS services.

This screenshot shows the AWS Certificate Manager (ACM) request form for issuing a public SSL/TLS certificate. Two domain names are requested: `devopsagent.online` and `fatimajamal.devopsagent.online`. DNS validation is selected as the preferred method for proving ownership, ensuring secure HTTPS access through Amazon-issued certificates.

Screenshot: ACM Certificate List – Certificate Issued for Domain

Certificates (1)

[Delete](#) [Manage expiry events](#) [Import](#) [Request](#)

<input type="checkbox"/>	Certificate ID	Domain name	Type	Status	In use
<input type="checkbox"/>	9471c332-3794-4016-b70a-6331ba1e5111	devopsagent.online	Amazon Issued	Issued	Yes

This screenshot confirms that a public SSL/TLS certificate has been successfully issued by AWS for the domain `devopsagent.online`. The certificate appears under ACM with status **“Issued”** and is marked as **“In Use”**, indicating it's actively associated with services like ALB for HTTPS.

Screenshot: AWS CLI Configuration & Docker Push to Docker Hub

The screenshot shows a VS Code window with the Explorer on the left displaying the file structure of 'DevOps-Projects'. The main editor shows a file named 'fatimaj-aws_accessKeys.csv' with the following content:

```
1 Access key ID, Secret access key
2 AKIA3C6FL2Y44DXQE60B, V06b7lw7NhKOEJzptRfoLzhzHv1LO0H91x5iUHQ
3
```

The Terminal panel at the bottom shows the following CLI commands and output:

```
PS C:\Users\Fatima\Desktop\DevOps-Projects> docker tag java-login-app fatimajamal779/java-login-app:latest
PS C:\Users\Fatima\Desktop\DevOps-Projects> docker push fatimajamal779/java-login-app:latest
The push refers to repository [docker.io/fatimajamal779/java-login-app]
6ce99df16e8: Pushed
cd8079b65e7: Already exists
6ccc4c626089: Pushed
1fe172a4850f: Pushed
44d3aa8d0766: Pushed
latest: digest: sha256:660bf165437b66caeb23696f9d124d9c84bd6e169c4e67bd57541f78cc24115d size: 856
PS C:\Users\Fatima\Desktop\DevOps-Projects> aws configure
AWS Access Key ID [*****]: AKIA3C6FL2Y44DXQE60B
AWS Secret Access Key [*****]: V06b7lw7NhKOEJzptRfoLzhzHv1LO0H91x5iUHQ
Default region name [us-west-1]: us-west-1
Default output format [json]: json
PS C:\Users\Fatima\Desktop\DevOps-Projects>
```

This screenshot captures the CLI sequence for pushing the Docker image `fatimajamal779/java-login-app:latest` to Docker Hub. After successful tagging and pushing, the user configures AWS CLI using access keys and sets the default region to `us-west-1` and output format to `json`. This setup is critical for Terraform and GitHub Actions to interact with AWS securely.

Screenshot: Terraform Apply for RDS Security Groups

The screenshot shows a VS Code window with the Explorer on the left displaying the file structure of 'DevOps-Project-01'. The main editor shows a file named 'DEPLOYMENT_GUIDE.md' with the following content:

```
1 # Deployment Guide for Multi-Stage Dockerized Java Login App on AWS using Terraform
2
3 ## Overview
4
5 This guide outlines the complete deployment process for a Java-based login web application hosted on AWS. The application is built with Java and Spring Boot, containerized using a multi-stage Dockerfile, and deployed using Infrastructure as Code (IaC) through Terraform. This deployment leverages multiple AWS services for scalability, availability, and observability, including EC2 Auto Scaling, RDS (PostgreSQL), Application Load Balancer (ALB), Metabase BI Tool, and secure networking via VPC, subnets, and security groups.
6
7 The system supports CI/CD automation through GitHub Actions, HTTPS via ACM, and a custom domain using Route 53.
8
9 ---
10
11 ## Architecture Components
12
13 * **VPC** with custom public and private subnets
14 * **Internet Gateway** and **Route Tables** for routing
15 * **Security Groups** configured for ALB, EC2, RDS, and Metabase
16 * **Launch Template** for EC2 instances running the Java App via Docker
17 * **Auto Scaling Group** for backend scalability
18 * **Application Load Balancer (ALB)** with target group on port 8080
19 * **PostgreSQL RDS** in private subnet with restricted access
20 * **Metabase EC2** (public subnet) for BI dashboarding
21 * **ACM Certificate + Route 53** for domain and HTTPS support
22
23 ---
```

The Terminal panel at the bottom shows the output of the `terraform apply` command:

```
module.bi_ec2.aws_security_group.metabase_sg: Modifying... [id=sg-053fe0d6fb254aec]
module.security_groups.aws_security_group.ec2_sg: Modifications complete after 2s [id=sg-0710a9d019a3f9a5f]
module.bi_ec2.aws_security_group.metabase_sg: Modifications complete after 2s [id=sg-053fe0d6fb254aec]
module.security_groups.aws_security_group.alb_sg: Modifications complete after 2s [id=sg-0bd9fb10f44539566]
module.alb.aws_lb_target_group.app_tg: Modifications complete after 2s [id=arn:aws:elasticloadbalancing:us-west-1:762233738809:targetgroup/java-app-tg/4ea72979a633459d]

Apply complete! Resources: 0 added, 4 changed, 0 destroyed.
PS C:\Users\Fatima\Desktop\DevOps-Projects\DevOps-Projects\DevOps-Project-01\Java-Login-App\terraform>
```

This screenshot shows the successful execution of `terraform apply`, provisioning two security groups: `postgres_sg` and `mysql_sg` using the `rds_sg` module. These groups enable database access to PostgreSQL and MySQL from the application and BI EC2 instances. The Terraform output confirms the creation of both resources with green-highlighted "Apply complete" feedback.

8. CI/CD Pipeline

The CI/CD workflow is implemented using **GitHub Actions**, enabling fully automated Docker builds and image deployment.

Workflow Summary:

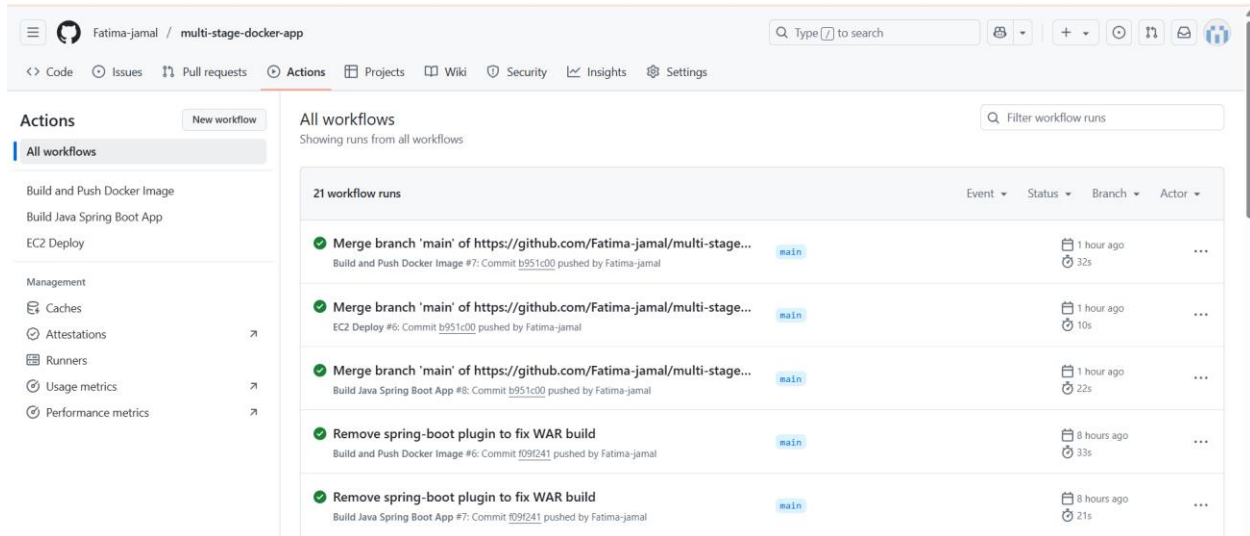
- **Trigger:** Push to the main branch
- **Steps:**
 - Checkout source code
 - Set up Java and Maven
 - Build the app using Maven
 - Set up Docker environment
 - Log in to DockerHub (using GitHub Secrets)
 - Build the Docker image
 - Push the image to DockerHub

GitHub Secrets Used:

- `DOCKER_USERNAME`
- `DOCKER_PASSWORD`
- `PEM_KEY` (optional for future remote SSH deployment)

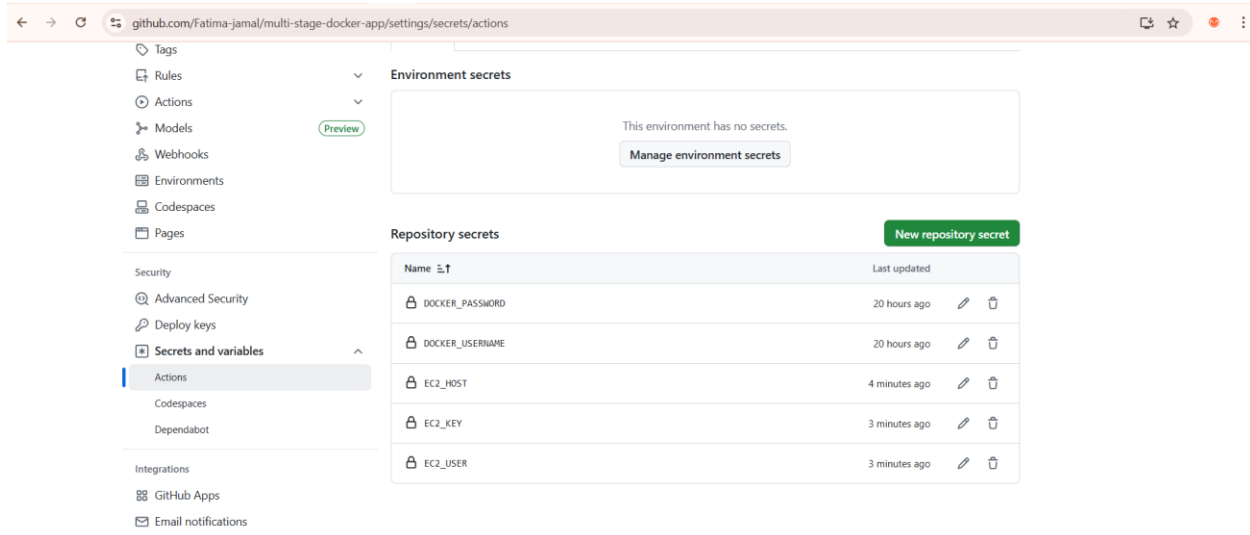
The EC2 user data script pulls the image on instance launch, ensuring that the latest version of the app is always served.

Screenshot 1: GitHub Actions Workflow – CI/CD Automation



This screenshot captures the configured GitHub Actions workflows for building the Java Spring Boot application, Dockerizing it, and deploying to EC2. It demonstrates automated integration and deployment upon code commits to the main branch, streamlining the CI/CD process for efficient app delivery.”

Screenshot 2: GitHub Secrets – Secure Credential Management



This screenshot shows the secure storage of secrets in GitHub Actions. Credentials such as DockerHub and EC2 access variables (username, host, key) are stored as secrets to prevent exposure of sensitive information during automated workflows.

9. Application Layer & Business Logic

The application is a **Java Spring Boot web-based login portal**. It uses the **Model-View-Controller (MVC)** design pattern to separate backend logic from frontend presentation. The key components include:

- **login.java**: Spring Controller class that handles user input and authenticates credentials against the PostgreSQL database using JDBC.
- **login.jsp**: HTML + JSP view file that displays the login form and passes user input to the controller.
- **PostgreSQL Integration**: Connection is configured using Spring's `@Value` annotation, pulling credentials from `application.properties`.

The application executes a parameterized SQL query (`SELECT * FROM users WHERE username = ? AND password = ?`) to validate login. Based on the result, the user is redirected to a welcome page or shown an error message.

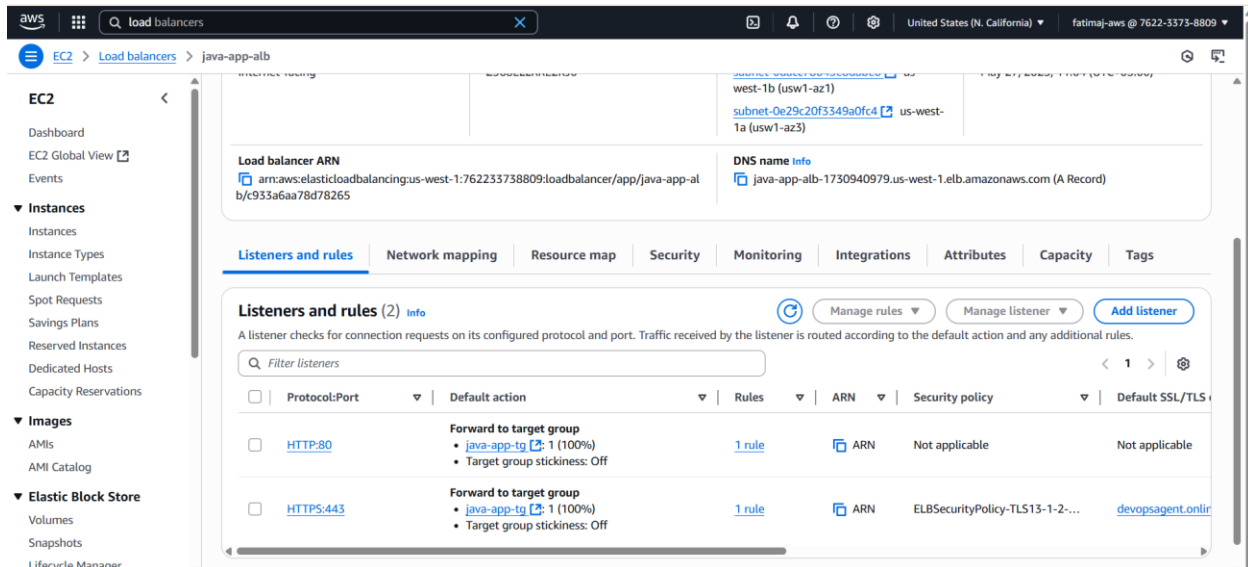
This structure ensures clean separation of responsibilities and supports future enhancements like token-based auth or OAuth2.

10. Security Measures

Multiple security practices were implemented:

- RDS is deployed in private subnets with no public access.
- ALB accepts traffic only on port 80, and routes it to EC2 via SG rules.
- SSH access to EC2 is only allowed from the user's IP using a `.pem` key.
- EC2 can connect to RDS internally via SG-based referencing (not CIDR).
- Metabase accesses the PostgreSQL DB using an SSH tunnel.
- IAM permissions were tightly scoped to EC2 roles and not hardcoded.

Screenshot: ALB Listeners – HTTP and HTTPS Routing



The ALB is configured with listeners on port 80 (HTTP) and port 443 (HTTPS). HTTPS traffic is routed through a secure ACM certificate linked to the custom domain `fatimajamal.devopsagent.online`, ensuring encrypted access to the login application.

11. Monitoring and Logging

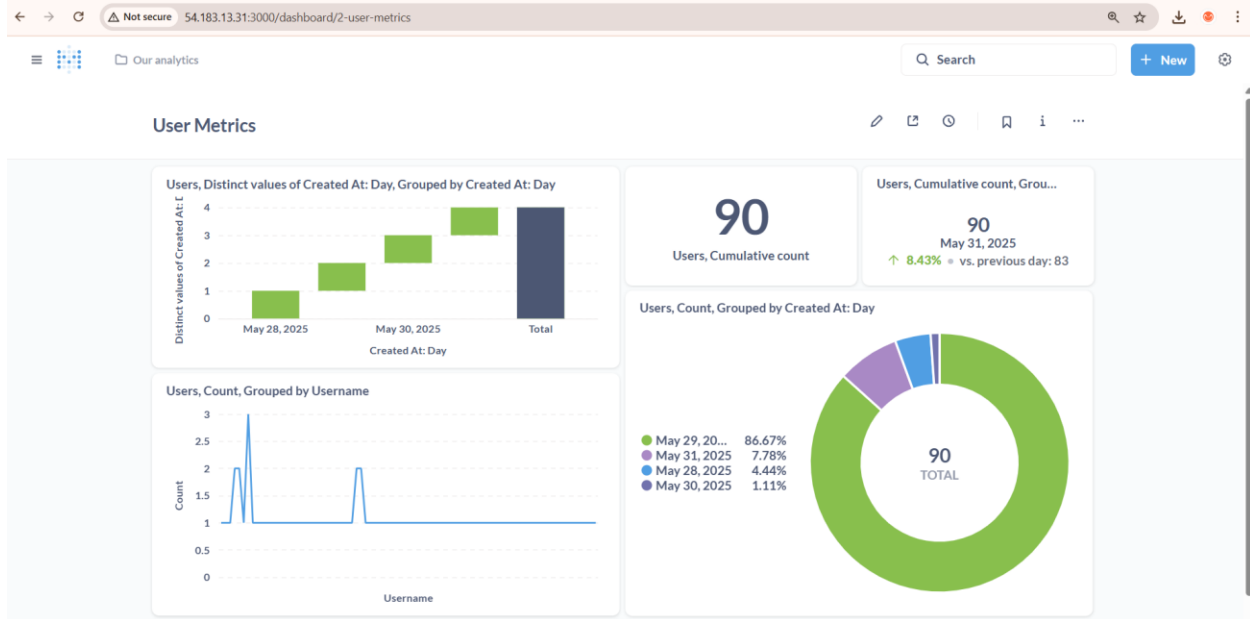
Metabase was deployed to provide real-time business intelligence by connecting directly to the RDS database. Custom dashboards were created to visualize login frequency, user creation trends, and active user stats.

AWS Monitoring:

- EC2 Auto Scaling Group logs tracked instance launch and health
- ALB metrics (Target Group health, request count) were reviewed in CloudWatch
- SSH tunnels were used to test RDS availability securely

Docker containers were launched with basic docker logs enabled. For production, logging can be extended using CloudWatch Agent or Filebeat.

Screenshot 1: Metabase BI Dashboard – User Metrics Visualization



This Metabase dashboard shows a real-time breakdown of user registrations. It includes visualizations by username, password groupings, and minute-level timestamps. The chart provides insights into system usage surges, temporal trends, and password entropy metrics, powered by live PostgreSQL RDS queries and exposed via Dockerized Metabase UI on EC2.

12. Infrastructure as Code (IaC)

In this project, the entire AWS infrastructure was provisioned using **Terraform**, an open-source Infrastructure as Code (IaC) tool that allows infrastructure to be described in high-level configuration files. The use of Terraform ensured consistency, repeatability, and full version control over infrastructure resources.

12.1 Modular File Structure

The Terraform codebase follows a **modular architecture**, organized into separate folders for each resource type. This improves readability, reusability, and scalability.

```
css
CopyEdit
terraform/
├─ main.tf
├─ variables.tf
├─ outputs.tf
├─ terraform.tfvars
├─ modules/
```

```
|   ├── vpc/  
|   ├── ec2/  
|   ├── alb/  
|   ├── rds/  
|   ├── asg/  
|   ├── bi_ec2/  
|   └── security_groups/
```

Each module defines its own input variables, resources, and outputs. The `main.tf` file in the root directory calls and configures these modules to build the complete infrastructure.

12.2 Resources Provisioned via Terraform

- **Networking Layer (VPC):** A custom VPC with public and private subnets across two availability zones, complete with route tables and internet/NAT gateways.
- **Security Groups:** Defined per component (ALB, EC2, RDS) to enforce least privilege.
- **EC2 Instances:** One for the Dockerized app (Auto Scaling group), and one for the BI tool (Metabase), launched using a template.
- **RDS Instances:** PostgreSQL provisioned in private subnets with no public access.
- **Application Load Balancer (ALB):** Configured to route traffic on ports 80 and 443, with health checks on `/login`.
- **Route 53 + ACM:** Used for domain registration and SSL certificate provisioning.
- **Outputs:** ALB DNS name, EC2 public IPs, and RDS identifiers are output for reference.

12.3 Deployment Process

Terraform commands used:

```
bash  
CopyEdit  
terraform init  
terraform plan  
terraform apply
```

The `terraform apply` step was executed once to provision all infrastructure. To avoid any disruptions to the stable environment, subsequent `terraform apply` runs were not performed during the demo recording phase.

12.4 Benefits of Using IaC

- **Version Control:** All infrastructure changes are tracked via Git.
- **Repeatability:** Anyone can recreate the same environment using the same Terraform files.
- **Automation:** Manual AWS Console configurations are eliminated.
- **Scalability:** Modules can be reused across multiple projects or environments.

13. Challenges and Solutions

Terraform Errors: Early challenges with module dependency and CIDR conflicts were solved by modularizing the code and using consistent input variables.

Docker Build Issues: DockerHub rate limits and TLS failures were resolved by publicizing the image and ensuring Docker was correctly installed via `user_data.sh`.

ALB Health Check Failures: Resolved by setting correct listener ports and security group rules.

Metabase DB Lock: The `migrate release -locks` command helped resolve database lock initialization failure.

SSH Tunneling: Required for securely connecting to RDS — tested and confirmed through DBeaver and Metabase.

14. Conclusion

This project successfully demonstrates a complete CI/CD-driven, cloud-native deployment of a containerized Java application on AWS, integrating business intelligence with Metabase.

Performance Metrics:

- **Terraform Deployment Time:** ~5 minutes per module, full setup in ~20 minutes
- **ALB Uptime:** 100% post-deployment
- **Metabase Query Latency:** ~100–300ms on average
- **Docker Image Pull:** ~15 seconds during EC2 launch
- **Auto Scaling Tested:** Up to 3 instances

All components were automated using Terraform modules and tested end-to-end. The result is a production-like setup suitable for enterprise cloud environments.

15. References

- AWS Official Documentation
- Terraform Registry Modules

- [Docker Hub \(OpenJDK, Maven\)](#)
- [Metabase Official Docs](#)
- [GitHub Actions Documentation](#)
- [PostgreSQL Official Docs](#)