

Faculty of Engineering and Applied Sciences

Information Systems

Central University of the Ecuador

Distributed Programming

Title: Report on Architecture and Functionality

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Course: SI8-001

Date: 04/03/2025





Description:

This document presents a detailed overview of the architecture, functionality, and interaction between microservices within a system structured under the microservices architecture paradigm. It covers essential aspects such as scalability, security, integration, and system optimization to ensure efficiency and long-term sustainability. The system is composed of 30 microservices, categorized into distinct modules that handle authentication, user management, recipe handling, security, and internal communication. This design promotes independent deployment and scaling of each service, guaranteeing modularity, flexibility, and high availability.

2. General Architecture

The system adopts a decentralized microservices architecture, where each microservice operates within **Docker containers** hosted on **AWS EC2 instances**. Each service is designed to perform a specific function, ensuring that modifications in one do not impact others, thereby facilitating maintenance and scalability.

2.1 Technologies Used

- **Programming Languages:** Python, Go, PHP, JavaScript
- **Databases:** MySQL, PostgreSQL, MongoDB
- **Security:** JWT, Encryption, CORS
- **DevOps:** GitHub (Pull Requests, Code Review), CI/CD
- **Load Balancing:** AWS Load Balancer
- **Scalability:** AWS Auto Scaling Group
- **API Gateway:** AWS API Gateway



- **Messaging & Events:** AWS SNS, SQS, Kinesis
- **Documentation:** Swagger

3. Microservices Organization

The system is structured into the following key functional groups:

3.1 Authentication and User Management

- **Login:** Authenticates user credentials and generates a JWT token for secure access.
- **Registration:** Facilitates new user account creation with data validation to ensure integrity.
- **Password Reset:** Implements a secure mechanism for account recovery.
- **Email Verification Token:** Ensures account activation through an email verification link.
- **User Management:** Enables creation, deletion, and retrieval of user information to maintain system integrity.

3.2 Recipe Management

- **Recipe Creation and Editing:** Allows users to create and modify recipes with detailed ingredient lists and steps.
- **Ingredient and Step Management:** Supports granular modifications to individual recipe components.
- **Recipe Listing and Search:** Implements advanced filtering based on user, category, and keywords.
- **Permission Verification:** Ensures that only recipe owners can modify or delete their content, maintaining data integrity.



3.3 Security and Authentication

- **User Authentication:** Implements secure session handling using JWT and OAuth 2.0.
- **API Error Management:** Centralized handling of errors and failures.
- **Asynchronous Middleware:** Enables efficient inter-microservice communication without performance bottlenecks.
- **Session Token Management:** Ensures continuous authentication without compromising security.

3.4 User Profile Management

- **User Data Editing:** Securely updates user details such as name, email, and password.
- **Profile Viewing:** Provides access to user information while maintaining security restrictions.
- **User Administration:** Manages the centralized listing of registered system users.

3.5 Comment Management

- **Comment Creation, Editing, and Deletion:** Efficiently manages user interactions within recipes.
- **Permission Control:** Ensures only comment authors can modify or remove their contributions.

4. Communication Between Microservices

4.1 REST API

Each microservice exposes RESTful endpoints for structured and scalable data access over HTTP.



4.2 WebSockets

WebSockets facilitate real-time updates, enhancing functionalities such as notifications and collaborative editing.

4.3 WebHooks

WebHooks improve inter-service communication efficiency by eliminating redundant polling, reducing latency, and optimizing resource consumption.

4.4 RabbitMQ with RPC

For asynchronous operations, such as permission verification during recipe modifications, RabbitMQ acts as a messaging broker.

4.5 SOAP Integration

Some services maintain compatibility with legacy systems by supporting SOAP-based communication.

5. Security and Data Protection

5.1 Authentication and Authorization

- **JWT (JSON Web Tokens):** Ensures secure authentication without storing session states.
- **OAuth 2.0:** Enables integration with third-party authentication providers.

5.2 Data Protection

- **Password Encryption:** Uses secure hashing algorithms (e.g., bcrypt) for password storage.
- **Sensitive Data Encryption:** Protects critical information using AES and TLS encryption mechanisms.



5.3 Threat Protection

- **CORS Policies:** Regulates cross-origin resource sharing for security.
- **Firewall & API Gateway:** Shields the system from DDoS attacks and filters malicious traffic.

6. Design and Development Principles

6.1 SOLID Principles

Adherence to SOLID principles ensures a modular, scalable, and maintainable codebase.

6.2 Simplicity and Reusability

- **KISS (Keep It Simple, Stupid):** Prevents unnecessary architectural complexity.
- **DRY (Don't Repeat Yourself):** Promotes code reusability to minimize redundancy.

6.3 API Documentation with Swagger

Interactive Swagger documentation facilitates seamless integration with external systems.

7. Databases & Storage

The system leverages a combination of databases:

- **Relational Databases:** MySQL and PostgreSQL for structured data storage.
- **NoSQL Database:** MongoDB for flexible and scalable data management.
- **Additional Databases:** Five new PostgreSQL databases have been integrated for 10 additional microservices.

8. Security & AWS Integration

- **JWT Middleware:** Enables secure authentication between microservices.
- **CORS Configuration:** Restricts unauthorized cross-domain access.



- **Encryption Mechanisms:** Safeguards sensitive user information.

9. Communication Architecture

The system employs multiple communication paradigms:

1. **REST API:** Standard protocol for most CRUD operations.
2. **GraphQL:** Optimized query resolution for user and recipe data.
3. **WebSockets:** Enables real-time notifications and UI updates.
4. **RPC/SOAP:** Facilitates secure inter-microservice transactions.

10. DevOps & Deployment

- **Version Control:** GitHub-based repository with code reviews and pull requests.
- **Deployment Pipeline:** CI/CD pipeline using GitHub Actions and AWS CodeDeploy.
- **Docker Containerization:** Each microservice is packaged and deployed in EC2 environments.

11. Monitoring & Scalability

- **Load Balancing:** AWS Load Balancer evenly distributes traffic.
- **Auto Scaling:** Ensures dynamic resource allocation via AWS Auto Scaling Group.

12. Protection Against DDoS and EDoS Attacks

12.1 DDoS Protection

- **Rate Limiting:** Restricts **100 requests per IP every 15 minutes**.
- **IP Blocking:** Three failed login attempts trigger a 15-minute block.
- **Security Logging:** Suspicious activities are recorded in logs/ddos_attempts.log.

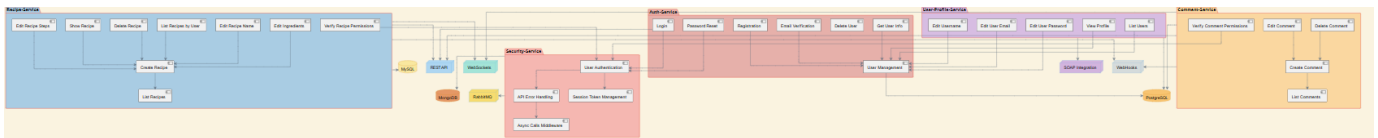


12.2 EDoS Protection

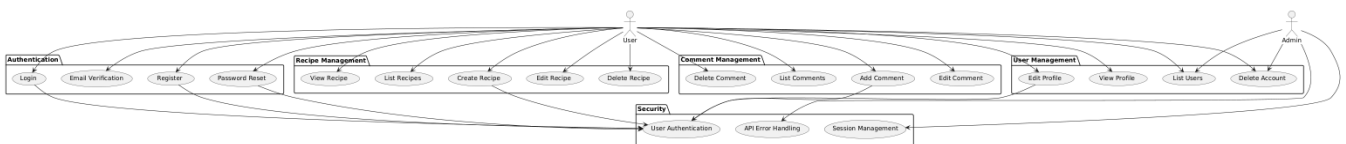
- **JWT Validation:** Requires a valid token for all requests.
- **Process Termination:** Unauthorized or excessive requests are blocked immediately.

13. Diagrams

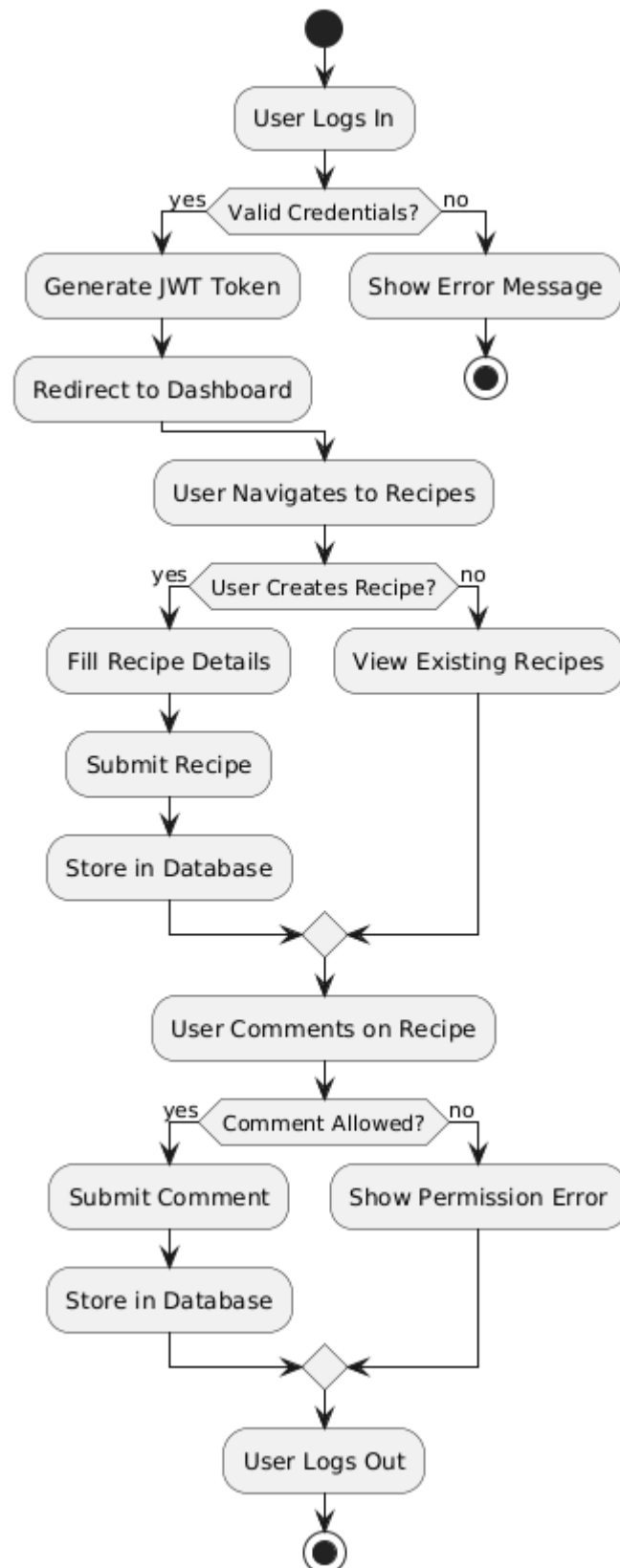
Architecture diagram



Use Cases

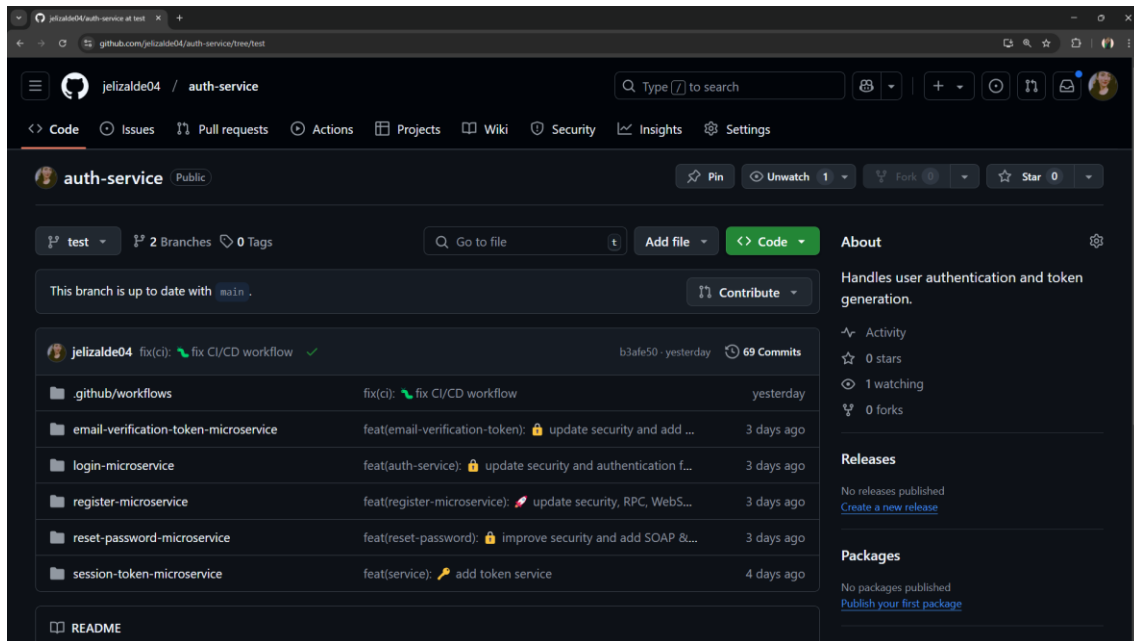


Flowchart

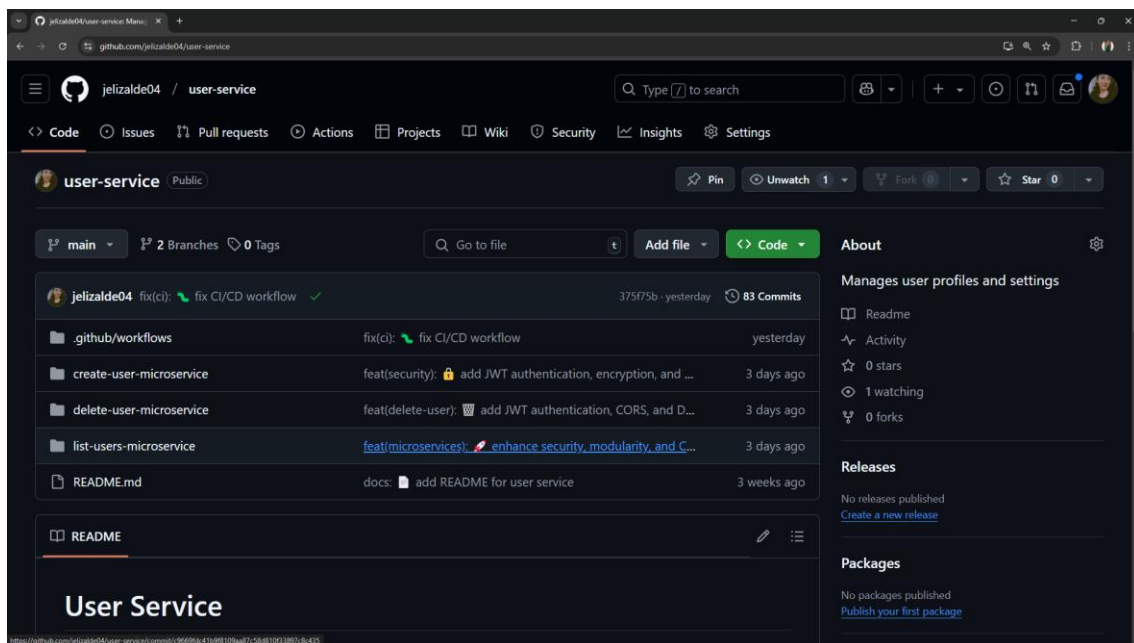




Code Repositories



<https://github.com/jelizalde04/auth-service.git>



<https://github.com/jelizalde04/user-service.git>



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The screenshot shows the GitHub repository page for 'security-service'. The repository is public and has 2 branches and 0 tags. The commit history shows a recent commit by 'jelizalde04' titled 'fix(ci): fix CI/CD workflow' from yesterday, with 38 commits in total. The file list includes '.github/workflows', 'api-error-handler-microservice', 'async-handler-middleware-microservice', 'jwt-auth-middleware-microservice', and 'README.md'. The right sidebar shows the 'About' section with no description, website, or topics provided, and sections for 'Releases' and 'Packages' with no published items.

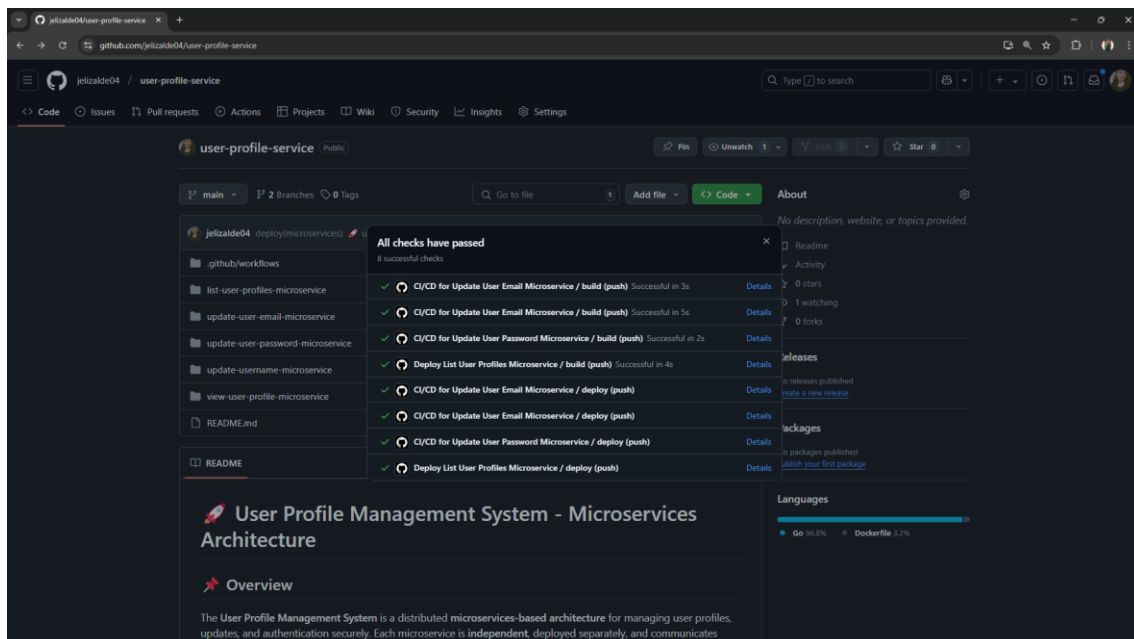
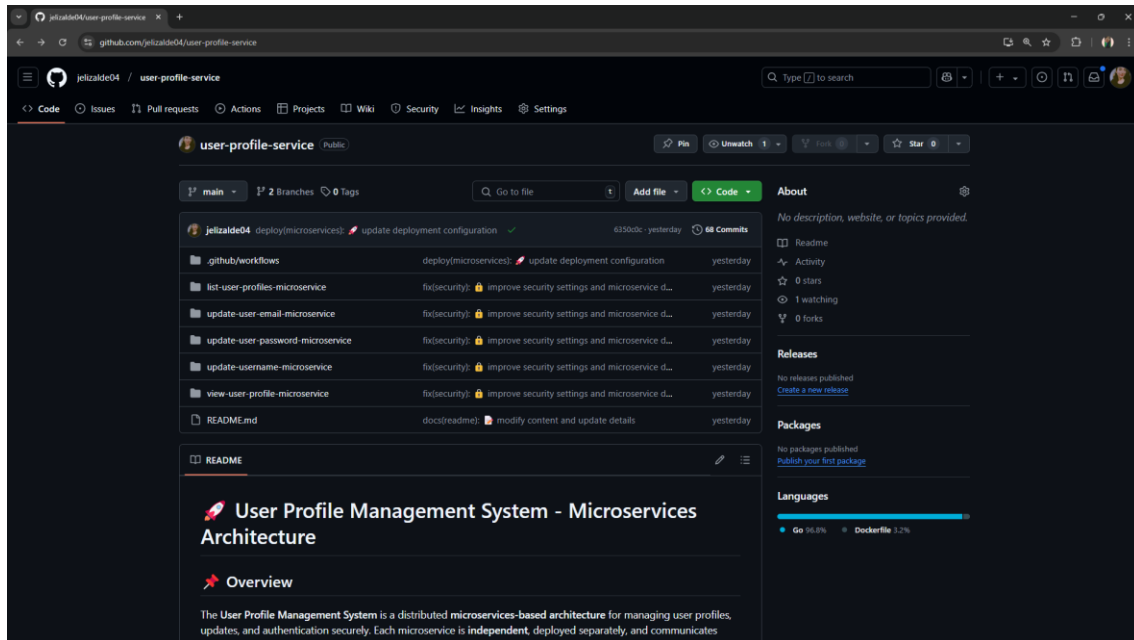
<https://github.com/jelizalde04/security-service.git>

The screenshot shows the GitHub repository page for 'recipe-service'. The repository is public and has 2 branches and 0 tags. The commit history shows a recent commit by 'jelizalde04' titled 'update (ci): CI/CD workflows for recipe microservices' from yesterday, with 148 commits in total. The file list includes '.github/workflows', 'create-recipe-microservice', 'delete-recipe-microservice', 'get-recipe-by-id-microservice', 'list-all-recipes-microservice', 'list-user-recipes-microservice', 'recipe-modification-permission-microservice', 'update-recipe-ingredients-microservice', 'update-recipe-name-microservice', 'update-recipe-steps-microservice', and 'README.md'. The right sidebar shows the 'About' section with the description 'Handles recipe creation, updates, and publication.', and sections for 'Releases', 'Packages', 'Contributors', and 'Languages'.

<https://github.com/jelizalde04/recipe-service.git>



New Microservices implemented



<https://github.com/jelizalde04/user-profile-service.git>



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comment-service Public

jelizalde04 docs/readme modify content and update details ✓ (418610 · yesterday) 67 Commits

- .github/workflows fix(security) improve security settings and microservice d... yesterday
- comment-modification-permission-microservice fix(security) improve security settings and microservice d... yesterday
- create-comment-microservice fix(security) improve security settings and microservice d... yesterday
- delete-comment-microservice fix(security) improve security settings and microservice d... yesterday
- list-comments-microservice fix(security) improve security settings and microservice d... yesterday
- update-comment-microservice feat(utils) add JWT handler utility 2 days ago
- README docs(readme) modify content and update details yesterday

README

Comment Service - Microservices Architecture

Overview

The "Comment Service" is a distributed "microservices-based system" for managing user comments efficiently. Each microservice is "independent", deployed separately, and communicates using "REST, Websocket, Webhook, RPC, and SOAP".

Microservices Overview

Comment Modification Permission Microservice

- "Purpose": Manages permissions for modifying comments.
- "Security": JWT authentication, CORS, rate limiting, DDoS protection.
- "Communication": REST API.

comment-service Public

jelizalde04 docs/readme modify co

All checks have passed
10 successful checks

- ✓ CI/CD for Comment Permission Microservice / build (push) Successful in 2s Details
- ✓ CI/CD for Create Comment Microservice / build (push) Successful in 2s Details
- ✓ CI/CD for Delete Comment Microservice / build (push) Successful in 3s Details
- ✓ CI/CD for List Comments Microservice / build (push) Successful in 3s Details
- ✓ CI/CD for Update Comment Microservice / build (push) Successful in 3s Details
- ✓ CI/CD for Comment Permission Microservice / deploy (push) Details
- ✓ CI/CD for Create Comment Microservice / deploy (push) Details
- ✓ CI/CD for Delete Comment Microservice / deploy (push) Details
- ✓ CI/CD for List Comments Microservice / deploy (push) Details
- ✓ CI/CD for Update Comment Microservice / deploy (push) Details

README

Comment Service - Microservices Architecture

Overview

The "Comment Service" is a distributed "microservices-based system" for managing user comments efficiently. Each microservice is "independent", deployed separately, and communicates using "REST, Websocket, Webhook, RPC, and SOAP".

Microservices Overview

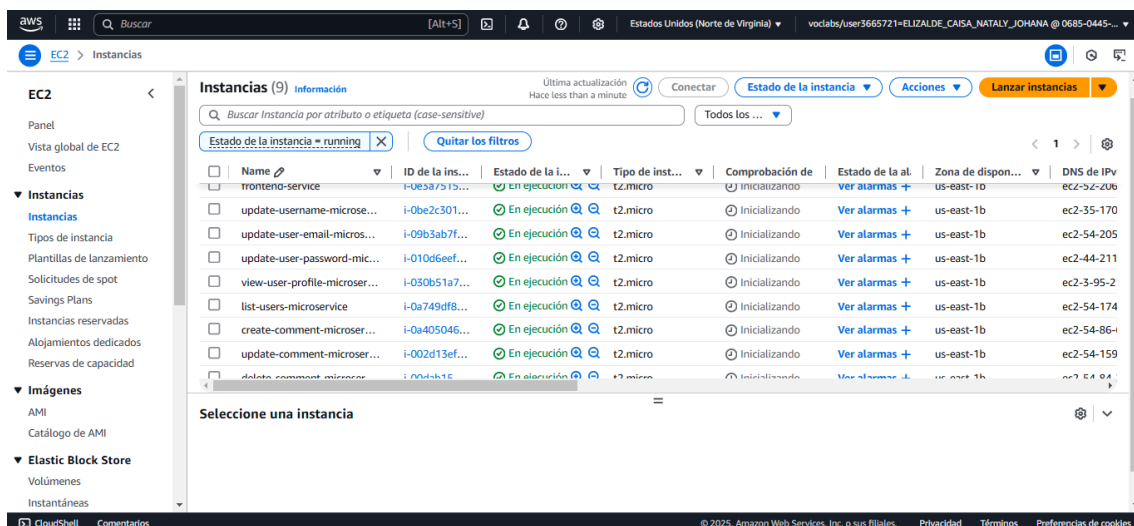
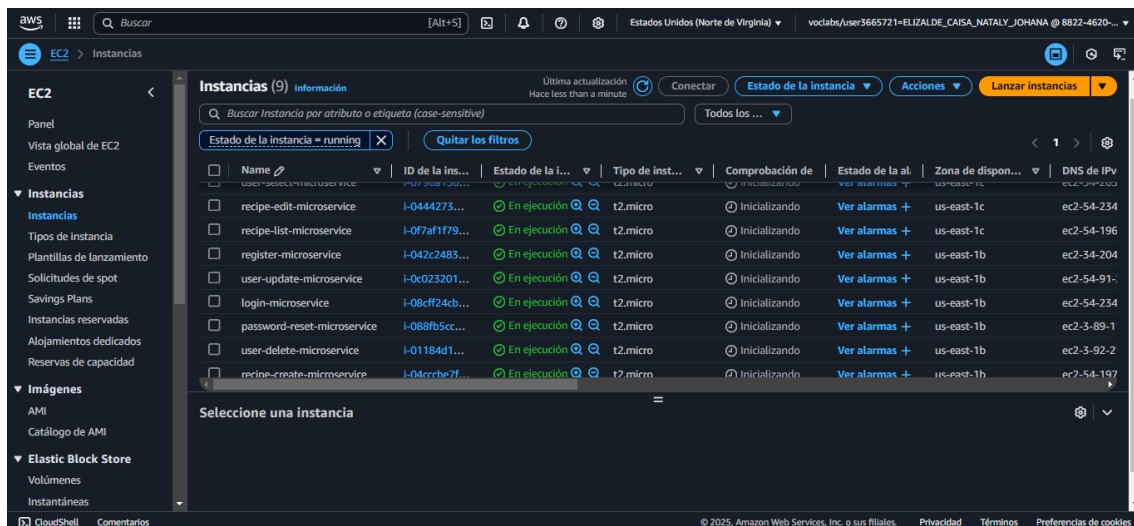
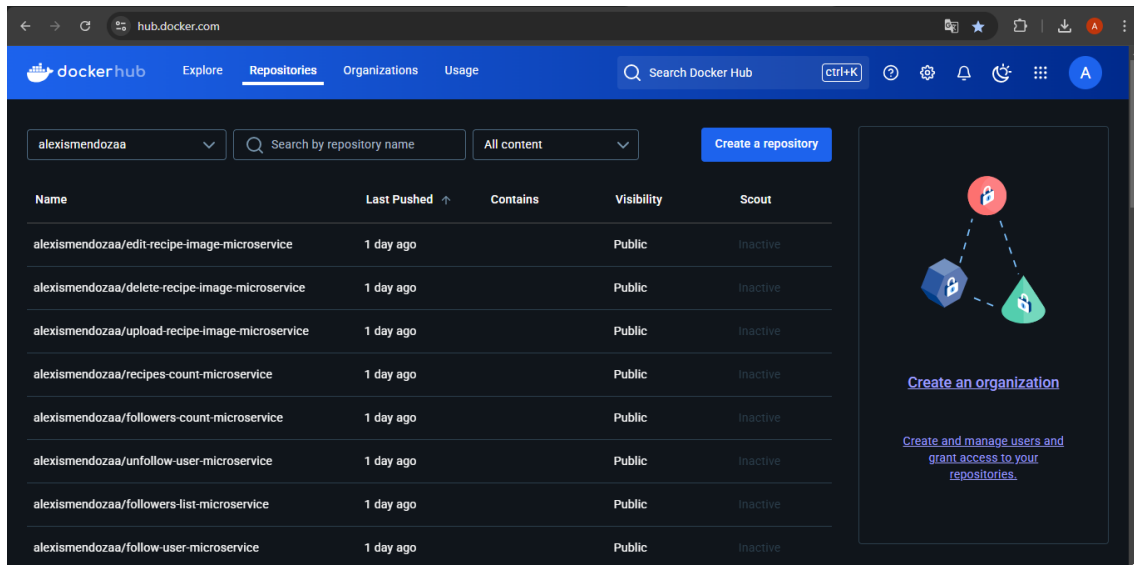
Comment Modification Permission Microservice

- "Purpose": Manages permissions for modifying comments.
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- "Communication": REST API.

<https://github.com/jelizalde04/comment-service.git>



Deployment





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CloudShell Comentarios

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aws [Alt+S] Estados Unidos (Norte de Virginia) voclabs/user:3665695-MENDOZA_FLORES_ALEXIS_FERNANDO @ 8935-084...

EC2 > Balanceadores de carga

Balanceadores de carga (1/1) Acciones Crear balanceador de carga

Elastic Load Balancing escala automáticamente la capacidad del equilibrador de carga en respuesta a los cambios en el tráfico entrante.

Filtrar equilibradores de carga

Nombre	Nombre de DNS	Estado	ID de VPC	Zonas de disponibi...	Tipo	Fecha crear
ALB	ALB-1443654161.us-east-1...	Activo	vpc-0f3fc08f5c8be41d1	6 Zonas de disponibilidad	application	27 de febre

Equilibrador de carga: ALB

< Detalles Agentes de escucha y reglas Mapeo de red Mapa de recursos Seguridad Monitorización Integraciones Atr >

Detalles

Tipo de equilibrador de carga Aplicación	Estado Activo	VPC vpc-0f3fc08f5c8be41d1	Tipo de dirección IP del equilibrador de carga IPv4
Esquema Internet-facing	Zona hospedada Z355XDOTRQ7X7K		Fecha creada 27 de febrero de 2025, 16:52 (UTC-05:00)

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aws [Alt+S] Estados Unidos (Norte de Virginia) voclabs/user:3665695-MENDOZA_FLORES_ALEXIS_FERNANDO @ 8935-084...

EC2 > Grupos de Auto Scaling

Grupos de Auto Scaling (1/1) Info Configuraciones de lanzamiento Plantillas de lanzamiento Acciones Crear grupo de escalado automático

Buscar sus grupos de Auto Scaling

Nombre	Plantilla de lanzamiento/config...	Instanc...	Estado	Capacidad des...	M...
DelisHub-ASG	Template	Versión Predeterminado	0	Actualización de cap	1

Grupo de Auto Scaling: DelisHub-ASG

< Detalles Integraciones - nueva Escalado automático Administración de instancias Actualización de instancias Actividad >

DelisHub-ASG Descripción general de la capacidad Editar

am:aws:autoscaling:us-east-1:893508463940:autoScalingGroup:dd5f0343-60b4-4d25-b546-dcd50f154e98:autoScalingGroupName/DelisHub-ASG

Capacidad deseada 1	Límites de escalamiento (Mín. - Máx.) 1 - 1	Tipo de capacidad deseado Unidades (número de instancias)	Estado Actualización de capacidad
-------------------------------	---	---	---

Fecha de creación
Tue Mar 04 2025 21:18:14 GMT-0500 (hora de Ecuador)

CloudShell Comentarios

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Project Execution

DelisHub

No seguro 52.206.180.103:5173/login

Inicia Sesión en DelisHub

Correo Electrónico

enmacaisa16@gmail.com

Contraseña

Iniciar Sesión

¿No tienes una cuenta? [Regístrate aquí](#)



Distributed Programming

Mi Perfil

Configuración

Cerrar Sesión

Feed de Recetas

Helado de Mora

Un delicioso y refrescante helado casero de mora, perfecto para los días calurosos.

- Ingredientes:** Moras, Leche, Crema de leche, Azúcar, Jugo de limón
- Pasos:** Licuar las moras con un poco de agua y colar -> Mezclar el jugo de mora con leche, crema de leche y azúcar -> Añadir unas gotas de jugo de limón -> Verter la mezcla en un recipiente y llevar al congelador -> Revolver cada 30 minutos hasta obtener la textura deseada

Ver Receta

Fritada

Un plato tradicional con carne de cerdo frita y crujiente, acompañado de mote y plátano.

- Ingredientes:** Carne de cerdo, Ajo, Cebolla, Comino, Sal, Aceite, Mote, Plátano maduro
- Pasos:** Cortar la carne de cerdo en trozos medianos -> Sazonar con ajo, cebolla, comino y sal -> Cocinar a fuego medio sin aceite hasta que suelte su grasa -> Freír en su propia grasa hasta dorar -> Acompañar con mote y plátano maduro frito ->

Ver Receta

Bolón de Verde

Un desayuno tradicional hecho con plátano verde y queso o chicharrón.

- Ingredientes:** Plátanos verdes, Queso, Mantequilla, Sal, Chicharrón (opcional)
- Pasos:** Hervir los plátanos hasta que estén blandos -> Machacar hasta formar un puré -> Agregar mantequilla y sal al gusto -> Mezclar con queso o chicharrón -> Formar bolas compactas y freír hasta dorar ->

Ver Receta

Patacones

Trozos de plátano verde fritos y crujientes, perfectos como acompañamiento o snack.

- Ingredientes:** Plátanos verdes, Aceite, Sal
- Pasos:** Pelar y cortar los plátanos en rodajas

Donas

Donas caseras esponjosas y dulces, perfectas para disfrutar con café.

- Ingredientes:** Harina, Azúcar, Levadura, Leche, Mantequilla, Huevo, Sal, Aceite
- Pasos:** Mezclar harina, azúcar, levadura y sal -> Agregar leche tibia, mantequilla derretida y huevo -> Amasar hasta obtener

Colada Morada

Una bebida tradicional ecuatoriana espesa y aromática, preparada con frutas y especias, ideal para el Día de los Difuntos.

- Ingredientes:** Mora, Mortiño, Piña, Naranja, Harina de maíz morado, Canela, Clavo de olor, Pimienta dulce, Panela, Agua, Hojas de ishpingo
- Pasos:** Hervir la mora y el mortino en agua hasta que suelten su jugo -> Licuar y colar -> Cocinar la pila en trozos con canela, clavo de olor, pimienta dulce y hojas de ishpingo -> Agregar la panela y dejar que se disuelva -> Disolver la harina de maíz morado en agua fría y añadir a la mezcla

Ver Receta

Johana Elizalde

johana-elizalde21@hotmail.com

Crear Receta

DelisHub

Perfil de Johana Elizalde

Patacones

Trozos de plátano verde fritos y crujientes, perfectos como acompañamiento o snack.

Editar

Eliminar

Publicado por: Johana Elizalde (johana-elizalde21@hotmail.com) - alrededor de 7 horas

Ingredientes:

- Plátanos verdes
- Aceite
- Sal

Pasos:

- Pelar y cortar los plátanos en rodajas gruesas
- Freír en aceite caliente hasta que estén blandos
- Retirar y aplastar con una tabla o prensa
- Volver a freír hasta dorar
- Espolvorear con sal y servir
-

Comentarios:

Edgar Hugo (huguito@gmail.com) - 04 mar 2025, 17:23

Ideal para un desayuno

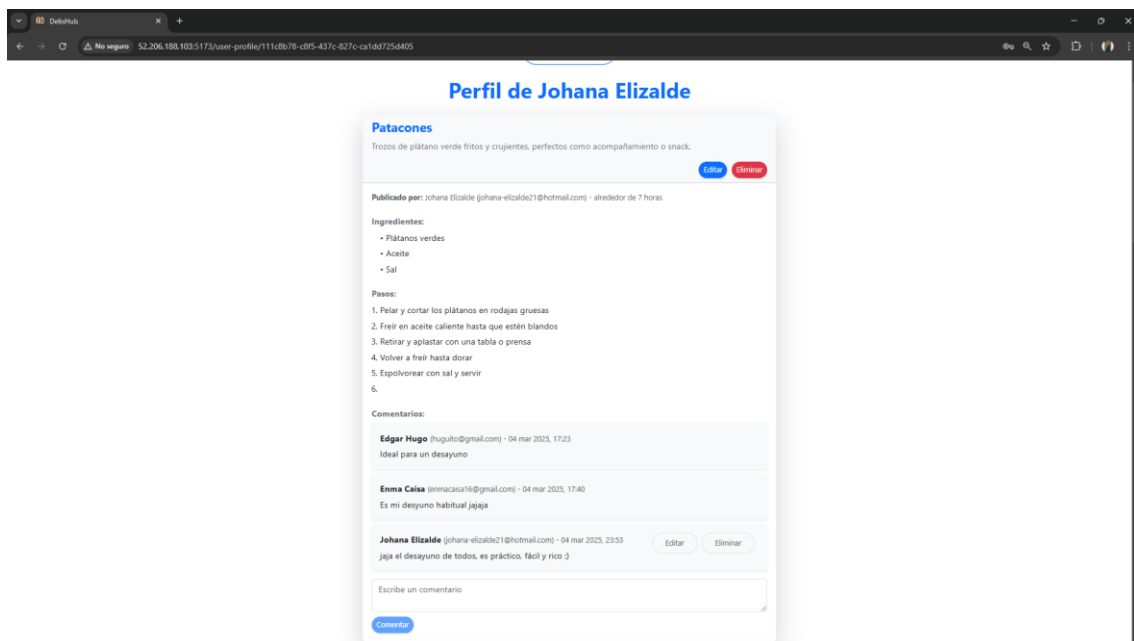
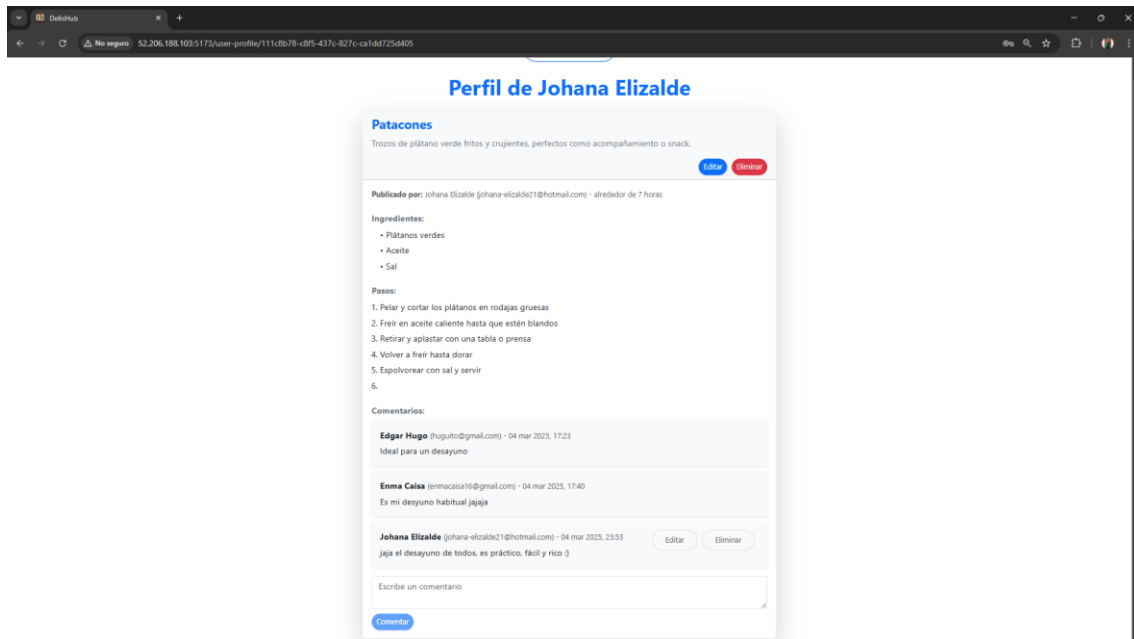
Enma Calsa (ennacalsa16@gmail.com) - 04 mar 2025, 17:40

Es mi desayuno habitual jajaja

Escribir un comentario



Distributed Programming





Distributed Programming

DelisHub Configuración de Usuario

Nombre:
Johana Elizalde
[Editar Nombre](#)

Email:
johana-elizalde21@hotmail.com
[Editar Correo](#)

Contraseña:

[Cambiar Contraseña](#)

[Eliminar cuenta](#)

DelisHub Configuración de Usuario

Nuevo Nombre
Johana Elizalde

Contraseña Actual
Contraseña Actual

[Guardar Cambios](#) [Cancelar](#)



DelisHub

No seguro 52.206.188.103:5173/recipes/3b7dc19d-bd65-4b40-9099-7255ac51431e

1. Pelar y cortar los plátanos en rodajas gruesas
2. Freír en aceite caliente hasta que estén blandos
3. Retirar y aplastar con una tabla o prensa
4. Volver a freír hasta dorar
5. Espolvorear con sal y servir

Comentarios

Johana Elizalde (johana-elizalde21@hotmail.com) - hace 8 minutos

jaja el desayuno de todos, es práctico, fácil y muy rico :)

Enma Calsa (enmacalsa16@gmail.com) - hace alrededor de 6 horas

Es mi desayuno habitual jajaja

Editar Eliminar

Edgar Hugo (huguito@gmail.com) - hace alrededor de 7 horas

Ideal para un desayuno

Escribe un comentario...

Agregar Comentario

DelisHub

Configuración de Usuario

Nuevo Correo Electrónico

johana-elizalde21@hotmail.com

Contraseña Actual

Contraseña Actual

Guardar Cambios Cancelar



Distributed Programming

DelisHub Configuración de Usuario

Contraseña Actual

Contraseña Actual

Nueva Contraseña

Nueva Contraseña

Confirmar Nueva Contraseña

Confirmar Nueva Contraseña

Guardar Cambios Cancelar

DelisHub

2. Freir en aceite caliente hasta que estén blandos

3. Retirar y aplastar con una tabla o prensa

4. Volver a freir hasta dorar

5. Espolvorear con sal y servir

Comentarios

Comentario editado exitosamente.

Johana Elizalde (johana-elizalde21@hotmail.com) - hace 9 minutos
jaja el desayuno de todos, es práctico, fácil y muy rico :)

Enma Calsa (enmacalsa16@gmail.com) - hace alrededor de 6 horas
Es mi desayuno habitual [Editar](#) [Eliminar](#)

Edgar Hugo (huguito@gmail.com) - hace alrededor de 7 horas
Ideal para un desayuno

Escribe un comentario... [Agregar Comentario](#)



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DelisHub

52.206.188.103:5173/settings

52.206.188.103:5173 dice
¿Estás seguro de que deseas eliminar tu cuenta? Esta acción no se puede deshacer.

Configuración de Usuario

Nombre:
Johana Elizalde
[Editar Nombre](#)

Email:
johana-elizalde21@hotmail.com
[Editar Correo](#)

Contraseña:

[Cambiar Contraseña](#)

[Eliminar cuenta](#)

52.206.188.103:5173/recipes/3b7dc194-bd86-4bd0-9099-7255ac51491e

2. Freir en aceite caliente hasta que estén blandos
3. Retirar y aplastar con una tabla o prensa
4. Volver a freir hasta dorar
5. Espolvorear con sal y servir

Comentarios

Comentario editado exitosamente.

Johana Elizalde (johana-elizalde21@hotmail.com) - hace 9 minutos
jaja el desayuno de todos, es práctico, fácil y muy rico :)

Enma Calsa (enmacalsa16@gmail.com) - hace alrededor de 6 horas
Es mi desayuno habitual [Editar](#) [Eliminar](#)

Edgar Hugo (huguito@gmail.com) - hace alrededor de 7 horas
Ideal para un desayuno

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