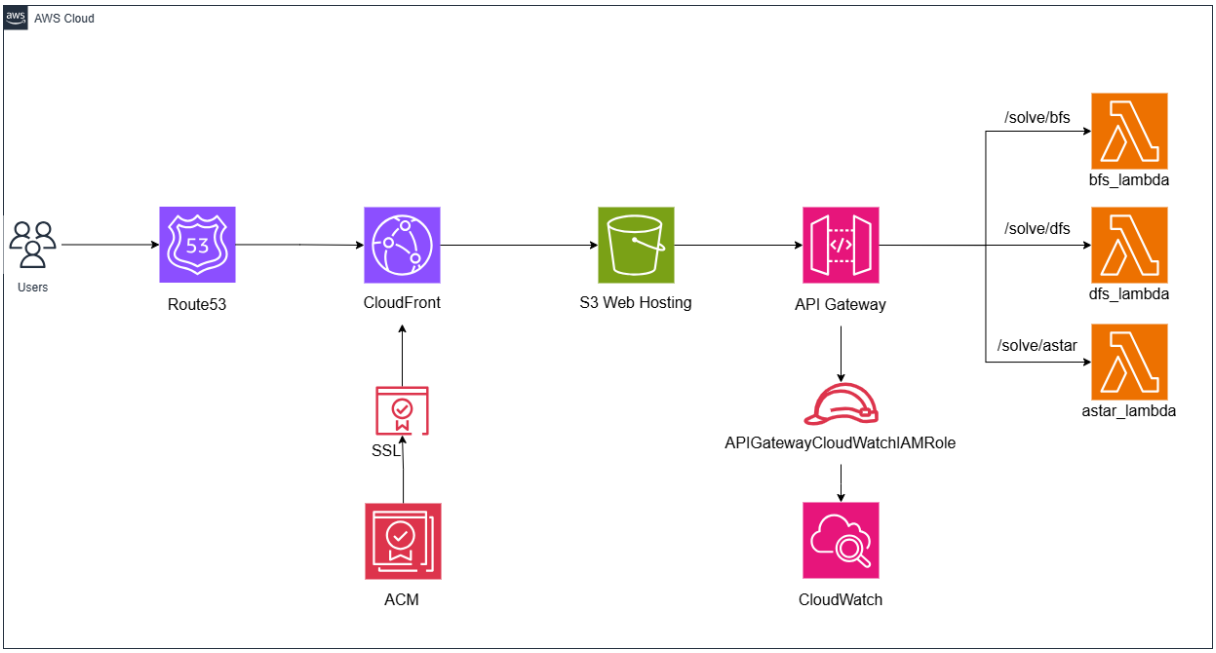
AWS Project – Serverless Graph Search Visualizer

Project Overview

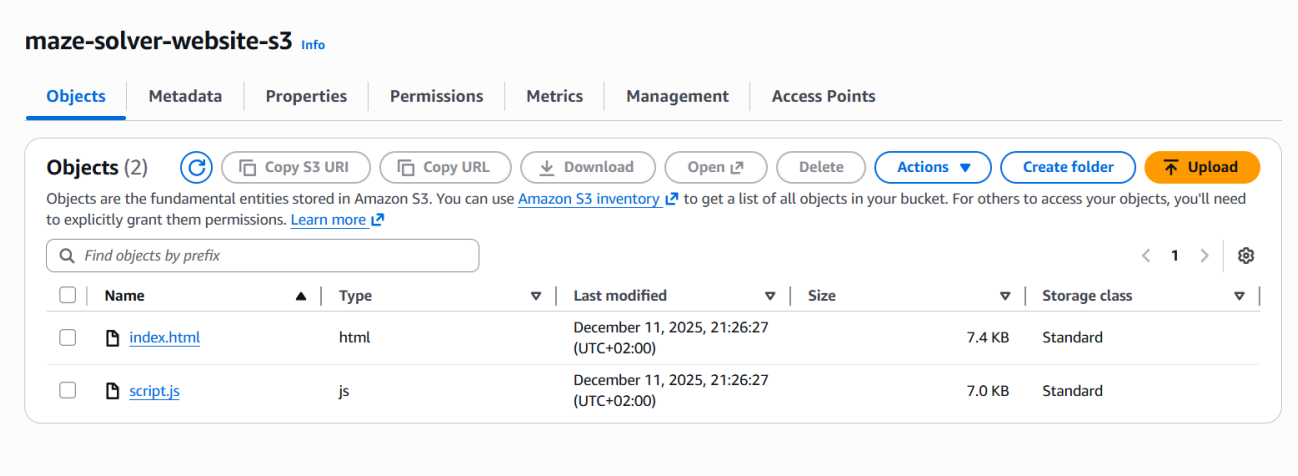
- This project is a cloud-native interactive web application designed to visualize Graph Search Algorithms (BFS, DFS, A*) in a grid-based maze environment. The system is built entirely using Cloud Computing technologies on the AWS platform, leveraging a **Serverless Architecture** to ensure high scalability, performance, and cost-efficiency (Pay-as-you-go model).

Solution Architecture

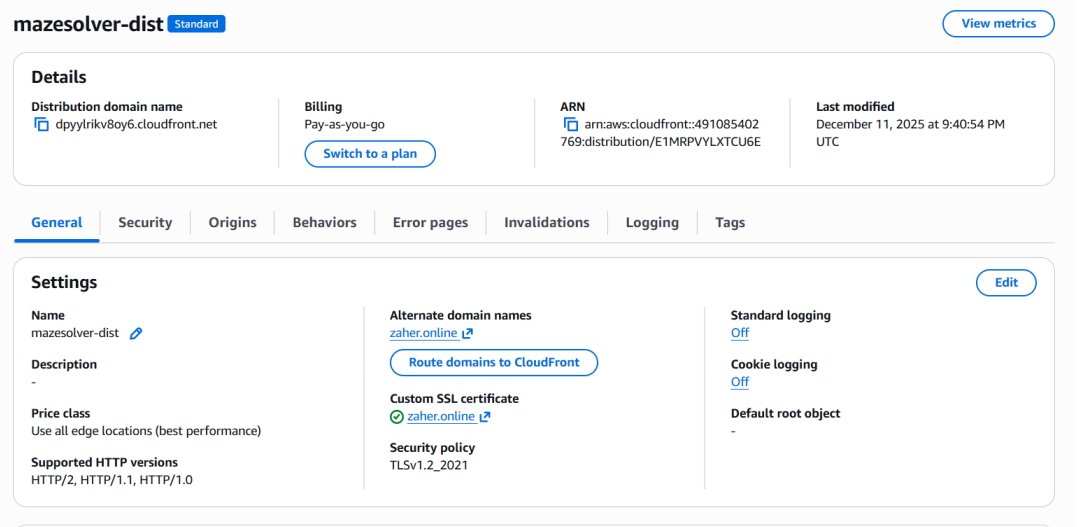
- The system design follows a decoupled architecture, separating the Frontend from the Backend. The application interface is hosted statically and distributed globally via a CDN, while the algorithmic logic is executed via cloud functions triggered through a secure API.
  - 

Frontend & Hosting Components

- **Amazon S3 (Simple Storage Service)**
  - Used for hosting the static website files (`index.html`, `style.css`, `script.js`).
  - **Configuration:** "Block Public Access" is enabled to ensure security. Access is restricted solely to CloudFront using **Origin Access Control (OAC)** policies.
  - **Purpose:** Secure, durable, and highly available storage for frontend assets.

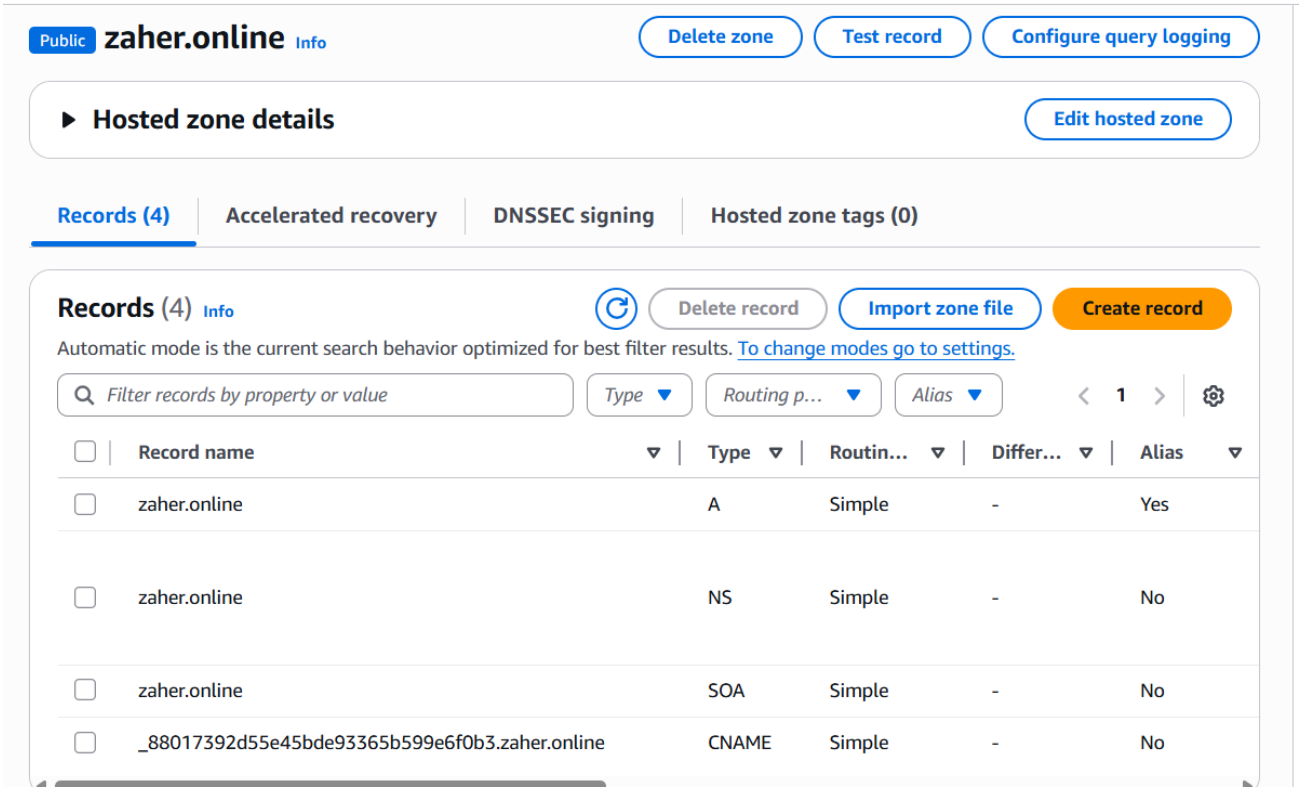


- **Amazon CloudFront (CDN)**
  - **Function:** Caches content at Edge Locations worldwide to minimize latency and improve load times.
  - **Security:** Provides a secure layer (HTTPS) using an SSL certificate and manages access to the S3 origin.
  - **Integration:** Configured with the S3 Bucket as the origin source.



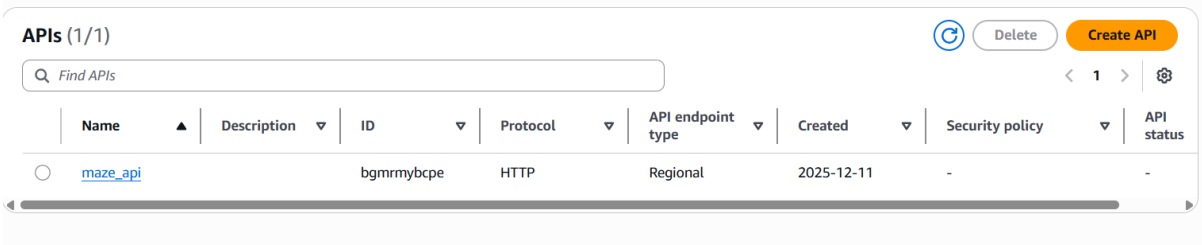
- **Amazon Route53 (DNS)**

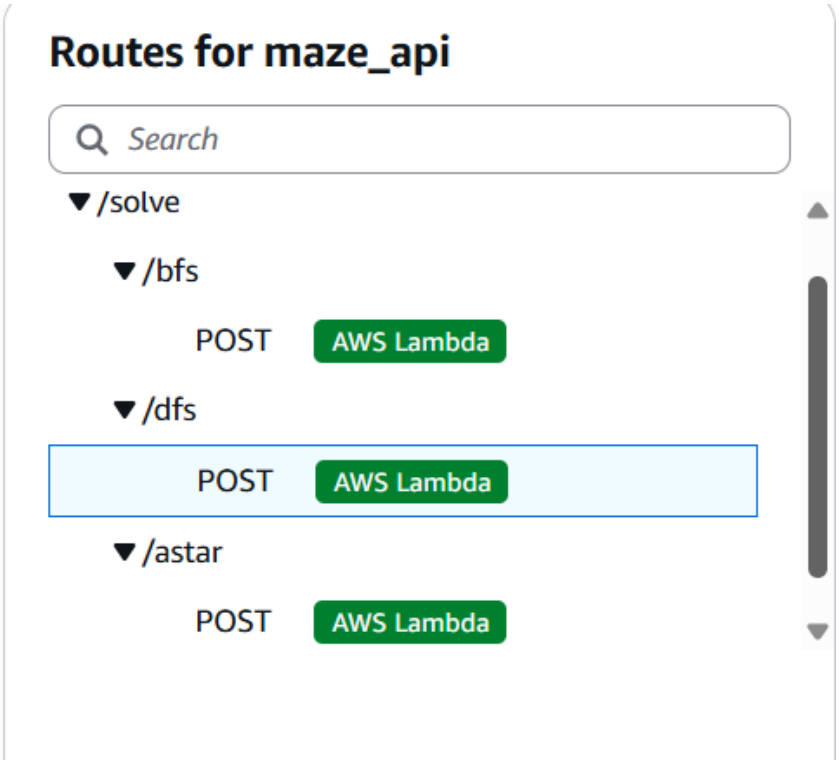
- Used for Domain Name System management (`zaher.online`).
- **Function:** Routes user traffic to the CloudFront distribution using an **Alias Record**, ensuring a branded and professional entry point.



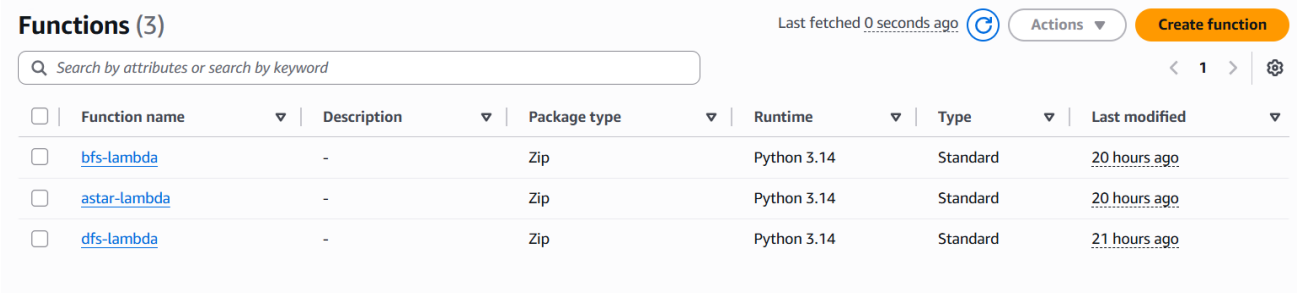
Backend & Compute Components

- **Amazon APIGateway (HTTP API)**
  - Acts as the unified entry point for the backend, receiving requests from the frontend and routing them to the appropriate Lambda function.
  - **Routes:** Defined paths for each algorithm:
    - `POST /solve/bfs`
    - `POST /solve/dfs`
    - `POST /solve/astar`
  - **CORS: Cross-Origin Resource Sharing** is enabled to allow the browser to securely send API requests from the frontend domain.





- **AWS Lambda (Compute)**
  - Represents the core logic of the system. Python (Flask-based logic) is used to execute the pathfinding algorithms. A **Microservices Pattern** was adopted by creating a separate function for each algorithm:
    - **`bfs-lambda`**: Calculates the shortest path using Breadth-First Search.
    - **`dfs-lambda`**: Explores paths using Depth-First Search.
    - **`astar-lambda`**: Finds the optimal path using the A* Heuristic.



- **AWS Lambda Layer**
  - To adhere to the **DRY (Don't Repeat Yourself)** principle, shared logic and helper functions (such as `get_neighbors` and `reconstruct_path`) were encapsulated in a separate **Lambda Layer** named `maze-modules`.
    - **Benefit:** Reduces code redundancy, simplifies maintenance, and ensures consistency across all functions.

Data Flow Workflow

1. The user navigates to `https://zaher.online`.
2. **Route 53** resolves the domain and routes traffic to **CloudFront**.
3. **CloudFront** serves the cached frontend assets from **S3** to the user.
4. The user clicks "Simulate"; the JavaScript client sends a POST request containing the start node, end node, and wall data.
5. **API Gateway** receives the request and routes it to the specific **Lambda Function** (e.g., `bfs-lambda`).
6. The **Lambda** function imports shared logic from the **Layer**, executes the algorithm, and returns the result (Visited Nodes & Path) as JSON.
7. The Frontend processes the response and visualizes the animation in real-time.

Key Technical Benefits

- **Serverless:** No infrastructure management (No EC2 instances to patch or maintain).
- **Cost-Effective:** Costs are incurred only when code is running (Pay-as-you-go).
- **Scalability:** The system automatically scales to handle thousands of concurrent requests via AWS Lambda.
- **Performance:** High availability and low latency achieved through CloudFront's global edge network.

Source Code & Live Demo

The complete project source code (Frontend & Backend) is available on GitHub. Additionally, a persistent **Live Demo** has been deployed on Vercel to ensure accessibility for review purposes after decommissioning the AWS resources for cost optimization.

- **GitHub Repository:** GitHub
- **Live Demo (Vercel):** Live Demo