

# Backend (JDBC + DAO)

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## Overall Architecture

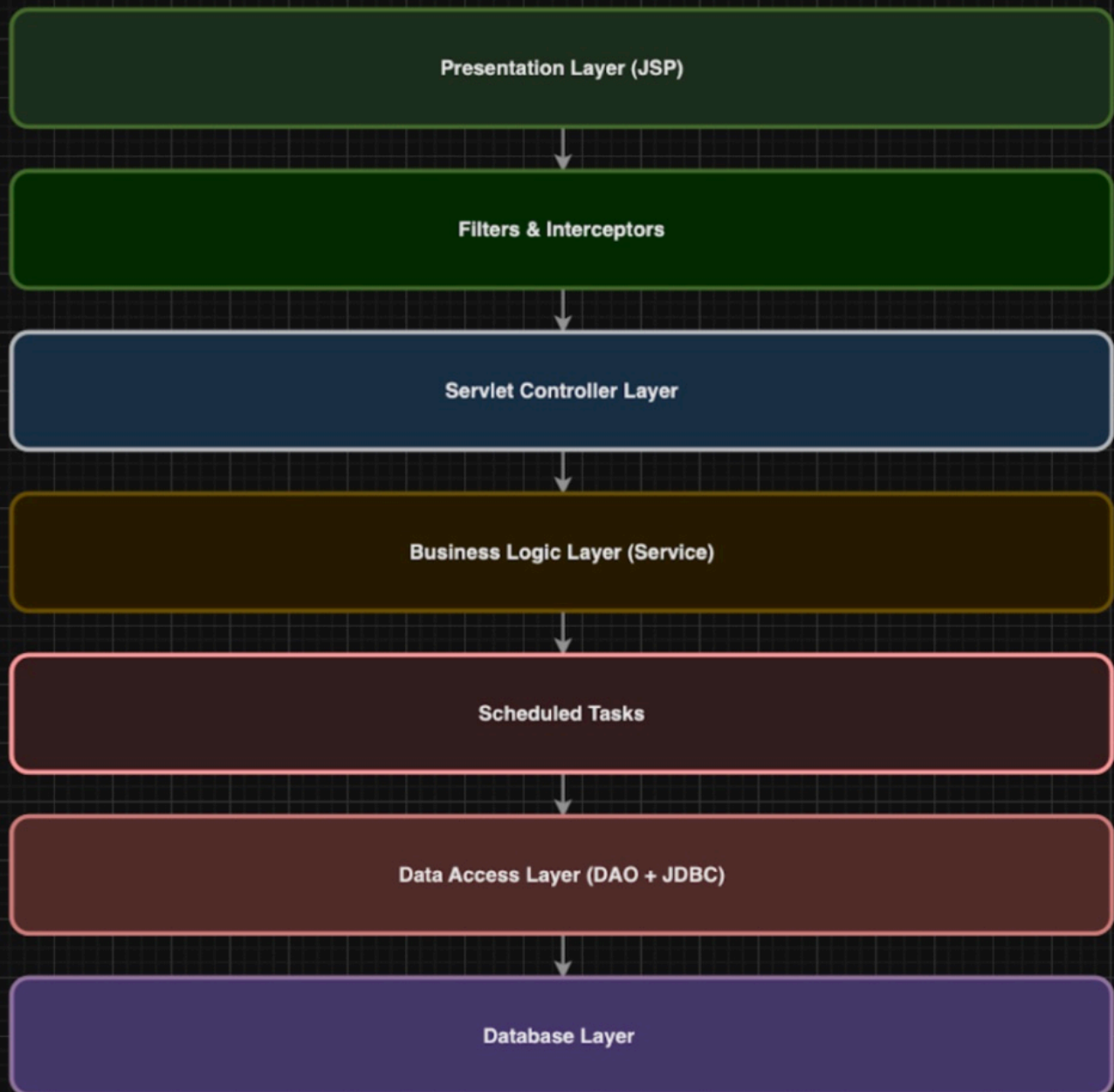
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The backend of this project follows a **JDBC + Servlet + DAO layered architecture**, structured as follows:

```
Controller (Servlet)
    ↓
Service (Business Logic Layer)
    ↓
DAO (Data Access Layer)
    ↓
JDBC (ConnectionManager)
    ↓
Database (MySQL Mode)
```

- The **Controller layer** receives HTTP requests from JSP pages and determines the requested CRUD operation (create, read, update, delete) based on the parameters. It then invokes the appropriate Service or DAO method, attaches results to the request attributes, and forwards the response back to the JSP page.
  - The **DAO layer** contains one DAO class per database table. Each DAO uses JDBC `PreparedStatement` to execute SQL queries and perform CRUD operations, working closely with the corresponding entity classes (User, CrimeReport, UserAlert).
  - The **JDBC ConnectionManager** centralizes database connection handling. It reads configuration values from `application.properties`, provides a unified `getConnection()` method, and ensures reliable connection management for all DAO classes.
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## SafePath Backend Architecture



## Database Schema

The database consists of three core tables, each supporting one major module of the application.

### users

Column	Type	Notes
user_id	INT AUTO_INCREMENT	PK
email	VARCHAR	unique
password_hash	VARCHAR	hashed password
created_at	TIMESTAMP	auto generated

crime\_reports

Column	Type
report_number	VARCHAR PK
report_datetime	TIMESTAMP
precinct	VARCHAR
sector	VARCHAR
beat	VARCHAR
mcpp_neighborhood	VARCHAR
blurred_address	VARCHAR
blurred_latitude	DOUBLE
blurred_longitude	DOUBLE

user\_alerts

Column	Type
alert_id	INT PK auto_increment
user_id	INT FK → users.user_id
radius_m	INT
center_lat	DOUBLE
center_lon	DOUBLE
crime_type_filter	VARCHAR
active_flag	BOOLEAN
created_at	TIMESTAMP
updated_at	TIMESTAMP

# CRUD

## User CRUD

HTTP Method	Endpoint	Description	Parameters
GET	/users	Retrieves all users; supports optional search	searchEmail (optional)
GET	/users?id={userId}	Retrieves detailed information for a single user	id (required)
POST	/users?action=create	Creates a new user	email, password
POST	/users?action=update	Updates an existing user	id, email, password (optional)
POST	/users?action=delete	Deletes a user	id

## Crime Reports CRUD

HTTP Method	Endpoint	Description	Parameters
GET	/crimeReports	Retrieves all crime reports; supports multi-field search	searchReportNumber, searchPrecinct, searchNeighborhood (optional)
GET	/crimeReports?reportNumber={X}	Retrieves a single crime report by report number	reportNumber
POST	/crimeReports?action=create	Creates a new crime report	Multiple form fields (all report attributes)
POST	/crimeReports?action=update	Updates an existing crime report	Multiple form fields
POST	/crimeReports?action=delete	Deletes a crime report	reportNumber (or corresponding primary key field)

## User Alerts CRUD

HTTP Method	Endpoint	Description	Parameters
GET	/alerts	Retrieves all user alerts; supports optional search	searchUserId, searchAlertId (optional)
GET	/alerts?id={alertId}	Retrieves detailed information for a single alert	id (alertId)
POST	/alerts?action=create	Creates a new user alert	Form fields (radius_m, center_lat, center_lon, etc.)
POST	/alerts?action=update	Updates an existing user alert	Multiple alert fields
POST	/alerts?action=delete	Deletes a user alert	id (alertId)

## DAO Layer and JDBC Workflows Example

# CREATE Workflow

## Workflow Explanation

1. The user fills in the **Email** and **Password** fields in the JSP form and submits the request.
2. The `UserServlet` receives the request and detects that `action=create`.
3. The Servlet invokes `UserDAO.createUser()`.
4. The DAO constructs and executes the following SQL statement:

```
INSERT INTO users (email, password_hash, created_at)
VALUES (?, ?, NOW());
```

5. A JDBC connection is retrieved from the `ConnectionManager`, and a `PreparedStatement` is executed.
6. After a successful insertion, the Servlet redirects the user back to the user list page.

```
-- Insert three data into users
INSERT INTO users (email, password_hash)
VALUES
('admin@safepath.com', 'hash_admin123'),
('alice@gmail.com', 'hash_alice123'),
('bob@gmail.com', 'hash_bob123');

-- Insert three data into user_alerts
```

```
INSERT INTO user_alerts (user_id, radius_m, center_lat, center_lon,
crime_type_filter)
VALUES
(1, 1000, 47.6062, -122.3321, 'ASSAULT'),
(2, 500, 47.6205, -122.3493, 'BURGLARY'),
(3, 1500, 47.6097, -122.3331, 'ROBBERY');
```

# READ Workflow

## Workflow Explanation

To retrieve all users:

```
SELECT * FROM users ORDER BY user_id DESC;
```

To retrieve a single user by ID:

```
SELECT * FROM users WHERE user_id = ?;
```

The DAO maps each result row to a `User.java` entity object and returns it to the Servlet, which then forwards the data to the JSP page for rendering.

SELECT \* FROM USERS;

USER_ID	EMAIL	PASSWORD_HASH	CREATED_AT
8	admin@safepath.com	hash_admin123	2025-11-10 03:39:41.32971
9	alice@gmail.com	hash_alice123	2025-11-10 03:39:41.33071
10	bob@gmail.com	hash_bob123	2025-11-10 03:39:41.33071

(3 rows, 71 ms)

Edit

SELECT \* FROM USER\_ALERTS;

ALERT_ID	USER_ID	RADIUS_M	CENTER_LAT	CENTER_LON	CRIME_TYPE_FILTER	ACTIVE_FLAG	CREATED_AT	UPDATED_AT
5	9	500	47.6205	-122.3493	BURGLARY	TRUE	2025-11-10 03:39:41.333711	2025-11-10 03:39:41.333711
6	10	1500	47.6097	-122.3331	ROBBERY	TRUE	2025-11-10 03:39:41.334711	2025-11-10 03:39:41.334711
7	12	1000	47.6062	-122.3321	ALL	TRUE	2025-11-11 01:35:34.173421	2025-11-11 01:35:34.173421
8	13	1500	47.6062	-122.3321	THEFT	TRUE	2025-11-11 01:35:34.174425	2025-11-11 01:35:34.174425

(4 rows, 11 ms)

## UPDATE Workflow

### Workflow Explanation

1. The user clicks the “Edit” button on the list page.
2. The Servlet loads the existing user and pre-fills the edit form in the JSP.
3. After the user submits the form, the Servlet detects `action=update`.
4. The DAO executes the following SQL statement:

```
UPDATE users
SET email = ?, password_hash = ?
WHERE user_id = ?;
```

5. If the password field is left empty, the original password is preserved (handled in the Servlet logic).
6. After a successful update, the user is redirected back to the list page.

## Edit User

Email:

Password (leave blank to keep current):

Update User

Cancel

SELECT \* FROM USERS;

USER_ID	EMAIL	PASSWORD_HASH	CREATED_AT
8	admin1@safepath.com	hash_admin123	2025-11-10 03:39:41.32971
9	alice@gmail.com	hash_alice123	2025-11-10 03:39:41.33071
10	bob@gmail.com	hash_bob123	2025-11-10 03:39:41.33071

(3 rows, 0 ms)

## DELETE Workflow

### Workflow Explanation

1. The user clicks the “Delete” button on the list page.
2. The Servlet detects `action=delete` and calls the DAO method that executes:

```
DELETE FROM users WHERE user_id = ?;
```

3. After successful deletion, the application returns to the user list view.



Users List

User ID	Email	Created At	Actions
8	admin1@safepath.com	2025-11-10T03:39:41.329710	<div><div>Edit</div><div>Delete</div></div>
9	alice@gmail.com	2025-11-10T03:39:41.330710	<div><div>Edit</div><div>Delete</div></div>
10	bob@gmail.com	2025-11-10T03:39:41.330710	<div><div>Edit</div><div>Delete</div></div>

[Back to Home](#)

SELECT \* FROM USERS;

USER_ID	EMAIL	PASSWORD_HASH	CREATED_AT
9	alice@gmail.com	hash_alice123	2025-11-10 03:39:41.33071
10	bob@gmail.com	hash_bob123	2025-11-10 03:39:41.33071

(2 rows, 1 ms)

# Advanced Feature

The advanced feature selected in **Milestone 1** is the **User Alert System**.

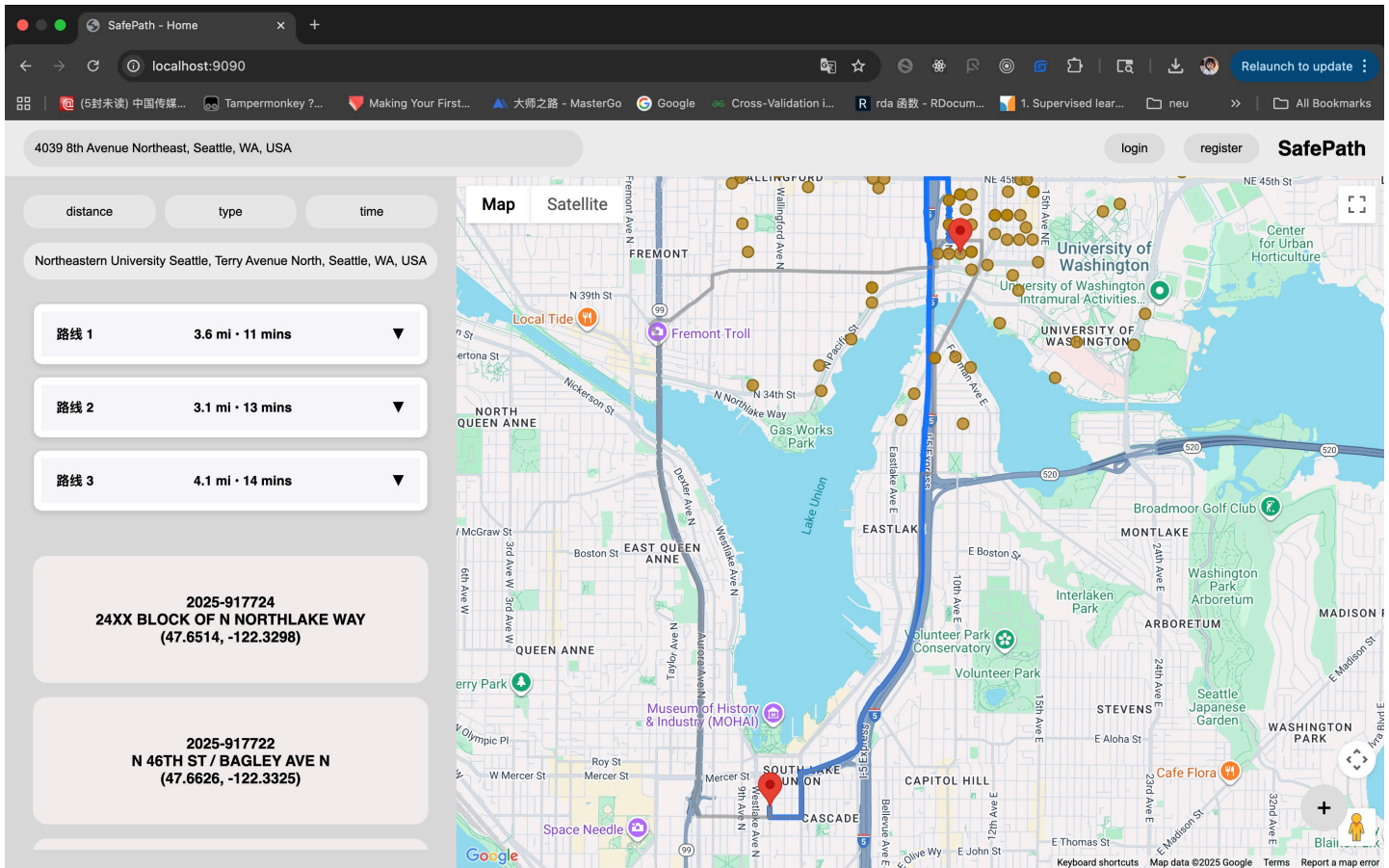
This feature allows each user to configure a personal *geofence-based safety alert*, where the system monitors crime activity within a user-defined geographic radius.

## Key Capabilities

- 1. Users can create custom **geofence alerts**.
- 2. The backend processes user-selected geofence parameters:
  - `center_lat`
  - `center_lon`
  - `radius_m`
- 3. The frontend displays all crime reports that fall within the user’s configured area.
- 4. All alert configurations are stored in the `user_alerts` table.

## API Endpoints for Advanced Feature

```
GET /alerts
GET /alerts?id={alertId}
POST /alerts?action=create
POST /alerts?action=update
POST /alerts?action=delete
```



## Build & Run Instructions

```
# Build the WAR package
mvn package

# Local Development (Recommended)
mvn jetty:run

# Deploy to Apache Tomcat
Copy target/*.war into the Tomcat webapps/ directory.
```

# Frontend (JSP)

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## Overview

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The frontend of this project is built using traditional JSP-based server-side rendering, combined with modern JavaScript modules for dynamic map interaction and data visualization. It consists of three major layers:

- **View Layer**

`index.jsp` serves as the main entry point of the application, designated as the welcome page through `web.xml`.

- **Styling Layer**

`style.css` defines the global layout, including the top navigation bar, left-side information panel, right-side map container, and expandable route detail cards.

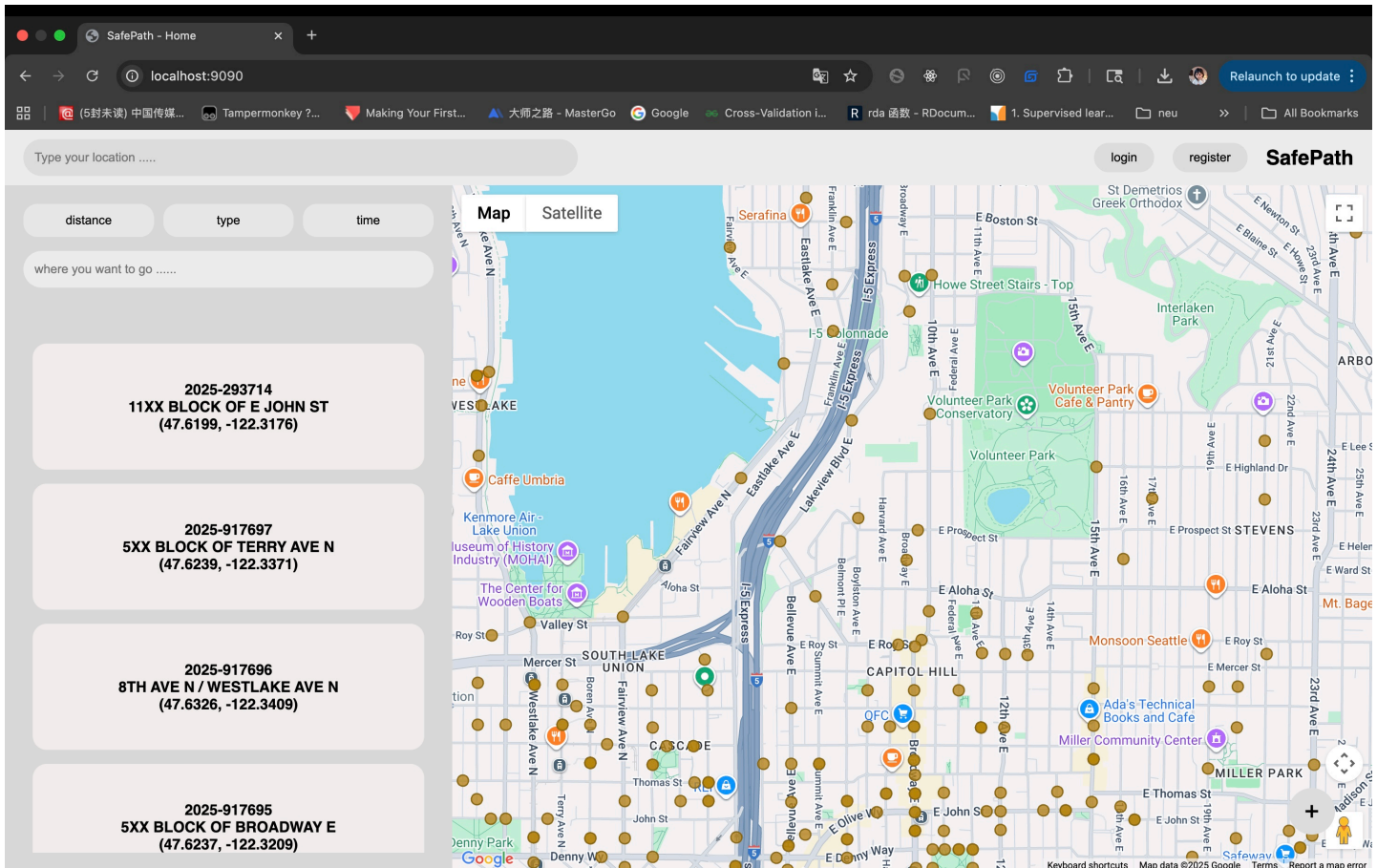
- **Script Layer**

- `map.js`: Initializes the Google Maps interface, handles route planning, Place Autocomplete, and integrates crime overlay data.
- `crime.js`: Fetches crime reports from the backend `/crime-report` API based on geographic and temporal filters, updates the sidebar list, and renders crime markers on the map.

## Page Structure: `index.jsp`

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The user interface follows a classic **“Sidebar + Map” single-page layout**, where JavaScript fetches data asynchronously from backend servlets. All map updates and crime data rendering occur without reloading the page.



Because `web.xml` sets `index.jsp` as the **welcome file**, visiting the root path `/` automatically loads this interface.

## Top Navigation Bar — `.header`

Styled via `.header` in `style.css`, this section provides:

- Left: Application logo ( `.logo` )
- Center: Search input ( `.search-input` ), used for general search or location input
- Right: Authentication buttons ( `.auth-buttons` ) for login and registration

## Main Layout — `.main`

The central portion of the UI is a horizontal flex container containing:

- **Left Panel ( `.sidebar` , ~30% width )**  
Displays crime reports and route information.
- **Right Map Area ( `.map-area` )**  
Contains the Google Map initialized by `map.js`.

Key DOM elements referenced in the JavaScript modules include:

Element	Purpose
<code>.alert-list</code>	Populated by <code>crime.js</code> with crime report summaries
<code>#map</code>	Google Maps container
<code>#route-details</code>	Dynamic route summary panel (from <code>map.js</code> )
<code>#location-input</code> / <code>.search-destination</code>	Fields for Place Autocomplete

## JavaScript and Google Maps Script Loading

At the bottom of `index.jsp`, the application loads:

```
<script type="module" src="map.js"></script>
```

The Google Maps JavaScript API is loaded using:

```
<script src="https://maps.googleapis.com/maps/api/js?
key=...&callback=initMap&libraries=places"></script>
```

Because Google Maps requires a global callback, `map.js` registers:

```
window.initMap = initMap;
```

This mechanism is central to the advanced feature integration—once the map finishes initializing, the system automatically triggers crime-data loading based on the current map viewport.

## JavaScript Modules

The core frontend logic is organized into two ES module-based JavaScript files: `crime.js` and `map.js`. These modules work together to provide crime visualization, route planning, and real-time geographic filtering.

### `crime.js`

Crime Data Loading & Visualization Module

`crime.js` is responsible for fetching and rendering crime reports on the page. Its key functions include:

- Requesting crime data from the backend based on the **current map viewport** and **selected time range**

requesting crime data from the backend based on the current map viewport and selected time range

- Rendering crime reports in the left-side list panel (`.alert-list`)
- Adding crime markers to the Google Map, with icons and info windows

This module is automatically triggered whenever the map view changes, ensuring that the displayed crime data always matches the visible geographic area.

## map.js

Map Initialization, Route Planning & Crime Integration

`map.js` serves as the central controller for all map-related interactions and visualization features. It provides:

1. **Map Initialization**

Creates the Google Map instance and attaches it to `window.map`.

2. **Place Autocomplete**

Enables address autocomplete for both origin and destination input fields.

3. **Route Calculation**

Uses the Google Directions API to compute and display multiple alternative routes on the map.

4. **Viewport-Based Crime Loading**

Detects whenever the map is moved or zoomed, computes the geographic bounding box, and triggers

`crime.js` to fetch and display relevant crime reports.

Through these mechanisms, `map.js` acts as the bridge between user interactions, crime data visualization, and route planning.

## style.css

The `style.css` stylesheet defines the visual structure and appearance of the entire application, including:

- The top navigation bar
- The sidebar layout for crime lists and route details
- The map container
- The expandable route detail cards
- Spacing, typography, colors, and flexbox layout rules

It ensures that the user interface remains consistent, readable, and aligned with modern web design standards.

## Advanced Feature Description

The advanced feature integrates **Google Maps route planning** with **geographically and temporally filtered**

the advanced feature integrates these map-report features into a unified interactive map interface. This provides a safety-aware navigation experience.

## Feature Workflow

Whenever the user opens the page, drags the map, or zooms in/out:

1. The frontend calculates the visible bounding box:
  - Minimum/maximum latitude (`minLat`, `maxLat`)
  - Minimum/maximum longitude (`minLon`, `maxLon`)
2. A time filter (e.g., **last 50 days**) is applied.
3. The system sends a request to the backend endpoint:

```
/crime-report?action=range
```

with both geographic and temporal parameters.

1. The backend returns all crime reports that fall within the specified range.
2. The returned data is used for:
  - Displaying a crime list in the left `.alert-list`
  - Plotting crime markers dynamically on the map

## Integrated UI Effects

Although route planning and crime visualization are implemented in separate modules, they support each other when presented together:

- The map simultaneously displays **user-generated routes** and **local crime hotspots**
- The sidebar contains both **detailed route information** and **crime report summaries**
- Users can visually assess which route avoids higher-risk areas

This combined system enhances user safety awareness and supports smarter decision-making during route selection.

# Advanced Feature Plan

## Machine Learning Crime Classification & Prediction Model

This advanced feature extends the existing Crime Report Management System by introducing a **Machine**



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**Learning (ML) module** designed to analyze historical crime data, extract behavioral patterns, and perform risk prediction.

By training ML models on structured historical data, the system can automatically predict the likely crime category or risk level based on user-provided inputs such as neighborhood, time, weapon type, or domestic violence indicators. This enhancement upgrades the system from a simple information dashboard into an **intelligent decision-support platform**.

During this milestone, we completed the model training, evaluation scripts, and produced deployable model files. In the next milestone, the prediction logic will be integrated into the Servlet layer and exposed directly to the frontend.

## Dataset Preparation

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The ML module uses multiple fields from the historical crime dataset, including (but not limited to):

- `crime_category`
- `neighborhood`
- `report_datetime`
- `weapon`
- `domestic_violence_flag`
- `precinct`

Data preprocessing steps include:

- Missing value handling
- Encoding categorical fields (label encoding / one-hot encoding)
- Normalizing numerical attributes
- Splitting the dataset into training and test sets

These steps ensure that the dataset is clean and suitable for statistical modeling.

## ML Model Structure

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According to the specifications outlined in `ML_changes.readme`, the ML pipeline consists of the following components.

### Feature Engineering

- Converts raw database records into numerical feature vectors
- Encodes geographic features, crime types, and temporal patterns



- Ensures consistent feature columns for all ML models

## Model Selection

Depending on task requirements (classification vs. prediction), the ML module supports interchangeable model architectures, including:

- Logistic Regression
- Random Forest
- Decision Tree
- Naive Bayes
- Additional modular model configurations

The implementation uses **Java + Weka** or **Python + Scikit-Learn**, depending on the training environment described in the team's documentation.

## Model Training

Training scripts load data from CSV files or the database and export persistent model artifacts such as:

- `.model` (Weka binary format)
- `.pkl` (Scikit-Learn pickle format)

Training results include:

- Accuracy score
- Confusion matrix
- Feature importance ranking

These evaluation metrics help determine which model structure performs best for deployment.

## Integration with the Web System

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The trained ML model will be integrated into the backend through:

- **CrimeReportServlet** — for real-time prediction requests
- **JSP frontend** — for visualizing the prediction output

Workflow:

1. The user fills out crime-related attributes on the frontend form.
2. The frontend sends these attributes to the Servlet.

3. The Servlet loads and executes the ML model for prediction.
4. The predicted crime category or risk level is returned to the JSP page.

This integration allows end users to interactively test hypothetical scenarios and view real-time crime predictions.

## UI/UX Workflow

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A dedicated **“Crime Prediction”** input panel is added to the user interface.

### User Flow

1. The user selects or enters:
  - Neighborhood
  - Date/time
  - Optional factors (weapon type, domestic violence flag, etc.)
2. The user clicks **“Predict Crime Type / Risk Level”**.
3. The frontend sends these inputs to the ML prediction endpoint.
4. The prediction result is returned and displayed beneath the form.

This design provides a simple, intuitive interface for experimenting with the ML model and understanding crime pattern tendencies.