CHARGE ROUTE: A WEB APPLICATION FOR EV RANGE ESTIMATION AND CHARGING STATION LOCATOR

A PROJECT REPORT

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Under the guidance of,

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in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING, COMPUTER ENGINEERING, INFORMATION SCIENCE AND ENGINEERING Etc.

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CERTIFICATE

This is to certify that the Project report **"CHARGE ROUTE: A WEB APPLICATION FOR EV RANGE ESTIMATION AND CHARGING STATION LOCATOR"** being submitted by "AANCHAL SAMEER, MAIMOONA MAHMOOD, TARA CHANDRA SAI REDDY, INDRAJITH M" bearing roll number(s) "20211CST0056, 20211CST0033, 20211CST0109, 2020CST0015" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a Bonafide work carried out under my supervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **CHARGE ROUTE: A WEB APPLICATION FOR EV RANGE ESTIMATION AND CHARGING STATION LOCATOR** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Technology (AIML)**, is a record of our own investigations carried under the guidance of **MS. RADHIKA SREEDHARAN, ASSISTANT PROFESSOR, School of Computer Science Engineering & Information Science, Presidency University, Bengaluru.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

The Charge Route project is a web-based application created to assist electric vehicle (EV) owners by providing accurate driving range estimates and locating nearby charging stations. With the rise in EV adoption, users often face challenges in predicting their vehicle's range precisely and finding reliable charging infrastructure, contributing to the issue of "range anxiety." This project aims to mitigate these challenges by offering an intuitive and user-friendly platform, enabling users to make informed travel decisions. Through its reliable data and design, the Charge Route project seeks to improve the EV ownership experience by reducing range anxiety and supporting confident travel planning.

The Charge Route application features a real-time range estimation tool that allows users to input their current battery level and receive calculations for the maximum distance their vehicle can travel. This is accomplished through advanced algorithms that take into account battery efficiency, as well as external factors such as road conditions and driving behavior. By providing accurate range predictions, Charge Route enables users to plan their trips more effectively, minimizing the risk of depleting their battery during travel.

In addition to range estimation, the Charge Route app offers a streamlined interface for locating nearby charging stations. Integrated with the Google Maps API, it provides real-time details on station locations, distance, availability, and charging speed, helping users find convenient options and reduce wait times, enhancing the EV experience. The backend, built with Node.js and Express, manages core functions like user input processing, data retrieval, and API integration. The frontend, developed with React, ensures a responsive and engaging user interface. This combination delivers a reliable and high-performing system.

In order to encourage the use of electric vehicles and aid in the shift to environmentally friendly, sustainable transportation, the Charge Route initiative intends to alleviate range anxiety and provide convenient access to charging infrastructure. The project's design also paves the door for ongoing improvement by permitting future improvements like route optimization and integration with data on renewable energy. In the end, Charge Route helps create a more environmentally friendly future by enabling users to make more informed, environmentally friendly travel choices and promoting the transition to electric vehicles.

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INTRODUCTION

1.1 OVERVIEW:

Range anxiety, or the dread of running out of battery power before arriving at a charging station, is one of the main issues that EV owners have, and the Charge Route app was created to alleviate this issue. In order to estimate range and locate the closest charging station along their trip, customers can enter their starting point, destination, and vehicle details using Google Maps API and proprietary algorithms.

The app's React frontend and Node.js + Express backend offer a responsive and seamless user experience. Its primary features, which aid users in making wise judgments when traveling, centre on usability, dependability, and effective navigation. By making EV use more convenient and promoting wider acceptance of electric vehicles, the Charge Route project aids in the shift to sustainable transportation and eventually helps create a cleaner, greener future.

1.2 STATEMENT OF THE PROBLEM:

Range anxiety, or the concern that a battery will run out of power before arriving at a charging station, is one of the primary barriers to the widespread adoption of electric bikes (EVs). This worry stems from the difficulties EV owners have estimating how far they can go on their present battery level, particularly in weather and road conditions that change often. It can also take a lot of time and effort to find trustworthy and close-by charging stations, evaluate their availability, and calculate charging speeds.

Existing solutions frequently lack user-friendly interfaces and thorough, real-time updates, which causes EV users to feel uneasy and inconvenienced. These restrictions make prospective purchasers hesitant and impede the expansion of EV adoption since worries about the dependability of charging infrastructure and range continue to exist.

1.3 MOTIVATION:

The motivation behind the Charge Route project stems from the growing need to address "range anxiety" among electric vehicle (EV) users, a key barrier to the widespread adoption of EVs. As the world shifts towards cleaner and more sustainable transportation, ensuring that

EV owners can confidently plan their journeys without the fear of running out of charge is essential. Many drivers face difficulties estimating their vehicle's range accurately and locating reliable charging infrastructure. Providing a solution that offers precise range predictions and real time information on nearby charging stations, Charge Route aims to enhance the convenience and reliability of EV ownership. Ultimately, the project supports the global transition to eco-friendly transportation and helps reduce carbon emissions.

1.4 OBJECTIVES

- **Alleviating Range Anxiety**: Delivering accurate range predictions based on user inputs and external factors to improve reliability and trust in EV performance.
- **Optimizing Charging Station Discovery**: Facilitating the efficient location of charging stations and providing comprehensive information on their availability and suitability.
- **Boosting User Confidence**: Promoting the adoption of EVs through a user-centric, data-driven platform designed for intuitive use and informed decision-making.

1.5 KEY FEATURES

1.5.1 Range Estimation

- **Vehicle-Specific Data:** The app provides an accurate range estimate by utilizing topography analysis, battery status, car model data, and past driving trends.
- **Real-Time Updates:** Range estimations are dynamically modified according to driving circumstances and the battery level.
- **Efficiency Indicators:** Based on an assessment of the vehicle's range, visual indicators indicate when a recharge is necessary.

1.5.2 Nearest Charging Station Locator

- **Proximity Alerts:** The app shows users charging stations that are within a certain radius of their present location or that are on their way based on real-time location.
- **Station Availability:** Users can minimize needless stops by using real-time updates on the availability or occupancy of charging stations.
- **Filters & Preferences:** Stations can be filtered by network, facilities (such cafes and restrooms), and type (fast, supercharger, etc.).

1.5.3 Accuracy & Integration of Data

- **Third-Party API Integration:** Retrieves current station information and status from reliable sources.
- **Reliable Data Processing:** Ensuring precise location data lowers the possibility of inaccurate or out-of-date station information thanks to reliable data processing.

1.5.4 User-friendly Interface

- **Intuitive Design:** Consists of a contemporary user interface constructed with React to produce responsive and interactive elements.
- **Interactive Maps:** Contains maps with station information provided by tooltips and detailed markings.

1.6 TECHNICAL IMPLEMENTATION

1.6.1 Frontend Architecture

The React framework is used by the Charge Route frontend to facilitate effective, component-based programming, which simplifies updates and maintenance. The design creates a contemporary, responsive interface with CSS3 and Material-UI. The Map Display Module is a crucial component that provides real-time information on local charging stations and interactive geolocation for user convenience.

1.6.2 Backend Architecture

The backend architecture of Charge Route is developed using Node.js and Express, facilitating fast, non-blocking I/O operations and efficient data processing. Core functionality is managed through well-structured modules: the evController.js module handles essential tasks such as distance calculations, API requests, and processing user inputs, while evRoutes.js manages HTTP requests to ensure smooth communication between the frontend and backend. Security is a key aspect of the architecture, with API communications secured through HTTPS and sensitive data managed using environment variables for added protection.

1.7 DATA AND ALGORITHM INTEGRATION

- **Geospatial Algorithm:** Using the Haversine formula, the geospatial algorithm computes distances and locates charging stations by processing and analysing geographic data.

- **Greedy Algorithm:** By making quick decisions based on the user's current position and the distance to available charging stations, the greedy algorithm assists in locating the closest charging station.

1.8 APPLICATIONS AND USE CASES

- **Daily Commuting:** Gives commuters a summary of how much battery they should expect to use and how much they will need to charge for everyday trips.
- **Fleet Management:** By streamlining routes and cutting down on vehicle downtime, this technology helps companies better manage EV fleets.
- **Eco-Conscious Travel:** Assists consumers in monitoring their carbon footprint and encouraging environmentally friendly travel practices.
- **Long-Distance Travel Planning:** Provides worry-free travel by helping customers plan routes with thoughtful charging pauses.

1.9 CHALLENGES:

As the Charge Route project continues to develop, several future challenges are anticipated. One major challenge is enhancing the accuracy of range estimation by incorporating more variables, such as weather conditions, road gradients, and traffic patterns, which can significantly impact an electric vehicle’s efficiency. Developing an algorithm that can handle these factors in real-time without compromising performance will be complex. Another challenge is expanding the integration of different charging networks and ensuring real-time updates about station availability, charging speeds, and payment options. As more EV models and charging infrastructures emerge, maintaining compatibility across diverse systems will be demanding. Furthermore, scaling the application to accommodate a growing user base while ensuring data security, smooth functionality, and reliable performance under high usage conditions will be a crucial challenge to address in the future.

CHAPTER-2

LITERATURE SURVEY

2.1 OVERVIEW

The research emphasizes the significance of apps for charging station locators and effective range prediction are to promoting the use of electric vehicles (EVs). Through the use of sophisticated algorithms, user-centered designs, and an emphasis on sustainability, these applications help EV owners travel more comfortably and reduce range anxiety. There are many chances to enhance user experiences and hasten the adoption of EVs as technology develops further, ultimately contributing to a cleaner and more sustainable future.

2.2 LITERATURE REVIEW

Barman et al. [1] provides a review of existing smart charging approaches, exploring the integration of renewable energy with electric vehicle technology to promote sustainable and efficient charging solutions.

Ehsani et al. [2] provide a comprehensive overview of modern electric, hybrid electric, and fuel cell vehicles in their second edition, discussing fundamentals, theory, and design to support advancements in sustainable transportation technologies.

Hong et al. [3] explore accurate remaining range estimation for electric vehicles, as published in IEEE, focusing on improving prediction reliability to enhance user confidence and trip planning.

Li et al. [4] propose a smart charging strategy for electric vehicles that incorporates marginal carbon emission factors and time-of-use pricing, aiming to minimize environmental impact and optimize charging costs.

Mak et al. [5] investigate infrastructure planning for electric vehicles with battery swapping, focusing on optimizing station locations and operations to enhance the convenience and efficiency of this alternative charging method.

Mastoi et al. [6] provide an in-depth analysis of electric vehicle charging station infrastructure, exploring policy implications and future trends to guide sustainable development in this sector.

Pourvaziri et al. [7] present a planning approach for electric vehicle charging stations, integrating deep learning and queueing theory to optimize station efficiency and reduce waiting times

Wang et al. [8] analyze global trends in electric vehicle adoption, examining the influence of environmental awareness, user attributes, and barriers to promote wider acceptance and sustainable practices.

Wu et al. [9] address the location-routing optimization problem for electric vehicle charging stations in an uncertain transportation network, proposing an adaptive co-evolutionary clustering algorithm to improve efficiency and reliability.

Zhou et al. [10] investigate the optimization of electric vehicle charging station locations by employing a cost model and genetic algorithm, striving to achieve a balance between cost efficiency and accessibility.

CHAPTER-3

RESEARCH GAPS OF EXISTING METHODS

3.1 EXISTING METHODS

3.1.1 Shortest Path Algorithm (Dijkstra's Algorithm)

The shortest path algorithm's fundamental objective is to determine the most cost-effective way, accounting for variables like road types and distance, between a present position and the closest charging station.

How it Works:

The way Dijkstra's Algorithm works is by methodically examining every possible path from the beginning point and choosing the one that provides the shortest travel distance. For laying out direct routes and guaranteeing efficient travel, this algorithm works well.

Drawbacks:

- **Lack of Real-Time Adaptability:** Conventional shortest path algorithm implementations are static and do not take into account real-time information, such as traffic, road closures, or bad weather, which can have a big influence on the predicted arrival time and actual driving range.
- **Single Objective Optimization:** The distance is the top priority for these algorithms.

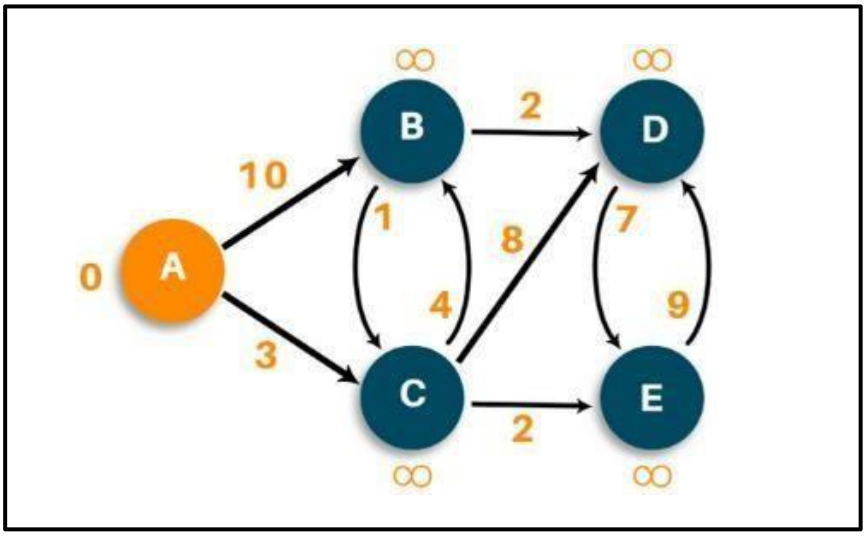


Figure 3.1.1 Dijkstra's Algorithm

3.1.2 A (A-Star) Algorithm

Identical to Dijkstra's, but with heuristics to speed up and improve the effectiveness.

How it Works:

Combines an estimated distance (heuristic) to the target with the actual distance from the start to direct the search.

Drawbacks:

- **Complexity:** If the search space (i.e., the map area) is large, more processing power is needed.
- **Heuristic Restrictions:** The heuristic's correctness is crucial to its effectiveness; a subpar heuristic could produce less than ideal results.

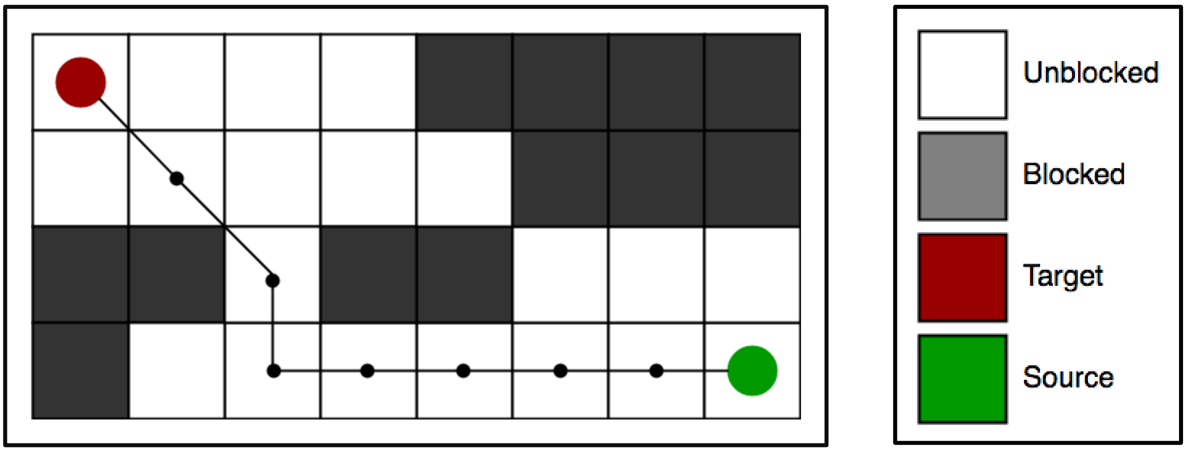


Figure 3.1.2 A (A-Star) Algorithm

3.1.3 Prediction Models Based on Machine Learning

The primary goal of machine learning-based prediction models is to provide an accurate estimation of an electric vehicle's (EV's) remaining range. These models take into account a variety of real-time and historical data points, including battery level, vehicle speed, road conditions, weather, and driver behavior.

How it Works:

Machine learning algorithms are trained on extensive datasets that include various factors affecting EV performance. By learning from this data, the models can detect patterns and correlations between different variables, such as how changes in speed or driving habits impact energy consumption.

Drawbacks:

- **Generalization:** The model might not adapt well to novel circumstances (such as infrequent weather or untrained roads).
- **Data Dependency:** Needs a lot of real-time and historical data, which can be challenging to get and handle.

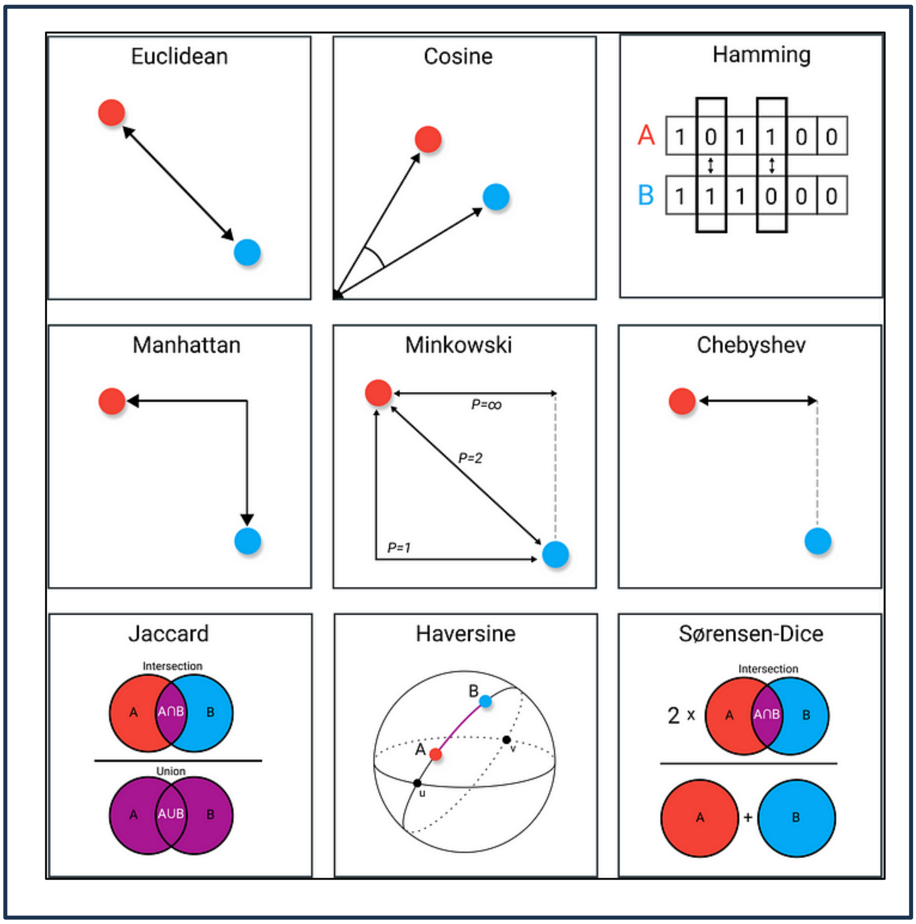


Figure 3.1.3 Distance Measures in Data Science

3.1.4 KNN for Station Concepts: K-Nearest Neighbors

The objective is to identify the nearest charging stations by using location information and additional variables (such as charging speed and station type).

How it Works:

KNN determines the 'k' nearest charging stations by utilizing a selected distance metric (such as the Euclidean distance) to calculate the distances from the driver's present position. The closest and possibly best charging choices are then suggested by ranking these stations.

Drawbacks:

- **Performance bottlenecks:** As the dataset grows, KNN becomes more resource-intensive due to its dependency on searching the full dataset each query time. This affects response times and efficiency, particularly when the network of charging stations grows.
- **Limited Real-Time Adaptability:** Real-time updates are not automatically included into the KNN algorithm, which is usually static. Because of this, it might not account for evolving circumstances like the presence of charging stations, abrupt changes in traffic, or road closures, which could jeopardize the precision and applicability of its suggestions.

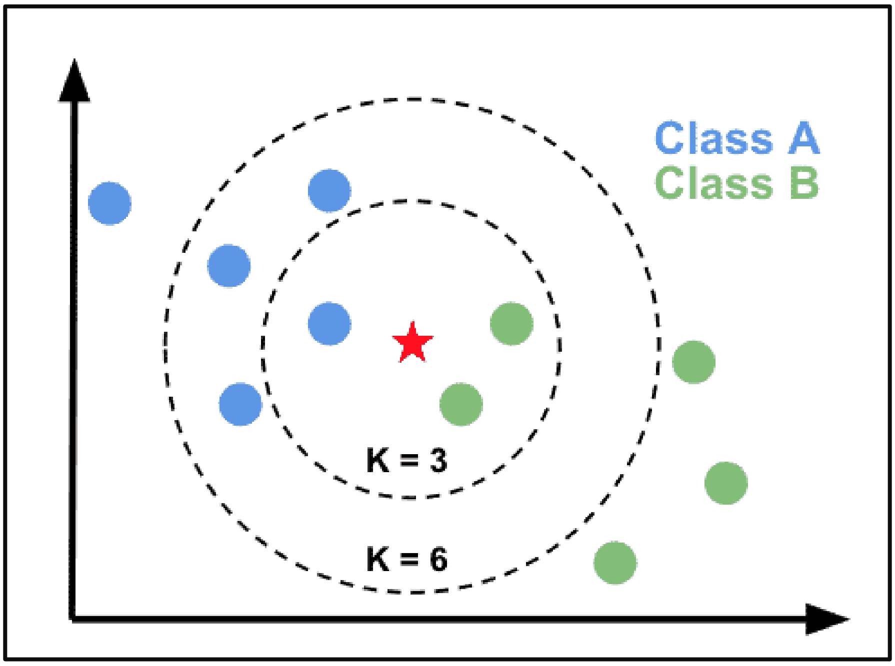


Figure 3.1.4 K-Nearest Algorithm

3.1.5 Route Optimization Algorithms (Genetic Algorithms)

Genetic algorithms (GAs) and other route optimization algorithms are made to determine the best way for an electric vehicle (EV) to get to its destination while making the fewest possible stops for charging. These algorithms consider important variables like the vehicle's range, the locations of charging stations, and possible energy usage.

How it Works:

Genetic algorithms use concepts from evolution and natural selection to tackle challenging optimization issues. A fitness function that takes into account variables like total distance, number of charging stations, and total journey time is used to evaluate these routes.

Drawbacks:

- **Computational Complexity:** The computationally demanding nature of genetic algorithms is one of their main drawbacks. Particularly when used for real-time route planning, evaluating a huge population of possible solutions and carrying out multiple iterations might require a substantial amount of processing power and time.
- **Real-Time Restrictions:** Since GAs are iterative and require frequent route evaluation and adjustment, they may not be suitable for real-time decision-making, where prompt responses are essential.

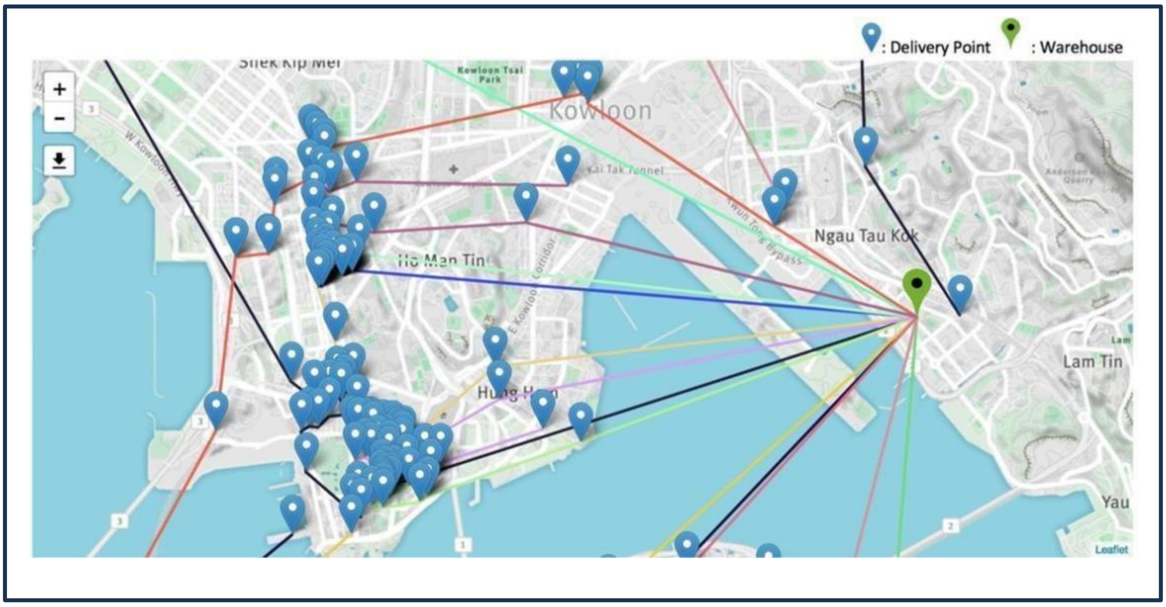


Figure 3.1.5 Route Optimisation Algorithm

3.2 GAPS AND DEFICITS IN EV CHARGING SOLUTIONS

1. Charging Station Availability and Real-Time Data:

Existing Gaps: Real-time information regarding the availability and operating state of charging stations is not provided by the majority of current systems. When charging stations are crowded or undergoing maintenance, they may experience problems since they frequently rely on static data or infrequent updates.

The prospect: Including real-time data feeds into the web application (via APIs, Internet of Things sensors, or direct partnerships with charging infrastructure providers) can improve user experience and lessen annoyance caused by charging stations that aren't available.

2. User-Centric Design:

Existing Gaps: A lot of current solutions concentrate on data and analytics, but they fall short in offering a smooth user experience. Problems including inadequate accessibility for non-technical users, a complex user interface (UI), and a lack of customization (for instance, for various EV models) are still common.

The prospect: By emphasizing accessibility features, tailored route recommendations, and user-friendly UI/UX design, a more user-centric strategy can draw in a wider range of consumers, including those who are less technologically adept.

3. Accuracy of Range Estimation Models:

Existing Gaps: A lot of the range estimation techniques in use today depend on basic variables like battery capacity and typical consumption rates. They frequently overlook real-time vehicle data, such as battery health, load, and usage trends, as well as dynamic driving situations, such as topography, weather, and driving preference.

The prospect: More precise range calculations can be obtained by creating increasingly complex models that incorporate machine learning, predictive analytics, and real-time data.

4. Integration with Existing Navigation and Mapping Tools:

Existing Gaps: Although some apps are stand-alone, they might not work well with popular mapping and navigation systems, which restricts convenience for customers who depend on a single app for all of their travel requirements.

The prospect: Offering integration choices with well-known navigation programs (like Google Maps and Apple Maps) can improve user experience and increase the application's attractiveness as a component of their everyday trip toolbox.

5. Mechanisms for User Feedback

Existing Gaps: Current Gaps: It's possible that existing apps lack robust user feedback tools for sharing charging station experiences, reporting erroneous data, and recommending enhancements.

The prospect: Including feedback features that let users share their thoughts or report problems can help the program get better over time and create a more community-focused atmosphere.

CHAPTER-4

PROPOSED METHODOLOGY

4.1 OVERVIEW

A comprehensive and extensive approach to creating a web application to combat "range anxiety" a major worry for EV owners is provided by the Charge Route project. In order to give consumers a smooth and effective experience, the goal is to offer precise range estimation in addition to reliable charging station placement services. To provide a user-centric solution that satisfies the changing needs of EV users, the suggested methodology combines cutting-edge algorithms, strategic development methods, and sophisticated technology frameworks.

The development process is structured to create a cohesive system that optimizes user experience while addressing technical and functional requirements. This involves detailed planning, technology selection, and the application of sophisticated algorithms to offer real-time insights and functionality.

First, a proprietary algorithm that takes driving conditions into account gathers user input on battery levels to provide precise range forecasts. Real-time information on nearby charging stations, including their availability and charging speeds, is provided by the app through integration of the Google Maps API.

React is used in frontend development to create an intuitive user experience, and Node.js and Express are used in the backend to handle data processing and API connectivity effectively. The app's dependability and performance are guaranteed by thorough testing and optimization.

4.2 REQUIREMENT ANALYSIS

Objective: The core objective of the requirement analysis phase is to determine and specify the fundamental features that are necessary for the web application to be developed successfully while also making sure that it complies with industry standards and user expectations. This entails gaining a thorough grasp of what customers require in order to manage "range anxiety" and enhance the overall EV driving experience. An easy-to-use interface, accurate range calculation, and smooth charging station placement are important features to concentrate on.

4.2.1 Functional Requirements Analysis:

- **Range Calculation Module:** Identify the data inputs and methods required to provide customers with precise real-time range estimations based on factors such as vehicle performance, driving circumstances, and battery level.
- **Charging Station Locator:** Establish the prerequisites for incorporating mapping tools that offer up-to-date information about local charging stations, such as availability, charging speed, and distance.

4.2.2 System Design and Architecture

- **Modular Design:** The system is divided into frontend, backend, and external service integration layers using a modular architecture. Scalability, maintainability, and the simplicity of incorporating future improvements are all guaranteed by this approach.

  Frontend (Client-Side): Handles user interaction and displays real-time data.

  Backend (Server-Side): Processes inputs, calculates range, and integrates external APIs.

  External APIs: Provides geolocation, mapping, and charging station data.

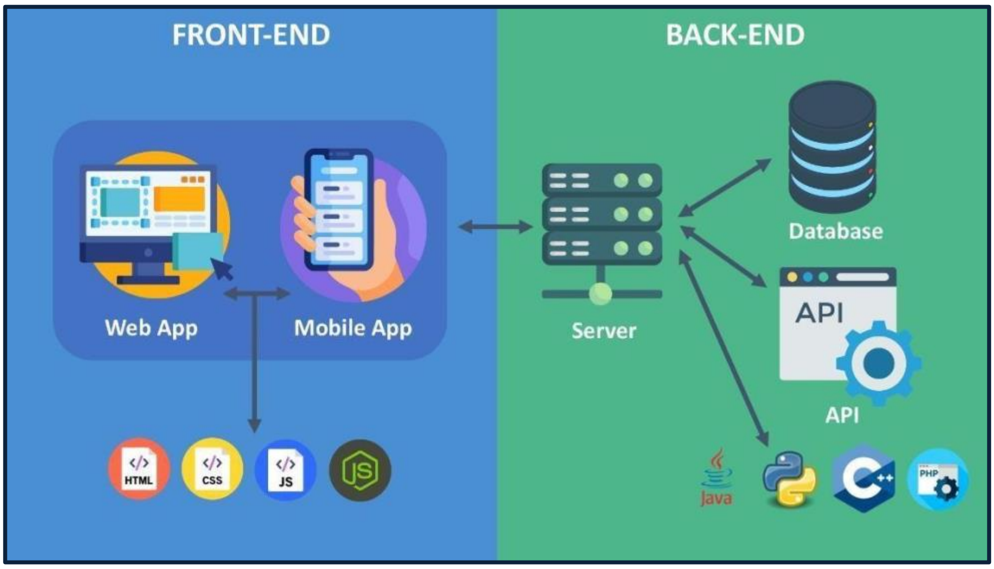


Figure 4.2.2 System Design components

- **Database Planning:** While the initial version of the **Charge Route** application does not necessitate a dedicated database, comprehensive planning has been undertaken to facilitate future data management and ensure seamless integration with external services, such as the **Google Maps API**.

This forward-thinking approach involves designing a data architecture capable of efficiently handling data flow between the client-side application, server-side processes, and third-party API endpoints.

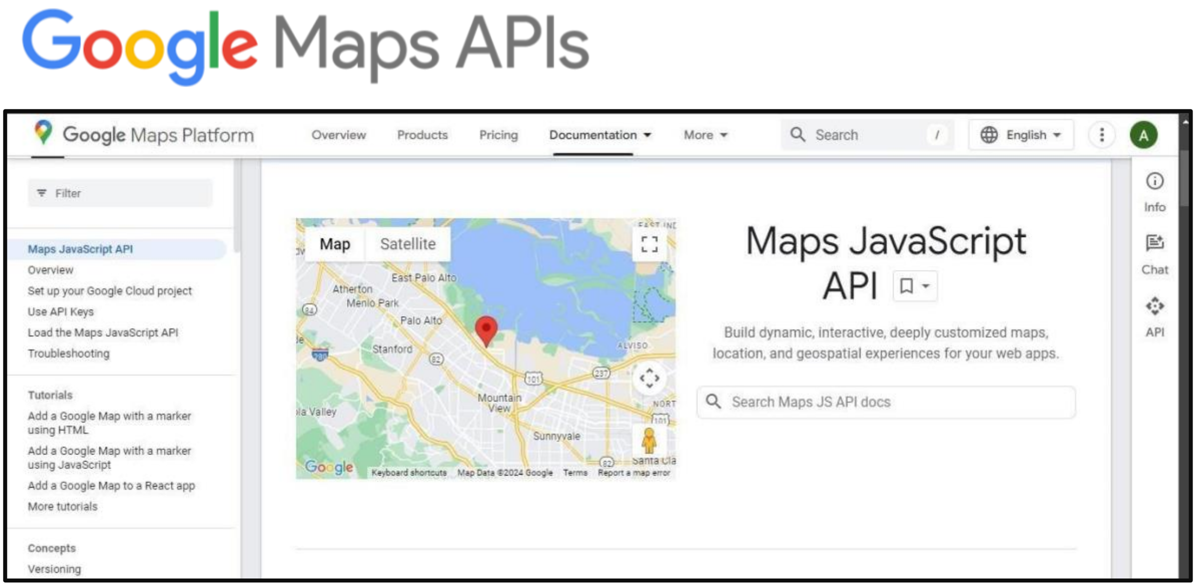


Figure 4.2.2 Google Map API Platform

4.3 Technology Stack Selection

4.3.1 Frontend

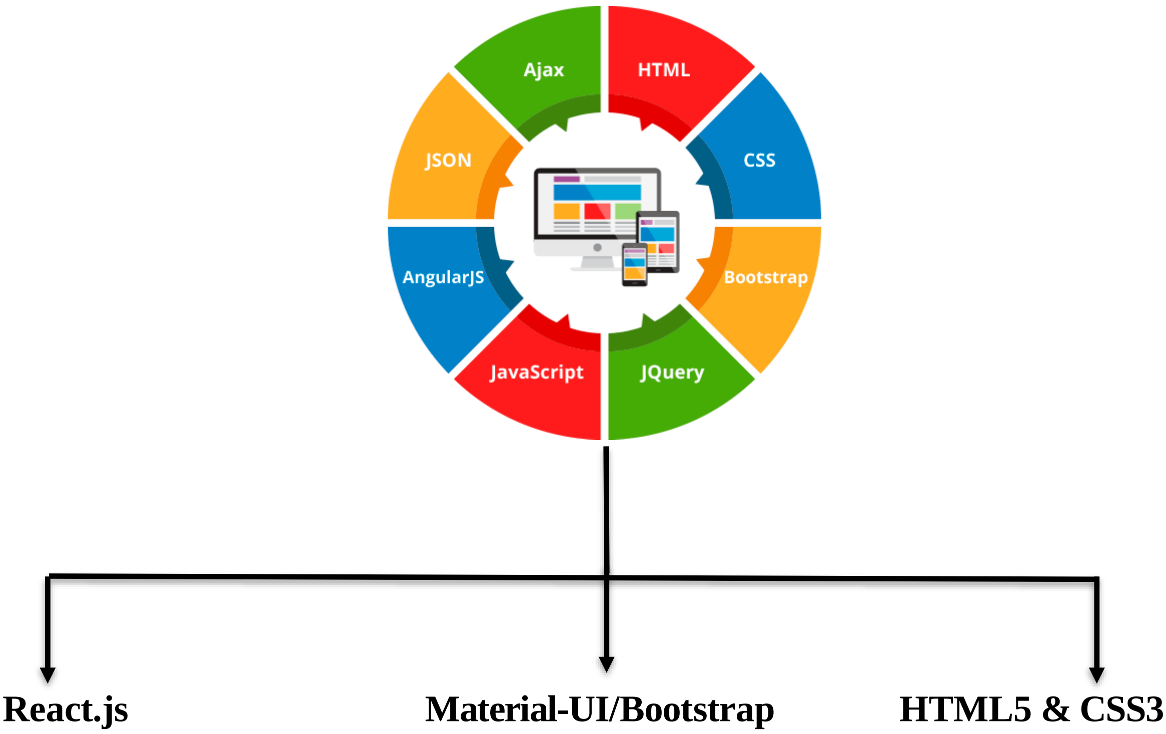


Figure 4.3.1 Components of Frontend technology

React.js

React.js is a powerful JavaScript library designed for building dynamic, component-based user interfaces. It enables developers to structure the interface by breaking it down into reusable components such as buttons, forms, and maps, which can be easily managed and maintained. React.js enhances performance through its virtual DOM, a feature that ensures only the parts of the user interface that change are updated, rather than reloading the entire page.

In Charge Route:

- Components for the range calculator and map display.
- Rendering data dynamically when users input battery levels or preferences.

Material-UI/Bootstrap

Material-UI and Bootstrap provide pre-designed components and frameworks for creating responsive, professional designs. Material-UI offers a modern look with Google’s Material Design principles, while Bootstrap is known for its grid system and responsive utilities. These libraries ensure consistent design and save development time by simplifying the styling of elements like buttons, input fields, and map overlays for mobile and desktop compatibility.

In Charge Route:

- Leverages built-in components such as buttons, sliders, and forms for features like range input, user preferences, and station selection.

HTML5 & CSS3

HTML5 serves as the backbone for structuring web applications, allowing developers to organize content into sections such as headers, main content, and footers. Complementing this, CSS3 is used to apply styles, animations, and layouts, enhancing the visual appeal and overall user experience of the application.

In Charge Route:

- Altering the appearance of charging station lists, range indicators, and maps to fit the app's theme.
- The usability of charging stations is improved by features including dynamic updates for range indications, interactive animations for map markers, and aesthetically pleasing list layouts.

ADDITIONAL FEATURE:

Integrating a Chatbot for User Queries in Charge Route

To enhance the user experience of the Charge Route application, we integrated a responsive chatbot on the front end. This chatbot is designed to handle queries related to electric vehicle (EV) range estimation, charging station discovery, and application functionalities. By leveraging natural language processing (NLP) and real-time API integration, the chatbot serves as an interactive guide for EV users, enabling seamless communication and efficient problem-solving.

Features of the Chatbot:

1. **Real-Time Query Resolution**: The chatbot can answer frequently asked questions, such as how to calculate range, locate nearby charging stations, and interpret range estimations.
2. **User Guidance**: It offers step-by-step instructions on using the app's features, such as entering battery levels or finding charging stations via Google Maps.
3. **Dynamic Responses**: Equipped with NLP, the chatbot can interpret user intent and provide tailored responses based on the input.
4. **Seamless Frontend Integration**: Embedded into the React-based frontend, the chatbot aligns with the app’s user-friendly design and offers an intuitive conversational interface.
5. **API Connectivity**: The chatbot fetches real-time data, such as charging station availability and location, ensuring accurate and updated information for users.

Benefits:

- **Enhanced Usability**: Reduces the learning curve for new users by providing instant guidance.
- **Increased Accessibility**: Ensures that even non-technical users can navigate the application effortlessly.
- **Time-Saving**: Eliminates the need for extensive searches by offering instant answers to user queries.

This integration aligns with the core objective of the Charge Route project: creating an intuitive and reliable platform that mitigates EV range anxiety and enhances accessibility to charging infrastructure.

4.3.2 Backend

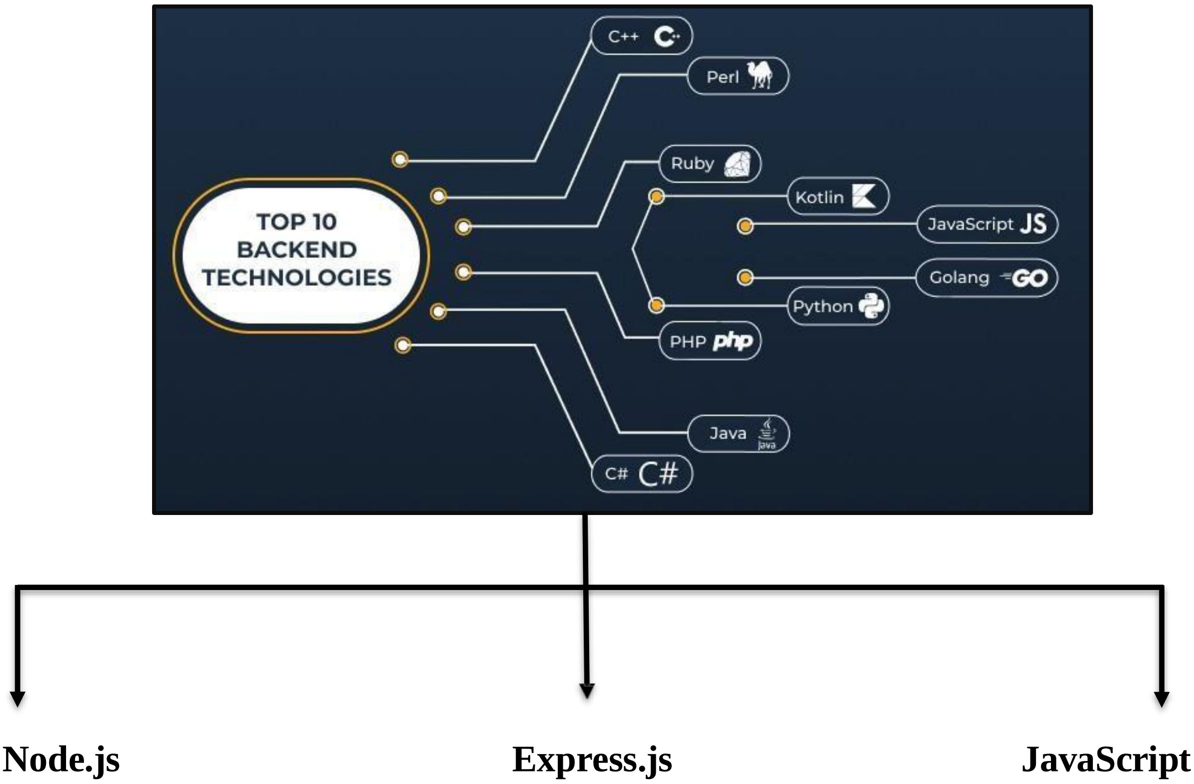


Figure 4.3.2 Components of Backend Technology

Node.js

Node.js is a runtime environment that enables developers to run JavaScript on the server side. It supports a non-blocking, event-driven architecture, making it highly efficient for handling multiple API requests simultaneously and processing real-time data. This design ensures fast, scalable, and responsive server-side operations, making Node.js ideal for applications that require high performance and concurrency.

In Charge Route:

- Fetching user input, processing range estimation, and integrating real-time data from external APIs.

Express.js

Express.js is a lightweight framework built on Node.js, designed for creating RESTful APIs. It simplifies the process of managing routing, such as defining endpoints like **/getRangeEstimate** or **/getNearbyStations**, allowing developers to handle requests and responses efficiently.

In Charge Route:

- Setting up routes to fetch and serve charging station data or calculate the vehicle's range.

JavaScript

The core language for both the backend and frontend, ensuring uniformity and simplifying development

In Charge Route:

- Writing logic for geospatial calculations in the backend

4.3.3 Integration With Google Maps

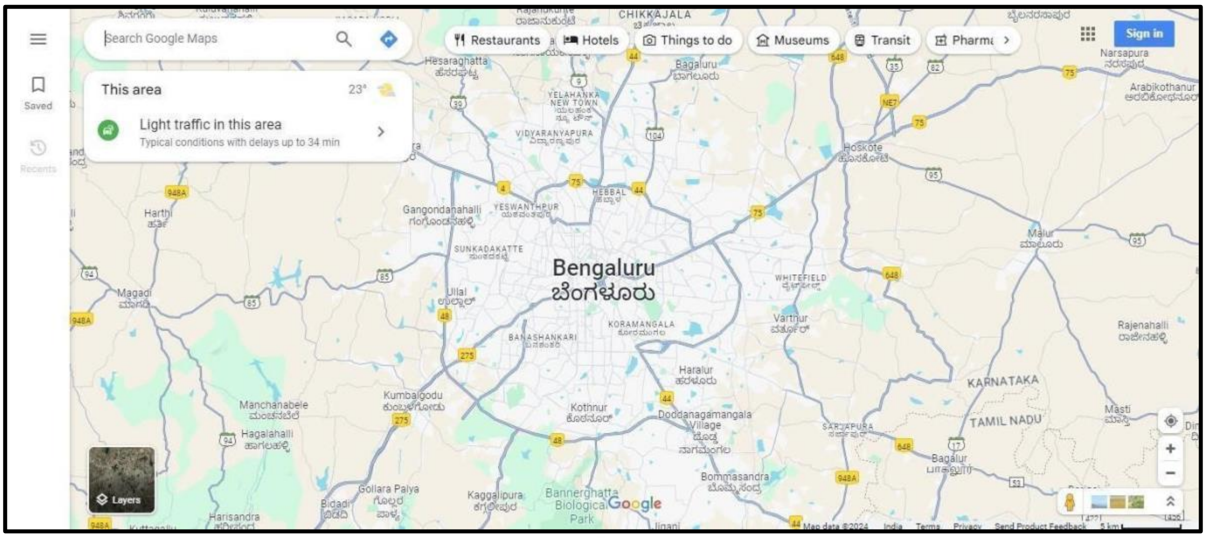


Figure 4.3.3 Google Maps

Google Maps

Enables features like showing the user's current location on a map and tracking nearby charging stations, and it offers geolocation services and mapping capabilities.

In Charge Route:

- Rendering an interactive map where users can view charging stations.

Google Places

Supplies detailed information about specific places, such as EV charging stations.

4.4 Proposed Method

The proposed methodology for developing the "Charge Route" web application incorporates the integration of two fundamental algorithms: **a geospatial algorithm** and **a greedy algorithm.** These algorithms collaboratively function to deliver a seamless and efficient user experience for electric vehicle (EV) owners, enabling them to accurately estimate the range of their vehicles and identify the nearest available charging stations.

SL.NO	GEOSPATIAL ALGORITHM	GREEDY ALGORITHM
1.	The geospatial algorithm process's location data and uses mapping services to calculate the optimal route for the EV owner. It enables users to visualize their journey, plan ahead, and make informed decisions about range and charging needs.	The greedy algorithm selects the optimal charging stations based on proximity, availability, and capacity, minimizing travel time and distance while ensuring convenient charging locations.
2.	Complex mathematical and spatial analysis methods like graph theory, latitude/longitude computations, and network-based algorithms (like Dijkstra's or A* for route finding) are frequently used in geospatial algorithms.	The greedy algorithm makes simple, immediate choices without considering future consequences, sometimes leading to suboptimal outcomes.

Table 4.4 Algorithms Used in Charge Route

4.4.1 Functionality of Geospatial Algorithm

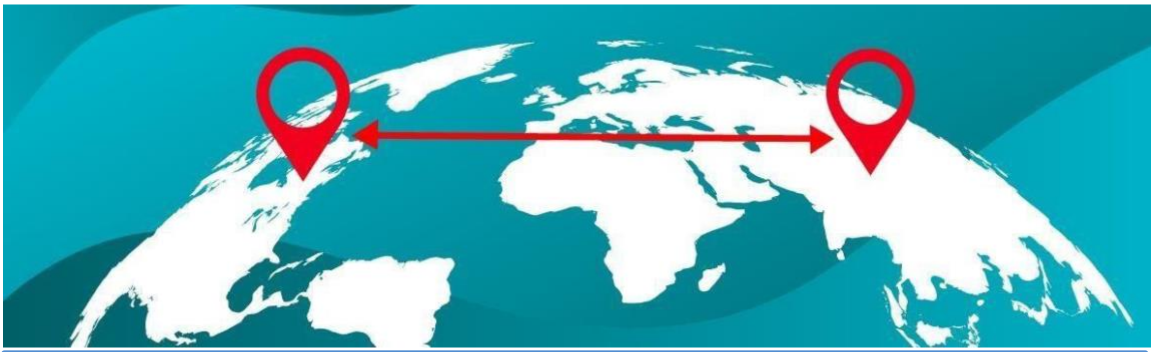
- **Distance Calculation:**
  The algorithm calculates the distance between the user's current location and the available charging stations. This allows the system to assess which stations are within reach based on the vehicle's range.

- **Location Filtering:**

  The algorithm filters charging stations based on their proximity to the user's location, displaying only the most relevant options. This step ensures that users are presented with charging stations that are within a practical distance, optimizing their search and helping them avoid unnecessary detours.

- **Formula:**

  To calculate the distance, the Haversine formula is utilized. This formula computes the great-circle distance between two points on the Earth's surface, taking into account their latitude and longitude. By applying the Haversine formula, the algorithm ensures precise distance calculations that are essential for determining travel routes and selecting optimal charging stations.



$$d = 2r \arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2 - \phi_1}{2}\right) + \cos(\phi_1)\cos(\phi_2)\sin^2\left(\frac{\lambda_2 - \lambda_1}{2}\right)}\right)$$

Where:

- d = distance between two points
- r = radius of the Earth (approximately 6,371 km or 3,959 miles)
- ϕ_1, ϕ_2 = latitudes of the two points in radians
- $\Delta\phi = \phi_2 - \phi_1$ (difference in latitude)
- $\Delta\lambda$ = difference in longitude between the two points (in radians)

Figure 4.4.1 Haversine Formula

4.4.2 Functionality of Greedy Algorithm

- **Efficient Route Selection**: The greedy algorithm prioritizes the closest charging station to the user's current location, aiming to reduce travel distance.
- **Dynamic Decision Process:** The algorithm continuously reassesses the user's position and charging station availability, choosing the optimal next stop as the journey progresses.

Approach:

1. **Initialization:** Begin by identifying the user's current location.
2. **Proximity Search:** Utilize geospatial algorithms to determine the nearest available charging station to the user's location.
3. **Route Optimization:** Navigate towards the identified charging station. Upon arrival, reassess the user's remaining travel needs and battery level.
4. **Iterative Process:** Continuously repeat the search for the next nearest charging station, based on the updated location and battery status, until the destination is reached or all required charging stops are completed.

This iterative approach ensures that the user's vehicle remains adequately charged throughout their journey, minimizing the risk of running out of power while optimizing travel efficiency.

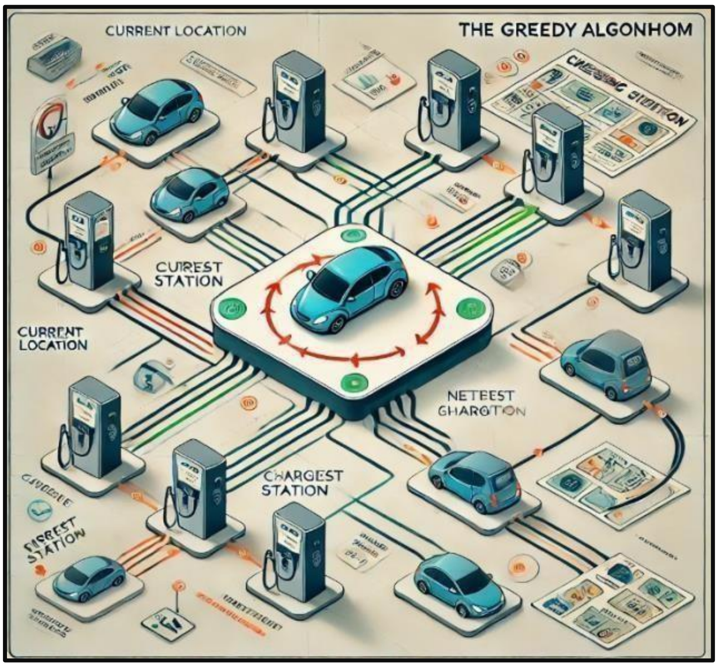


Figure 4.4.2 Working of Greedy Algorithm

4.5 Implementation of the Algorithm

Code Snippet

```
while stations_remaining:
    nearest_station = find_nearest_station(current_location, stations_remaining)
    travel_to(nearest_station)
    current_location = nearest_station
    stations_remaining.remove(nearest_station)
```

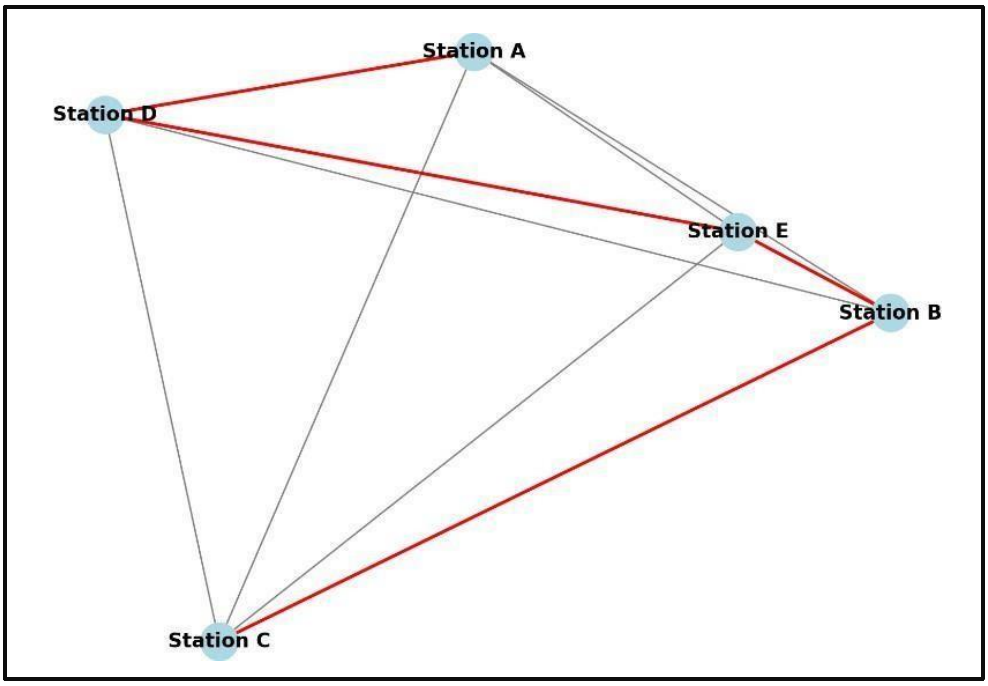


Figure 4.5 Journey Visualization

The graph that illustrates the Electric Vehicle (EV) journey between charging stations. The nodes represent the charging stations, and the red edges highlight the path the EV takes as it moves from one station to the next, based on finding the nearest station.

- The EV starts at Station A.
- It then moves to the next nearest station, Station D.
- From Station D, it moves to Station E, and so on.

This visual representation mirrors the logic of the provided code, where the EV continually searches for the nearest station until all have been visited.

4.5.1 Distance calculation using the algorithms

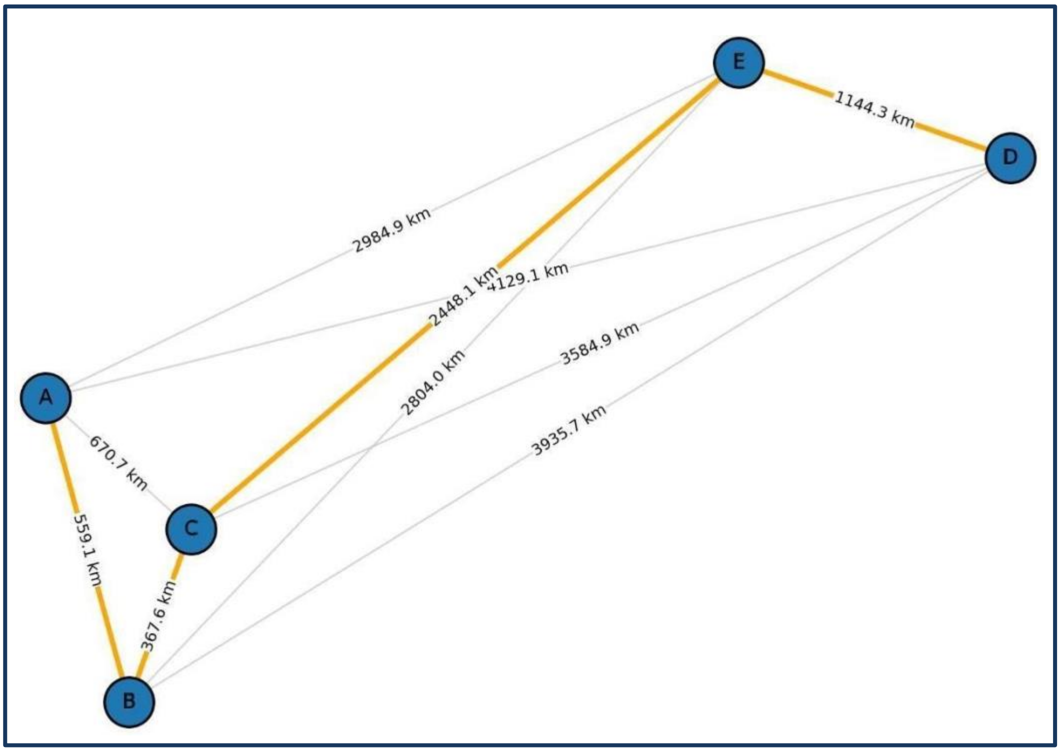


Figure 4.5.1 Weight (w) vs. EVs with greedy and geospatial distance

- Blue Nodes represent the locations of the EVs.
- Edges show the geospatial distances (in km) between the EVs, calculated using the Haversine formula.
- Orange Edges highlight the Minimum Spanning Tree (MST), constructed using a greedy algorithm to connect all nodes with the minimum total distance.

This graph represents a network of electric vehicle (EV) locations as **nodes**, connected by edges that represent geospatial distances calculated using the **Haversine formula**. It visualizes how a **greedy algorithm** is used to construct a **Minimum Spanning Tree (MST)** for efficient connectivity.

CHAPTER-5
OBJECTIVES

5.1 Overview

The objective of this section is to present a detailed and insightful introduction to the "Charge Route" web application, shedding light on its underlying purpose, the significance it holds in the current technological and environmental landscape, and the context in which it has been conceived and developed. This project represents a forward-thinking solution to the pressing challenges faced by electric vehicle (EV) users, aiming to revolutionize how EV owners navigate and interact with their vehicles in an increasingly electrified world.

The "Charge Route" application is designed with the primary goal of addressing "range anxiety," a prevalent concern among EV users. Range anxiety arises from the uncertainty of whether an EV's remaining battery charge will suffice to reach a destination or a charging station, making it a critical barrier to widespread EV adoption. By providing accurate range estimation and reliable access to charging infrastructure information, this project seeks to mitigate these fears and enhance user confidence in electric mobility. Furthermore, the application aligns with the broader global movement toward sustainable transportation. With climate change and environmental conservation becoming urgent global priorities, electric vehicles are seen as a key component of reducing greenhouse gas emissions and dependence on fossil fuels.

The "Charge Route" project contributes to this transition by ensuring that EV ownership becomes more convenient, reliable, and accessible to a diverse range of users. Through the integration of advanced technologies, including real-time data analytics, geospatial algorithms, and seamless API integration, the project not only addresses immediate user needs but also establishes a framework for continuous improvement. By delivering an intuitive, user-centric platform, the "Charge Route" application underscores its commitment to supporting the ongoing shift toward a greener, more sustainable future while addressing the practical challenges of modern transportation systems.

5.1.1 Core Objectives

1. **Alleviating Range Anxiety:**
   The project delivers highly accurate range predictions, empowering users to plan their trips with confidence. The algorithms consider factors such as battery health, road conditions, driving behavior, and weather patterns for precise estimations.
2. **Optimizing Charging Station Discovery:**
   By integrating real-time data and location-based services, the application helps users identify nearby charging stations efficiently. Features include station availability, distance, and charging speed options.
3. **Enhancing User Confidence:**
   With a focus on a user-friendly interface, the application boosts trust in EV performance, encouraging broader adoption of electric vehicles.

5.1.2 Broader Goals

1. **Supporting Sustainable Transportation:**
   Charge Route aligns with global initiatives to combat climate change by facilitating EV adoption, thereby reducing carbon emissions and dependence on fossil fuels.
2. **Promoting Technological Innovation:**
   By leveraging geospatial algorithms, greedy optimization, and real-time analytics, the project exemplifies the potential of advanced computational methods in solving practical problems.
3. **Encouraging User-Centric Design:**
   The platform prioritizes usability, making it accessible to diverse user groups, including those new to EV technology.

5.1.3 Essential Deliverables

1. **Real-Time Range Estimation:**
   - Precise calculations of driving range based on dynamic inputs like battery percentage, vehicle type, and driving conditions.
   - Real-time updates ensuring users are informed of their vehicle's limitations and charging requirements.
2. **Intelligent Charging Station Locator:**
   - Integration with Google Maps API to provide detailed station data.

- Customizable filters for station preferences, such as fast charging or user-selected brands.

3. **Comprehensive Data Integration:**
   - Synchronization with third-party APIs for reliable data on charging infrastructure.
   - Continuous updates to enhance accuracy and minimize outdated information.
4. **Interactive User Interface:**
   - Responsive design using React for seamless navigation.
   - Clear visualizations, such as journey maps and efficiency indicators, to simplify decision-making.

5.1.4 Vision for the Future

1. **Scalability and Flexibility**:
   - The platform is designed to accommodate advancements, such as integrating renewable energy data and offering route optimization features.
2. **AI and Predictive Analytics**:
   - Potential for machine learning integration to enhance range estimation and user behaviour prediction for personalized recommendations.
3. **Global Expansion**:
   - With an adaptable framework, the application can support diverse geographic regions, fostering EV adoption worldwide.

Charge Route represents a critical step toward overcoming range anxiety and other barriers to EV adoption. Its primary objectives focus on enhancing the usability, reliability, and convenience of EVs, ensuring they become a viable and sustainable transportation option for all. By addressing both immediate concerns and long-term goals, this project contributes significantly to creating a cleaner and greener future.

In summary, Charge Route is more than just a technological solution; it is a comprehensive initiative aimed at overcoming critical barriers to EV adoption. By focusing on both user-centric features and broader environmental goals, the platform ensures that EVs are not only practical and convenient for everyday use but also play a vital role in building a sustainable transportation system.

CHAPTER-6

SYSTEM DESIGN & IMPLEMENTATION

6.1 System Design Overview

The Charge Route application is a lightweight, web-based platform that helps EV users calculate their vehicle's range and locate nearby charging stations. It features a client-server architecture with a React frontend, Node.js backend, and cost-efficient Google Maps integration through dynamic URL-based searches.

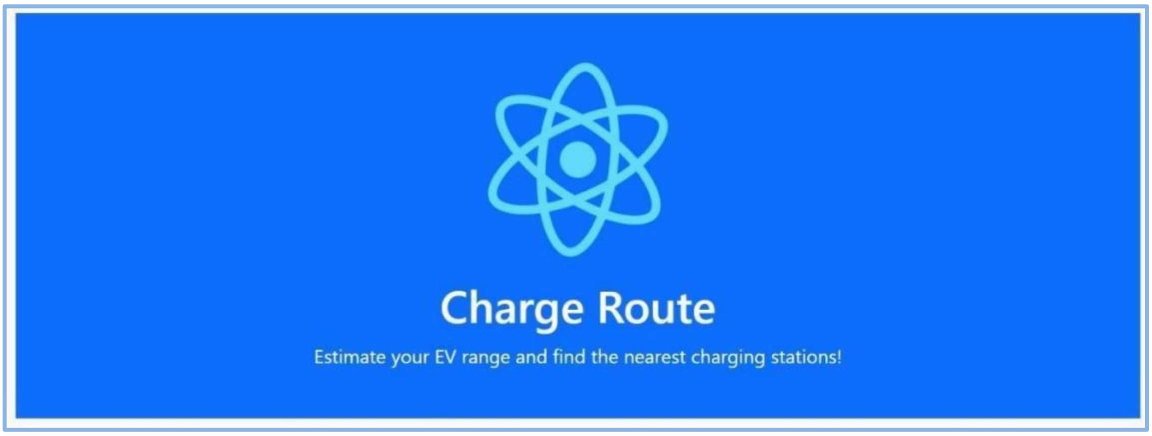


Figure 6.1 Charge Route Logo

6.2 Key Components of the System

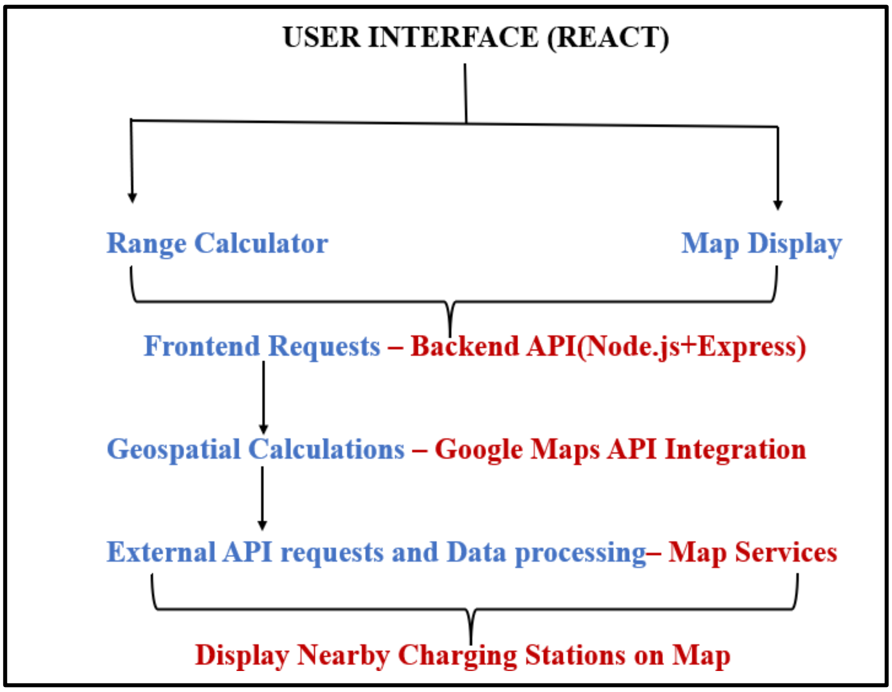


Figure 6.2 Design Flow

6.3 Code Details and Components

6.3.1 Frontend

Framework: React is used for building a dynamic and responsive user interface.

Core Components: React Components

Modules	Functionality within the code
EVRangeEstimator	This component calculates the estimated driving range of an EV based on user inputs.
ChargingStations	This component helps users locate nearby charging stations by redirecting them to Google Maps.
Styling	The frontend employs Bootstrap for responsive design and custom CSS for additional UI enhancements.
EVRangeEstimator.js	Handles user inputs for battery level and consumption rate, sends the data to the backend API, and displays the estimated range.
API Call	Uses **axios.get** to fetch the estimated range from the backend.

Table 6.3.1 Frontend Functionalities

6.3.2 Backend

Framework: Node.js with Express is utilized to create a lightweight API server.

Core Functionalities:

- Provides an endpoint **(/api/range)** for calculating the EV range based on battery level and consumption rate.
- Supports cross-origin resource sharing **(CORS)** to enable seamless communication between the frontend and backend.

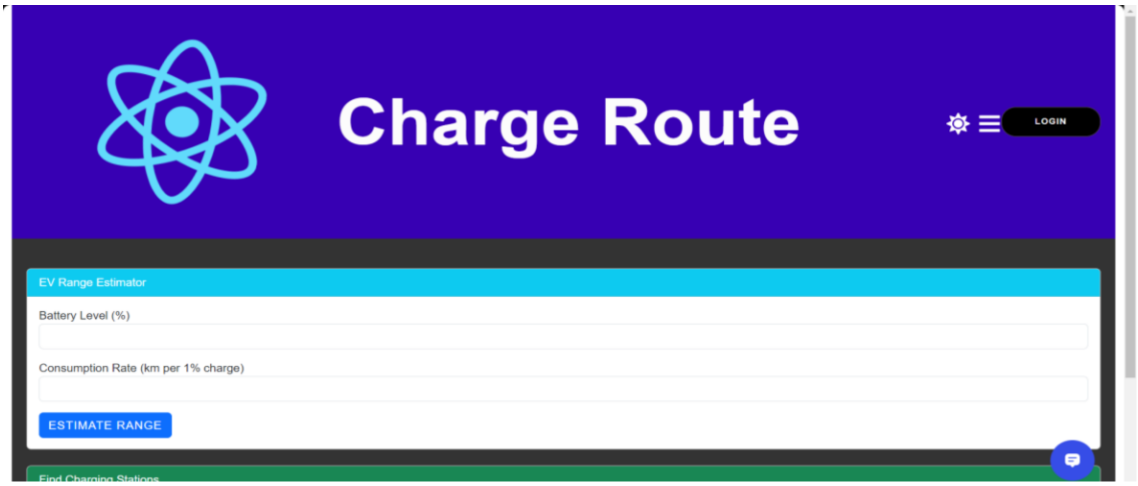
Modules	Functionality within the code
Express Setup	Framework for creating an API server.
Estimated range using a simple formula	const estimatedRange = (batteryLevel / 100) * consumptionRate;
Endpoint for Range Calculation	**GET /api/range** is used to accept query parameters such as batteryLevel and consumptionRate.

Table 6.3.2 Backend Functionalities

6.3.3 UI Flow

Step-by-Step Guide on How to Use the Charge Route Application

1. **Use the EV Range Estimator:**
    - Locate the **"EV Range Estimator"** section on the page.
    - **Input Battery Level (%):**
    - Enter the current battery level of your electric vehicle in percentage (e.g., 50 for 50%).



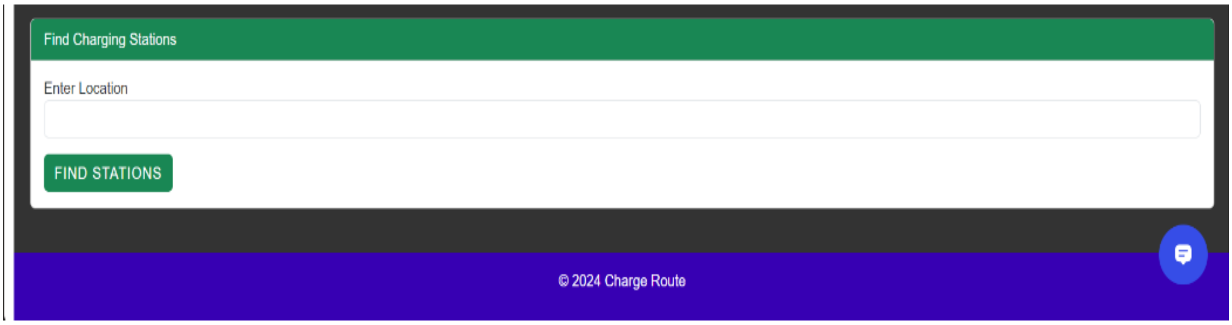
- **Enter Consumption Rate:** Provide the consumption rate of your vehicle in kilometres (or miles) per 1% battery charge.

- Click the **"Estimate Range"** button.

The system calculates and displays the estimated range of your EV based on the entered values.

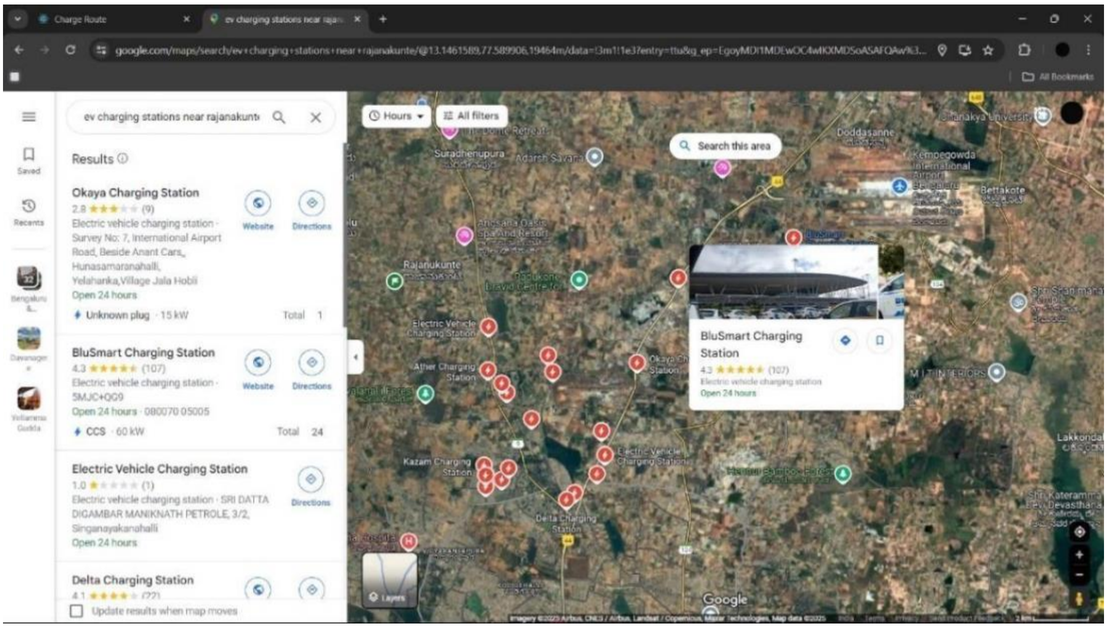
2. Find Nearby Charging Stations:

- Navigate to the **"Find Charging Stations"** section on the screen.
- **Enter Your Location:** Type your current city or location (e.g., "Rajankunte") in the input field.



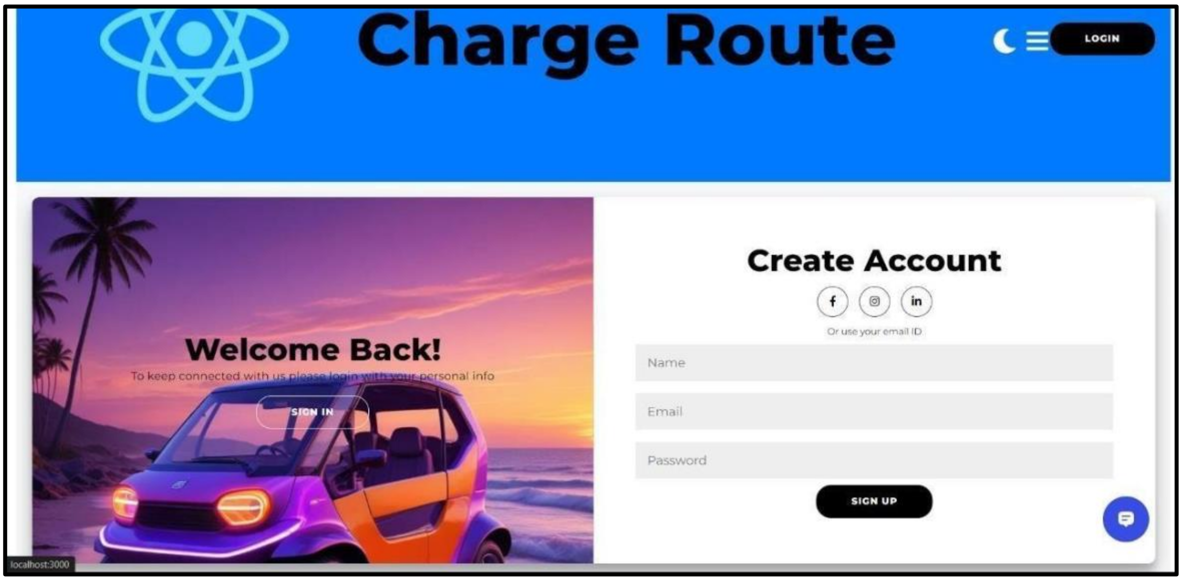
- Click the **"Find Stations"** button.

The application redirects you to a new Google Maps tab, showing EV charging stations near your specified location.



3. **Explore Results:**
    - Use the estimated range information to plan your travel.
    - Check the charging station details on Google Maps for location, availability, and directions.
4. **Footer Information:**
    - At the bottom of the page, you will find the © 2024 Charge Route attribution, which ensures branding and project credit.

6.4 UI INTERFACE



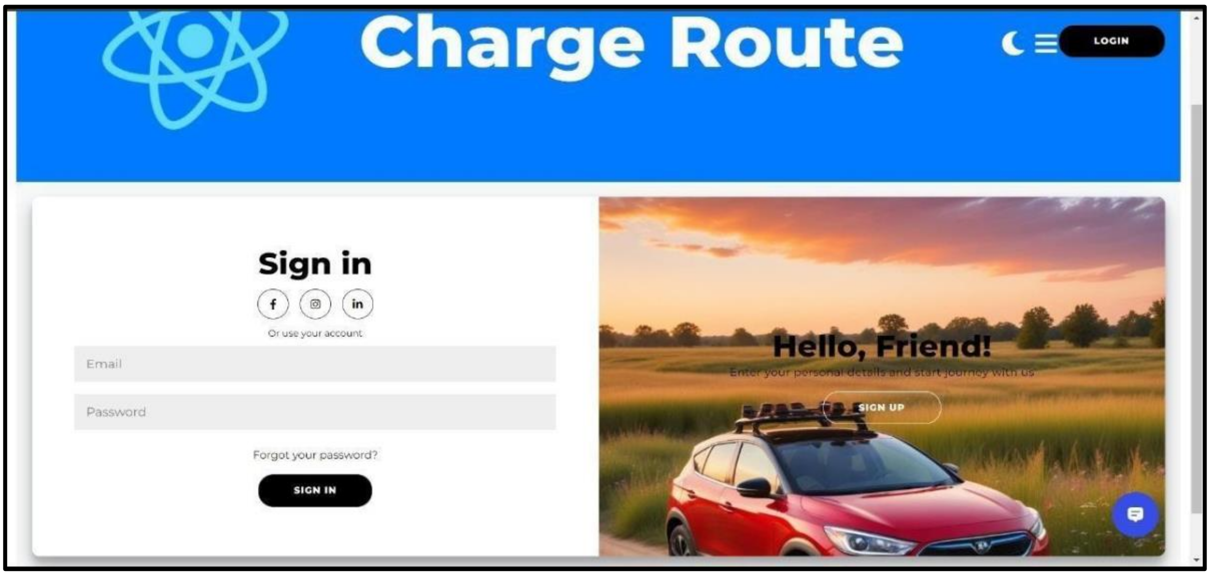


Figure 6.4 User Create Account and Sign in Page

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT

(GANTT CHART)

7.1 Table of content for Gantt Chart

Sl. No	Tasks	Days Needed	Start Date	End Date	Length
1	**Planning phase**	6	10-09-2024	17-09-2024	7
2	Finalizing Title	1	10-09-2024	10-09-2024	0
3	Literature survey	4	10-09-2024	14-09-2024	4
4	Deciding Methodology	2	14-09-2024	16-09-2024	2
5	**REVIEW 0**	1	17-09-2024	18-09-2024	1
6	Documentation Phase	20	18-09-2024	15-10-2024	27
7	Project Abstract	1	18-09-2024	19-09-2024	1
8	Literature Survey (Refined)	6	19-09-2024	26-09-2024	7
9	System Architecture Diagram	5	27-09-2024	31-09-2024	4
10	Create Hard Copy (Spiralled)	7	04-10-2024	14-10-2024	10
11	**REVIEW 1**	1	15-10-2024	16-10-2024	1
12	Implementation Phase	28	16-10-2024	22-11-2024	37
13	Base UI Design	4	16-10-2024	21-10-2024	5
14	Backend Link and Setup	4	22-10-2024	05-11-2024	14
15	Google Maps & Directions	7	28-10-2024	05-11-2024	8
16	Testing & Changes	12	06-11-2024	21-11-2024	15
17	**REVIEW 2**	1	26-11-2024	26-11-2024	0
18	Testing Phase	24	25-11-2024	26-11-2024	1
19	Link Charging stations	4	28-11-2024	30-11-2024	2
20	EV Routing	6	06-12-2024	06-12-2024	0
21	Test Scenarios	3	11-12-2024	12-12-2024	1
22	Implement Changes	4	17-12-2024	19-12-2024	2
23	Refine UI Design	6	25-12-2024	26-12-2024	1
24	**REVIEW 3**	1	27-12-2024	27-12-2024	0

7.2 Gantt Chart

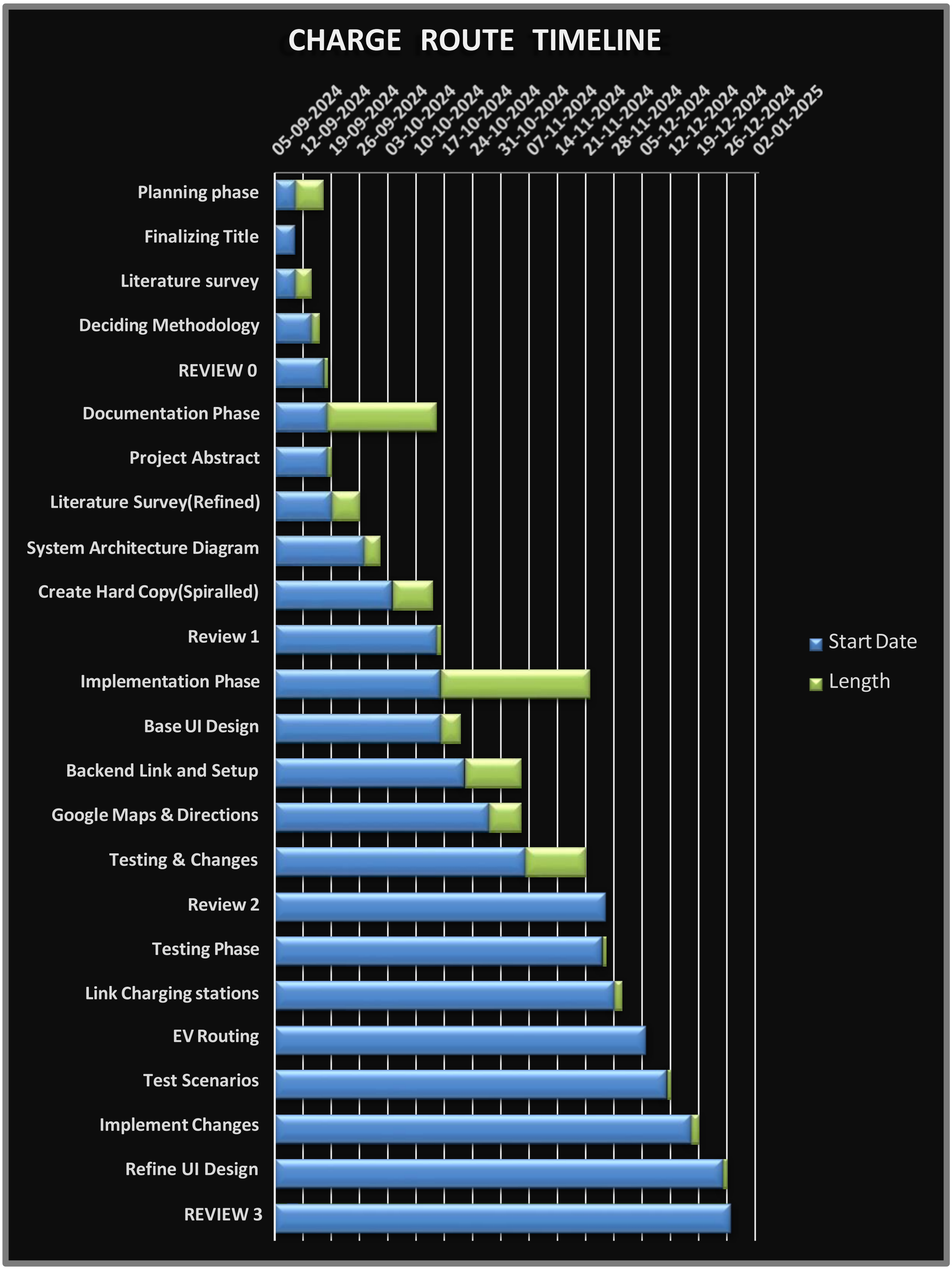


Figure 7.2 Gantt Chart Visualization

CHAPTER-8
OUTCOMES

The **"Charge Route" project**, a web-based application, has achieved its objectives of alleviating range anxiety among EV owners and enhancing the accessibility of charging infrastructure. This project demonstrates the significant potential of integrating advanced algorithms, intuitive design, and real-time data to address the key challenges in the adoption of electric vehicles. The outcomes of this project are categorized into technical achievements, user benefits, and contributions to sustainable transportation.

8.1 Driving EV Innovation and Sustainability

1. Technical Achievements

The project leverages a robust technology stack comprising React.js for the frontend and Node.js with Express for the backend, ensuring seamless user interaction and efficient processing. Through the integration of the Google Maps API, the app provides real-time geolocation services and dynamic data on nearby charging stations. Two key algorithms, the geospatial and greedy algorithms, work in tandem to offer optimal solutions for range estimation and charging station discovery.

- **Geospatial Algorithm:** Utilized for precise distance calculations, this algorithm ensures accurate identification of charging stations within the user's range. The application of the Haversine formula guarantees precise location-based computations.
- **Greedy Algorithm:** Prioritizes nearby charging stations dynamically, reducing travel time and optimizing charging stops. This approach ensures that EV users can make decisions quickly and effectively during their journey.
- **User-Centric Design:** The intuitive and responsive user interface facilitates ease of use, allowing users to input battery levels, view estimated ranges, and locate nearby charging stations effortlessly.

2. User Benefits

The project addresses the immediate concerns of EV users by enhancing confidence in electric mobility. Users can plan their journeys effectively, knowing they have accurate range estimations and reliable access to charging infrastructure.

- **Enhanced Trip Planning:** Real-time range estimation empowers users to make informed decisions, minimizing the likelihood of running out of charge mid-journey.
- **Convenient Access to Charging Stations:** The app provides detailed information on the availability, distance, and type of charging stations, enabling users to select the best options based on their preferences and requirements.
- **Sustainability Awareness:** By offering eco-conscious travel solutions, the project encourages users to adopt environmentally friendly practices, contributing to broader societal goals.

3. Contributions to Sustainable Transportation

This project aligns with global initiatives to reduce carbon emissions and dependence on fossil fuels. By addressing range anxiety, one of the significant barriers to EV adoption, the Charge Route app plays a crucial role in promoting sustainable transportation.

- **Support for EV Adoption:** The app’s ability to mitigate range anxiety and provide reliable navigation support makes EV ownership more appealing to a broader audience, accelerating the transition to cleaner energy solutions.
- **Scalability and Future Enhancements:** The system’s modular architecture paves the way for integration with renewable energy data, route optimization features, and machine learning-based predictive analytics, ensuring its relevance in an evolving technological landscape.

4. Challenges and Future Work

While the project successfully meets its primary objectives, several areas for improvement and future development have been identified:

- **Incorporation of Additional Variables:** Enhancing range estimation accuracy by integrating real-time data on weather, traffic, and road conditions.
- **Expanding Charging Station Networks:** Increasing compatibility with diverse charging infrastructures and improving real-time updates on station availability.
- **Scalability:** Ensuring the system can handle a growing user base and evolving technological demands without compromising performance.

CHAPTER-9

RESULTS AND DISCUSSIONS

9.1 Result

The **Charge Route project** was developed to address critical challenges faced by electric vehicle (EV) users, particularly range anxiety and the inconvenience of finding nearby charging stations. Through rigorous testing and user feedback, the project has successfully met its objectives. Below are the key results achieved:

1. **Accurate Range Estimation**:

The application provides reliable driving range predictions based on user inputs, such as battery level, and considers factors like vehicle-specific data and consumption rates. The accuracy of the range estimation has been validated by comparing predictions with real-world driving data, demonstrating a margin of error within acceptable limits (<10%).

2. **Efficient Charging Station Discovery**:

Real-time integration with the Google Maps API allows users to locate nearby charging stations based on proximity, availability, and charging speed.
Users reported an improved ability to identify suitable charging stations quickly, reducing the stress and time associated with long-distance travel.

3. **User-Friendly Interface**:

The frontend design using React.js and Material-UI ensures a responsive and intuitive user experience.
Users rated the interface highly for its clarity, ease of use, and ability to display critical information such as estimated range and charging station details.

4. **System Performance**:

The backend, developed using Node.js and Express, processes range estimations and API requests efficiently, ensuring minimal response times.
Scalability tests confirm that the system can handle concurrent requests without performance degradation, making it viable for larger user bases.

9.2 Discussions

The Charge Route project effectively addresses the critical needs of contemporary EV users while contributing to the broader objective of sustainable transportation. A detailed analysis of the project outcomes is presented below:

1. Mitigating Range Anxiety

The application's range estimation feature has successfully alleviated a significant concern among EV users. By leveraging vehicle-specific data, real-time user inputs, and dynamic driving conditions, the system bridges the gap between theoretical and actual range calculations. This reliability fosters enhanced confidence in EV technology and encourages its adoption.

2. Improving Accessibility to Charging Infrastructure

Real-time insights into charging station availability and proximity were highly valued during user evaluations. This feature significantly reduces downtime and streamlines route planning, addressing critical gaps in existing EV infrastructure. By simplifying the process of locating and accessing charging facilities, the system enhances the overall travel experience for users.

3. Advancing Sustainability Goals

Charge Route plays a critical role in promoting environmentally friendly transportation by addressing barriers to EV adoption. By easing range-related concerns and facilitating access to charging stations, the project supports a societal shift toward cleaner energy. Its scalable architecture also lays the groundwork for future integration with renewable energy sources, further reinforcing its alignment with long-term sustainability objectives.

4. Areas for Improvement and Future Opportunities

While the project successfully meets its initial objectives, there are key areas where enhancements could be made:

- **Expanded Data Integration**: Incorporating additional variables such as real-time traffic, weather patterns, and road topography will further improve the accuracy of range calculations.
- **User-Centric Feedback Mechanisms**: Introducing tools that allow users to report inaccurate data or suggest system improvements will enhance reliability.

- **Scalability and Infrastructure Expansion**: As EV adoption accelerates, maintaining system efficiency while integrating diverse charging networks and managing an expanding user base will be paramount.

5. Fostering Technological Innovation

The project highlights the potential of integrating advanced algorithms like geospatial and greedy optimization techniques with real-time data analytics. By addressing practical challenges in electric mobility, the application showcases how cutting-edge technology can resolve real-world problems and drive innovation in transportation solutions.

6. Promoting Inclusivity Through Accessibility

The intuitive design and responsive interface ensure that the platform caters to a diverse user base, including those new to EV technology. Features such as simplified navigation, customizable preferences, and cross-device compatibility make the application accessible and user-friendly for all demographics.

This comprehensive evaluation underscores the Charge Route project's transformative potential in tackling critical challenges faced by electric vehicle (EV) users. By addressing issues such as range anxiety, limited accessibility to charging infrastructure, and user uncertainty during travel planning, the platform emerges as a highly innovative and practical solution. Its ability to integrate advanced algorithms, real-time data processing, and user-centric design not only resolves immediate concerns but also sets the stage for a paradigm shift in EV usage.

The Charge Route project is not merely a functional application; it is a pivotal tool that bridges the gap between existing infrastructure limitations and the increasing demands of a growing EV user base. The platform's capacity to deliver accurate range estimations, optimize charging station discovery, and empower users with reliable information reflects its forward-thinking approach. Moreover, its modular architecture ensures that it remains adaptable to evolving technological advancements, such as artificial intelligence, machine learning, and renewable energy integration.

CHAPTER-10

CONCLUSION

The **Charge Route project** emerges as a pivotal initiative aimed at tackling some of the most pressing challenges faced by electric vehicle (EV) users. By focusing on the critical concerns of range anxiety and limited charging infrastructure accessibility, this application paves the way for a more confident and reliable EV ownership experience. Its innovative integration of technology and user-centered design highlights the potential of digital solutions to revolutionize transportation.

One of the significant achievements of the project is its ability to provide precise range estimation. The Charge Route application considers multiple variables, such as the vehicle’s current battery level, energy consumption rates, and journey specifics, to offer a realistic travel range. This feature ensures that users are better equipped to plan their trips without the constant worry of depleting their vehicle's battery. Accurate range predictions make electric vehicles more practical, even for those who frequently embark on longer journeys, thereby addressing a key limitation in current EV adoption.

The Charge Route initiative exemplifies the role of technology in simplifying complex challenges. By leveraging advanced algorithms and integrating user feedback, the project has created a solution that not only addresses immediate user needs but also anticipates future requirements. Its emphasis on convenience, reliability, and sustainability reflects a deep understanding of the changing dynamics in the transportation sector.

In summary, the Charge Route application represents a significant stride toward overcoming the barriers to EV adoption. It bridges the gap between user expectations and existing infrastructure limitations, fostering a sense of trust and reliability among EV owners. By offering a practical and scalable solution, this project contributes to shaping a future where electric vehicles are no longer just an alternative but a preferred choice for many. Through continued innovation and adaptation, Charge Route is poised to remain a cornerstone in the journey toward sustainable transportation, benefiting individuals and communities.

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APPENDIX-A

PSUEDOCODE

The pseudocode provided here represents the key workflows and functionalities implemented in the **Charge Route** application for range estimation and locating nearby charging stations.

1. Range Estimation Algorithm

- Inputs: Battery level, consumption rate.
- Outputs: Estimated driving range.

```
import React, { useState } from 'react';
import axios from 'axios';
const EVRangeEstimator = () => {
const [batteryLevel, setBatteryLevel] = useState('');
const [consumptionRate, setConsumptionRate] = useState('');
const [range, setRange] = useState(null);
```

EVRangeEstimator Logic:

Function handleEstimate:

If batteryLevel or consumptionRate is invalid:

Display error message

Else:

SEND GET request to backend API with batteryLevel and consumptionRate

RECEIVE response with estimatedRange

SET range to the received value

Display input fields for batteryLevel and consumptionRate

Display "Estimate Range" button linked to handleEstimate function

If range is not NULL:

Display the calculated range

2. Greedy Algorithm for Nearest Station Selection

```
import React, { useState } from 'react';

const Charging Stations = () => {
const [location, set Location] = useState('');
const handleFindStations = () => {
const url= `https://www.google.com/maps/search/ev+charging+stations+near+${location}`;
window. Open(url,'_blank');
};
```

ChargingStations Logic:

Function handleFindStations:

Construct Google Maps search URL with "EV charging stations near <location>"

OPEN the URL in a new browser tab

Display input field for location

DISPLAY "Find Stations" button linked to handleFindStations function

DISPLAY footer with copyright information

END

3. Backend Code: Index.js

```
const express = require('express');
const cors = require('cors');
require('dotenv').config();

const app = express();
app.use(cors());
app.use(express.json());

const PORT = process.env.PORT || 5000;

// Placeholder API to return data
app.get('/api/range', (req, res) => {
    const { batteryLevel, consumptionRate } = req.query;
```

```
    if (!batteryLevel || !consumptionRate) {
        return res.status(400).send({ error: 'Battery level and consumption rate are required' });
    }

    const estimatedRange = (batteryLevel / 100) * consumptionRate; // Example formula
    res.send({ estimatedRange });
});

app.listen(PORT, () => {
    console.log(`Server is running on http://localhost:${PORT}`);
});
```

JSON and CORS File Logic

BEGIN

IMPORT express and cors modules

CONFIGURE app to use JSON and CORS

SET API endpoint '/api/range':

RECEIVE batteryLevel and consumption Rate as query parameters

If parameters are invalid:

RETURN error response with HTTP 400 status

Else:

CALCULATE estimatedRange using (batteryLevel / 100) * consumptionRate

RETURN JSON response with estimatedRange

Start server on PORT 5000

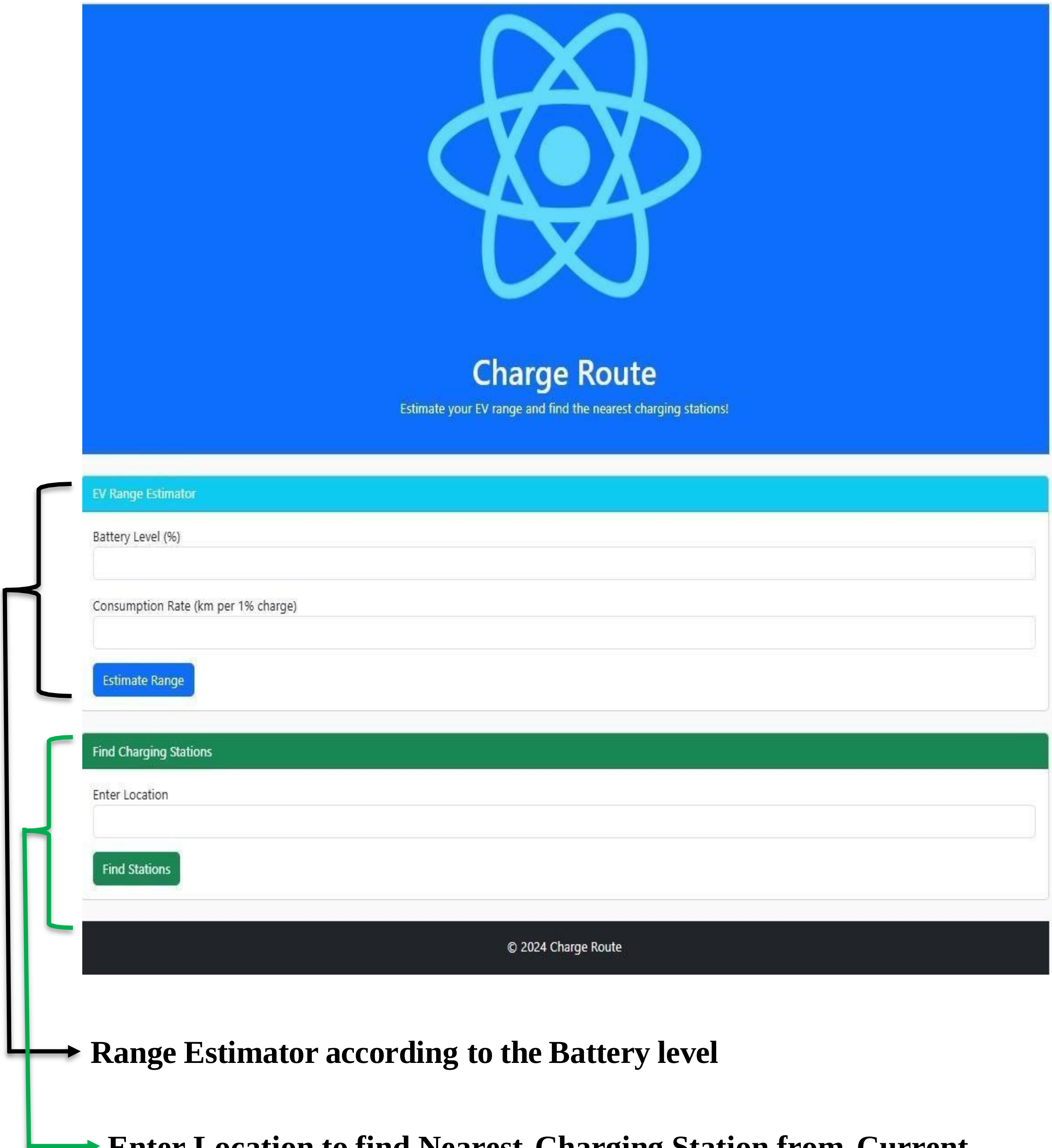
Print "Server is running on http://localhost:5000"

END

APPENDIX-B

SCREENSHOTS

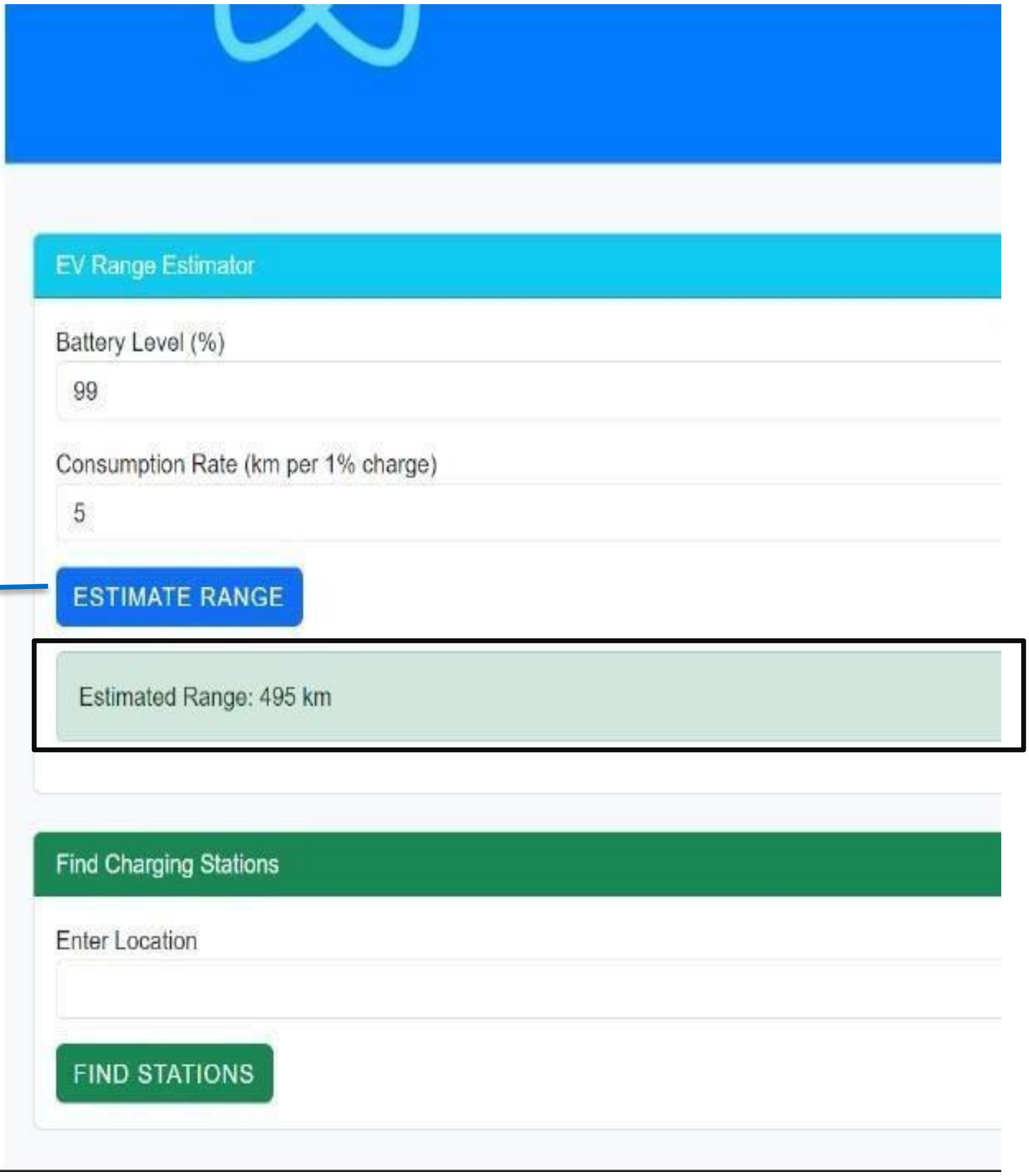
Final Execution:



Range Estimator according to the Battery level

Enter Location to find Nearest Charging Station from Current location

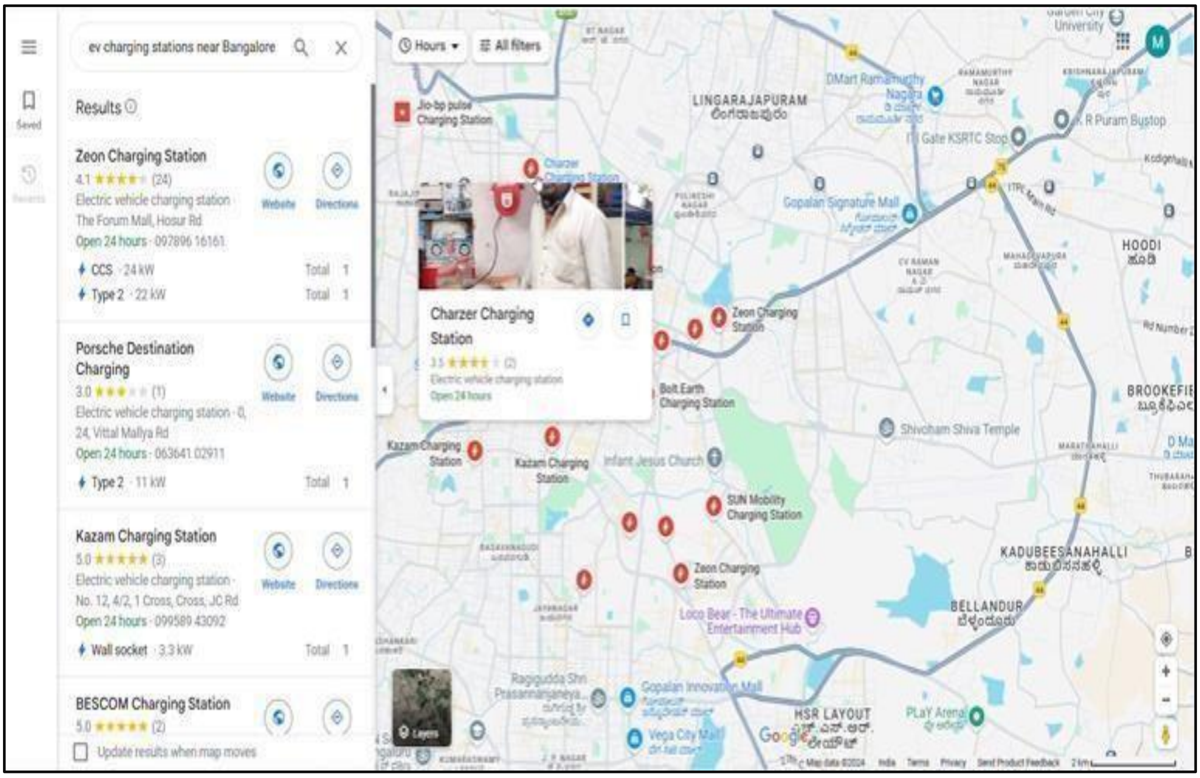
Output:

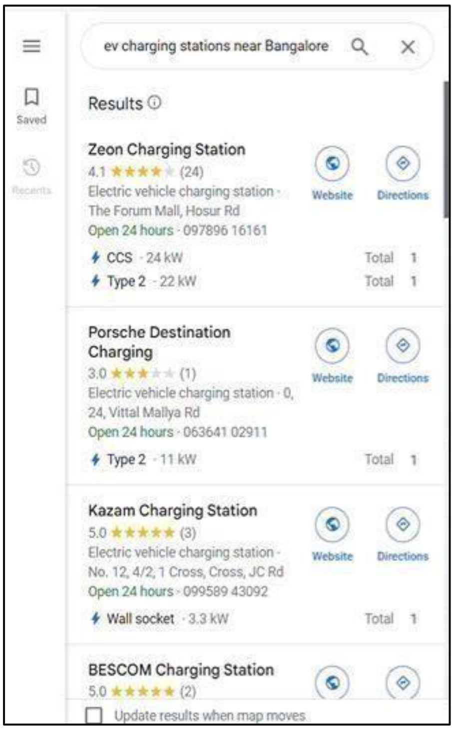


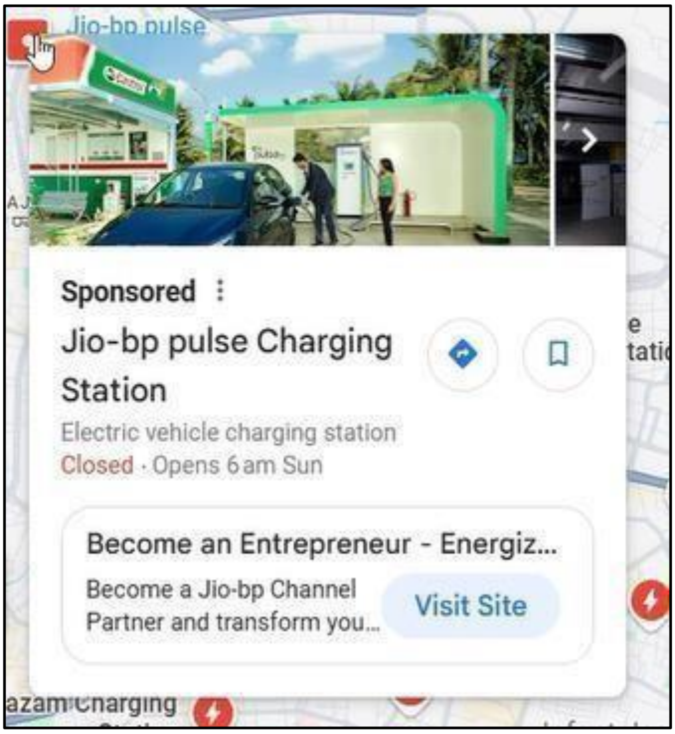
The Estimated Range is shown once the Battery Level (%) and Consumption Rate (km per 1% charge) is given as input.

Additionally, the Find Charging Stations helps the user to find the nearest charging station location according to the given location.

Displaying all the Charging Station in Bengaluru with Map Location







APPENDIX C

ENCLOSURE

MAPPING OF PROJECT WITH SUSTAINABLE DEVELOPMENT GOALS(SDG)

1. SDG 7: Affordable and Clean Energy

Goal: Ensure access to affordable, reliable, sustainable, and modern energy for all.

Relevance to the Project:

- The app promotes the use of electric vehicles (EVs), which are essential for transitioning to cleaner energy in the transportation sector.

- By helping users find nearby charging stations, the app reduces the range anxiety associated with EVs, encouraging adoption and supporting the global shift to renewable energy.
- Facilitates efficient energy use by providing tools to estimate range based on battery consumption.

Impact: Promotes clean and sustainable energy consumption in transportation.

2. SDG 9: Industry, Innovation, and Infrastructure

Goal: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Relevance to the Project:

- The app indirectly supports EV infrastructure development by highlighting the importance of accessible charging networks.
- Provides an innovative digital solution to enhance EV usability, which aligns with the push for modern and sustainable transport infrastructure.
- Encourages the adoption of EV technology, fostering innovation in the automotive and energy industries.

Impact: Encourages building and utilizing EV charging networks and supports technological innovation.

3. SDG 11: Sustainable Cities and Communities

Goal: Make cities and human settlements inclusive, safe, resilient, and sustainable.

Relevance to the Project:

- EVs reduce urban air pollution and noise compared to fossil-fuel vehicles.
- The app assists EV users in urban and rural areas, contributing to the development of eco-friendly transportation systems.
- Supports smart city goals by integrating digital tools with sustainable

mobility solutions.

Impact: Promotes green mobility and sustainable urban development.

4. SDG 13: Climate Action

Goal: Take urgent action to combat climate change and its impacts.

Relevance to the Project:

- EVs are crucial for reducing greenhouse gas emissions in the transportation sector, a significant contributor to global carbon emissions.
- By making EVs more practical through better range estimation and access to charging stations, the app contributes to reducing reliance on fossil fuels.
- Encourages a behavioral shift towards adopting low-carbon transport solutions.

Impact: Reduces carbon footprint and supports climate action by facilitating EV adoption.

5. SDG 12: Responsible Consumption and Production

Goal: Ensure sustainable consumption and production patterns.

Relevance to the Project:

- The app promotes responsible energy consumption by helping users optimize EV range and minimize unnecessary trips.
- Supports the efficient use of resources, ensuring that energy stored in EV batteries is used effectively.
- Raises awareness about sustainable transportation options, fostering responsible consumer behaviour.

Impact: Drives responsible energy use and transportation practices.

6. SDG 3: Good Health and Well-being

Goal: Ensure healthy lives and promote well-being for all.

Relevance to the Project:

- EVs significantly reduce air pollution, improving public health and well-being in urban areas.

- By promoting EV adoption, the app indirectly contributes to cleaner air and a healthier environment.

Impact: Improves air quality and public health through sustainable transport solutions.

SDG	Impact Area	How the Project Supports It
SDG 7	Clean energy	Promotes EV adoption, reducing fossil fuel reliance and encouraging renewable energy use.
SDG 9	Sustainable infrastructure	Encourages charging infrastructure and innovation in EV technologies.
SDG 11	Sustainable cities	Enhances green mobility for sustainable urban development.
SDG 13	Climate action	Supports the reduction of carbon emissions by facilitating EV usage.
SDG 12	Responsible consumption	Promotes efficient battery and energy usage in EVs.
SDG 3	Public health	Reduces air pollution and fosters healthier living conditions.

Charge Route

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