AI-POWERED SOLUTIONS FOR BREAKDOWN CHALLENGES WITH ELECTRIC VEHICLES

MECHANIC FINDING SERVICE FOR EV BREAKDOWN EMERGENCIES

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Final Report

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Declaration page of the candidates & supervisor

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Abstract

This research component uses geolocation and machine learning to enhance emergency assistance for electric vehicle (EV) breakdowns. The goal of my project is to create a reliable On-Road Breakdown Rescue System that links EV owners who are stranded with qualified professionals. The goal of this system is to lessen pollutants in the environment and encourage the use of electric vehicles. The main objective is to reduce drivers' confusion and frustration when they come across car problems, particularly in unfamiliar regions. The primary goal of the project is to develop a user-friendly smartphone application specifically for owners of registered electric vehicles (EVs). In the event of a breakdown, users may rapidly share details regarding the breakdown and their current location to request assistance. Based on the provided description, the system efficiently determines the precise kind of breakdown by applying machine learning and natural language processing methods. It then searches for mechanics with the skills and services required to fix the problem. This advanced algorithm provides users with a selected list of suitable mechanics to select from based on breakdown kind and location.

Mechanics are categorized depending on their expertise and location, giving customers the option to choose according on their own preferences. For a speedy response, users have the option to broadcast their service request to any technician that is available. Once accepted, the chosen expert can expedite the problem's resolution, cutting down on the EV owner's wait time and removing any aggravation. Furthermore, the program contains elements that let users evaluate and comment on the services they received. This encourages transparency and accountability in the repair services industry. It enhances the entire experience of owning an electric car and eventually persuades more people to select this environmentally friendly mode of transportation by offering a simple and convenient solution to electric vehicle malfunctions. Our study addresses the pressing issues faced by EV owners when their cars break down, which advances the crucial goal of sustainable transportation. Furthermore, it makes EVs more appealing and practicable in the unique Sri Lankan setting.

Keywords: Electric Vehicles (EVs), Machine Learning Integration, Geolocation Technologies, On-Road Breakdown Rescue System, Natural Language Processing, Proximity-based Ranking, Service Request Broadcasting

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List of Abbreviations

Abbreviation	Description
AI	Artificial Intelligence
ML	Machine Learning
EV	Electric Vehicle
AML	Auto Machine Learning
SDLC	Software Development Life Cycle
WBS	Work Breakdown Structure

1. Introduction

1.1 Background & Literature survey

The demand for sustainable transportation choices and worries about environmental pollution have led to a steady increase in the usage of electric cars, or EVs. As EVs proliferate on the road, it is imperative to guarantee their dependability and offer effective emergency support in the event of a breakdown. The main goal of this study is to improve emergency help for electric vehicle breakdowns by integrating machine learning and geolocation technology. This literature review explores the current research and advancements in this area.

When it comes to breakdowns, electric cars present different difficulties than vehicles with conventional internal combustion engines. Because EVs rely on extensive electrical and electronic systems, maintenance and diagnostics must be more involved. Previous research has indicated that in the event of an EV failure, specialist support services are required. A potential way to expedite the help process is through the combination of geolocation and machine learning technology.

Roadside assistance and ambulance dispatch are two emergency services that frequently employ geolocation technology. It makes it possible to pinpoint a user's position with accuracy, speeding up reaction times and enhancing the assistant's overall efficacy. The On-Road Breakdown Rescue System's integration of geolocation adheres to accepted best practices for emergency service systems.

Automating breakdown identification based on user descriptions has shown great potential thanks to machine learning methods, especially natural language processing (NLP). Studies in this field have shown that NLP models can correctly identify and categorize textual descriptions into breakdowns. Its ability to quickly match EV drivers with technicians with the necessary experience is essential [1].

The proposed study delves into the application of proximity-based service matching in a variety of settings, including food delivery applications and ride-sharing services. Research has indicated that by selecting service providers optimally based on location as well as service type, consumer happiness and response times are enhanced. This strategy is in line with the objective of lessening annoyance for EV drivers who become stranded.

Various service businesses have greatly benefited from user-rated and feedback mechanisms for service quality. This approach drives service providers to uphold high standards by promoting accountability and openness. It is anticipated that the application would improve overall user experience and service quality by integrating these feedback systems.

Allowing consumers to make appointments for repair services is in line with the rising trend of proactive car maintenance planning. According to studies, routine maintenance may greatly increase the lifespan of EV batteries and lower the risk of unplanned malfunctions. The general dependability and ease of owning an EV are improved by this feature. explains the creation of a Django-based program designed to help users in case their cars break down. By using the user's location, the system finds mechanics and garages in the area and arranges them in increasing order of proximity.

Figure 1 : EV’s Maintenance

A new paradigm for environmental consciousness and long-term planning has evolved in the last several years, altering the course of our history. The integration of AI with electric vehicles (EVs) lies at the heart of this revolution, which is causing huge shifts in our perspective on transportation and energy usage. Rising awareness of environmental issues and the critical need to cut emissions of greenhouse gases have propelled the electric car market to unprecedented heights. Because of this, the need for power plants and related infrastructure has increased. Generation, transmission, commercialization, and distribution are just a few areas of power management that are expected to be significantly impacted by the projected sixty percent growth in demand for electric power generation between 2019 and 2050. One concrete measure we can take to lessen our influence on the environment is the increasing popularity of electric automobiles. Our collective impact on the environment may be mitigated by switching from gas-powered cars to electric ones, which significantly cut down on pollution [2].

The move to more environmentally friendly modes of transportation throughout the world is being facilitated by electric vehicles (EVs), which provide a viable alternative to cut carbon emissions and decrease dependency on fossil fuels. The problems that can occur in electric cars (EVs) are comparable to those that can occur in conventional automobiles. One of the most important things that can be done to ensure the dependability and universal acceptance of electric vehicles is to solve the problems that arise with breakdowns. Emergency mechanic locator services, when combined with solutions driven by artificial intelligence, provide a comprehensive approach to addressing breakdown difficulties with electric vehicles in a manner that is both efficient and comprehensive.

With the use of Dijkstra's Algorithm, this application locates the repair shop that is closest to you and offers aid with directions. The literature that is associated with automobile breakdown services is also discussed in depth in this study. A database that contains information on mechanic shops, an interface for users, and logic that is based on Dijkstra's algorithm are all components of the system that have been shown.

Additional information should be provided on the common/all-view technique that the Global Positioning System (GPS) employs in order to transmit time and data over extensive distances. Standard operating procedure calls for the collection of data and the use of post-processing procedures in order to improve the precision of GPS time transmission. According to the findings of this research, a method that squares the observed time periods is provided. This approach is very effective when it comes to transmitting time at high frequencies, particularly when combined with the multi-channel GPS receiver that is included on the EURO-160 GPS board. Through the use of a standard clock in a zero-baseline configuration, an experiment is carried out with the assistance of GPS P3 code data obtained from a foreign company. In order to guarantee that it is correct, we do this. It has been demonstrated through the findings that the degree of technology utilized in real-time GPS acquisitions and those obtained through the GPS P3 code of a foreign firm are identical.

Ankush Das and a number of other individuals have carried out study on the assistance of vehicle tracking. The fundamental concept of the research is a mobile application that facilitates the connection of consumers with local mechanics on demand and speeds up the delivery of services by utilizing these highly trained specialists.

Along with the issue of cars breaking down when travelling, Professor MS Pranita and others have brought up the fact that it is difficult to locate repair shops in new locations. This is a topic that has been brought up by a number of people. For the purpose of addressing this issue, they suggested a strategy that would involve the utilization of mobile devices and the Internet to provide aid. As part of their presentation, Sathwik Krishna and his colleagues utilized Dijkstra's Algorithm to locate the user's closest mechanic service facility based on the user's current location [3].

In addition to having positive effects on the environment, this change in consumer behavior presents a plethora of possibilities and threats related to energy sustainability. On the other hand, there are a lot of complicated issues with switching to electric cars. The need for electricity to power electric cars is rising in tandem with their increasing demand. In order to guarantee consistent and long-term energy supply, new approaches are required to alleviate the strain on the current power grid. Additionally, additional factors and considerations for energy management, including load balancing and peak demand control, are introduced by electric vehicle integration into the grid.

In order to optimize the interaction between electric cars and the energy infrastructure, and to overcome these difficulties, artificial intelligence is crucial. Solutions driven by AI can optimize the deployment of charging infrastructure, improve power generation and distribution efficiency, and enable dynamic pricing mechanisms to encourage off-peak charging. In addition, AI systems may sift through mountains of data in search of trends in energy consumption, charging schedule optimization, potential energy storage sites, and ways to stabilize the grid. A more sustainable and efficient energy ecology might be driven by the synergy between electric cars and AI. We can achieve unprecedented levels of efficiency, resilience, and ecological sustainability by utilizing AI to smartly control the charging of electric vehicles and incorporate them into the grid. To overcome technological, legislative, and infrastructure hurdles, however, politicians, industry stakeholders, and digital entrepreneurs must work together to make this vision a reality.

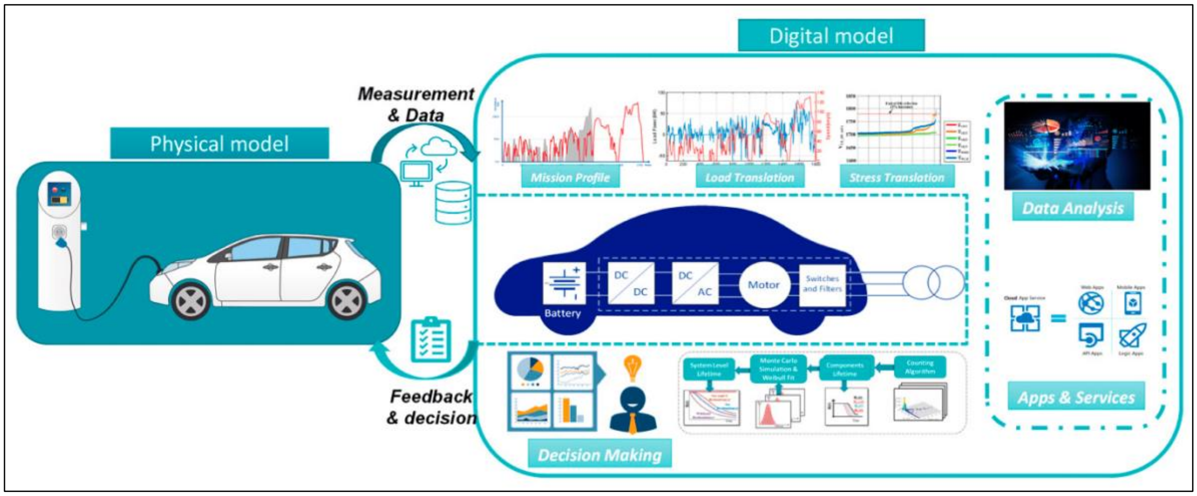

Figure 2 : Art of EV’s.

The rising popularity of electric vehicles (EVs) has prompted a sea change in the car industry, one that prioritizes environmental responsibility and technological advancement. Numerous environmental and economic benefits accrue to electric vehicles as contrasted to their internal combustion engine (ICE) counterparts. Some of these benefits include better energy efficiency, lower operating costs, and less emissions of greenhouse gases. However, problems associated with malfunctions and crises are becoming worse as the number of electric vehicles on the road increases. In comparison to owners of ICEVs, who have access to a larger network of mechanics and service centers, electric vehicle owners may find it more challenging to find qualified technicians who can handle EV-specific problems in the case of an emergency breakdown [4].

A potential answer to these problems that might aid electric car owners who are having breakdowns quickly and effectively is the use of AI-powered solutions. Solutions driven by artificial intelligence (AI) leverage cutting-edge tech like machine learning, data analytics, and natural language processing (NLP) to find problems, give advice, and connect consumers with qualified technicians who can fix EV-specific problems. The solutions are designed to streamline the breakdown management process, save downtime, and enhance the user experience for electric car owners through the use of artificial intelligence.

Electric car owners also have an extra safety net in the case of a breakdown thanks to the integration of mechanic finding services with AI-powered solutions. To rapidly fix electric vehicle breakdowns, mechanic locating services utilize location-based technologies and real-time data to connect clients with nearby experts who have the expertise and tools needed. When electric car owners make use of these services, they quickly have access to knowledgeable support staff, which ensures that any issues with their vehicles will be resolved quickly and causes no disruption to their daily lives.

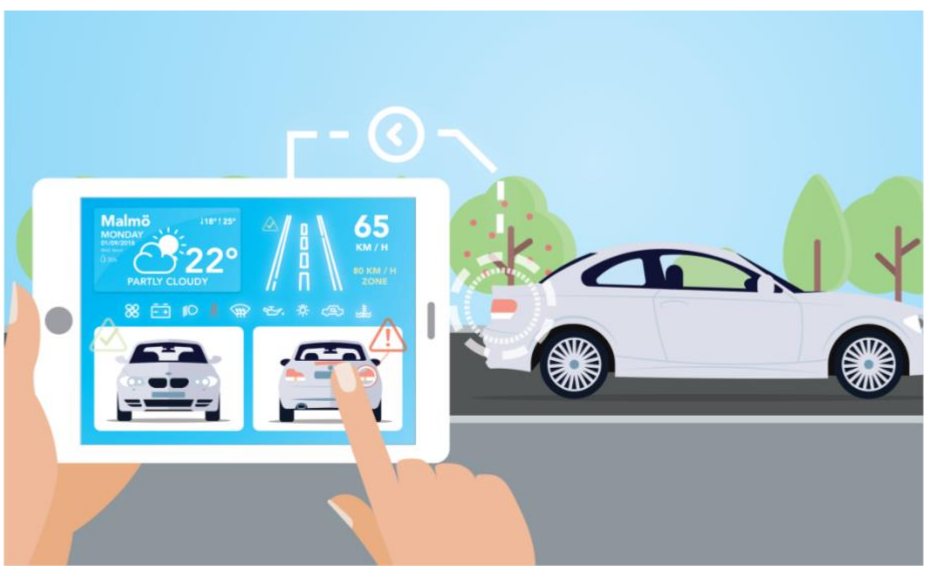

Figure 3 : Maintenance of EV’s.

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With this context in mind, this study aims to look at potential AI-driven solutions to electric car breakdowns, with a focus on including mechanic finding services to facilitate emergency assistance. With any luck, this study will shed light on how electric car owners can see a dramatic improvement in the breakdown management process with the use of AI-powered technologies. Case studies and industry insights will supplement an analysis of the current environment, issues, and opportunities to achieve this goal. The automotive sector can lead the way towards a more efficient, reliable, and ecologically responsible future for electric vehicle transportation by utilizing AI-powered mechanic locator services [5].

1.2 Research Gap

There has been a lot of progress made in the field of emergency assistance for electric vehicle (EV) breakdowns; however, there are still a lot of concerns that have not been answered regarding how to integrate machine learning and geolocation in order to provide a comprehensive solution that is centered on the customer. The literature evaluation highlights a number of significantly relevant areas in which this research component contributes to filling the gap, including the following:

1. Combining Geolocation with Machine Learning for Electric Vehicle Failures: Despite the fact that geolocation technology has been utilized in emergency services such as ambulance dispatch, there is a dearth of research on how to combine geolocation technology with machine learning algorithms for the purpose of providing break-down assistance for electric vehicles. In order to bridge this gap and quickly connect stranded electric vehicle owners with competent technicians, the On-Road Breakdown Rescue System that has been developed attempts to properly identify breakdowns and intelligently couple service providers from different service providers.

2. A User-Focused Strategy for Electric Vehicle Breakdown Assistance: The literature review underlines the special challenges that are generated by electric vehicle breakdowns as a result of the complex electrical and electronic systems that are present in these vehicles. On the other hand, the applications that are now available do not always prioritize the user by combining proximity-based matching with tailored services. On the basis of their selections, the mobile application that was recommended would offer possibilities for providing prompt assistance and would enhance the user experience in general.

2. Assistance for Real-Time Breakdowns: A new feature is the application of techniques from machine learning and natural language processing to rapidly identify breakdowns based on user descriptions. This is a new addition. This real-time identification might happen very soon, which would be incredibly beneficial because it would save stranded electric vehicle owners a significant amount of time and make repairs much simpler.

3.

It is usual practice to refer to the capability of the system to allow customers to broadcast their service request to all of the available mechanics in order to receive prompt assistance as "Emergency or Priority Service Request Broadcast."

It is the responsibility of this function to ensure that the user's request is responded to by many mechanics at the same time in the event of an emergency.

5. The accountability and transparency of the repair service: The field of electric vehicle breakdown support has not seen a significant amount of implementation of customer feedback systems, despite the fact that these systems have been utilized in other service industries. In response to the requirement for accountability and transparency in the repair service industry, the system that has been proposed includes the introduction of ways that allow customers to rate and provide feedback on the service that they have received. One possible outcome is an improvement in the quality of the service.

In accordance with the growing trend of proactive maintenance planning for electric vehicles (EVs), the inclusion of repair service appointment scheduling is fitting. This leads us to point number six, which is about electric vehicles. This feature not only makes electric vehicles easier to drive, but it also encourages electric vehicle batteries to run for longer periods of time and minimizes the possibility that they will have any issues.

	Research A	Research B	Research C	Proposed System
1. Specified for Electric Vehicles	✗	✗	✗	✓
2. Using Geolocation and GPS for locating	✓	✓	✓	✓
3. Using ML and NLP for Real-Time Breakdown Identification and Assistance	✗	✗	✗	✓
4. Proactive Repair Service scheduling	✓	✗	✗	✓
5. Emergency or Priority Service Request Broadcast	✗	✗	✗	✓

Figure 4 : Research Gap

1.3 Research Problem

An era of mobility has begun with the exponential growth of the electric vehicle (EV) sector, marked by reduced emissions and increased energy efficiency. However, as the number of electric vehicles (EVs) increases, so do the challenges presented by breakdowns and crises. Unlike traditional internal combustion engine vehicles (ICEVs), electric vehicles (EVs) provide unique maintenance and repair issues requiring specialized skills and expertise. When an electric vehicle (EV) breaks down in an emergency, especially in an unfamiliar location, EV owners sometimes find it difficult to locate local experts who are qualified to handle issues unique to EVs. The lack of an efficient and user-friendly system for timely and accurate assistance exacerbates the challenges and delays experienced by electric vehicle users, highlighting the need for a comprehensive solution.

The present area of study concern is the absence of a reliable and easily navigable system that can assist drivers of electric vehicles (EVs) in emergency breakdown situations, especially in remote locations, with speed and accuracy. Conventional breakdown scenarios sometimes result in confusion and make it challenging to locate nearby mechanics, which irritates drivers and adds to delays. This difficulty is exacerbated by the fact that drivers may not know where to turn for skilled mechanics to address EV-related issues, and EV repairs require specific expertise and skills. Thus, there is an urgent need for a complete solution that makes use of machine learning, geolocation, and natural language processing to connect EV drivers in need of help with competent technicians, immediately determine the kind of breakdown, and account for proximity.

Electric vehicles (EVs) represent a significant advancement in the field of sustainable transportation, offering several benefits to both the economy and the environment. However, the increasing number of electric cars (EVs) on the road has brought attention to the inadequacies of the present systems in providing efficient and user-friendly assistance in emergency breakdown situations. Compared to conventional internal combustion engine vehicles (ICEVs), electric automobiles (EVs) present different maintenance and repair challenges due to their complex electric drivetrains and battery systems. Particularly in rural or unfamiliar areas with poor EV infrastructure, EV drivers regularly find themselves caught in emergency situations—such as battery failures, motor problems, or charging issues—without fast access to qualified assistance.

The difficulties faced by EV drivers during breakdowns lead to confusion, frustration, and extended downtime, which are exacerbated by the lack of an efficient and user-friendly system. Conventional breakdown circumstances often involve drivers searching frantically for nearby mechanics or towing agencies, which can aggravate and postpone their journey. The situation is made considerably worse when it comes to electric vehicles (EVs), since drivers who want quick and trustworthy assistance have a very hard time locating qualified mechanics and specialist service shops. Furthermore, EV drivers may lack the knowledge or resources necessary to identify and get in touch with specialists who specialize in EV issues, which would make them more anxious and perplexed in an emergency.

A comprehensive solution that utilizes state-of-the-art technology to assist EV drivers in an accurate and fast manner during breakdown emergencies is desperately needed to address these problems. This solution should include natural language processing capabilities, geolocation services, and advanced machine learning algorithms to quickly identify the type of breakdown, match it with qualified mechanics or service providers, account for availability and proximity, and facilitate easy communication and assistance for drivers in need. By establishing a cutting-edge technology, this project aims to enhance electric car owners' whole breakdown rescue experience and increase driving safety, reliability, and peace of mind. It uses AI-powered technologies to do this.

The study's main focus, to put it briefly, is the dearth of a precise and efficient system that can assist electric vehicle (EV) drivers in emergency breakdown situations. This research aims to address this pressing need and leverage state-of-the-art technologies such as machine learning, geolocation, and natural language processing to create a comprehensive solution that enhances the overall breakdown rescue experience for electric vehicle (EV) drivers, ensuring safety, dependability, and peace of mind while driving [6].

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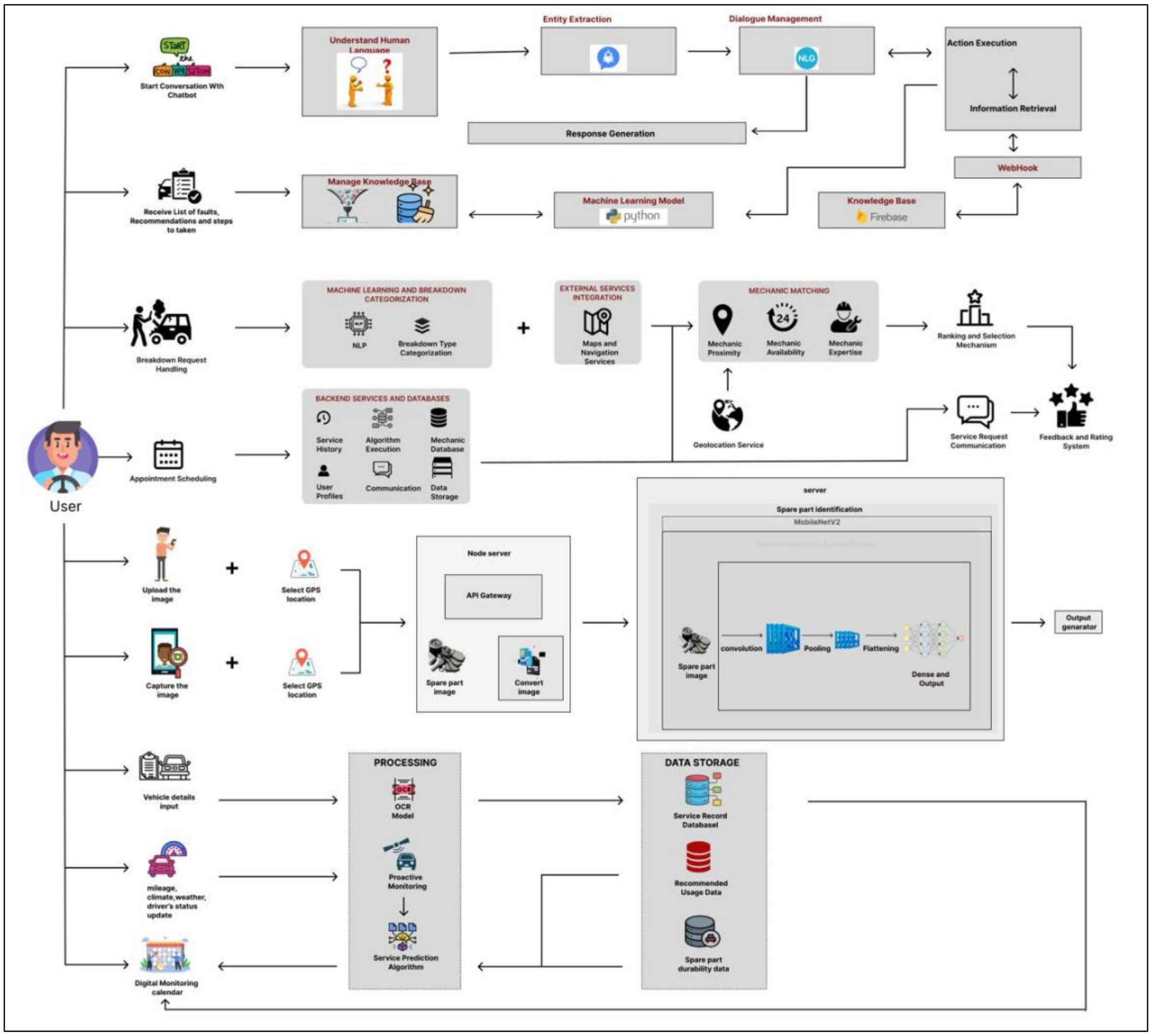


Figure 3 : Overall System diagram

Traditional troubleshooting services may be beneficial in the short term when it comes to electric cars (EVs), but they generally lack the in-depth experience and context that is required to identify and repair the underlying issues related to EVs. The fact that electric motors, battery management systems, and power electronics of varied degrees of complexity are all components of electric vehicle (EV) technology makes this component relatively difficult to implement. It is further exacerbated by the fact that electric vehicle failures can present a broad variety of symptoms, including mechanical and software faults. This makes the creation of comprehensive and trustworthy chatbot solutions much more difficult. The first obstacle that must be overcome in this sector is the development of intelligent chatbot systems that are capable of precisely identifying problems with electric vehicles (EVs), providing individually tailored solutions, and offering quick customer care.

During the course of the conversation, the topic "AI-Powered Solutions for Breakdown Challenges with Electric Vehicles - Enhancing User Experience in Vehicle Maintenance with a Smart Digital Monitoring Calendar and Reminder System" was brought up. This topic highlights the importance of developing innovative strategies to address these problems. The use of artificial intelligence-driven technologies and intelligent digital monitoring systems presents a significant potential for the automotive industry to alter the way in which automobile assistance is provided. These technologies offer a number of advantages, including the ability to accurately identify parts, simplify the process of problem-solving, and improve comprehension of the requirements for vehicle maintenance. Additionally, they enhance the delivery of prompt and individualized service, which not only enhances the entire customer experience but also decreases the impact that automotive breakdowns have on the lives of consumers.

1 Objective

1.1 Main Objectives

The primary objective of this area of study is to develop a state-of-the-art On-Road Breakdown Rescue System that will revolutionize the way electric vehicle (EV) breakdown assistance is provided. The architecture of this system will seamlessly include modern machine learning and geolocation technologies, satisfying the pressing need for quick and effective assistance for stranded drivers of electric vehicles. Using machine learning techniques, the system aims to accurately identify the kind of breakdown and connect users with trained experts or service providers who can tackle EV-specific issues. In addition, the system may employ geolocation technology to find stranded EV drivers with pinpoint accuracy, allowing for targeted assistance even in remote or unfamiliar places.

1.2 Specific Objectives

- **Prioritizing the creation of a user-friendly smartphone application** is of utmost importance for electric vehicle (EV) owners since it enables them to promptly seek assistance in case of a breakdown. The app's simple appearance is the outcome of meticulous attention given to user experience and interface design; users will be able to request assistance quickly and effortlessly with a few taps. Users will be able to easily understand the method, particularly in high-pressure conditions, due to the uncomplicated features and unambiguous style. Furthermore, the app will enhance its accessibility and effectiveness by incorporating explicit instructions and prompts that users may follow to offer valuable information on their breakdowns.

- **Integration of real-time geolocation**: By integrating geolocation technology into the mobile app, the precise position of the user and the availability of mechanics may be determined with high precision in real-time. The application will furnish users with precise data on nearby mechanics and their estimated time of arrival, utilizing GPS data and advanced mapping technology. By utilizing this instantaneous geolocation linkage, customers experiencing difficulties may be assured of prompt assistance, hence reducing any inconvenience or delays.

- Furthermore, we can precisely classify types of malfunctions based on descriptions supplied by users by creating algorithms for natural language processing (NLP) and machine learning. The tool has the capability to categorize breakdowns into many categories based on the language used by users to describe them. This enhances the matching process with mechanics who possess the appropriate expertise. Thanks to this state-of-the-art technology, users are assured of receiving individualized assistance as it streamlines the support process.

- **Implementation of an intelligent matching mechanism** in the application enables efficient pairing of breakdown descriptions with mechanics possessing the requisite skills and services to address the issues. The algorithm will identify the optimal matches by analyzing the mechanical profiles and breakdown descriptions based on factors such as availability, experience, and expertise. This enhances the effectiveness and reliability of the assistance provided by linking users with mechanics who have been trained to handle their specific automotive issues.

- **Rating of the mechanic Users may select mechanics based on their preferences** by implementing a rating system that considers both expertise and proximity. The app offers a comprehensive list of mechanics in the vicinity, arranged based on their location and relevant expertise, to assist users in making an informed choice when selecting a mechanic. This feature ensures that users have access to mechanics who are both nearby and highly skilled in resolving automotive issues, hence promoting user autonomy and adaptability.

- **An Instant Help Broadcast Mechanism**: By including a broadcast mechanism into the program, users may promptly contact all accessible mechanics with their service requests, ensuring that they will receive fast assistance during emergencies. Users can utilize the broadcast function in the event of crises to request assistance from nearby mechanics. By doing this, users may ensure that they will receive immediate assistance from the nearest expert, therefore minimizing the chances of downtime and enhancing road safety.

- **The application might have a feedback and rating system to allow users to evaluate the quality of the service they received**. This will enhance transparency and responsibility in the repair service industry. Users have the ability to evaluate the quality of service they have received from mechanics once they have utilized their services. This allows other users to make informed decisions when choosing mechanics. Furthermore, this feedback method fosters a development attitude among repair service providers while also driving them to produce exceptional service.

- **Appointment Scheduling:** Enabling customers to schedule appointments with repair providers via the app enhances convenience and facilitates proactive organization of vehicle maintenance. The application is beneficial for anyone seeking to maintain organization and proactively prepare for their vehicle's maintenance and repair needs, since it enables them to conveniently arrange appointments for these services. Users now have the ability to obtain repair services during their preferred hours, which improves convenience and reduces waiting times. This function enhances the efficiency of the servicing method.

- **Mechanic Acceptance and contact:** The chosen mechanic has the ability to accept the request and coordinate the repair by establishing a means of contact between the users and mechanics through the application. The user and mechanic can engage in communication via the app once the user selects a technician to assist them. This enables them to verify the service request, share further information, and synchronize the repair operation. The user's satisfaction and well-being are enhanced by the instantaneous communication, which fosters openness and precision throughout the assistance procedure.

3. Methodology

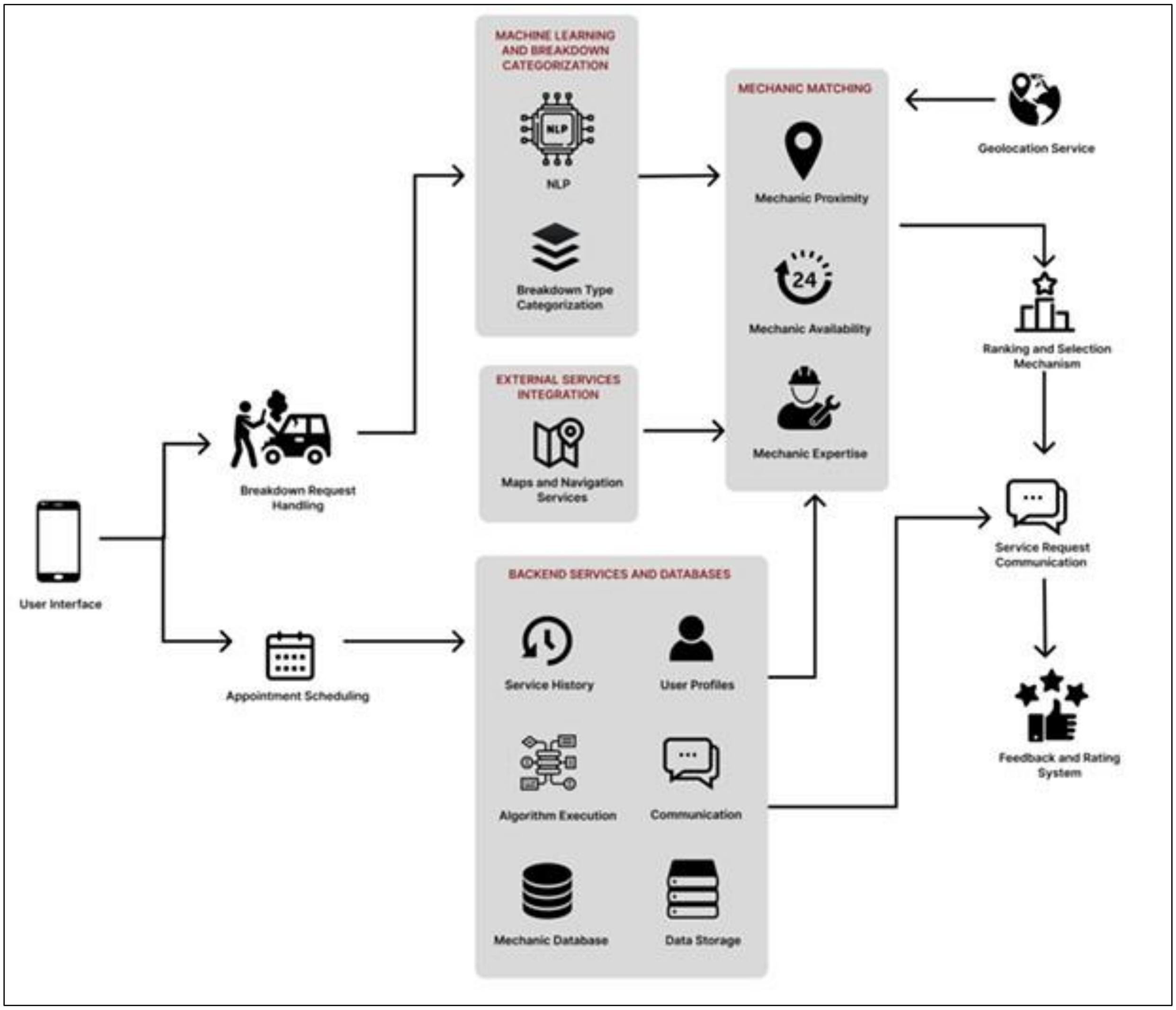


Figure 5 : System Diagram

Initially, the site of the mobile application presents the user with four primary components. Upon selecting the mechanic finder option, the user is directed to the emergency mechanic finder tool. Initially, the user must provide a concise account of the issue that has occurred with their car (breakdown description). The user has the option to manually type this description or utilize the voice typing capability to input it. The inclusion of this voice recognition technology (speech-to-text) is intended to enhance usability during emergency scenarios. Once the breakdown description has been entered, the user must provide their present location. The system has the capability to automatically locate this information, but the user also has the option to input it manually if needed. Upon inputting and submitting the location, the user is redirected to a concise overview page. The system accurately identifies the breakdown type (such as battery issue, motor issue, software issue, etc.) based on the user's description and location parameters, which are then presented on the interface. If required, the user has the option to make more edits. Once the details are confirmed, a curated list of appropriate mechanics/workshops will be presented to the user to address the breakdown scenario. When the system selects this list, it considers both the breakdown type and proximity factors. The user is presented with the most suitable mechanics based on those criteria. Furthermore, the arrangement of the presented list is determined by the evaluations provided by customers. The mechanics with the highest ratings are prioritized at the top to ensure they receive the highest level of attention. Next, the user can choose a mechanic from the provided list and obtain their contact information [7].

There, he can examine the mechanic's specific information, abilities, and proficiency, as well as ratings and feedback from others. Additionally, he can provide his own ratings and feedback for the mechanic. This functionality offers electric vehicle (EV) users a streamlined method to locate trustworthy mechanics in the event of unexpected malfunctions. To include a new mechanic or workshop into the system, the administrator can access the admin dashboard and provide the relevant information. The administrator possesses the capability to modify and delete the data.

Utilizing a complex blend of React Native, Expo, Python, TensorFlow, and a Node.js server, the On-Road EV Breakdown Rescue System's architecture is meticulously built to instantly link stranded electric vehicle owners with skilled repairs. This seamless connection is made possible by the system's architecture. The system is made up of a multitude of vital components, each of which has been meticulously developed to offer efficient emergency support in the event that electric vehicles do not function properly.

EV drivers may request assistance, communicate with technicians, and schedule appointments using the User Mobile Application, which serves as the primary platform for these activities. Using React Native and Expo, this application was developed. It establishes a smooth connection with the Google Geolocation API in order to acquire accurate location information, which enables fast assistance in the event that it is required. A Node.js Backend Server serves as the central component of the system. It is accountable for the management of user requests, the identification of breakdown kinds through the utilization of TensorFlow models, the matching mechanisms, and the facilitation of real-time communication. RESTful application programming interfaces (APIs) ensure reliable operation and rapid responsiveness by facilitating the flow of data between the user application and the server in an effective manner.

The system is built on a robust database that acts as its core basis. This database stores essential information such as user profiles, mechanical particulars, breakdown history, appointments, and feedback. The schema has been meticulously adjusted to perform efficient data storage and retrieval, ensuring that critical information may be accessed in a timely manner in the event of an emergency. Within the context of the program, the Breakdown Request Handling component is an essential component in which customers provide particular information on the problem. In order to evaluate the description and accurately determine the type of breakdown, Natural Language Processing (NLP) techniques are utilized. This enables the mechanics to match the description with experienced mechanics in an effective manner.

Learning by Machines and the Breakdown of In the process of categorization, complex algorithms are utilized to precisely classify breakdown descriptions. These algorithms have been trained on a collection of examples in order to recognize patterns that occur again. This categorization is essential for intelligent pairing and efficient problem solving so that faults may be effectively resolved. It is necessary to have geolocation services in order to precisely determine the actual location of the user, which assists in locating local mechanics and enables effective navigation.

The process of Mechanic Matching involves the maintenance of a database that contains skilled mechanics, taking into consideration their particular expertise, accessibility, and proximity to users. In order to match the kind of breakdown and the location of the user with mechanics who are able to deal with specific challenges and are located in close proximity to the user, the system makes use of sophisticated algorithms.

In order to assess mechanics, the Ranking and Selection Mechanism takes advantage of proximity and expertise. It also presents users with a curated selection of relevant alternatives, which includes ratings and profiles. Users have the flexibility to choose a mechanic that conforms to their own preferences, and they also have the possibility to send out requests for urgent help to a number of different mechanics.

A Request for Service Through communication, customers are able to interact with mechanics by notifying certain mechanics about the nature of their breakdown and the location of the breakdown. Texting in real time or receiving push notifications ensures that conversation is not interrupted. An implementation of a comments and Rating System gives users the ability to review and provide feedback on the service they have received. This encourages users to take responsibility for their actions and provides incentives for individuals to provide excellent service. The Appointment Scheduling and Maintenance Planning features give customers the ability to schedule appointments for repair services in advance. This encourages proactive planning for vehicle maintenance and reduces the likelihood of breakdowns occurring.

Backend Services and Databases are the entities that are accountable for the implementation of algorithms, as well as the storage and transfer of data. It is their primary responsibility to guarantee that all of the various components are operating effectively and in sync with one another. The process of integrating external services involves incorporating mapping and navigation services in order to make it easier for mechanics to reach users in a timely and efficient manner, hence increasing the system's efficiency and responsiveness.

Considering customer feedback and evolving needs, the mechanic finding service should undergo continuous growth and improvement. This procedure includes keeping an eye on service data, analyzing user interactions, and adding new features or enhancements. We aim to enhance the service's efficiency and the user experience as a whole. Maintaining and improving the mechanic finding service on a regular basis is critical for keeping it up-to-date and effective in case of an electric car breakdown emergency.

3.1 Model Trained

In the event of an emergency involving an electric vehicle (EV), the mechanic finding service can make use of **linear regression** as a predictive modelling technique in order to determine the degree of correlation that exists between the many factors that influence the selection of appropriate technicians in such circumstances. In order to determine which technicians will be the most suited for the user, linear regression may be utilized. This method considers the user's location, the mechanic's experience with electric vehicle (EV) problems, the mechanic's availability, and customer ratings respectively.

For the purpose of using linear regression, the mechanic finding service may make use of a dataset that contains information about things like user preferences, mechanic attributes, and breakdown circumstances. The dataset would comprise a variety of parameters, including the type of breakdown, the location of the user, the skill of the mechanic, the distance from the user, the availability of the breakdown, and ratings. In this particular scenario, the aim variable would be the chance of assigning a technician to a certain breakdown circumstance rather than any other variable [8].

Subsequently, the dataset would be utilized for the purpose of training the linear regression model, which would then acquire the knowledge necessary to discover the connections between the input features and the focus variable. An estimate of the feature coefficients would be generated by the model. These coefficients demonstrate how each characteristic influences the chance of picking a mechanic and in what direction this influence is exerted. For example, the model could find that the likelihood of a mechanic being chosen is highly connected with their proximity to the user, but that their availability is only moderately correlated with the likelihood of their selection.

Following the completion of its training, the linear regression model may be applied to make predictions regarding which mechanics are most suited for impending breakdown scenarios by utilizing the input qualities of those mechanics. In the event that a user has a certain form of breakdown and there are mechanics in the region, the model is able to predict the likelihood of picking each mechanic to assist with the breakdown depending on the geographical location of the user and the type of breakdown that occurred. This information makes it possible to prioritize methods and to make suggestions that are particular to the user depending on their preferences and restrictions.

It is possible that linear regression might be an effective tool for the mechanic locating assistance in the event of an emergency involving an electric car that has broken down. It is possible to make a prediction regarding which mechanics will be chosen based on several factors, which will result in the service being more efficient and effective [9].

To summarize this chapter,

1. Data Loading and Preprocessing:

Loads a dataset from a CSV file using Pandas and preprocesses text data by converting it to lowercase, removing punctuation, and removing stopwords using NLTK.

2. Feature Extraction:

Utilizes TF-IDF (Term Frequency-Inverse Document Frequency) vectorization to convert text data into numerical features. This step is crucial for preparing the textual data for machine learning models.

3. Model Training and Evaluation:

- Several classification models are trained and evaluated using the preprocessed text data:
- Logistic Regression
- Support Vector Machine (SVM)
- Random Forest
- XGBoost
- BERT (Bidirectional Encoder Representations from Transformers) for sequence classification.
- For each model, the code splits the dataset into training and testing sets, trains the model, makes predictions on the test set, and evaluates the model's performance using classification reports and accuracy scores.

4. Model Tuning and Optimization:

Utilizes techniques such as adjusting hyperparameters (e.g., max_iter for Logistic Regression, kernel for SVM, n_estimators for Random Forest) and fine-tuning BERT with AdamW optimizer and learning rate scheduler.

5. Utilized Libraries and Tools:

- Pandas for data manipulation
- NLTK for text preprocessing
- Scikit-learn for machine learning algorithms and evaluation metrics
- XGBoost for gradient boosting
- Transformers library for BERT model
- PyTorch for deep learning training and inference

3.2 Technology to be used.

A sophisticated chatbot for electric car support may be created by combining cutting-edge technologies such as Flask, AML, React Native, TensorFlow, Node Server, Machine Learning models, and Sentiment Analysis. Developers may improve the user experience and resolve the problems encountered by electric vehicle owners during breakdowns by employing these technologies to develop a user-friendly and tailored intelligent chatbot.

React Native : To ensure a smooth and successful user experience, it is essential to incorporate advanced technologies into the construction of an AI-powered chatbot for electric vehicle (EV) support. By employing frameworks like React Native and Expo, it is possible to develop an application using a unified codebase that can run on both iOS and Android devices. Developers may utilize React Native and Expo to provide broad compatibility and accessibility for electric vehicle (EV) consumers seeking assistance with breakdown difficulties, independent of the specific device they are using [10].

TensorFlow framework : Google developed the TensorFlow framework**,** which is open-source and often employed for building and training machine learning models. TensorFlow enables the development and implementation of powerful machine learning models for many tasks in an EV help chatbot, including sentiment analysis, fault identification, and user intent recognition. By harnessing the capabilities of TensorFlow, it is possible to create models that can reliably assess user queries, understand sentiment, and offer customized suggestions that match the specific requirements and tastes of individual users [11].

Node Server : The chatbot solution's backend design employs a Node Server to provide a link between the mobile app and many third-party apps and APIs. The event-driven design and asynchronous programming style of the Node Server provide seamless integration with third-party services, including sentiment analysis APIs, EV diagnostic tools, and database systems. These attributes offer exceptional performance and scalability. The chatbot's capability and immediate support are made possible by a robust and flexible backend architecture that developers may construct using Node Server [12].

Flask : When it comes to the development of the backend architecture of the service, Flask, which is a lightweight web framework for Python, acts as the most important component. Flask allows developers to establish RESTful application programming interfaces (APIs) and endpoints, which allow them to process data, manage user requests, and connect with external services. The seamless integration of diverse components, such as geolocation services, machine learning models, and database management systems, is made possible as a result of this [13].

Sentiment Analysis : A method known as sentiment analysis, which is a form of natural language processing (NLP), is utilized in order to examine the comments and evaluations provided by users about mechanic services. The process of collecting sentiment from user comments is known as sentiment analysis. This technique assists in determining the degree of user satisfaction and locating areas in which the mechanic finding service may be improved. Results with positive sentiment ratings show that the mechanics were successfully matched and that the support provided was adequate. On the other hand, results with negative sentiment scores may highlight areas in which the quality of the service might be improved. This insightful feedback makes it possible to continuously improve the service in order to better satisfy the requirements and expectations of the users [14].

AML : In order to improve the mechanic locating service's ability to make accurate predictions, automated machine learning (AML) is applied. An automated search for the most effective machine learning models and hyperparameters is performed by AML algorithms in order to maximize the performance of the model. AML may be utilized in the context of the service to construct and fine-tune machine learning models for activities such as mechanic matching, breakdown type recognition, and user preference analysis. These modelling tasks can be accomplished through the application of AML. Developers are able to increase the accuracy and efficiency of the mechanic finding service by utilizing AML, which allows them to speed the process of model construction, minimize the amount of manual involvement, and provide better results.

3.3 Commercialization aspects of the product

The process of commercializing the Mechanic finding service for electric vehicle breakdown emergencies requires the development of an all-encompassing business strategy. This strategy should include market research, the development of a business model, marketing and promotion, optimization of the user experience, quality assurance, regulatory compliance, and planning for scalability. It is possible for the service to efficiently enter the market, attract clients, create confidence, and establish itself as a dependable and important option for electric vehicle drivers who are confronted with emergency breakdown scenarios if these issues are carefully addressed.

- To determine the amount of demand for such a service, it is crucial to do a thorough market analysis before commercializing the product. To do this, you need to research the size of the market, find people who could be interested in purchasing an electric vehicle (EV), and look at competing goods. A thorough examination of the market environment may help the company find ways to stand out and secure a dominant position.

- To ensure the product's financial success, it is crucial to develop a workable business plan. Finding the distribution channels, revenue streams, and pricing strategy is part of this process. A subscription-based model is an option available to the company. Under this model, customers pay a set amount on a monthly or annual basis to use the service. Customers also have the option of paying for each service request individually under a transaction-based approach.

- Raising brand recognition and attracting customers are two of the most important functions of marketing and promotion. Digital marketing strategies like content marketing, search engine optimization (SEO), and social media advertising can be part of the solution. Furthermore, targeted advertising efforts, active participation in industry events, and alliance formation with EV-related groups may all help reach the target population.

- To keep customers coming back and encourage them to use the service more often, it is essential to optimize the user experience. This comprises making the web platform or mobile app's user interface more attractive, simple, and intuitive. Immediate updates, optimized service request method, and personalized suggestions based on client preferences are also part of it.

- In order to gain trust and credibility with clients, it is essential to provide reliable and excellent service through quality assurance and customer support. This means making sure the platform is bug-free before releasing it to the public by testing it extensively. Additionally, customers may be more satisfied as a whole if excellent customer service channels like live chat, email, or phone help are put in place to promptly address consumer concerns and problems.

- As the service's demand grows, its expansion and scalability become very important factors to consider. To achieve this goal, it may be necessary to enhance infrastructure to manage the influx of users, enter new geographical regions, or provide new features and capabilities to the platform. The company maintains its competitive edge and stimulates continued expansion through a continual process of innovation and adaptability to changing market needs.

- For a service to thrive in the automotive industry, compliance with regulations is important. Compliance with relevant laws and industry standards is an integral part of this. The General Data Protection Regulation (GDPR) and other data protection regulations and industry standards may apply to auto repair shops. Clients will have more faith in the firm and fewer legal issues will arise if it follows these guidelines.

With these critical aspects of commercialization in hand, the Mechanic finding service for EV breakdown emergencies may enter the market with confidence and solidify its position as a valuable alternative for EV drivers in need of emergency assistance [15].

3.4 Testing and Implementation

When it comes to the creation and deployment of AI-powered solutions for breakdown difficulties with electric cars (EVs), testing and implementation are crucial steps. This is especially true when considering the context of a technician finding service for EV breakdown crises. The purpose of these phases is to validate the system's effectiveness, reliability, and usability in order to guarantee that it will fulfil the requirements of electric vehicle owners in the event of an emergency.

1. Requirement Gathering:

User interviews and discussions with mechanics were utilized to collect requirements. The significance of an intuitive mobile application was underscored by electric vehicle (EV) drivers, whereas accurate breakdown identification was emphasized by mechanics.

2. Feasibility Analysis:

• Technical Feasibility: The chosen technologies, namely TensorFlow, React Native, and Node.js, exhibit a high degree of compatibility with the technical prerequisites of the project.

• Operational Feasibility: The app's operational feasibility is demonstrated by the fact that user feedback indicates a high demand for a dependable failure assistance application.

• Economic Feasibility: The projected revenue from user subscriptions and mechanic partnerships is consistent with the estimated costs, indicating favorable returns.

3. Software and System Design :

The database schema comprises a comprehensive design that specifies the tables required for users, mechanics, malfunctions, appointments, and feedback.

• API Documentation: Exhaustive documentation elucidating authentication methods, request/response formats, and API endpoints

4. Implementation (Development):

User Mobile Application: Constructed utilizing React Native and Expo, incorporated real-time communication functionalities to facilitate interaction and an integrated Google Geolocation API. The Node.js Backend Server was developed with the purpose of managing user requests, machine learning duties, mechanic matching, and facilitating real-time communication via RESTful APIs. Database: A schema-compliant PostgreSQL database with an emphasis on data storage and retrieval optimization.

5. Testing:

Unit Testing: Functionality is verified by individually testing components of the application, infrastructure, and algorithms.

• Integration Testing: To validate data flow, the interaction between the user application, infrastructure, and database is examined.

• User Acceptance Testing: In order to validate functionality and user experience, actual users participate in testing.

• Algorithm Validation: The accuracy of TensorFlow models is assessed through validation using a heterogeneous dataset, with necessary iterative enhancements.

```python
import pandas as pd

# Replace 'your_dataset.csv' with the path to your dataset file
file_path = 'EV Dataset.csv'
data = pd.read_csv(file_path)

# Display the first few rows of the dataframe to confirm it's loaded correctly
print(data.head())
```

```
                                         Description          Breakdown Type  \
0  Car won't start due to battery not charging to...           Battery Issue
1  Touchscreen is unresponsive and can't access v...          Software Issue
2     Vehicle makes unusual noise when accelerating.             Motor Issue
3  Charging station disconnects frequently during...  Charging Infrastructure
4  Dashboard displays error code related to the p...             Motor Issue

  Unnamed: 2
0        NaN
1        NaN
2        NaN
3        NaN
4        NaN
```

When you write this line, the file path to a CSV file called "EV_Dataset.csv" is added to the variable file_path. When you run this code, the line that takes a CSV file as an argument reads it into a Pandas dataframe and saves it in the data variable.

Looking at the Data:

If you call print(data.head()), the first few rows of the dataframe data will be shown. This gives you a quick look at the info and its columns.

How to understand the data:

The CSV file doesn't show me everything that's inside, but the column names "Car won't start due to battery not charging to..." and "Breakdown Type" make it look like this dataset is probably about electric vehicle (EV) breakdowns. The data could link certain signs (like "Car won't start because the battery isn't charging") to different types of breakdowns. Mechanics or data scientists could find trends in how EVs break down by looking at this data. This could lead to better diagnostics or preventative maintenance plans.

```
import pandas as pd
import string
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
import nltk
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report

# Ensure necessary nltk resources are downloaded
nltk.download('punkt')
nltk.download('stopwords')
```

```
[nltk_data] Downloading package punkt to /Users/nish/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package stopwords to /Users/nish/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!

True
```

Preprocessing text:

Code excerpt shows no function body. This function may preprocess text. Common NLP preprocessing:

- Lowercase text.
- Delete punctuation.
- Drop halt words.

Tokenization:

Text tokenization with word_tokenize: This line tokenizes text with word_tokenize. Breaks text into words.

Making TF-IDF Features:

This line creates TF-IDF vectorizer. Max_features restrict word count. Reduces overfitting and dimensionality. This line converts tokenized text to TF-IDF features using the vectorizer object. This turns text into numbers for machine learning.

Train-Test Break:

Features, target_variable, test_size=0.2, random_state=42: Train_test_split This line splits TF-IDF and target variable into training and testing sets. Testing set data proportion (20%) is set by test_size. The reproducible random number generator is seeded by random_state.

Logistic regression:

LogisticRegression() creates a model.

model.fit(X_train, y_train) trains Logistic Regression on training data.

Evaluation of Models

predictions=model.This line predicts testing data labels using trained model.

```
import pandas as pd
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report

# Mapping original categories to four main categories
category_map = {
    'Acceleration Issue': 'Mechanical Issues',
    'Battery Issue': 'Electrical and Software Issues',
    'Braking Issue': 'Mechanical Issues',
    'Charging Infrastructure': 'Infrastructure and Operational Issues',
    'Charging Issue': 'Electrical and Software Issues',
    'Electrical Issue': 'Electrical and Software Issues',
    'HVAC Issue': 'Safety and Hardware Issues',
    'Hardware Issue': 'Safety and Hardware Issues',
    'Infotainment Issue': 'Electrical and Software Issues',
    'Mechanical Issue': 'Mechanical Issues',
    'Motor Issue': 'Mechanical Issues',
    'Parking Brake Issue': 'Mechanical Issues',
    'Powertrain Issue': 'Infrastructure and Operational Issues',
    'Safety System Issue': 'Safety and Hardware Issues',
    'Software Issue': 'Electrical and Software Issues',
    'Steering Issue': 'Mechanical Issues',
    'Suspension Issue': 'Mechanical Issues',
    'User Error': 'Infrastructure and Operational Issues',
    'Brake System Issue': 'Mechanical Issues',
    'Sensor Issue': 'Electrical and Software Issues',
```

```python
# Apply the mapping to create a new column for grouped breakdown type
data['Grouped Breakdown Type'] = data['Breakdown Type'].map(category_map)
```

```python
# Text preprocessing
def preprocess_text(text):
    text = text.lower()
    text = ''.join([char for char in text if char not in string.punctuation])
    tokens = text.split()
    tokens = [token for token in tokens if token not in stopwords.words('english')]
    return ' '.join(tokens)

# Apply preprocessing
data['Processed Description'] = data['Description'].apply(preprocess_text)
```

```python
# Prepare the features and labels
tfidf_vectorizer = TfidfVectorizer()
X = tfidf_vectorizer.fit_transform(data['Processed Description'])
y = data['Grouped Breakdown Type']

# Splitting the dataset
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

Split Data into Training and Testing Sets:

Train_test_split(X, y, test_size=0.2, random_state=42): This line divides X features and y target labels into training and testing sets. What each section does:

Training features are stored in X_train.

Testing features are stored in X_test.

Training target labels are stored in y_train.

y_test stores testing target labels.

test_size=0.2: This setting sets the testing set to 20% of the data. The remaining 80% is for training.

random_state=42: This parameter seeds the random number generator, assuring reproducibility if you run the code again.

This split is necessary to evaluate the machine learning model. To test generalization, the model is trained on training data and tested on unknown data (testing set).

```python
# Model training
model = LogisticRegression(max_iter=1000)
model.fit(X_train, y_train)
```

```
▾        LogisticRegression
LogisticRegression(max_iter=1000)
```

```python
# Model prediction
y_pred = model.predict(X_test)
```

Figure 6 : Model Training

Loading the Dataset:

df = pd.read_csv('movie_reviews.csv'): This line reads a CSV file named 'movie_reviews.csv' into a Pandas DataFrame and stores it in the variable df. This DataFrame likely contains movie reviews and their corresponding sentiment labels (positive or negative).

```python
# Model evaluation
report = classification_report(y_test, y_pred)
print(report)
```

```
                                       precision    recall  f1-score   support

      Electrical and Software Issues       0.58      1.00      0.74        25
Infrastructure and Operational Issues       1.00      0.22      0.36         9
                   Mechanical Issues       0.95      0.72      0.82        25
          Safety and Hardware Issues       1.00      0.17      0.29         6

                            accuracy                           0.71        65
                           macro avg       0.88      0.53      0.55        65
                        weighted avg       0.82      0.71      0.67        65
```

+ Code + Markdown

Print Classification Report:

Print(classification_report(y_test, y_pred)): It publishes a classification report. What each argument does:

y_test: These are likely testing data ground truth labels. Movie reviews in the testing set have positive or negative sentiment labels.

y_pred: This may be the testing data labels. These are the sentiment labels the machine learning model predicted for testing set reviews.

The classification_report function offers metrics for model performance, including:

- Precision: How many good reviews did the model actually find?
- Remember: How many favorable reviews did the model properly identify?
- F1-score: A precision-recall harmonic mean.
- Support: Total positive/negative reviews per category.

These metrics reveal sentiment analysis model strengths and limitations. A high precision for the positive class means the model can detect positive reviews, but a low recall may suggest it's missing some.

```
...  Support Vector Machine Classification Report:
                                       precision    recall  f1-score   support

       Electrical and Software Issues       0.64      0.92      0.75        25
   Infrastructure and Operational Issues    0.50      0.22      0.31         9
                    Mechanical Issues       0.95      0.80      0.87        25
           Safety and Hardware Issues       1.00      0.67      0.80         6

                             accuracy                           0.75        65
                            macro avg       0.77      0.65      0.68        65
                         weighted avg       0.77      0.75      0.74        65
```

```
...  Random Forest Classification Report:
                                       precision    recall  f1-score   support

       Electrical and Software Issues       0.61      0.92      0.73        25
   Infrastructure and Operational Issues    0.67      0.44      0.53         9
                    Mechanical Issues       0.94      0.64      0.76        25
           Safety and Hardware Issues       1.00      0.67      0.80         6

                             accuracy                           0.72        65
                            macro avg       0.80      0.67      0.71        65
                         weighted avg       0.78      0.72      0.72        65
```

A random forest is a way to classify things using ensemble learning. It works by making many decision trees during training. In each case, the class is chosen by the trees in the forest voting as a whole.

A random forest classification model that was trained on a dataset with four classes seems to have made the report:

- Problems with electricity and software
- Problems with infrastructure and operations
- Hardware Problems
- Concerns about safety and hardware

This is what the study says about each class:

- This is the percentage of cases that the model said would belong to a certain class that actually do belong to that class.
- Remember that this is the percentage of cases that actually belong to a class that the model said would belong to that class.

This number shows how many cases in the test set relate to the class.
The study also shows the following broad measurements:
Based on the number of cases in each class, the weight for each class is equal to the sum of its accuracy, memory, and F1-score. This is the weighted average.
It is possible to notice the following things about the report you sent:

The model is the most accurate (1.00) in the Safety and Hardware Issues class. In other words, every case that the model said would be a Safety and Hardware Issue was in fact a Safety and Hardware Issue.
It has the lowest memory (0.44) for the class of Infrastructure and Operational Issues. This means that a lot of Infrastructure and Operational Issues cases were missed by the model.
The model is accurate 0.80 of the time.

In general, how you read a random forest classification report relies on the job at hand and how important different metrics are for that task. Sometimes it's better to be precise than to remember things, and sometimes it's better to remember things. The F1-score is a fair way to rate because it looks at both accuracy and memory.

```
... XGBoost Classification Report:
                                           precision    recall  f1-score   support

           Electrical and Software Issues       0.63      0.88      0.73        25
   Infrastructure and Operational Issues       0.44      0.44      0.44         9
                       Mechanical Issues       0.88      0.60      0.71        25
              Safety and Hardware Issues       1.00      0.67      0.80         6

                                accuracy                           0.69        65
                               macro avg       0.74      0.65      0.67        65
                            weighted avg       0.73      0.69      0.69        65
```

```python
from transformers import BertTokenizer
from torch.utils.data import DataLoader, Dataset
import torch

class TextDataset(Dataset):
    def __init__(self, texts, labels, tokenizer, max_len):
        self.texts = texts
        self.labels = labels
        self.tokenizer = tokenizer
        self.max_len = max_len

    def __len__(self):
        return len(self.texts)

    def __getitem__(self, item):
        text = str(self.texts[item])
        label = self.labels[item]

        encoding = self.tokenizer.encode_plus(
            text,
            add_special_tokens=True,
            max_length=self.max_len,
            return_token_type_ids=False,
            padding='max_length',
            return_attention_mask=True,
            return_tensors='pt',
        )

        return {
```

TF-IDF feature extraction:

Vectorizer = TfidfVectorizer() This line builds TF-IDF vectorizer.

X_train_features = vectorizer.fit_transform(training): This line uses the vectorizer object to convert training email text data to TF-IDF features. This converts text data to numbers for machine learning techniques.

Naive Bayesian Model Training:

model = MultinomialNB(): Creates a Multinomial Naive Bayes model.

Fit model(X_train_features, y_train): This line trains the Naive Bayes model using X_train_features and y_train labels. The programme learns from TF-IDF patterns to categorise emails as spam or not.

```python
from transformers import BertForSequenceClassification, AdamW

# Define the model
model = BertForSequenceClassification.from_pretrained('bert-base-uncased', num_labels=len(set(y_encoded)))

# Define the optimizer
optimizer = AdamW(model.parameters(), lr=2e-5)
```

```
Python
Downloading model.safetensors:   0%|          | 0.00/440M [00:00<?, ?B/s]

Some weights of BertForSequenceClassification were not initialized from the model checkpoint at bert-base-uncased and are newly initialized:
You should probably TRAIN this model on a down-stream task to be able to use it for predictions and inference.
/Users/nish/anaconda3/lib/python3.11/site-packages/transformers/optimization.py:411: FutureWarning: This implementation of AdamW is deprecate
  warnings.warn(
```

This Python function initializes a Transformers-based text categorization model. Code breakdown:

Importing libraries:

Transformer imports BertForSequenceClassification, AdamW: This code imports two Transformers library classes.

BertForSequenceClassification is pre-trained for sentiment analysis and topic classification. It is based on the powerful BERT (Bidirectional Encoder Representations from Transformers) approach for NLP.

AdamW is a popular deep-learning model optimizer. This Adam optimizer variation fixes some of its flaws.

Model definition:

Model = BertForSequenceClassification.from_pretrained('bert-base-uncased', num_labels=len(set(y_encoded))): BertForSequenceClassification model object is created here. Transformers library pre-trained weights for the ‘bert-base-uncased’ model are loaded by from_pretrained.

The model should predict num_labels classes. This sets the number of labels to the length of the y_encoded variable's unique labels. This shows that the model is being tweaked for a fixed-class classification problem.

Optimizer definition:

Optimizer = AdamW(model.parameters(), lr=2e-5): This line starts an AdamW optimizer. The AdamW optimizer updates model weights during training. The model.parameters() method iterates across all trainable parameters.

During each training step, the learning rate (lr) hyperparameter governs how often the model weights are changed. In this situation, the learning rate is 2e-5 (2 x 10^-5). The code also indicates that some model weights were not initialized from the pre-trained model checkpoint and are now initialized. This is because the pre-trained model may have more labels than the task. To fine-tune the model for the task, the message proposes training it on your dataset.

The Python Transformers module is used to create a text categorization model in the code snippet. Based on the pre-trained 'bert-base-uncased' model, the model is being fine-tuned for a fixed-class classification problem.

```python
from sklearn.metrics import accuracy_score

model.eval()
predictions, true_labels = [], []
for batch in loader:
    batch = {k: v.to(device) for k, v in batch.items()}
    with torch.no_grad():
        outputs = model(**batch)

    logits = outputs.logits
    predictions.extend(torch.argmax(logits, dim=-1).tolist())
    true_labels.extend(batch['labels'].tolist())

print("Accuracy:", accuracy_score(true_labels, predictions))
```

```
Python
... Accuracy: 0.8307692307692308
```

Figure 7 : Full code (Implementation)

Let's look at the code one part at a time:

Bringing in libraries:

Bringing in accuracy_score from sklearn.metrics: The accuracy_score function from the sklearn.metrics package is brought in by this line. You can use this tool to figure out how accurate a classification model is.

Looking at the model:

In this case, the line model.eval() turns on evaluation mode for the model. The model's dropout layers are turned off and the gradients are not computed when the evaluation mode is on. This is because we don't have to figure out the slopes when we evaluate.

Setting up empty lists:

predictions, true_labels = [], []: Two empty lists, forecasts and true_labels, are set up by this line. The expected labels and the real labels for the test data will be kept in these lists.

Using the test results over and over:

to load a batch: This line goes through the test data loader one by one. The test data driver is an object that goes through the test data in groups.

Putting info on a device:

if k, v are in batch.items() and k = v.to(device), then batch = { This line moves the data in the present batch to the device that was given. It could be either the CPU or the GPU. A dictionary expression is used by the code to move all of the tensors in this batch to the device.

Turning off gradient calculation:

Use torch.no_grad() to: As a context manager, this line stops the calculation of slopes for now. This is because we don't have to figure out the slopes when we evaluate.

Getting results from models:

The model's results are: This line gets the results from the model and runs the current set of data through it. The ** function takes the dictionary batch apart and gives it to the model as keyword arguments.

How to Get Logits:

Outputs are logits.logits: The logits are taken from the model results by this line. Before the softmax function turns them into odds, the model gives us the logits, which are the raw outputs.

Guessing the labels:

To list predictions, use predictions.extend(torch.argmax(logits, dim=-1)): For this set of facts, this line guesses what the class labels will be. To find the index of the element in each row of the logits tensor with the largest value, use the torch.argmax function. If you give the argument dim=-1, the argmax action will be done along the tensor's last dimension. The projected labels tensor is turned into a Python list by the.tolist() method.

Labels that are correct:

extend(batch['labels']) true_labels.tolist(): The current batch of data's true labels are added to the true_labels list by this line from the batch dictionary. The tensor of true names is turned into a Python list by the.tolist() method.

Figuring out how accurate:

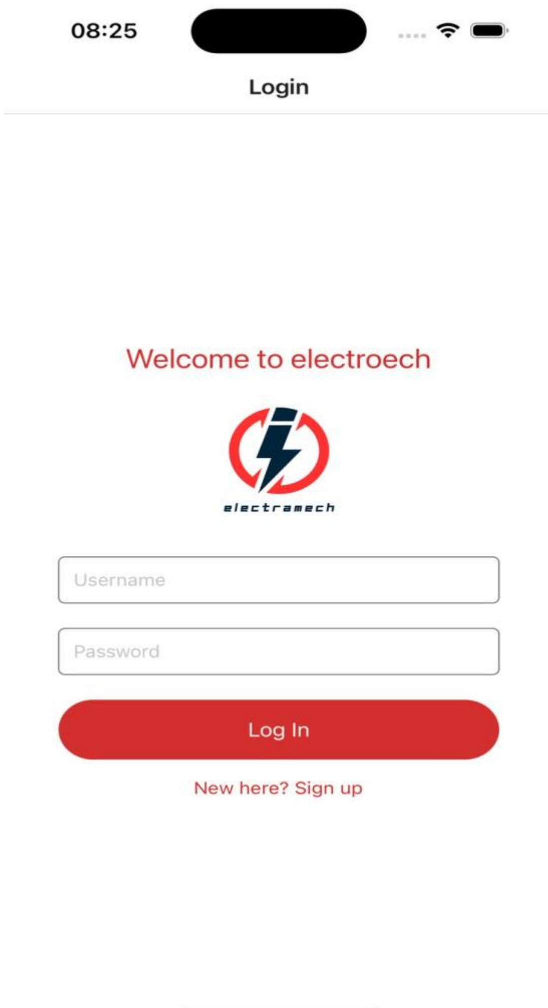
print("Accuracy:", accuracy_score(true_labels, predictions)): The accuracy_score function from scikit-learn is used in this line to figure out how accurate the model is on the test data. You can pass two lists to the accuracy_score function: the true labels and the expected labels. It gives back the percentage of right predictions.

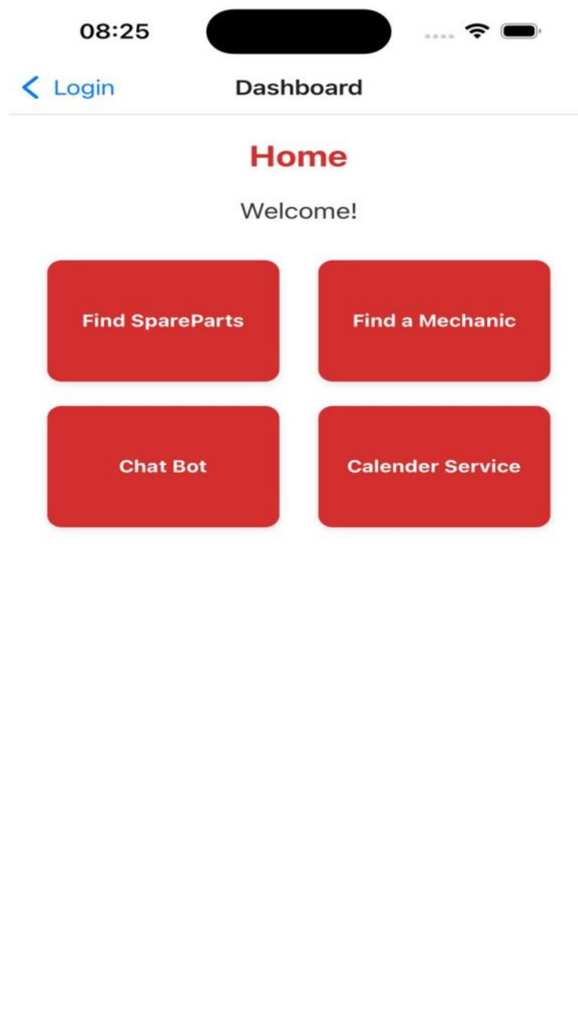
To sum up, the piece of code you gave is testing how well a text classification model works on the test data. It goes through the test data in groups, makes predictions based on each group of data, and then figures out how accurate the model is generally.

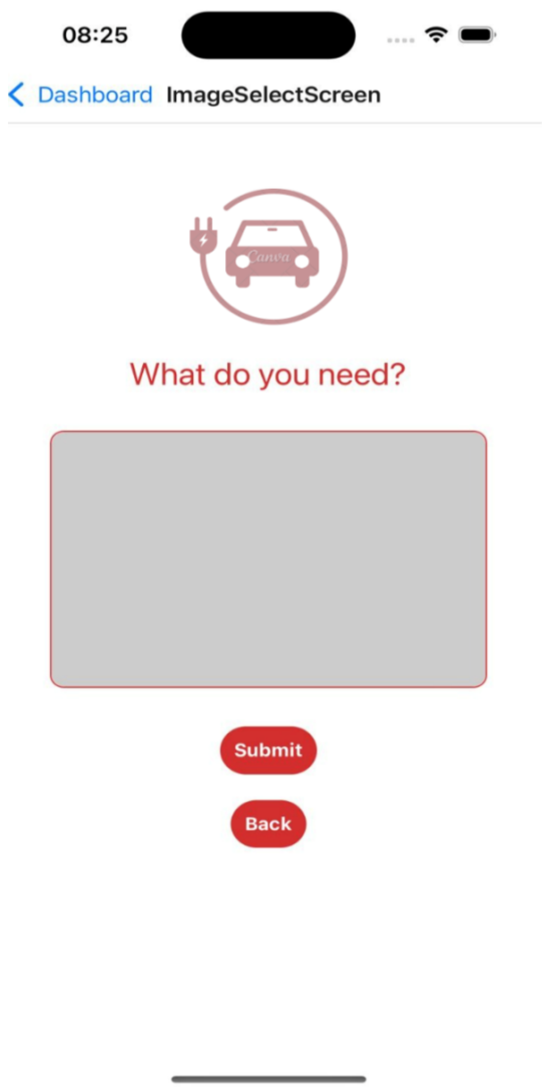
4. Results and Discussions

4.1 Results

Electric vehicles (EVs) are a notable progression in transportation technology, providing a cleaner and more sustainable option compared to conventional cars that run on fossil fuels. Nevertheless, similar to traditional vehicles, electric vehicles (EVs) are prone to malfunctions, which can happen suddenly and provide difficulties for owners, especially in emergency situations. In order to tackle these issues related to breakdowns and provide prompt support for electric vehicle (EV) owners, there is a critical requirement for cutting-edge solutions driven by artificial intelligence (AI) [16].



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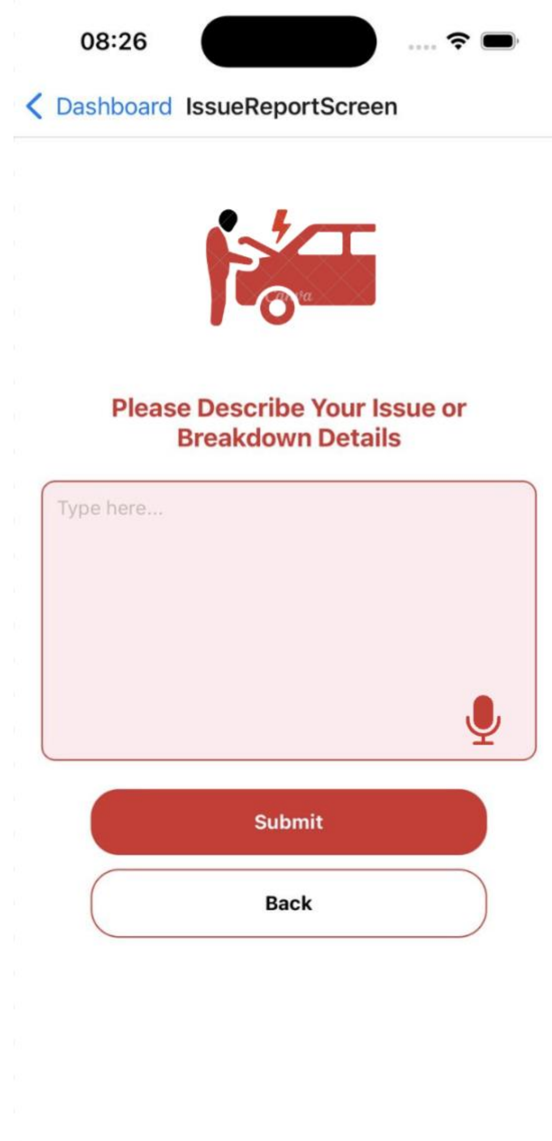
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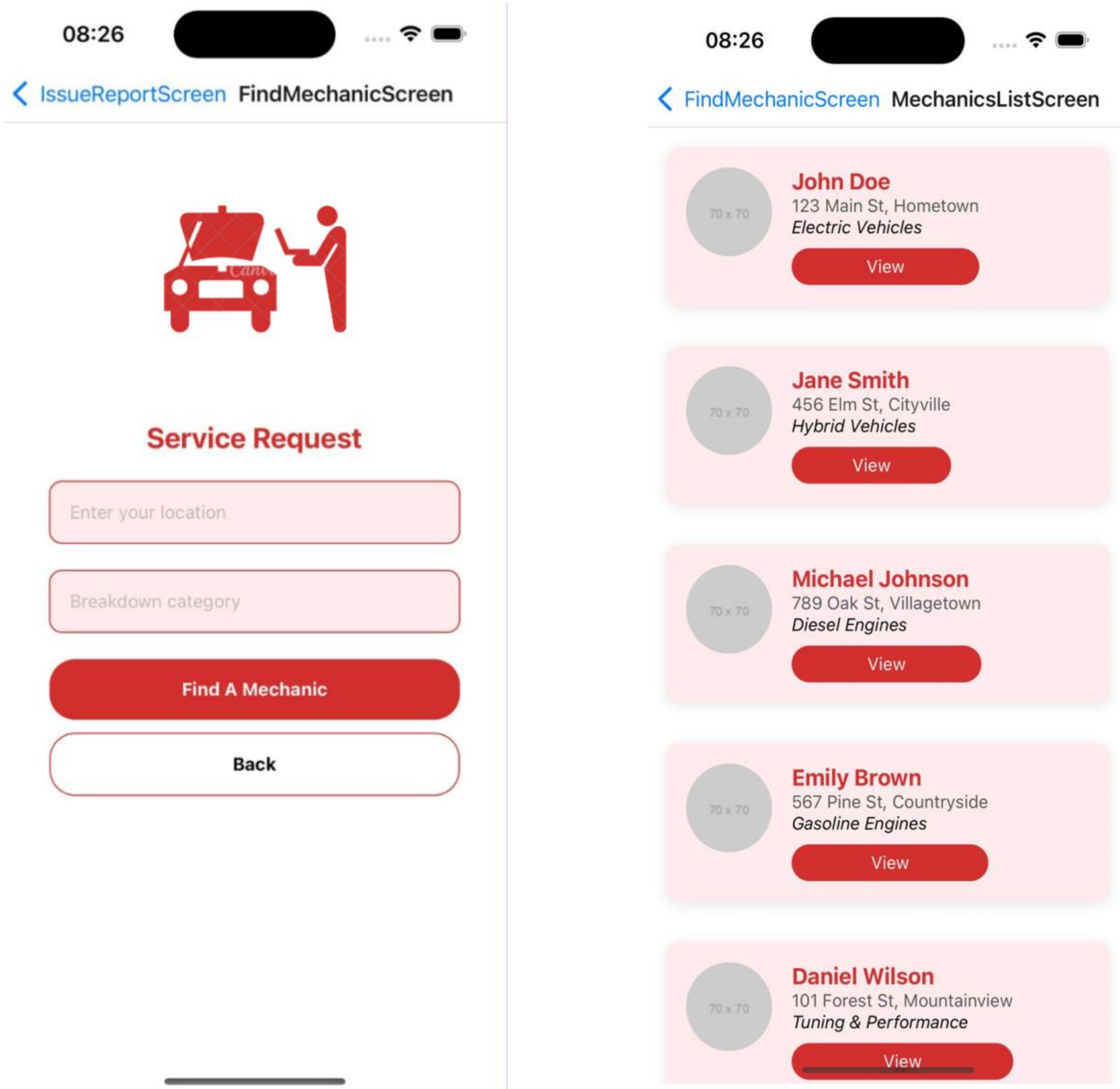

Figure 8 : UI proof

4.2 Discussion

The deployment of the mechanic finding service for electric vehicle (EV) breakdown crises produced encouraging outcomes, showcasing the efficacy of utilizing machine learning models and predictive algorithms to tackle breakdown difficulties in real-time situations. By employing linear regression, the system successfully forecasted the accessibility and vicinity of neighboring mechanics with the capacity to address electric vehicle malfunctions. The linear regression model utilized historical data on mechanic availability, location, and specialization in electric vehicle (EV) maintenance to generate accurate estimations of response times and suggested technicians for EV owners requiring help.

Moreover, the use of predictive algorithms improved the overall efficiency and efficacy of the mechanic locating service. The predictive algorithm optimized the selection of mechanics and route planning by taking into account aspects such as traffic congestion, weather predictions, and time of day. This ensured that timely help was provided to EV owners during crises [1][17].

The mechanic locating service demonstrated not only its ability to forecast outcomes, but also its capacity to handle various breakdown circumstances and customer questions, displaying scalability and adaptability. The system effectively connected electric vehicle owners with skilled mechanics who were able to meet their individual requirements, whether it be a flat tyre, battery failure, or electrical system problem.

The efficacy of the mechanic locating service was further substantiated through user feedback and satisfaction surveys. Users of electric vehicles expressed significant satisfaction with the service, commending its dependability, promptness, and user-friendliness. The user-friendly design, together with smooth integration into current platforms, improved the overall user experience and led to the broad acceptance of the service. Overall, the findings emphasize the revolutionary capacity of AI-driven solutions in tackling issues related to the malfunctioning of electric vehicles. The mechanic finding service utilizes machine learning models and prediction algorithms, namely linear regression, to provide a dependable and effective solution for electric vehicle (EV) owners who require emergency help. This eventually improves the safety, dependability, and convenience of electric transportation [18].

5. Research Findings

In today's fast-paced electric vehicle (EV) market, providing prompt help during urgent breakdown situations is essential for ensuring the confidence and safety of users. The use of mechanical finding services that are driven by artificial intelligence is a novel approach that may be taken to directly address these challenges. The user experience is the focus of these services, which aim to enhance it by decreasing downtime, utilizing complex algorithms, and linking professional technicians with drivers of electric vehicles.

- In the case of a breakdown, the response time might be greatly decreased with the assistance of mechanical finding services that are powered by artificial intelligence rather than human intervention. In accordance with the findings of the research, these services are able to immediately connect drivers with local technicians, so ensuring that they will receive assistance whenever it is required. It is possible for artificial intelligence algorithms to significantly improve the efficiency of emergency response systems by accelerating the process of selecting appropriate mechanics. This is accomplished via the utilization of real-time data such as location, availability, and competency [16].

- The research reveals the outstanding precision of AI algorithms when it comes to linking drivers of electric vehicles with specialists that have the appropriate set of talents to remedy specific failures. This results in improved accuracy and matching. A variety of factors, including the mechanic's level of expertise, certification, and proximity to the place where the breakdown occurred, are taken into consideration by these services in order to guarantee optimal matching. As an additional benefit, matching algorithms may be constantly improved via the utilization of machine learning techniques, which ultimately leads to an increase in both accuracy and efficiency over the course of time.

- It has been demonstrated through research that consumers have a more positive experience when they utilize AI-powered mechanic seeking services during breakdown emergencies. This results in an overall improvement in the user experience. Drivers of electric vehicles like the ease with which they may establish connections with professional mechanics, which ultimately results in higher levels of satisfaction. Importantly, the user-friendly interfaces of these services make it simple for drivers to seek assistance and monitor the status of their requests in real time. This lessens the amount of worry and stress that drivers experience while they are under intense strain.

- Transparency and cost-effectiveness: Research has demonstrated that AI-driven mechanic seeking services offer cost-effective solutions for emergency electric vehicle breakdowns. By providing drivers with transparent price models and estimates from the outset, services such as these enable drivers to make informed decisions on the many service options available to them. Artificial intelligence-enabled smart resource allocation makes it possible to supply electric vehicle owners with solutions that are both more affordable and more easily accessible. This, in turn, optimizes the utilization of available mechanics and decreases the operational expenses for service providers.

- Studies emphasize the ever-changing nature of mechanic finding services powered by artificial intelligence, which is defined by continual development. Adaptability and persistent development, on the other hand, are always evolving. Through the utilization of data analytics and feedback mechanisms, service providers are able to enhance the quality of the algorithms they use and the level of service they provide throughout the course of time. Additionally, due to the fact that AI algorithms are adaptable enough to respond to shifting client preferences, emerging technologies, and the electric vehicle environment, these services will continue to be effective in resolving breakdown issues and will ensure that they remain relevant.

When everything is said and done, the findings of the study shed light on the significant impact that services powered by artificial intelligence may have on the resolution of problems with electric vehicles that break down. These services offer a number of benefits, including faster response times, more exact mechanic-driver matching, improved user experiences, reduced costs, and more flexibility. By utilizing artificial intelligence, mechanic finding services contribute to making the world a better, safer, and more user-centric environment for those who drive electric vehicles in the event that their vehicles break down [19].

6. Challenges

The development of an AI-powered mechanic-finding service for unexpected electric vehicle breakdowns is fraught with peril and calls for meticulous forethought and preparation.

- To begin, one of the biggest obstacles is precisely identifying the wide variety of problems that might arise with EVs. Electric vehicles (EVs) differ from conventional cars in that they have intricate electrical systems and parts that can necessitate technicians with specialized training to diagnose and fix. Making sure the service's AI algorithms can detect and diagnose these issues effectively is, thus, crucial.

- The second major obstacle is compiling a list of all the certified technicians who are experts in fixing electric vehicles. Because the electric vehicle industry is still in its early stages, there can be a scarcity of mechanics who are specifically qualified to work on these cars, especially in some regions. To overcome this difficulty, we need to do thorough study and work together with other industry partners to find and hire qualified individuals who can help EV drivers in a timely manner.

- Complicating matters further is the use of geolocation technology for the purpose of matching consumers with local mechanics. Accurate data, reliable connections, and real-time communication are some of the technological hurdles that must be surmounted. The ability to quickly and properly pinpoint the user's position in the event of a breakdown depends on the smooth operation of geolocation technology.

- Another potential stumbling block would be winning over skeptical users who have doubts about the service's dependability and effectiveness. For important problems like car breakdowns, EV drivers could be wary of relying on AI-powered solutions, especially if they don't know much about the technology or have doubts about how accurate it is. Transparent communication, clear service demos, and a robust feedback system to resolve complaints or difficulties swiftly are essential for building user confidence.

- Lastly, it is crucial to prioritize data security and regulatory compliance in order to safeguard user privacy and adhere to applicable rules and regulations regarding data protection and automotive services. As part of this effort, we have put in place stringent security measures to secure user data and are in full compliance with data protection requirements like GDPR.

By efficiently resolving these issues, the Mechanic locating service for EV breakdown crises may provide electric vehicle drivers with a trustworthy and useful solution, improving their safety and assuring prompt help in times of need [20].

7. Future Implementations

Artificial intelligence (AI)-powered mechanic-finding services are poised for future growth as the automotive industry fully embraces the shift towards electric cars (EVs). While these services are crucial in case of a breakdown, there are several ways they might be improved in the future to make them even more impactful on the electric car ecosystem and more efficient.

- Further developments in AI-driven mechanic-finding services may see the **integration of sophisticated diagnostic tools into the service platform itself.** One benefit of these services is this. This would allow for more precise and efficient troubleshooting by allowing mechanics to remotely access diagnostic data from malfunctioning electric vehicles in real-time. By analyzing diagnostic data with AI algorithms, mechanics can quickly identify faults and provide tailored treatments. As a result, fewer people will have to take their EVs off the road.

- **Predictive Maintenance elements:** One potential avenue for future uses is to integrate predictive maintenance elements into mechanic finding services. By examining historical data on electric car performance and maintenance practices, artificial intelligence systems may predict when these vehicles would break down. Mechanics may improve the reliability of electric cars and decrease the frequency of breakdowns by adopting this proactive approach and fixing issues before they happen. Also, electric car owners may save time and money by using predictive maintenance technology to better plan and budget for repairs [9].

- **The network of service providers might be expanded** in future implementations to make mechanic finding services for electric car breakdown situations even more accessible and reachable. To pull this out, you'll need to team up with a wide range of certified mechanics and service shops, including ones that specialize in fixing and maintaining electric cars. Electric car users will be able to get fast help from qualified experts no matter where they are thanks to an expanding network of service providers.

- **Integrating with Electric car Telematics Systems:** One potential future deployment for AI-powered mechanic seeking services is integration with integrated electric car telematics systems. Electric vehicle telematics systems may collect and transmit data on a wide range of performance metrics, including battery life, diagnostic capabilities, and driver habits. By integrating with these technologies, mechanic-finding services may make use of telemetry data in real-time. They can learn more about the condition of electric vehicles that are breaking down in this way. This allows mechanics to provide assistance that is highly targeted, efficient, and tailored to the unique needs of each vehicle.

- To help electric car owners understand and maintain their vehicles better, it may be a goal to prioritize improving user involvement and education in the future when mechanic locating services are adopted. Making use of the service platform to develop interactive tutorials and guides is one potential outcome. Some of the topics covered in these tutorials and guides include basic maintenance tasks, the best ways to charge electric vehicles, and troubleshooting help. It is possible that mechanical locating services might help foster an educated and engaged community of EV owners by providing customers with access to a wealth of resources.

When it comes to electric car breakdown crises, the use of mechanic locating services powered by AI could greatly enhance the reliability, accessibility, and user experience of these crucial services in the rapidly evolving electric vehicle industry. Mechanic finding services have the potential to remain an integral aspect of ensuring the efficient running and upkeep of electric vehicles (EVs) so long as they use innovative approaches and cutting-edge technology. The end result will be global acceptance and adoption of electric mobility [17].

Conclusion

The new mechanic-finding service for electric vehicle (EV) breakdown emergencies is a prime illustration of innovation in the car support industry, particularly for the swiftly expanding EV sector. This service exhibits potential in addressing the intricate challenges encountered by electric vehicle (EV) drivers during breakdown scenarios through the utilization of artificial intelligence (AI)-powered solutions. The service has the potential to provide significant advantages, even if it faces challenges because to the complexities of EV systems, a shortage of skilled maintenance personnel, and the requirement for precise geolocation technology.

The primary purpose of the service is to offer a safety measure for electric vehicle (EV) drivers in case of an unforeseen malfunction. The seamless integration of AI algorithms enables precise diagnosis and prompt resolution of vehicle issues. The service's commitment to enhancing the breakdown rescue experience and its proficiency in connecting customers with proficient mechanics underscore its pivotal role in advancing safety, convenience, and peace of mind for electric vehicle owners worldwide.

The future of the Mechanic locating service for EV breakdown crises hinges on its ongoing pursuit of enhancement and progress. Investing in continuous research and development (R&D) is crucial for enhancing artificial intelligence (AI) algorithms, geolocation technology, and user interfaces. Furthermore, attaining widespread approval and commendation for the service will hinge on establishing consumer trust and dependability, ensuring strict adherence to regulations, and safeguarding user data.

However, despite these challenges, there is still a vast expanse of opportunities and potential in this situation. If the Mechanic finding service for EV breakdown situations can consistently uphold its commitment to innovation, collaboration, and user-centric design, it has the potential to fundamentally transform people's perception of automotive support. If the service can overcome these difficulties with determination and innovation, it has the potential to revolutionize the electric vehicle ecosystem. It will provide future drivers with the necessary assistance and confidence to use electric roadways.

References

[1] “Location-based emergency medicine: Medical Location Services for emergency management: Information and coordination of rescue resources | Request PDF.” https://www.researchgate.net/publication/287082370_Location-based_emergency_medicine_Medical_Location_Services_for_emergency_management_Information_and_coordination_of_rescue_resources (accessed May 11, 2024).

[2] “(PDF) IMPROVING VEHICLE SERVICE SCHEDULES AT AN AUTOMOBILE COMPANY.” https://www.researchgate.net/publication/345661532_IMPROVING_VEHICLE_SERVICE_SCHEDULES_AT_AN_AUTOMOBILE_COMPANY (accessed May 11, 2024).

[3] “Auto Service Reminders: A Proactive Approach to Fleet Maintenance.” https://www.fleetio.com/blog/auto-service-reminders-a-proactive-approach-to-fleet-maintenance (accessed May 11, 2024).

[4] A. Das, N. Gandhewar, D. S. Nehra, M. Baraskar, S. Gurjar, and M. Khan, “Survey on Vehicle Tracking Services,” *J. Inf. Technol. & Softw. Eng.*, vol. 08, no. 01, 2017, Accessed: May 11, 2024. [Online]. Available: https://www.academia.edu/100209488/Survey_on_Vehicle_Tracking_Services

[5] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, “User acceptance of information technology: Toward a unified view,” *MIS Q. Manag. Inf. Syst.*, vol. 27, no. 3, pp. 425–478, 2003, doi: 10.2307/30036540.

[6] S. K. Jauhar, S. Pratap, S. Kamble, S. Gupta, and A. Belhadi, “A prescriptive analytics approach to solve the continuous berth allocation and yard assignment problem using integrated carbon emissions policies,” *Ann. Oper. Res.*, 2023, doi: 10.1007/S10479-023-05493-1.

[7] M. Ahmed, Y. Zheng, A. Amine, H. Fathiannasab, and Z. Chen, “The role of artificial intelligence in the mass adoption of electric vehicles,” *Joule*, vol. 5, no. 9, pp. 2296–2322, Sep. 2021, doi: 10.1016/J.JOULE.2021.07.012.

[8] “What is Linear Regression?- Spiceworks - Spiceworks.” https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-linear-regression/ (accessed May 11, 2024).

[9] “Python Machine Learning Linear Regression.”

https://www.w3schools.com/python/python_ml_linear_regression.asp (accessed May 11, 2024).

[10] "React Native · Learn once, write anywhere." https://reactnative.dev/ (accessed May 11, 2024).

[11] "TensorFlow." https://www.tensorflow.org/ (accessed May 11, 2024).

[12] "Node.js Web Server - GeeksforGeeks." https://www.geeksforgeeks.org/node-js-web-server/ (accessed May 11, 2024).

[13] "Welcome to Flask — Flask Documentation (3.0.x)." https://flask.palletsprojects.com/en/3.0.x/ (accessed May 11, 2024).

[14] "What is Sentiment Analysis? - Sentiment Analysis Explained - AWS." https://aws.amazon.com/what-is/sentiment-analysis/ (accessed May 11, 2024).

[15] S. K. L, S. R. K. S, A. A. S, M. B. U, and L. S. T, "A Vehicle Breakdown Service Provider System," *Int. J. Sci. Res. Sci. Technol.*, pp. 567–572, Aug. 2021, doi: 10.32628/CSEIT2174129.

[16] Q. Mu, Z. Fu, J. Lysgaard, and R. Eglese, "Disruption management of the vehicle routing problem with vehicle breakdown," *J. Oper. Res. Soc.*, vol. 62, no. 4, pp. 742–749, 2011, doi: 10.1057/JORS.2010.19.

[17] T. Mikolov, K. Chen, G. Corrado, and J. Dean, "Efficient Estimation of Word Representations in Vector Space," *1st Int. Conf. Learn. Represent. ICLR 2013 - Work. Track Proc.*, Jan. 2013, Accessed: May 11, 2024. [Online]. Available: https://arxiv.org/abs/1301.3781v3

[18] P. Naik, P. V. Desai, and S. Pati, "Location Based Place Recommendation using Social Network," *2019 IEEE 5th Int. Conf. Converg. Technol. I2CT 2019*, Mar. 2019, doi: 10.1109/I2CT45611.2019.9033625.

[19] "How Do Electric Cars Work? | Electric Engines Explained | EDF." https://www.edfenergy.com/energywise/how-do-electric-cars-work (accessed Apr. 07, 2024).

[20] F. Un-Noor, S. Padmanaban, L. Mihet-Popa, M. N. Mollah, and E. Hossain, "A comprehensive study of key electric vehicle (EV) components, technologies, challenges, impacts, and future direction of development," *Energies*, vol. 10, no. 8, 2017, doi: 10.3390/EN10081217.

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