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PREDICTING PARKING BEHAVIOR OVER TIME WITH PERIODIC WEATHER-AWARE LSTM AND EVENT MECHANISM

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Abstract: Since there are so many variables to take into account, like the weather, the time of day, the day of the week, and nearby events, it can be challenging to predict parking behaviour. Conventional approaches to predicting parking behaviour have limitations since they don't take into consideration the periodic nature of the data or the impact of events and the weather. In this paper, we suggest an LSTM (Long Short-Term Memory) for forecasting parking behaviour that includes an event mechanism and periodic weather awareness. To accurately capture the periodicity and event dependencies in parking data, the recommended solution combines LSTM and event approaches. To increase the prediction's accuracy, weather data is also added.

Keywords: In this paper, we suggest an LSTM for forecasting parking behaviour that includes an event mechanism and periodic weather awareness.

I. INTRODUCTION

The fact that it might be challenging to get a parking place in metropolitan areas is a big contributor to the problem of parking congestion that occurs in these regions. The insights that may be gleaned from forecasting parking behaviour can aid municipal planners and businesses that manage parking in making the most use of available parking places. These planners and businesses can benefit from these insights. The periodicity of parking data is not taken into account by conventional methods for anticipating parking behaviour, which are frequently based on statistical techniques. In addition, the manner in which the weather and events effect parking habits are typically ignored as part of routine operating procedure.

II. LITERATURE SURVEY

REVIEW OF LITERATURE SURVEY

Predicting parking occupancy via machine learning in the web of things
The Web of Things (WoT) enables information gathered by sensors placed in urban environments to be publicly shared, promoting greater integration with other Web-based data and advancing knowledge.

WoT utilises open Web standards and semantic technologies. AI is a key element in understanding dynamic urban systems in addition to WoT. With the use of AI, the data produced by WoT-enabled sensory observations may be analysed and transformed into informative data that describes and foretells existing and future spatial and temporal conditions. This study considers anticipating parking availability as a practical issue when analysing the implications of WoT and AI in smart cities. Traffic cameras are used as WoT sensors, together with weather forecasting Web services. Machine learning (ML) is used in AI analysis to create prediction models utilising neural networks and random forests. The performance of the ML models for the prediction of parking occupancy is better than the cutting-edge work in the field, with an MSE of 7.18 at a time horizon of 60 minutes [1].

Parking Availability Prediction based on Machine Learning Approaches: A Case Study in the Short North Area
Drivers may make better parking decisions, reduce traffic, and balance the demand for parking with the supply of space. This study makes use of previous parking metre transactions to calculate the overall parking occupancy across all parking zones in Columbus' Short North. To find daily and weekly recurring trends, the parking availability time series is employed. The average weekly time series of each parking zone are grouped using clustering algorithms in order to identify common parking trends. Additionally, machine learning algorithms are trained to make predictions for each cluster of zones based on input characteristics like the hour of the day, day of the week, and month [2].

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A deep learning approach to real-time parking occupancy prediction in transportation networks incorporating multiple spatio-temporal data sources

A deep learning models utilized to forecast block-level parking availability in the real-time. The model uses Graph-Convolutional Neural Networks (GCNN) to remove the spatial relations of the traffic flow in large networks and Recurrent Neural Networks (RNN) with the Long-Short Term Memory (LSTM) to take a temporal picture feature. Various heterogeneously arranged traffic data sources, such as parking meter transactions, traffic speed, and also the weather data, may also be accepted as input by the model. Performance of the model is been evaluated using the case study in Pittsburgh's downtown region. The GCNN-based model beats competing baseline strategies like the multi-layer LSTM and LASSO when forecasting block-level parking occupancy 30 minutes in advance, with an average of testing MAPE of 10.6% [3].

EXISTING SYSTEM

Conventional approaches for forecasting parking behaviour are founded in statistical techniques such as regression analysis, time-series analysis, and clustering. These techniques are among the most used. These methods have a variety of limitations for the reason that they don't take into consideration the periodicity of the parking habit or the influence that the weather or events have on it. The precision of the prediction is also dependent based on level of the data that was provided, which is another component that adds to its accuracy.

PROPOSED SYSTEM

We recommend making using a periodic weather-aware LSTM in combination with an event mechanism when trying to anticipate parking behaviour. This will allow for more accurate results. In order to perform an analysis of parking data that is capable of taking into consideration both the data's periodicity and its event dependencies, the proposed system makes use of both LSTM and event mechanism. In addition, the data concerning the weather are taken into consideration, which contributes to the forecast being even more accurate. The system that was suggested has several advantages, including the ones that were listed below:

1. The system that has been suggested has the ability to recognise cyclical patterns and event dependencies in parking data.
2. The actual conditions of the weather are taken into consideration so as to offer a forecast that is as accurate as possible.
3. The proposed methodology is capable generate forecasts that are trustworthy in addition accurate.

III. SDLC METHODOLOGY

The Software Development Life Cycle, or SDLC for short, is the term used to describe the process or approach used to construct software systems. It offers a methodical way to direct the many stages of software development, from early design through ultimate deployment and maintenance.

Water Fall Model

The waterfall paradigm guides software development through a predetermined, sequential process. The software development process is divided into various stages, and each one builds on the results of the one before it. The waterfall model's phases typically include:

Requirements Gathering: The project requirements are determined, outlined, and verified at this phase. This calls for gathering information from stakeholders, comprehending their demands, and establishing the project's scope. A full requirements specification document will contain a list of the criteria.

System Design: The system design phase is focused with creating the architecture, parts, and user interfaces of the software system based on the requirements. It entails developing intricate system-level designs, which include requirements for modules, user interfaces, and database architectures.

Implementation: Based on the design criteria, the software system is created at this step. Individual modules or components are implemented when all coding and programming responsibilities have been completed. The objective is to convert the design into functional code.

Testing: Following implementation, testing is started. To ensures that the programme satisfies the stated requirements and performs as intended, test cases and scenarios are conducted. User acceptance testing, system testing, integration testing, and unit testing are a few forms of testing.

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Deployment: After being completely tested and bug-fixed, the programme is made available to the clients or end users. This phase entails setting up the required hardware and software infrastructure, as well as preparing the programme for usage and production. After a programme has launched, bugs, errors, and improvements are addressed during the maintenance phase. Customer support, updates, and bug fixes are all part of it. Corrective, adaptive, perfective, and preventative maintenance strategies fall under this category.

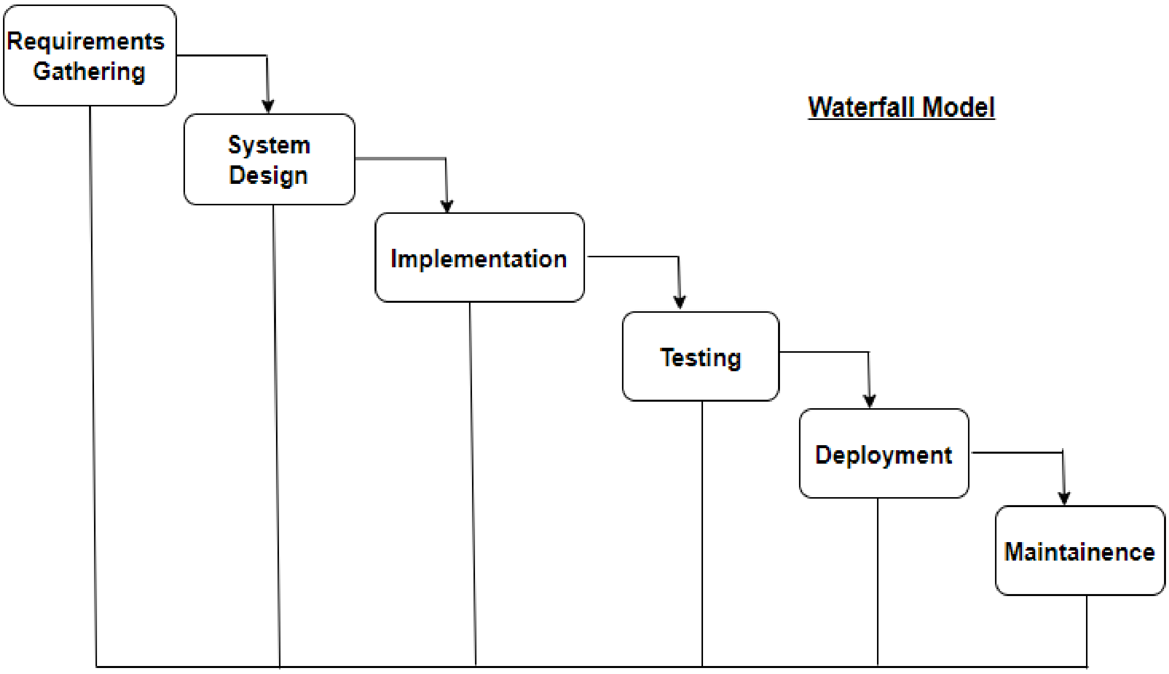
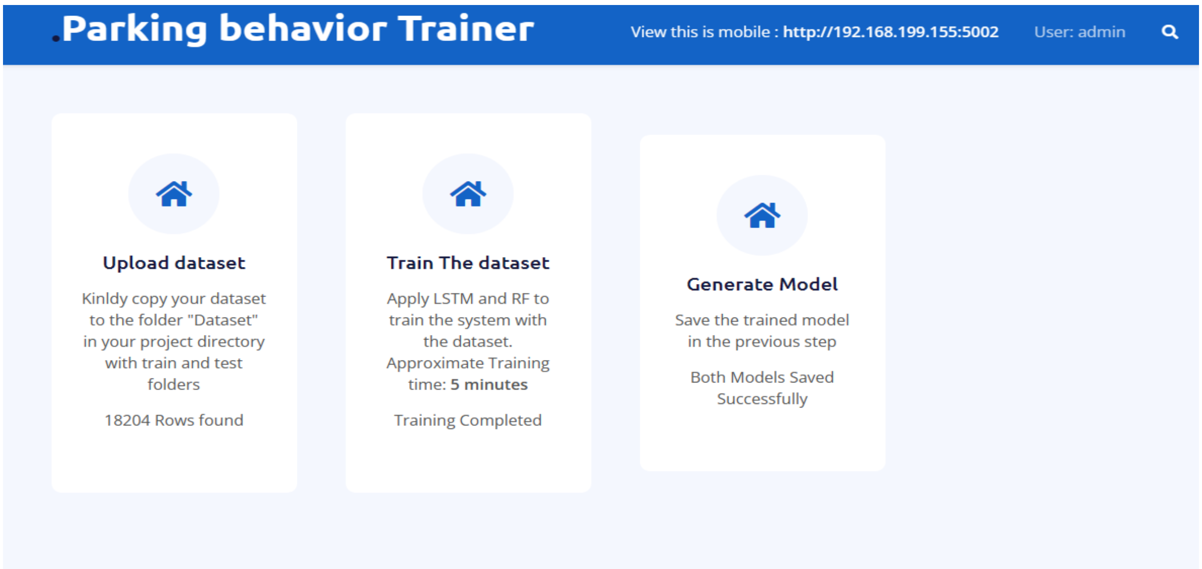


Figure: Water Fall Model

- **Parking Behavior Trainer** - responsible for overseeing the training phases of the applications, including uploading the training dataset, initiating the training process, creating an LSTM model, and viewing training results.



- **Parking Behavior Analyst**- responsible for overseeing the evaluation phases of the application, including uploading the test dataset and viewing test results.

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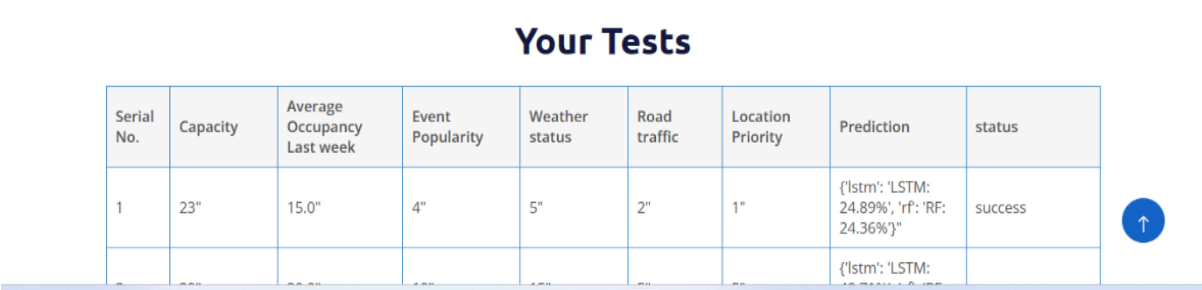
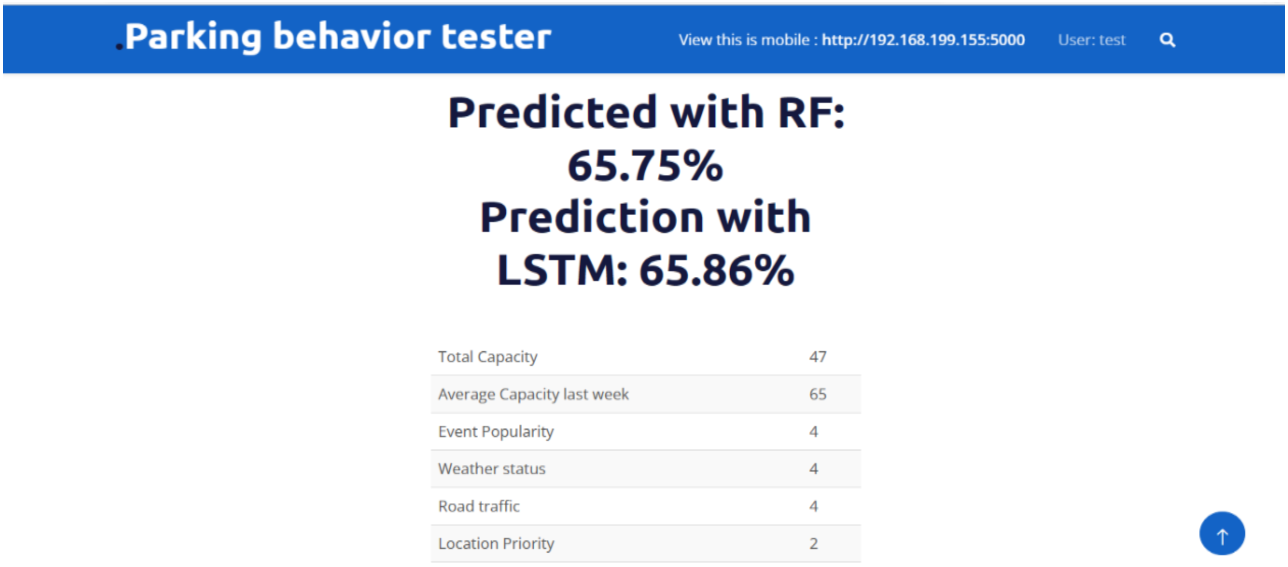


- **Parking Behavior Tester** - responsible for overseeing the testing phase of application, including registering with personal details, logging in, uploading a test data, and checking predictions for parking behavior in the smart city setting.



IV. SYSTEM DESIGN

Architecture Design

The process of developing the fundamental structure and organisation of a software system is referred to as the architectural design process. This process may be broken down into several steps. It is in charge of defining the system's overarching structure, as well as its linkages, the flow of information and control within the system, and so on. The specific architecture pattern, such as client-server, layered, or micro services, has an impact not only on the way the components of the system are organised but also on their capacity to communicate with one another.

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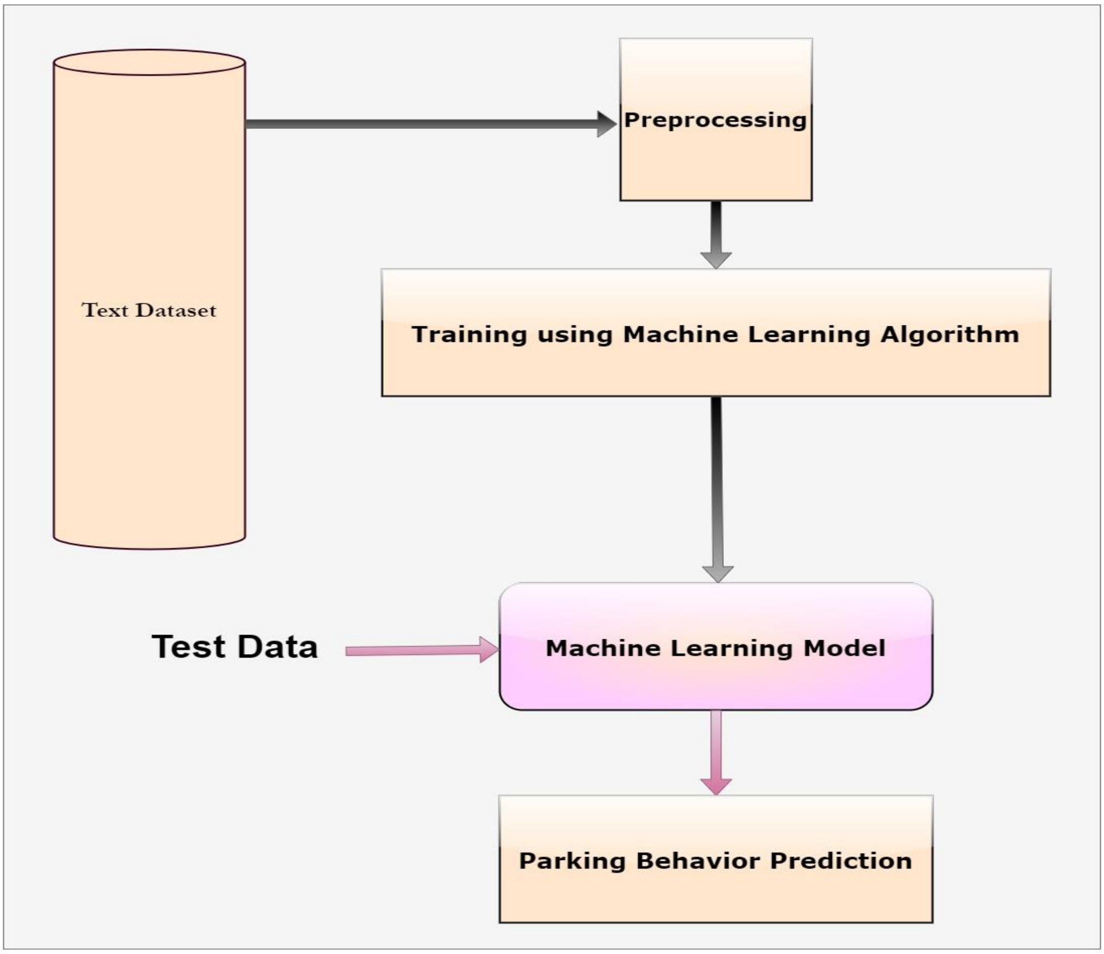

Figure: Architecture Diagram

V. IMPLEMENTATION

System implementation is the stage of the software development life cycle (SDLC) when the planned system is created, tested, and deployed. It is necessary to convert the system design into executable code before all the software system may be used. The following is in the list of key steps in system implementation process.

Input Design: Input design refers to the process of defining how data or information is captured and entered into a software system. It involves designing user interfaces, forms, and methods that allow users to input data accurately, efficiently, and conveniently. A well-designed input system ensures that the system can effectively process and utilize the inputted data.

Output Design: The process of showing information or outcomes produced by the software system to users or other stakeholders is known as output design. Designing an understandable, useful, and aesthetically beautiful structure, arrangement, and distribution plan for system's output is necessary. Enhancing user happiness, facilitating decision-making, and effectively communicating information are the objectives of an output design.

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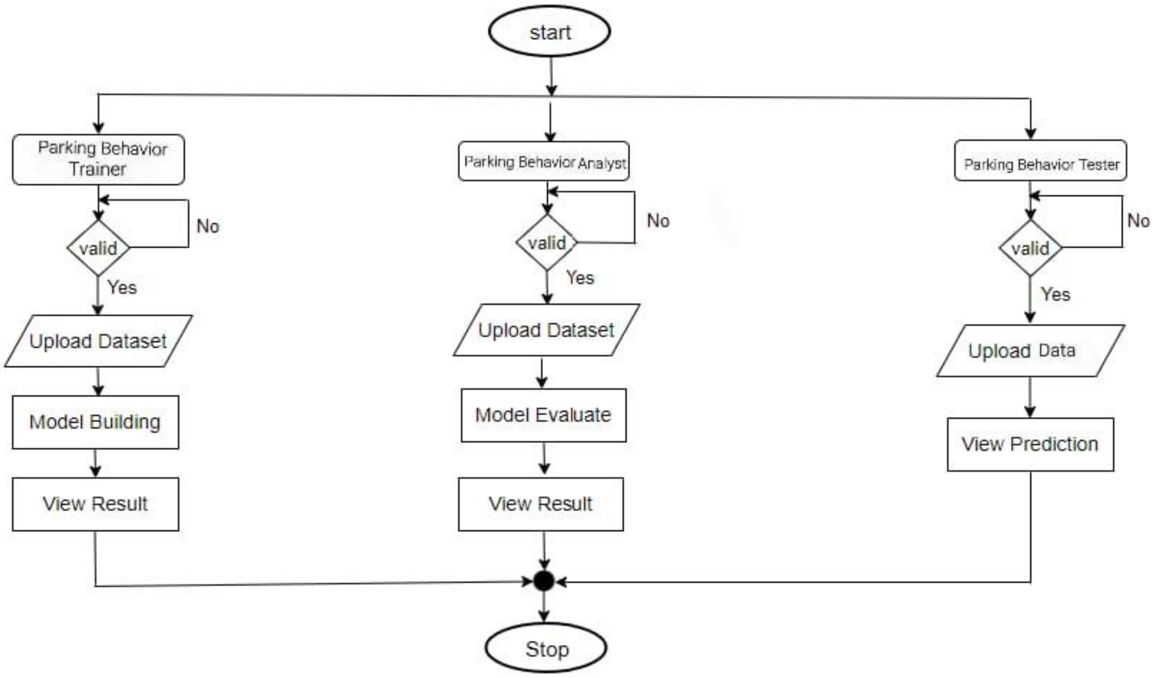

Figure: System Flowchart

Parking behaviour trainer logs in to the system of using which is valid email and the password combination for the authentication and the access purposes. Parking behaviour trainer login as successful. Parking behaviour trainer chooses the dataset and proceeds to upload it into system. Dataset had uploaded successfully and it will available for training. Performs the action of saving the trained model for future use. Model is saved successfully.

Parking behaviour analyst provides valid email and password for login purpose. Parking behaviour analyst login is successful. Analyst uploads test data and the verifies of corresponding output for the evaluation and analysis. Output and results are displayed successfully.

The Parking Behaviour Tester registers as an account by entering their email, username, and password details. Parking Behaviour Tester logs in by using provided valid email and password. Parking Behaviour Tester uploads the test data for testing. Parking Capacity will be predicted successfully.

VI. RESULT AND DISCUSSION

Predicting parking behavior over time using a periodic weather-aware LSTM and event mechanism involves training a deep learning model that considers weather conditions and periodic patterns to make accurate predictions. The event mechanism is used to capture specific events that might impact parking behavior. The results of such a model can be analyzed by evaluating its prediction accuracy, comparing it against other baseline models, and identifying patterns in parking behavior under different weather conditions and events. This analysis can provide insights into how weather and events affect parking demand, helping to optimize parking management and resource allocation. Keep in mind that implementing such a model and conducting a thorough analysis requires data, expertise in deep learning, and an understanding of parking dynamics. Additionally, ensure you have access to up-to-date weather data and event information for training and testing the model effectively.

VII. CONCLUSION

In this particular research endeavour, we suggested making use of a periodic weather-aware LSTM in combination with an event mechanism for the goal of forecasting parking behaviour. The proposed approach is able to take into consideration both the periodicity and the event dependencies provided in the parking data, in addition to the weather

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data, in order to increase the accuracy of the prediction. This is done by taking into account both sets of data simultaneously. The proposed method was put through its paces by way of training and assessment utilising a range of criteria, and the results indicate that it is capable of delivering accurate and trustworthy forecasts. Python and Flask were utilised to create a web application out of the model that was developed. As a consequence of this, parking management companies as well as municipal planners are able to easily and rapidly access the model and put it to use.

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