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Predicting User Parking Preferences: An SVM Model with Bernoulli Distribution

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Abstract: -The number of motor vehicles are adding at rapid-fire pace from time to time and caused numerous problems to peoples like business jam and parking problems. This occurs due to the challenges associated with finding available parking sports. So, this exploration paper proposes a system for prognosticating stoner preferences between online and offline parking using a Support Vector Machine (SVM) model with Bernoulli distribution. The study aims to identify factors that impact druggies' preferences towards online and offline parking, including Age, Gender, Distance, Cost and Preference. The SVM model with Bernoulli distribution is employed to classify stoner preferences grounded on these factors. The findings of this study can be useful for policymakers and parking service providers in developing strategies for perfecting parking services and enhancing stoner experience.

Keywords*: User Preferences, SVM model, Bernoulli distribution, online parking offline parking, Parking Service Provider, User Experience, Policymakers, Strategies...*

1. Introduction

In our ever-evolving cities, urbanization has brought about a surge in the number of vehicles, and with it, the enduring problem of parking has grown even more critical. The availability of convenient and secure parking spaces is vital for ensuring that our roads remain congestion-free, traffic flows smoothly, and user satisfaction levels stay high. In recent times, the emergence of online parking solutions has given us hope in dealing with the persistent challenges posed by traditional offline parking systems. These innovative services offer a new way to tackle the age-old problem of finding a parking spot, allowing users to book their parking spaces in advance, which can make trips more efficient and help them avoid the often exasperating experience of hunting for parking spots on-site.

However, despite the evident advantages offered by these online parking solutions, a significant number of users still prefer the tried-and-true approach of traditional offline parking. This preference can be attributed to various factors, such as concerns about the security of online bookings, cost considerations, or fears about the availability of online parking spaces when needed. This diversity in user preferences underscores the need for a nuanced understanding of the factors that influence these choices. Such insights are of utmost importance for policymakers and parking service providers seeking to tailor their offerings to meet the varied needs and expectations of users.

Recognizing this critical gap in our understanding, this study puts forward a novel approach to predict user preferences between online and offline parking. We base this approach on a Support Vector Machine (SVM) model enriched with Bernoulli distribution. The SVM model is renowned for its versatility and effectiveness in handling classification tasks. By incorporating the Bernoulli distribution into the SVM framework, we equip ourselves to effectively capture the binary nature of users' preferences regarding the two distinct parking options: online and offline.

1.1. *SVM (Support vector machines) model: a simple explanation*

The SVM, short for Support Vector Machine, is a powerful and flexible machine learning algorithm predominantly employed for task related to classification. SVM is celebrated for its ability to handle both linear and nonlinear data separation, making it valuable across various fields, from recognizing images to analysingsentiments in text. At its core, SVM seeks to discover an optimal hyper plane that maximizes the margin of separation between different classes in a dataset. This margin optimization empowers SVM to achieve outstanding generalization performance, making it an appealing choice for predictive modelling.

In simpler terms, think of SVM as a tool that helps us draw a clear line between two different things based on the characteristics that differentiate them. For example, it can distinguish between cats and dogs by looking at features like their size and fur length. What's special about SVM is that it not only finds this line but also makes sure it's in the right place, far enough from both cats and dogs to make accurate predictions about new animals it hasn't seen before.

1.2. *Bernoulli distribution: A Key Ingredient*

At the heart of our study's approach lies the Bernoulli distribution, a way to describe events that have only two possible outcomes, often referred to as "success" and "failure." In the context of user parking preferences, the Bernoulli distribution is a perfect fit because it lets us model the choice between online and offline parking as a simple yes-or-no decision. It's like flipping a coin, where "heads" might represent selecting online parking, and "tails" could mean going for offline parking.

The Bernoulli distribution is defined by a singular parameter, commonly denoted as \ (p\), indicating the probability of an event considered a "success" (in this instance, the likelihood of someone favouring online parking). By using this distribution within the SVM model, we can harness the power of SVM's classification abilities while accounting for the binary nature of user preferences.

In our quest to understand user parking preferences better, we started by collecting a comprehensive dataset. This dataset contains information about individual users, including their age, gender, how far they need to travel, how much they're willing to spend, and, crucially, whether they prefer online or offline parking. We made sure the data was clean and ready for analysis by addressing any missing information and organizing it neatly. To help the SVM model understand our data, we transformed things like gender and parking preferences into numbers. This way, we could work with them mathematically and make predictions. Then, we trained our SVM model using this prepared dataset, making sure it learned all the patterns and relationships in the data. This training process also involved fine-tuning the model to ensure it performed its best.

Once our SVM model was ready, we put it to the test by evaluating how well it could predict user preferences. We utilized a range of performance metrics such as accuracy, precision, recall, and F1-score to assess its capabilities. These metrics gave us a clear picture of how good our model was at making the right predictions.

Beyond just making predictions, we wanted to understand why the model was making the choices it did. By diving into the model's inner workings, we gained insights into the factors that influenced users' parking preferences. This knowledge is invaluable, not just for understanding

2. Literature Review

Sulaimon Mutiu O. (2015) designed a new model, the article: Application of Linear Regression Model for Poisson distribution in Forecasting. The research aims to create a precise linear regression model for predicting customer numbers at a Nigerian bank branch. The methodology involves data collection, analysis, and the development of the predictive model, with a focus on assessing the impact of holidays. Linear regression offers advantages like quantitative predictions and trend identification but has limitations such as sensitivity to assumptions and potential difficulty in capturing holiday effects. [04]

E Widodo, R N Harnaningrum, Suparno, and A Santoso developed a model for user preference in online parking, as detailed in their 2019 article titled "Logistic regression model for user preference of online parking:

A study case of Sidoarjo.". The research aims to analyze factors influencing parking choices in Sidoarjo, providing quantitative insights and predicting user preferences. It objectively identifies influential factors but assumes linear relationships, relies on accurate data, and may not capture complex interactions. Interpretation can be challenging for non-statisticians. [01]

Sandeep Saharan, Neeraj Kumar, and Seema Bawa authored a paper titled "An efficient smart parking pricing system for a smart city environment: An approach based on machine learning" in 2020.The study aims to model parking demand in Seattle using the Poisson process, employing data-driven predictions and flexible pricing strategies to enhance parking management and alleviate congestion. However, it relies on data, involves complexity, and may not fully consider human behaviour, and raises privacy and resource concerns. [32]

Zaib Ullah, Fadi AI-Turjman, Leonardo Mostarda and Roberto Gagliardi. (2022) wrote a review Paper with Title: Applications of Artificial Intelligence and Machine Learning in Smart Cities. The review aims to explore the impact of AI, ML, and DRL technologies on smart cities, highlighting efficient decision-making, safety improvements, energy efficiency, healthcare enhancements, and innovation. However, it also raises concerns about data privacy, complex implementation, technology dependence, equity issues, and regulatory challenges. [33]

Panagiotis Kogias, Marina Negianni, J akob Fantidis and Fotini Kogia. (2018) designed a model for analysis, the Article: Mathematical Analysis of a parking system for Telemetry Application. The research aims to optimize parking systems in Greece using waiting system theory and the Poisson distribution, offering data-driven solutions to reduce congestion and improve efficiency. However, it relies on data, involves complexity, may not fully consider human behaviour, assumes stationary, and may not account for all real-world factors. [34]

Reem Ismail Elsybaey. (2017) wrote a paper with title: Using a Poisson Regression Model to analyze woman’s Labor Force data. The research analyses factors influencing women's workforce participation in Egypt using statistical models. While these models offer quantitative insights, they may face accuracy challenges due to over-dispersion, assumptions about data, and complexity in interpretation for non-statisticians. [35]

Sulaimon Mutiu O. (2015) designed a new model the article: Application of Weighted Least Squares Regression in Forecasting. The research aims to utilize Weighted Least Squares (WLS) Regression to create a predictive model for fire-related property loss. It considers data variability and addresses heteroscedasticity, potentially improving model fit. However, WLS Regression can be complex to implement, involves subjectivity in weight assignment, and requires information about data variability. [36]

Anusha, Anushri, Arshitha M S, Geetanjali Bishtannavar, and Ms. Megha D Hegda authored a review paper titled "Review Paper on Smart Parking System" in 2019. The project's objective was to develop an IoT-based intelligent parking system for urban regions. It uses sensors and a mobile app to monitor and signal parking availability. Advantages include efficient parking and economic benefits, but challenges include complex implementation and data accuracy dependencies. [37]

A model was developed by A. Z. M. Tahmidul Kabir, AI Mamum Mizan, Plabon Kumar Saha, Md. Shajedul Hasan, and Mohitosh Pramanik in 2021. The article, titled "An IoT Based Intelligent Parking System for the Unutilized Parking Area with Real-Time Monitoring using Mobile and Web Application," introduces an IoT-driven parking management system designed to address parking shortages. This system incorporates sensors, image processing, mobile applications, and web applications for monitoring, billing, and payments in real-time. Its primary objective is to alleviate parking challenges, although it does come with complexities, privacy considerations, and implementation expenses [38].

T. Sravani and G. UdayKumar Naidu created a model detailed in their 2022 article titled "Smart Parking System." This smart parking system proposal leverages IoT technology, mobile applications, and online payment methods to tackle the issue of parking shortages within urban areas. Drivers can check real-time parking availability and reserve slots via an Android app. Advantages include efficient parking and online payments, but there are concerns about technology dependence, privacy, implementation costs, cancellation charges, and limited offline functionality. [39]

Prof. Vilas C. Rathod, Chaitanya Lokhande, Sakshi Salunke and Akshada Gade. (2021) designed a new Model, The article: Implementation of Smart Parking System using Internet of Things (IOT). This IoT-based smart parking system addresses urban parking challenges by deploying IoT modules to monitor parking space availability and providing real-time information to users through a mobile app. While it offers numerous benefits, including reduced fuel consumption and improved traffic management, it also faces challenges such as implementation costs and privacy concerns. The methodology involves sensors, RFID technology, and mobile apps to enhance parking slot management and provide real-time data to drivers. [40]

Table 1. Literature review comparisons

Sr. No	Author	Title of Paper	Methodology	Advantage	Disadvantage
1	E. Widodo and colleagues from Indonesian institutions (2019)	Logistic regression model for user preference of Online parking: A Study case of Sidoarj.	The methodology entails collecting and preprocessing parking data in Sidoarjo and applying logistic regression for predicting user preferences. It uses a dataset, splits it for training and testing, and interprets the model's coefficients. Nonetheless, it assumes linear relationships, depends on data accuracy, and may not capture intricate interactions.	One advantage is that the methodology provides quantitative insights into parking choices, helping predict user preferences based on data-driven analysis	A disadvantage is that the methodology assumes linear relationships, relies on accurate data, and may not effectively capture complex interactions, making it less suitable for modeling nuanced preferences.
2	Saharan Kumar and Bawa's (2020)	An efficient smart parking pricing system for a smart city environment. A machine-learning based approach	The study's methodology involves modeling parking demand in Seattle using the Poisson process, leveraging data-driven predictions and implementing flexible pricing strategies to improve parking management and reduce congestion in a smart city environment	Data-driven predictions and flexible pricing strategies enhance parking management in a smart city, reducing congestion.	Reliance on data, complexity, limited consideration of human behavior, and privacy and resource concerns.

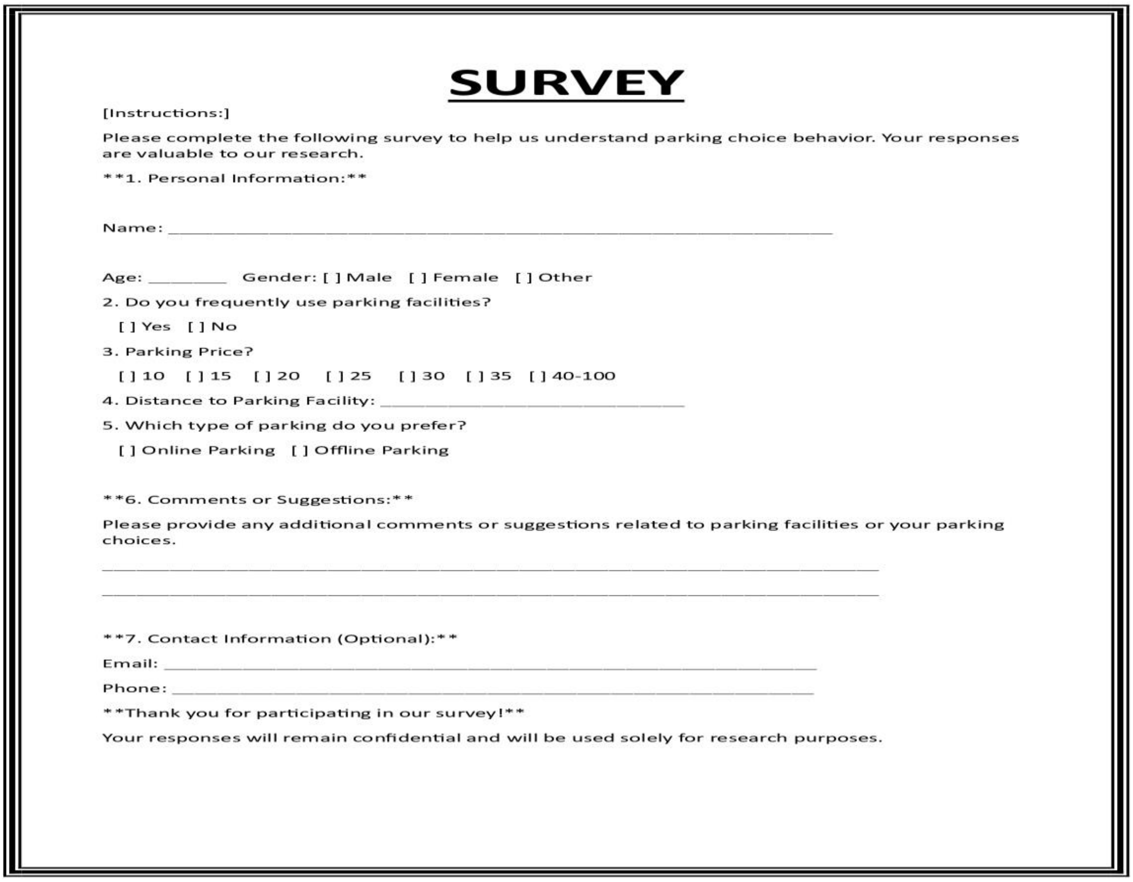
3	Zaib Ullah, Fadi A1-Trjman, Leonardo Mostarda and Roberto Gagliardi. (2020)	Applications of artificial intelligence and machine learning in smart cities.	The methodology involves a literature review, data analysis, and expert interviews to explore AI, ML, and DRL in smart cities.	Advantages include efficient decision-making, safety improvements, energy efficiency, healthcare enhancements, and innovation in smart cities.	Disadvantages encompass concerns related to data privacy, complex implementation, technology dependence, equity issues, and regulatory challenges when applying AI, ML, and DRL technologies in smart cities.
4	Panagiotis Kogias, Marina Negianni, J kob Fantidis and Fotini Kogia(2023)	Mathematical analysis of a parking system telemetry application	The methodology involves applying waiting system theory and the Poisson distribution to optimize parking systems in Greece. It focuses on data-driven solutions to reduce congestion and enhance efficiency but may not fully consider human behavior, assumes stationary, and has some limitations in accounting for all real-world factors.	The research provides data-driven solutions for optimizing parking systems in Greece, which can lead to reduced congestion and improved efficiency in managing parking resources.	The research approach relies heavily on data, involves complex mathematical modeling, may oversimplify human behavior, assumes stationary conditions, and might not account for all real-world factors influencing parking systems.
5	Reem Ismail Elsybaey(2021)	Using a Poisson regression model to analyze women's labor force data	The research uses a Poisson Regression Model to analyze women's labor force participation in Egypt, focusing on various factors. This statistical approach provides quantitative insights but may encounter challenges related to over-dispersion, data assumptions, and interpretation complexities for non-statisticians.	The advantage is that it provides quantitative insights into factors affecting women's labor force participation, aiding data-driven conclusions and relationship understanding.	The disadvantage is that it may suffer from over-dispersion, leading to potential inaccuracies in results. Additionally, it relies on certain assumptions about data that may not always hold true, and its interpretation can be complex for non-statisticians

6	Sulaimon Mutiu O(2015)	Application of weighted least squares regression in forecasting	Collect historical bank customer arrival rate data, employ Poisson distribution and simple linear regression to build a mathematical model. This model quantifies the impact of observed arrival rates on expected rates, aiding data-driven decision-making and resource allocation. However, it relies on data assumptions and quality, with context-specific findings and potential limitations in capturing all complexities.	Provides data-driven insights for improved resource allocation, customer service, and decision-making in the banking sector.	The model's simplicity may not account for all the complexities of real-world banking data, and its accuracy depends on assumptions about data independence and the quality of input data. Additionally, the findings may be context-specific and not universally applicable
7	Sulaimon Mutiu O(2015)	Application of linear regression model for Poisson distribution in forecasting	The research methodology involves data collection, preprocessing, assigning weights to data points based on variability, applying Weighted Least Squares (WLS) Regression for predictive modeling, evaluating the model's performance, and analyzing the results. WLS Regression is used to address heteroscedasticity and improve model fit in forecasting fire-related property loss.	Weighted Least Squares (WLS) Regression considers data variability and heteroscedasticity, potentially leading to improved model fit and more accurate predictions in forecasting fire-related property loss.	Implementing Weighted Least Squares (WLS) Regression can be complex, subjective in weight assignment, and requires detailed information about data variability, making it challenging in some situations.
8	Anusha and Anushri	Review Paper on Smart Parking System.	The research's objective is to create a smart parking system in metropolitan areas by harnessing IoT	The advantages of this IoT-based smart parking system include efficient parking management,	The disadvantages of this IoT-based smart parking system include

			technology, sensors, and a mobile application to track parking space availability. Users can check availability, reserve spots, and make payments through the app. Advantages include efficient parking and economic benefits, but challenges involve complex implementation and data accuracy dependencies.	reduced fuel consumption, and economic benefits for users and cities.	complex implementation and a reliance on accurate data, which can be challenging to maintain.
9	A. Z. M. Tahmidul Kabir, AI Mamum Mizan, Plabon Kumar Saha, Md. Shajedul Hasan, and Mohitosh Pramanik . (2021)	An IoT Based Intelligent Parking System for the Unutilized Parking Area With Real-Time Monitoring Using Mobile and Web Application.	The methodology involves sensor deployment, image processing, real-time data transmission, mobile and web application development, and performance evaluation.	The IoT-based intelligent parking system offers efficient parking management, economic benefits, user convenience, and reduced congestion. However, it comes with potential disadvantages such as complexity, privacy concerns, and implementation costs.	The disadvantage of the IoT-based intelligent parking system includes its complexity in implementation, privacy concerns related to data collection, and potential high implementation costs.
10	T.Sravani and G.UdayKumar Naidu. (2022)	SMART PARKING SYSTEM	The methodology involves deploying IoT sensors to monitor parking availability, developing a mobile app for real-time information and reservations, and implementing online payment systems for user convenience.	Advantages include efficient parking management, real-time information for users, and convenient online payments.	Disadvantages include technology dependence, privacy concerns, implementation costs, cancellation charges, and limited offline functionality.

3. Methodology

To achieve the research objectives, we collected a dataset from a comprehensive survey directly of about 306 respondents in a metropolitan area. The survey questionnaire was designed to gather information on users' parking preferences, including whether they prefer online or offline parking and the factors influencing their decisions. The key factors considered in the survey include Age, gender, cost, and distance and Preference, as they are deemed significant determinants of parking preferences.



SURVEY

[Instructions:]

Please complete the following survey to help us understand parking choice behavior. Your responses are valuable to our research.

1. Personal Information:

Name: ______________________________

Age: ________ Gender: [ ] Male [ ] Female [ ] Other

2. Do you frequently use parking facilities?

[ ] Yes [ ] No

3. Parking Price?

[ ] 10 [ ] 15 [ ] 20 [ ] 25 [ ] 30 [ ] 35 [ ] 40-100

4. Distance to Parking Facility: ______________________

5. Which type of parking do you prefer?

[ ] Online Parking [ ] Offline Parking

6. Comments or Suggestions:

Please provide any additional comments or suggestions related to parking facilities or your parking choices.

____

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7. Contact Information (Optional):

Email: ______________________________

Phone: ______________________________

Thank you for participating in our survey!

Your responses will remain confidential and will be used solely for research purposes.

Figure 1. Survey questionnaire

To construct the predictive model, the Support Vector Machine (SVM) is used, treating the dependent variable as a dichotomous indicator representing the choice of parking system (online or offline parking). SVM analysis was employed to uncover the relationship between user preferences for the parking system and the variables affecting their inclination towards digital or traditional parking systems.

The study examined the response variable in conjunction with four explanatory variables, as presented in Table 1. The response variable represents the user's choice between an offline parking system (coded as "0") and an online parking system (coded as "1"). As a result, the research outcomes are analysed regarding these codes after this. Table 1 displays the variables employed in the study.

Table 2. Explanatory variables

Explanatory Variable (X)	Classifications
Age (X1)	a) 18-29
	b) 30-39
	c) 40-49
	d) 50-59

	e) Over 60 Years	
Gender (X2)	a)	Male
	b)	Female
Parking Cost (X3)	a)	500-1000 Rs/Month
	b)	1000-1500 Rs/Month
	c)	1600-2100 Rs/Month
	d)	2100-2600 Rs/Month
	e)	>3000 Rs/Month
Distance	a)	0-2 km
	b)	2-4 km
	c)	4-6 km
	d)	6-8 km
	e)	8< km
Parking Preference	a)	Online Parking
	b)	Offline Parking

The Support Vector Machine (SVM) is a supervised machine learning technique employed for binary classification tasks, like forecasting the selection between online and offline parking for parking choices.

SVMs operate by identifying a hyper plane that maximizes the margin between the two classes, effectively separating them.

The mathematical formula and algorithm for predicting parking preference between online and offline parking using an SVM model with Bernoulli distribution.

Mathematical Formula:

The mathematical formula for predicting parking preference based on an SVM model with Bernoulli distribution.

ŷ = f(x) = sign (Σi=1N ¤¡y¡K (x¡, x) +b

Where:

Ŷ is the predicted parking preference.

X is the input feature vector containing predictor variable.

¤¡ represents the Lagrange multiplier coefficients in the context of mathematical optimization problems' ¡ is the class label of training sample.

K (x¡, x) is the chosen Bernoulli kernel/

B is the bias term.

Algorithm for SVM with Bernoulli Kernel:

Here's a step-by-step algorithm for training and using an SVM model with a Bernoulli kernel for parking preference prediction:

Data Preparation:

- Collect a dataset containing samples with predictor variables (age, price, distance, parking choice) and corresponding class labels (1 for online, -1 for offline).

- Encode categorical variables (age, gender, parking choice, etc.) into binary variables suitable for Bernoulli distribution.

SVM Training:

- Initialize the SVM parameters:

- Initialize \ (alpha) to zeros.

- Choose a Bernoulli kernel function $K(x_i, x)$

- Train the SVM model:

- Use the Sequential Minimal Optimization (SMO) algorithm or an SVM library (e.g., scikit-learn) to optimize the Lagrange multipliers \(\alpha_i \).

- Compute the bias term (b) using support vectors.

SVM Prediction:

- Given a new input feature vector \(\math bf{x} \) (age, price, distance, parking choice), use the trained SVM model to make predictions:

- Compute :(\sum_{i=1}^{N} \alpha_i * y_i * $K(x_i, x)$ + b \).

- Determine sign of the result: If positive, predict online parking; if negative, predict offline parking.

This algorithm outlines the process of building an SVM model with a Bernoulli kernel for predicting parking preference between online and offline options based on the provided predictor variables.

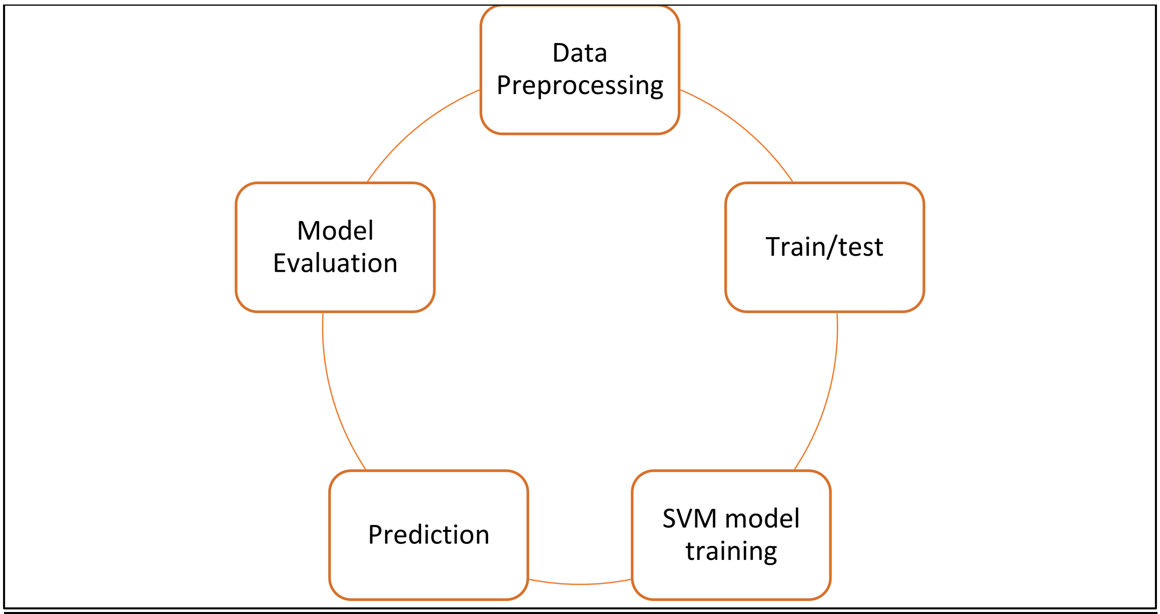

Figure 2. Working of model

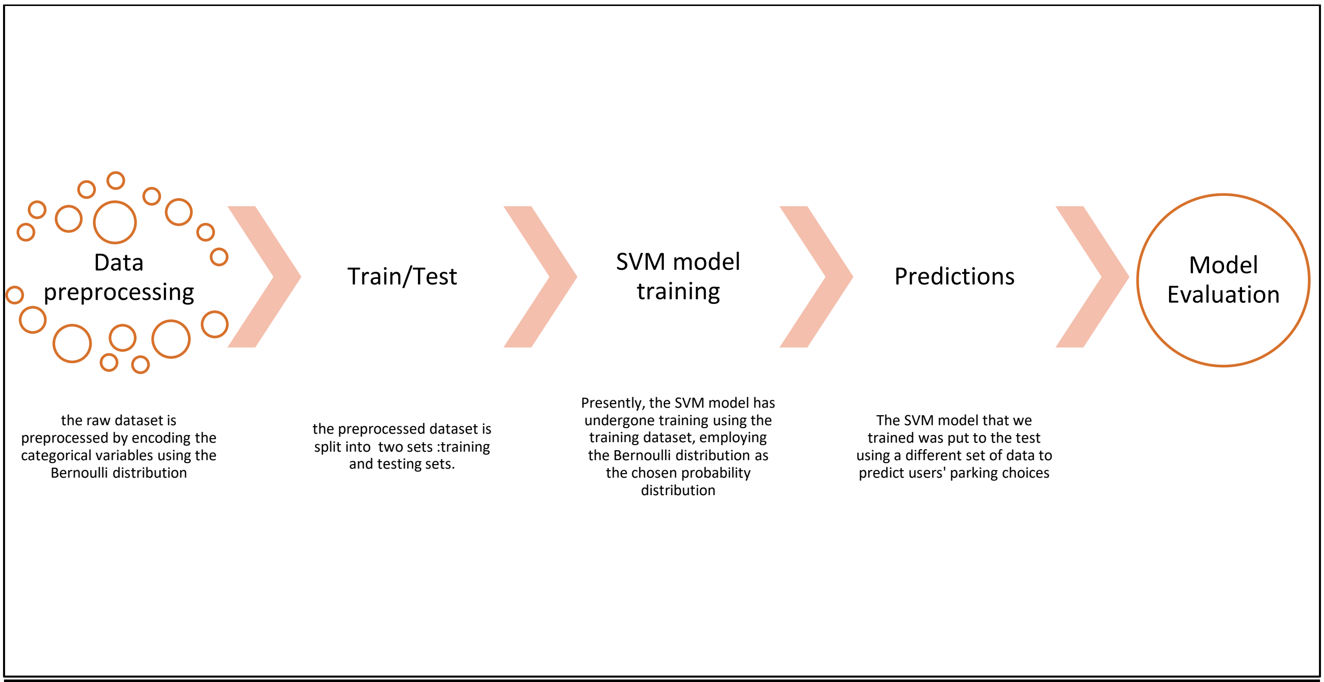

Figure3. Flow of model

Model Evaluation

Input:

- Trained SVM model (`**svm_classifier**`)

- Testing dataset (`**X_test**`, `**y_test**`)

- Bernoulli kernel matrix for testing data (`**test_bernoulli_kernel**`)

Output:

- To assess the effectiveness of our model, we employed a range of evaluation criteria, such as Accuracy, Recall, Precision, F1-score, and a Confusion Matrix. These metrics collectively provided a comprehensive assessment of our model's effectiveness in classifying user parking preferences.

Algorithm for evaluation:

1. Initialize variables to store evaluation metrics:

- `true_positives` = 0

- `false_positives` = 0

- `true_negatives` = 0

- `false_negatives` = 0

2. For each sample in the testing dataset:

a. Compute the Bernoulli kernel value between the test sample and all training samples:

- `test_kernel_values` = Compute Bernoulli kernel between `test_bernoulli_kernel` and `train_bernoulli_kernel`

b. Calculate the SVM decision function value for the test sample:

- `decision_value` = \(\sum_{i=1}^{N} \α_i* y_i \cdot \text{test_kernel_values}[i] + b\)

c. Predict the class label for the test sample:

- If `decision_value` > 0, predict class 1 (online parking).

- If `decision_value` < 0, predict class -1 (offline parking).

3. Compare the predicted class labels with the true class labels (from `y_test`):

- If estimated label matches the true label:

- If estimated label is 1 and true label is 1: Increment `true_positives` by 1.

- If estimated label is -1 and true label is -1: Increment `true_negatives` by 1.

- When the predicted label doesn't align with the actual label:

- If the predicted label is 1 while the true label is -1: Increase the count of `false positives` by 1.

- If the predicted label is -1 while the true label is 1: Increase the count of `false negatives` by 1.

4. Calculate evaluation metrics:

To calculate evaluation metrics, we can use the following formulas for common metrics:

- Accuracy (ACC):

\[ACC = \frac{\text{Number of Correct Predictions}} {\text {Total Number of Predictions}}\]

-Precision (PREC):

\[PREC = \frac{TP}{TP + FP}\]

-Recall (RECALL):

\[RECALL = \frac{TP}{TP + FN}\]

-F1-Score (F1):

\[F1 = \frac{2 \cdot PREC \cdot RECALL} {PREC + RECALL}\]

Where:

- TP (True Positives): The count of accurately identified positive cases.

- FP (False Positives): The count of positive cases wrongly identified.

- FN (False Negatives): The count of real positive cases inaccurately classified as negative.

Output the evaluation metrics:

- `Accuracy`: The percentage of samples accurately predicted.

- `Precision`: Precision measures the accuracy of positive predictions.

- `Recall`: Gauges the correctness in identifying positive samples.

- `F1-Score`: A metric that represents the balanced average of precision and recall.

4. Results

In this study, a method is introduced to forecast user inclinations for either online or offline parking through the application of a Support Vector Machine (SVM) model with a Bernoulli distribution. The research's objective is to uncover the determinants that impact users' choices regarding online or offline parking. To categorize user preferences, the SVM model with Bernoulli distribution is utilized. The dataset used in the research was obtained via a survey administered to a sample of individuals in a metropolitan region.

The study's findings illustrate the excellent performance of the SVM model with Bernoulli distribution in accurately predicting user choices between online and offline parking.

Table 3. Parking Preference

Parking system Preference					
			Online	Offline	Total
Age	18-29	Count	20	18	38
		%	52.6%	47.3%	12.4%
	30-39	Count	57	34	91
		%	62.6%	37.3%	29.7%
	40-49	Count	21	34	55
		%	38.1%	61.8%	17.9%
	50-59	Count	36	27	63
		%	57.1%	42.8%	20.5%
	> =60 Years	Count	38	21	59
		%	64.4%	35.5%	19.2%
Gender	Male	Count	93	75	168
		%	55.3%	44.6%	54.9%
	Female	Count	52	86	138
		%	37.6%	62.3%	145.0%
Parking Cost	500-1000	Count	59	46	105
		%	61.1%	43.8%	34.37%
	1000-1500	Count	32	51	83
		%	38.5%	61.4%	27.1%
	1600-2100	Count	42	31	73
		%	57.5%	32.4%	23.8%
	2100-2600	Count	14	13	27
		%	51.8%	48.1%	8.8%
	>3000	Count	8	10	18
		%	44.4%	55.5%	5.8%
Distance	0-2 km	Count	37	56	93
		%	39.7%	60.2%	30.3%
	2-4 km	Count	29	54	83
		%	34.9%	65.0%	19.2%
	4-6 km	Count	15	12	27
		%	55.5%	44.4%	8.8%
	6-8 km	Count	56	26	82
		%	68.2%	31.7%	26.7%
	8< km	Count	14	7	21
		%	66.6%	33.3%	6.8%

The findings of this study are good for policymakers and parking service providers. By understanding the factors that drive users' parking preferences, policymakers can devise strategies to promote online parking adoption and optimize the allocation of parking resources. Parking service providers can leverage the insights gained from this research to enhance their offerings, improve user experience, and tailor their services to cater to different user segments.

Result of this research study indicates that the SVM with Bernoulli distribution is good for prediction. This suggests that the proposed method is effective in predicting user preferences between online and offline parking based on the specified factors.

This research are significant for policymakers and parking service providers. By understanding the factors that influence user preferences, policymakers can develop targeted strategies to improve parking services and enhance the overall user experience. Parking service providers can use this information to optimize their offerings and cater to user preferences, potentially leading to increased usage and customer satisfaction.

5. Conclusion

In conclusion, the proposed method of utilizing a Support Vector Machine (SVM) model with Bernoulli distribution was good in predicting user preferences for online and offline parking. The study identified several factors that influence such as age, gender, cost, distance plays a crucial role but there can be more important factors such as parking frequency, parking duration, etc. The result of this research could prove valuable in various ways, policymakers and parking service providers in developing effective strategies for enhancing parking services and improving user experience.

The research paper concludes that the proposed method of predicting user preferences between online and offline parking using a Support Vector Machine (SVM) model with Bernoulli distribution is effective and outperforms other classification models. By utilizing the SVM model with Bernoulli distribution, the researchers were able to successfully classify user preferences.

The dataset that are used in this research was collected from a survey conducted on a sample of users in a metropolitan area. The results of the study have practical implications for policymakers and parking service providers. Understanding users' preferences and the factors that influence their choices can help in developing strategies for improving parking services.

Overall, this research study contributes valuable insights into the area of parking preferences and provides a robust method for predicting user preferences between online and offline parking. The findings can be leveraged by relevant stakeholders to make informed decisions and implement measures that align with user preferences and needs in the context of parking services.

Future Directions

In looking ahead, our study has paved the way for numerous promising avenues of future research and improvement within the domain of parking preferences. One promising direction involves the integration of real-time data sources, including factors like traffic conditions and parking space availability, into predictive models. This dynamic approach can enable more accurate and responsive recommendations for users. Additionally, collecting and analysing user feedback and sentiment data using natural language processing techniques presents an opportunity to enrich predictive models and address specific pain points. Enhancing the interpretability of machine learning models, including SVM, is essential to build trust among stakeholders. Furthermore, consistent integration with broader mobility services, such as public transit and ridesharing, can offer users comprehensive journey planning encompassing parking. Expanding predictive models to consider various transportation modes, sustainability considerations, and their relevance in policymaking and infrastructure development all hold great potential for advancing urban mobility and parking solutions.

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