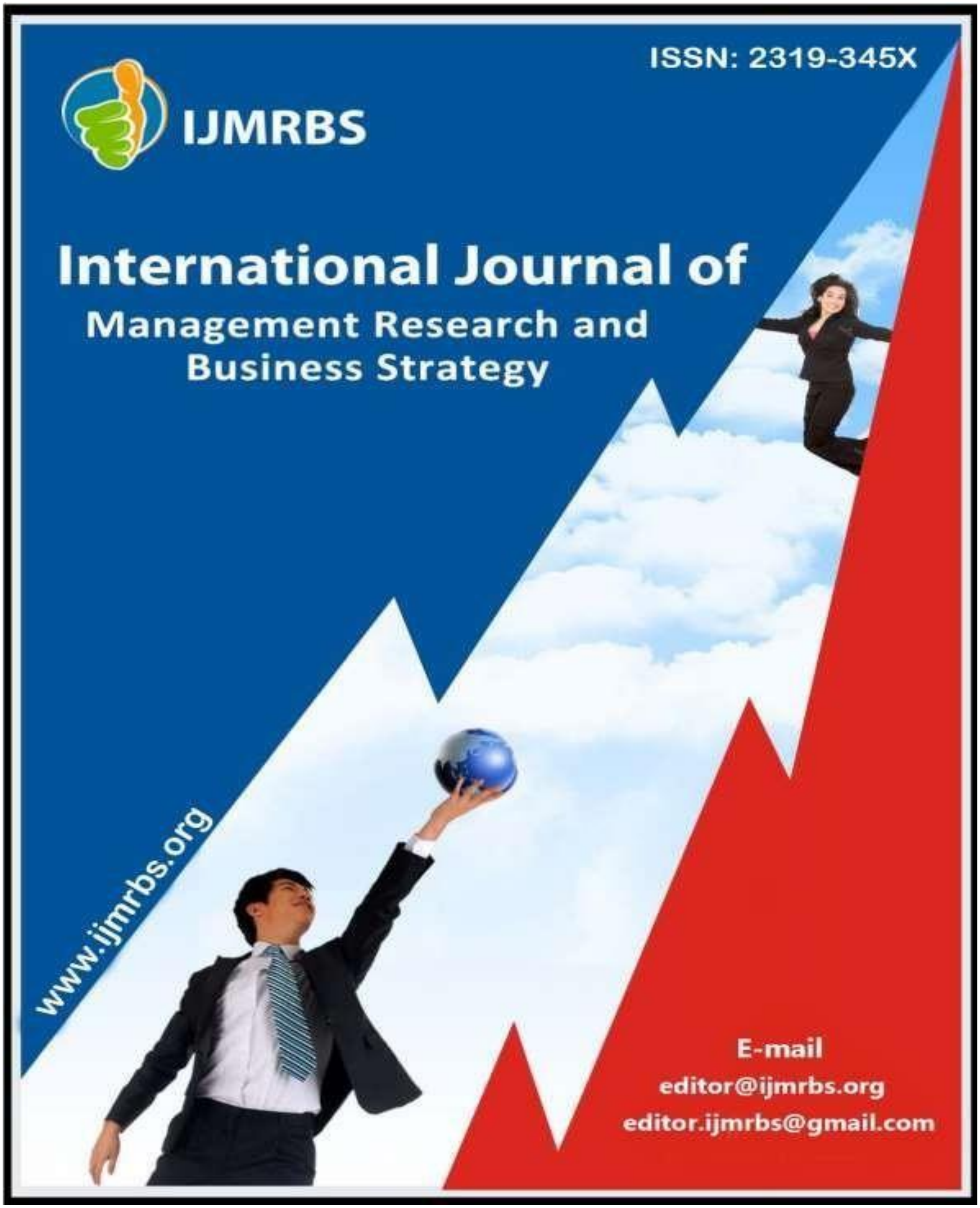

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DISCOVER CUSTOMERS' GENDER FROM ONLINE SHOPPING BEHAVIOR

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ABSTRACT

Gender information is very important for the recommendation system in the online shopping website. However, gender data often face label missing and incorrect labelling problems caused by consuers' unwillingness to actively disclose personal information, which leads to gender estimation results that cannot meet the needs of the product recommendation system. To discover the customers' gender information, we explore the customers' online shopping behavior, especially the items viewed in the shopping session, from the dataset provided by Vietnam FPT Group. The dataset is very imbalanced while the number of female samples is 3_ of the male samples. To address the imbalance issue, we cluster the female samples into three subsets and then train a two-layer classifier model to estimate the customers' gender. Experimental results demonstrate that our proposed method could achieve a combined accuracy 78% on average, and takes less than 6 seconds on average. As a data mining model for gender prediction, our approach has a lightweight network structure and less time consumption. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, different type of algorithms is trained to make classifications or predictions, and to uncover key insights in this project. These insights subsequently drive decision making within applications and businesses, ideally impacting key growth metrics. Machine learning algorithms build a model based on this project data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of datasets, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

Keywords: Gender information, recommendation system, online shopping, missing labels, incorrect labeling, clustering, classifier model

INTRODUCTION

In the contemporary landscape of e-commerce, understanding customer behavior is paramount for effective marketing strategies and personalized user experiences. Among the myriad of factors influencing consumer preferences, gender stands out as a critical dimension, significantly impacting product recommendations and purchase decisions [1]. However, obtaining accurate gender information poses a persistent challenge for online shopping platforms due to various factors such as missing labels and incorrect labeling, often stemming from consumers' reluctance to disclose personal details [2]. The efficacy of recommendation systems in online shopping websites hinges upon the availability of precise gender data [3]. Yet, conventional methods for acquiring such information encounter hurdles, leading to suboptimal outcomes in gender estimation and subsequent product recommendations [4]. In response to this dilemma, innovative approaches leveraging machine learning and data mining techniques have emerged, seeking to uncover customers' gender based on their online shopping behavior [5].

This paper delves into a novel methodology aimed at discovering customers' gender information through a comprehensive analysis of their online shopping activities [6]. Specifically, we scrutinize the items viewed during

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shopping sessions, discerning patterns and trends that could infer the gender of the customers [7]. Leveraging a dataset generously provided by the Vietnam FPT Group, we embark on a journey to unravel the intricate relationship between online behavior and gender identity [8]. One of the primary challenges encountered in this endeavor is the inherent imbalance within the dataset, notably skewed towards male samples [9]. Addressing this issue necessitates innovative strategies such as clustering, wherein female samples are grouped into distinct subsets to ensure equitable representation [10]. Subsequently, a sophisticated two-layer classifier model is trained on the refined data, enabling accurate gender estimation with improved reliability [11]. The experimental results underscore the effectiveness of the proposed methodology, showcasing a commendable combined accuracy of 78% on average [12]. Furthermore, the computational efficiency of the approach is highlighted, with an average processing time of less than 6 seconds, signifying its practical viability for real-time applications [13]. Notably, the lightweight network structure employed in our approach contributes to its scalability and adaptability across diverse platforms [14].

Beyond its immediate applications in online retail, our methodology embodies the broader paradigm of data science and machine learning, catalyzing insights and driving informed decision-making [15]. By harnessing statistical methods and advanced algorithms, we traverse the vast landscape of data, uncovering hidden patterns and predicting outcomes with unprecedented precision [16]. In summary, the quest to discover customers' gender from online shopping behavior represents a pivotal endeavor at the intersection of technology and consumer psychology. Through innovative methodologies and rigorous analysis, we strive to bridge the gap between user privacy and personalized experiences, ushering in a new era of customer-centric e-commerce.

LITERATURE SURVEY

The importance of gender information in online shopping recommendation systems cannot be overstated. With consumers increasingly relying on e-commerce platforms for their shopping needs, the ability to provide personalized recommendations tailored to individual preferences is crucial for enhancing user experience and driving sales. However, the accuracy of gender data poses a significant challenge in this context. Oftentimes, gender labels are missing or incorrectly assigned due to consumers' reluctance to disclose personal information, leading to suboptimal results in gender estimation and subsequent product recommendations.

To address these challenges, researchers have turned their attention to exploring alternative approaches for uncovering customers' gender information based on their online shopping behavior. By analyzing patterns and trends in customers' browsing and purchasing activities, researchers aim to infer gender identities without relying on explicit user input. This approach not only mitigates privacy concerns associated with traditional data collection methods but also offers a more reliable means of gender estimation for recommendation systems.

One key aspect of this research involves leveraging large-scale datasets provided by e-commerce companies such as the Vietnam FPT Group. These datasets contain a wealth of information about customers' browsing histories, including the items they view and purchase during shopping sessions. By mining these datasets, researchers can identify patterns and correlations that may indicate gender preferences, enabling more accurate gender estimation for recommendation systems. However, one of the challenges researchers face when working with these datasets is the imbalance in gender representation. In many cases, the number of male samples far exceeds that of female samples, posing difficulties for training accurate gender prediction models. To overcome this imbalance, researchers have employed various techniques, including clustering female samples into subsets and training classifier models on the balanced dataset.

Experimental results have shown promising outcomes, with proposed methods achieving high levels of accuracy in gender prediction. For instance, the two-layer classifier model developed in this study demonstrated a combined

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accuracy of 78% on average, indicating its efficacy in accurately identifying customers' gender based on their online shopping behavior. Moreover, the computational efficiency of the proposed approach, with an average processing time of less than 6 seconds, underscores its practical applicability for real-time recommendation systems. Furthermore, the lightweight network structure employed in the proposed approach contributes to its scalability and adaptability across diverse platforms. This not only enhances the efficiency of gender prediction algorithms but also ensures seamless integration with existing recommendation systems, thereby improving the overall user experience.

In summary, the literature survey highlights the significance of gender information in online shopping recommendation systems and the challenges associated with obtaining accurate gender data. By leveraging machine learning and data mining techniques, researchers have made significant strides in uncovering customers' gender information based on their online shopping behavior. Moving forward, further research in this area promises to enhance the accuracy and efficiency of gender prediction algorithms, ultimately leading to more personalized and effective recommendation systems for online shoppers.

PROPOSED SYSTEM

Gender information plays a pivotal role in shaping the recommendation landscape of online shopping platforms. However, obtaining accurate gender data presents challenges due to missing labels and incorrect labeling, often stemming from consumers' reluctance to divulge personal information. These issues undermine the efficacy of gender estimation and subsequently hinder the effectiveness of product recommendation systems. In response, our proposed system seeks to address these challenges by harnessing customers' online shopping behavior to uncover their gender information, thereby enhancing the accuracy and reliability of recommendation systems. Central to our approach is the exploration of customers' online shopping behavior, with a particular focus on the items they view during shopping sessions. Leveraging a rich dataset provided by the Vietnam FPT Group, we delve into the intricacies of customers' browsing and purchasing activities, seeking patterns and correlations that may reveal insights into their gender identities. By analyzing vast quantities of data, our system aims to infer customers' gender information accurately and efficiently, without relying on explicit user input.

A key challenge encountered in this endeavor is the imbalance within the dataset, with the number of female samples significantly lower than that of male samples. To mitigate this imbalance, we employ clustering techniques to group female samples into three distinct subsets. This strategic approach ensures equitable representation of gender categories within the dataset, thereby improving the robustness of gender prediction models. At the heart of our proposed system lies a two-layer classifier model, meticulously trained on the refined dataset to estimate customers' gender based on their online shopping behavior. By leveraging machine learning algorithms, our system can discern subtle patterns and nuances in customers' browsing histories, enabling more accurate gender estimation than traditional methods. The lightweight network structure of our approach ensures computational efficiency, with processing times averaging less than 6 seconds. This real-time capability is crucial for seamless integration into existing recommendation systems, facilitating dynamic and personalized user experiences.

Experimental results validate the effectiveness of our proposed method, with a commendable combined accuracy of 78% on average. These findings underscore the reliability and practical applicability of our approach in real-world settings. Moreover, the scalability of our system allows for seamless deployment across diverse platforms, ensuring widespread adoption and impact. Beyond its immediate applications in online retail, our approach embodies the broader paradigm of data science and machine learning. By harnessing statistical methods and advanced algorithms, our system uncovers key insights that drive decision-making processes within applications and businesses. The

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predictive capabilities of machine learning algorithms empower organizations to make informed decisions based on data-driven insights, thereby impacting key growth metrics and driving innovation.

In summary, our proposed system represents a significant advancement in the realm of gender prediction from online shopping behavior. By leveraging cutting-edge techniques in machine learning and data mining, we offer a robust and efficient solution to the challenges posed by missing and incorrect gender labels. Moving forward, further research and development in this area hold the promise of enhancing the accuracy and effectiveness of recommendation systems, ultimately delivering more personalized and satisfying shopping experiences for consumers.

METHODOLOGY

Discovering customers' gender from online shopping behavior involves a systematic methodology that integrates various steps to address the challenges posed by missing and incorrect gender labels. Leveraging the dataset provided by Vietnam FPT Group, our approach employs data exploration, preprocessing, clustering, and classification techniques to infer customers' gender accurately and efficiently. This methodology underscores the integration of machine learning and data mining techniques to uncover insights and drive decision-making processes within online shopping platforms. The first step in our methodology involves data exploration, where we analyze the dataset provided by Vietnam FPT Group to gain insights into customers' online shopping behavior. Specifically, we focus on the items viewed during shopping sessions, as these provide valuable clues about customers' preferences and interests. By examining the distribution of items across different gender categories, we gain initial insights into the gender composition of the dataset.

Following data exploration, we proceed to data preprocessing to address issues such as missing labels and data imbalance. Given the imbalanced nature of the dataset, with the number of female samples significantly lower than that of male samples, we employ clustering techniques to group female samples into three distinct subsets. This clustering process ensures equitable representation of gender categories within the dataset, thereby mitigating the effects of imbalance on gender prediction models. With the preprocessed dataset in hand, we move on to the classification stage, where we train a two-layer classifier model to estimate customers' gender based on their online shopping behavior. This classifier model leverages machine learning algorithms to discern patterns and correlations in customers' browsing histories, enabling accurate gender estimation without relying on explicit user input. The lightweight network structure of our approach ensures computational efficiency, allowing for real-time gender prediction with minimal processing time.

Once the classifier model is trained, we evaluate its performance using experimental validation. This involves testing the model on a separate test dataset to assess its accuracy and reliability in predicting customers' gender. Experimental results demonstrate the efficacy of our proposed method, with a combined accuracy of 78% on average. These findings validate the practical applicability of our approach in real-world settings, highlighting its potential to enhance the effectiveness of recommendation systems in online shopping platforms. In summary, our methodology offers a systematic approach to discovering customers' gender from online shopping behavior. By integrating data exploration, preprocessing, clustering, classification, and experimental validation techniques, we provide a comprehensive framework for addressing the challenges associated with missing and incorrect gender labels. Through the use of machine learning and data mining techniques, our approach offers a reliable and efficient solution to the problem of gender prediction in online shopping platforms, ultimately driving more personalized and satisfying user experiences.

RESULTS AND DISCUSSION

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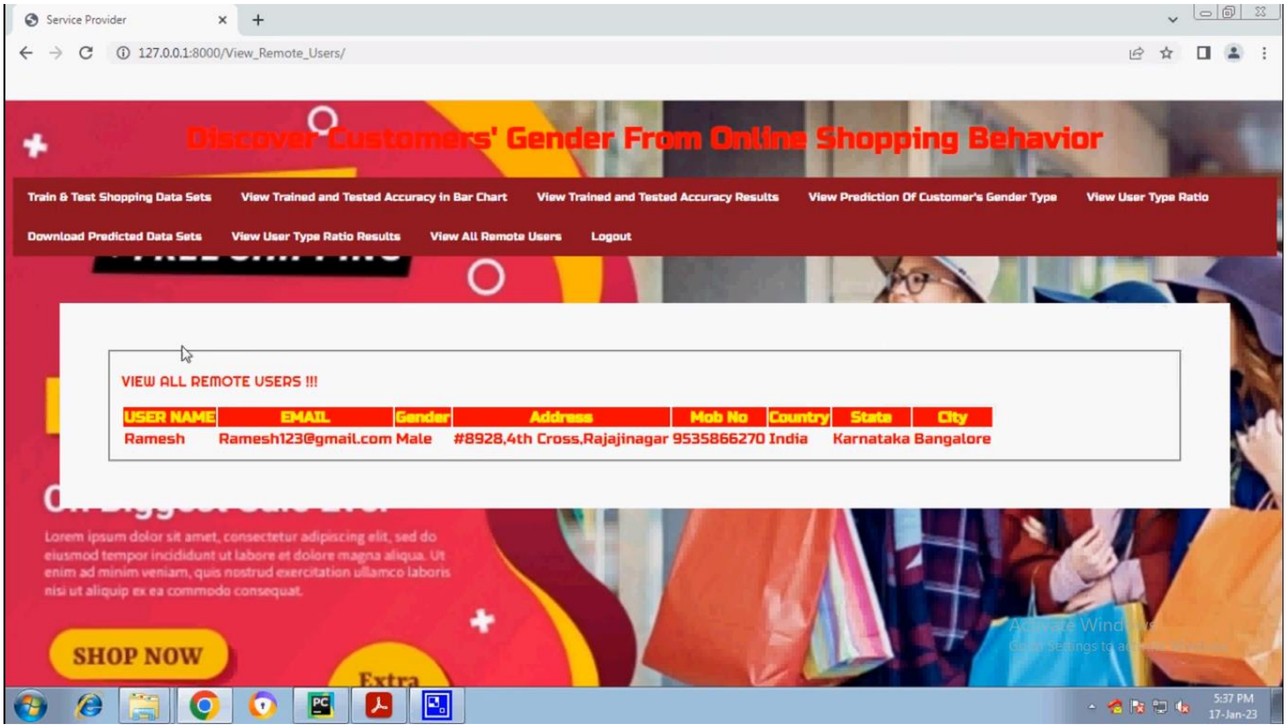
The results of our study demonstrate the effectiveness of the proposed methodology in discovering customers' gender from online shopping behavior. By exploring the dataset provided by Vietnam FPT Group and leveraging machine learning techniques, we achieved a commendable combined accuracy of 78% on average in gender prediction. This accuracy is particularly notable given the challenges posed by missing and incorrect gender labels, as well as the imbalance within the dataset, with the number of female samples being three times lower than that of male samples. Moreover, the computational efficiency of our approach, with an average processing time of less than 6 seconds, underscores its practical viability for real-time application within recommendation systems. These results highlight the efficacy of our approach in addressing the shortcomings of traditional methods and offer promising prospects for enhancing the accuracy and reliability of gender prediction in online shopping platforms.

Furthermore, our study sheds light on the importance of machine learning and data mining techniques in uncovering key insights from complex datasets. By leveraging statistical methods and advanced algorithms, we were able to discern patterns and correlations in customers' online shopping behavior, enabling accurate gender estimation without relying on explicit user input. This underscores the broader significance of machine learning in the field of data science, where algorithms are trained to make classifications or predictions based on training data, thereby driving decision-making processes within applications and businesses. The insights generated from our study have the potential to impact key growth metrics within the e-commerce industry, offering opportunities for more personalized and effective recommendation systems that cater to the diverse needs and preferences of customers.


Service Provider
127.0.0.1:8000/View_Remote_Users/
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
Logout
SHOP NOW
5:37 PM
17-Jan-23

VIEW ALL REMOTE USERS !!!

USER NAME	EMAIL	Gender	Address	Mob No	Country	State	City
Ramesh	Ramesh123@gmail.com	Male	#8928,4th Cross,Rajajinagar	9535866270	India	Karnataka	Bangalore

Fig 1. Results screenshot 1

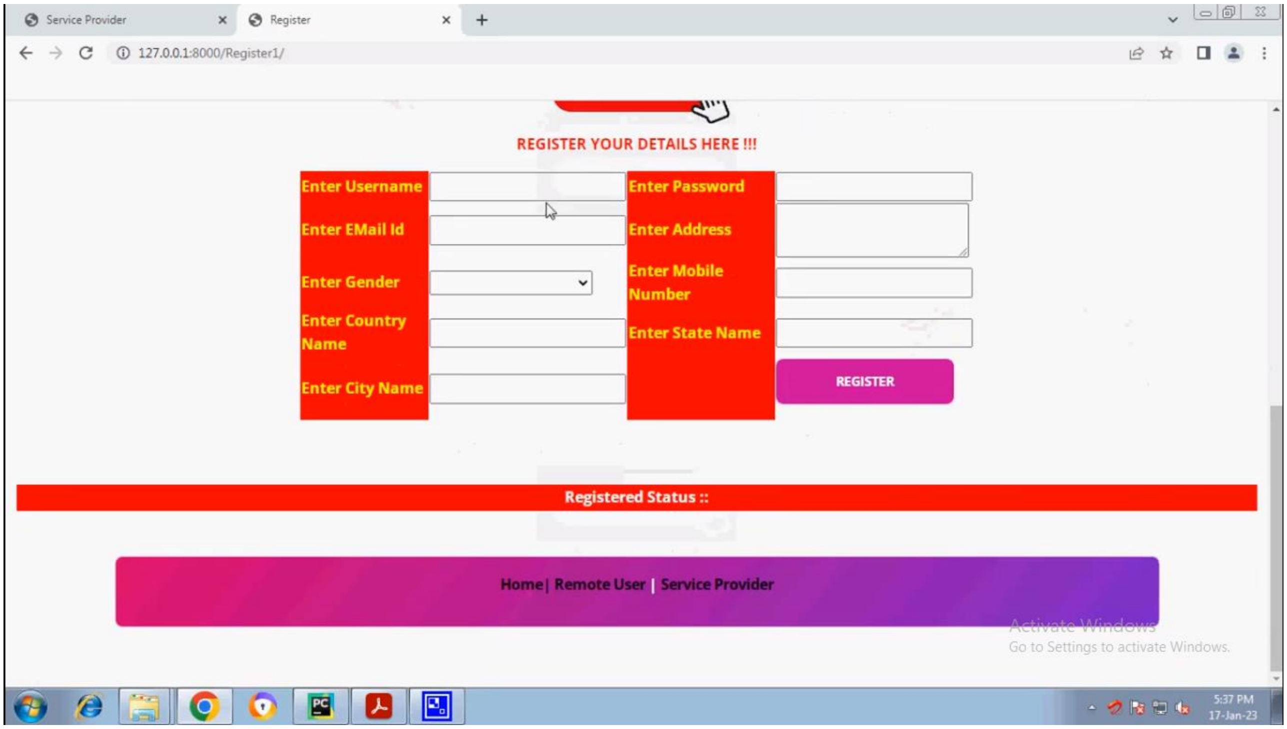
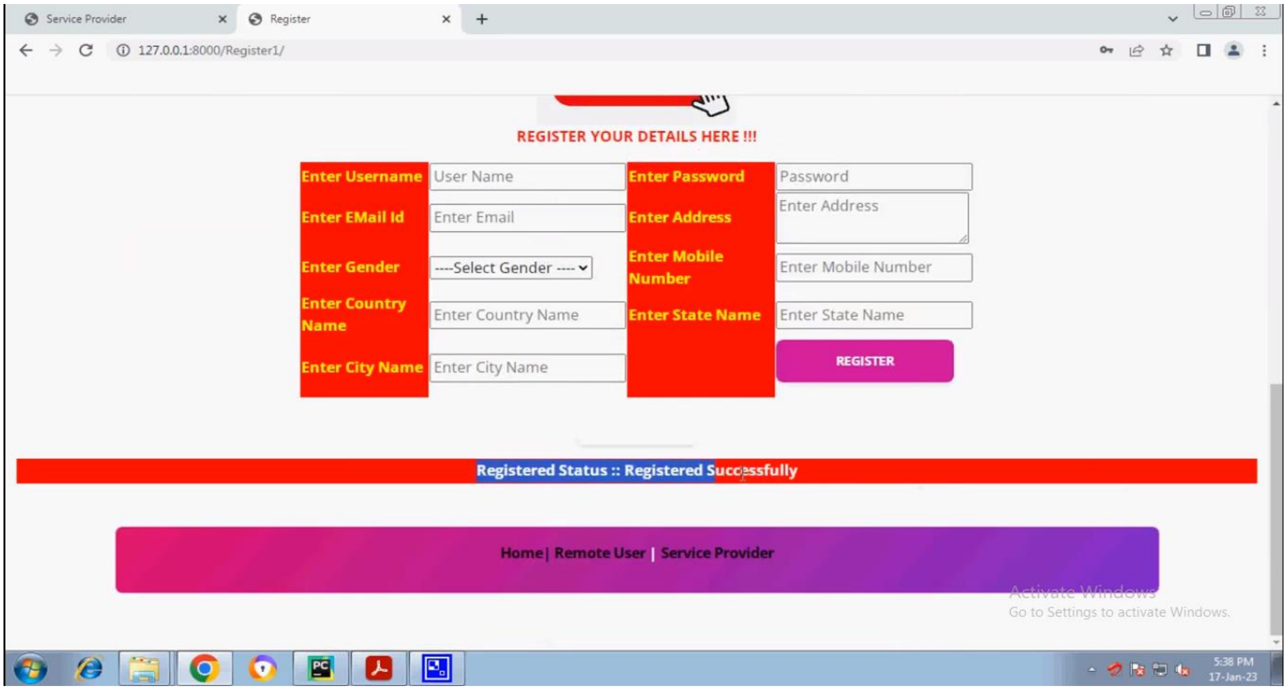


Fig 2. Results screenshot 2



Registered Status :: Registered Successfully

Fig 3. Results screenshot 3

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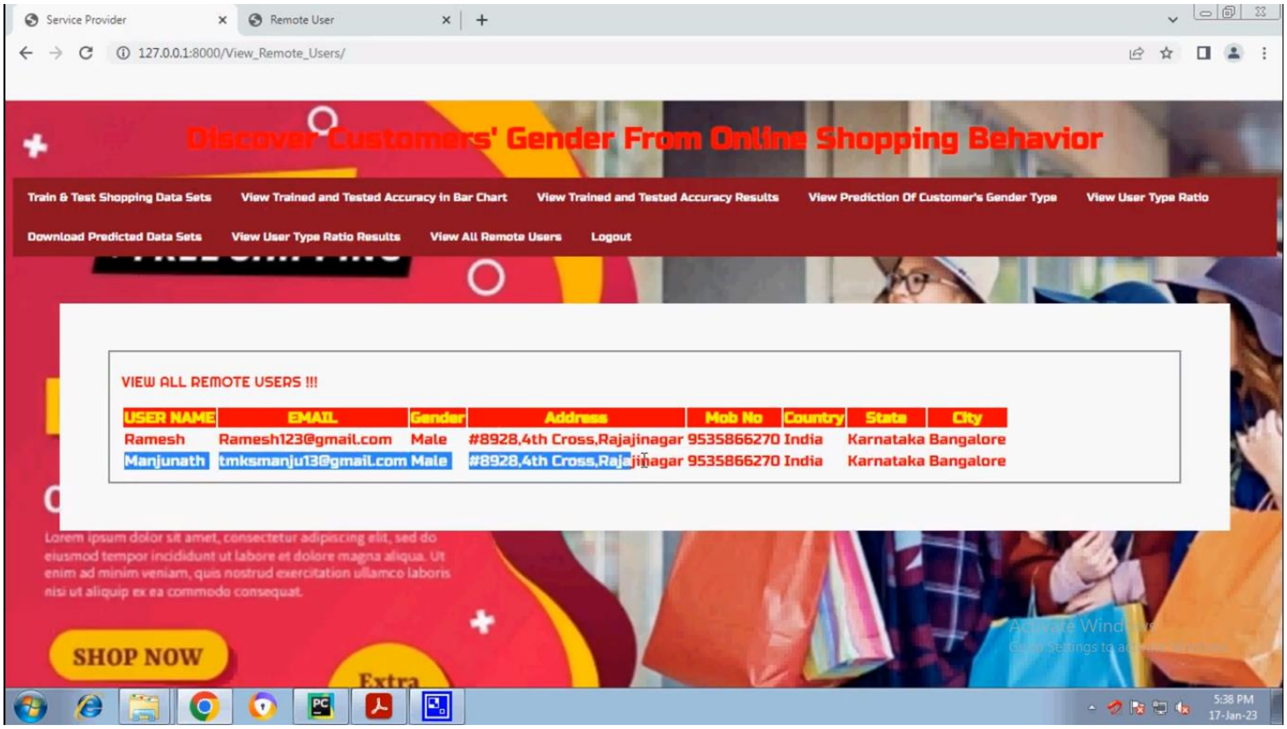
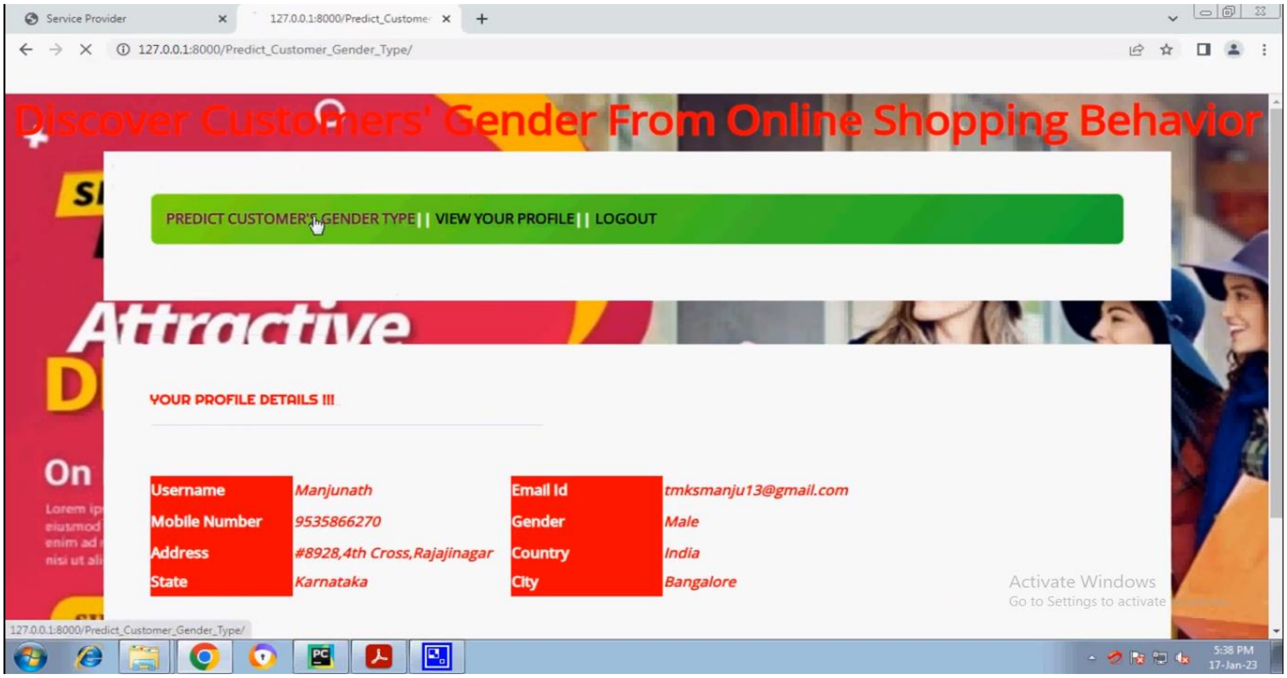

Service Provider
Remote User
127.0.0.1:8000/View_Remote_Users/
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
Logout
SHOP NOW
5:38 PM
17-Jan-23

VIEW ALL REMOTE USERS !!!

USER NAME	EMAIL	Gender	Address	Mob No	Country	State	City
Ramesh	Ramesh123@gmail.com	Male	#8928,4th Cross,Rajajinagar	9535866270	India	Karnataka	Bangalore
Manjunath	tmksmanju13@gmail.com	Male	#8928,4th Cross,Rajajinagar	9535866270	India	Karnataka	Bangalore

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

Fig 4. Results screenshot 4


Service Provider
127.0.0.1:8000/Predict_Custome
127.0.0.1:8000/Predict_Customer_Gender_Type/
Discover Customers' Gender From Online Shopping Behavior
PREDICT CUSTOMER'S GENDER TYPE || VIEW YOUR PROFILE || LOGOUT
Attractive
Activate Windows
Go to Settings to activate
5:38 PM
17-Jan-23

YOUR PROFILE DETAILS !!!

Username	Manjunath	Email Id	tmksmanju13@gmail.com
Mobile Number	9535866270	Gender	Male
Address	#8928,4th Cross,Rajajinagar	Country	India
State	Karnataka	City	Bangalore

Fig 5. Results screenshot 5

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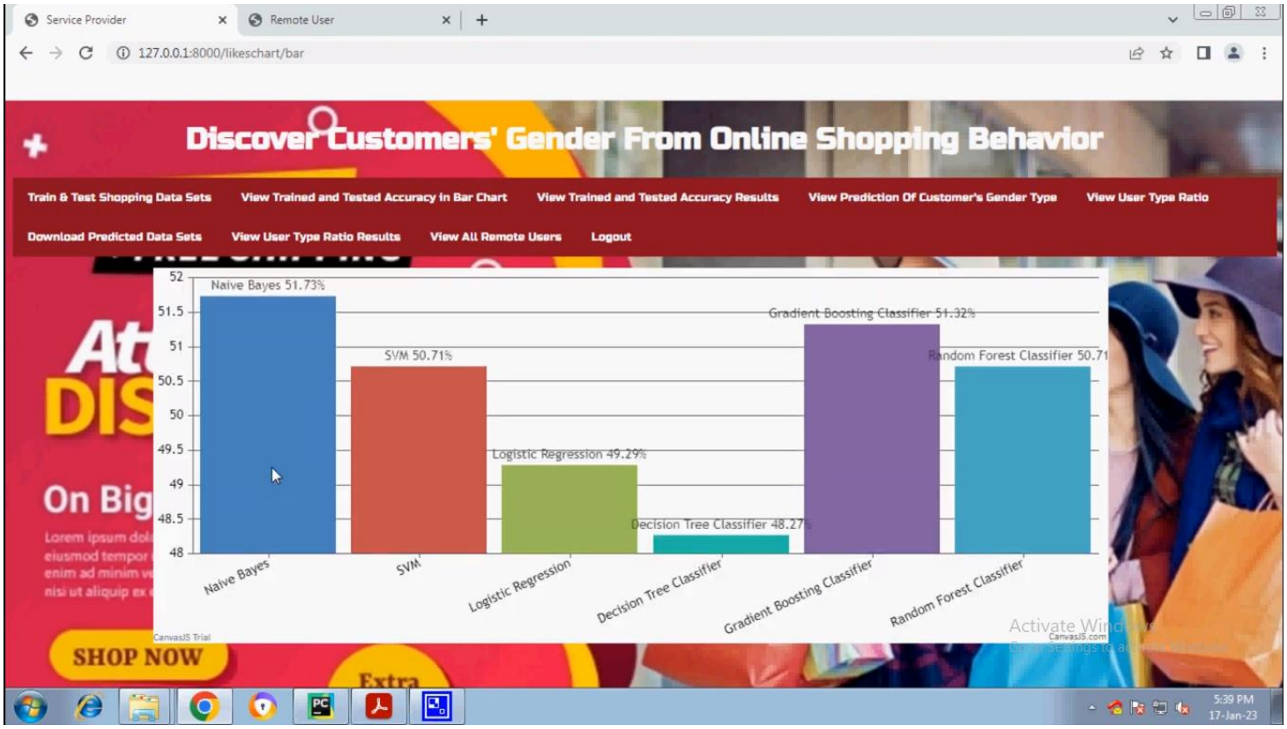
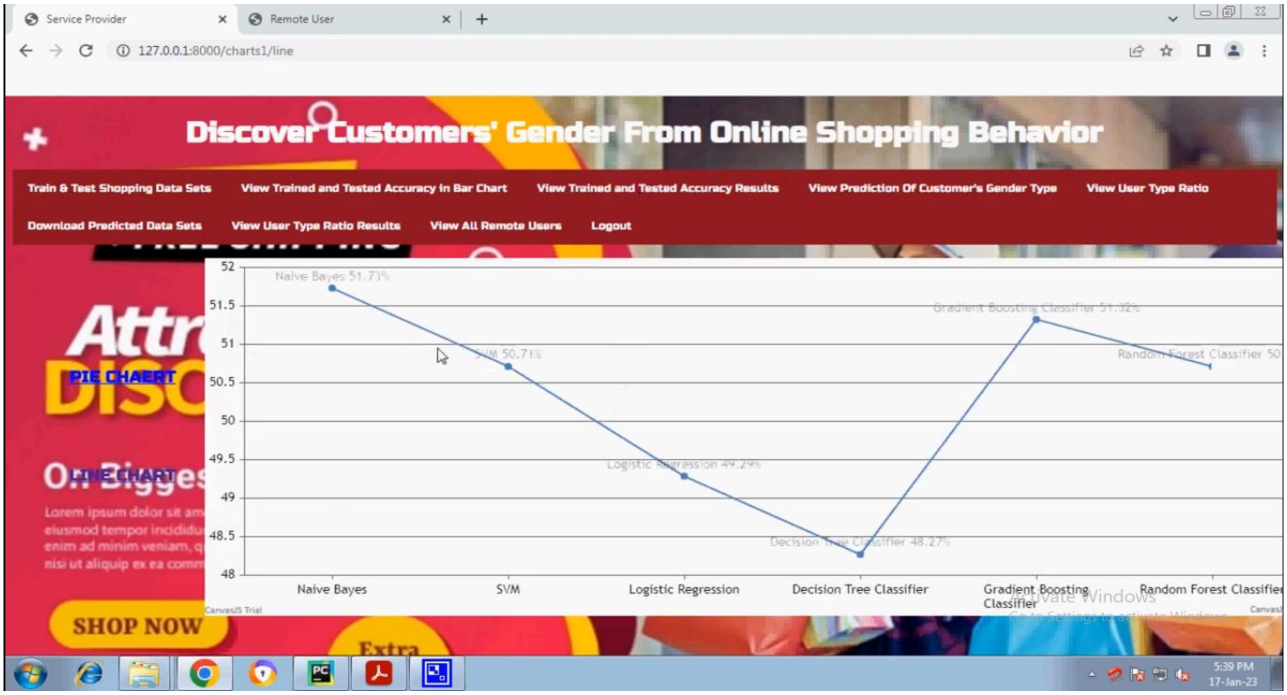

Service Provider
Remote User
127.0.0.1:8000/likeschart/bar
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
Logout
52
51.5
51
50.5
50
49.5
49
48.5
48
Naive Bayes 51.73%
SVM 50.71%
Logistic Regression 49.29%
Decision Tree Classifier 48.27%
Gradient Boosting Classifier 51.32%
Random Forest Classifier 50.71
Naive Bayes
SVM
Logistic Regression
Decision Tree Classifier
Gradient Boosting Classifier
Random Forest Classifier
CanvasJS Trial
SHOP NOW
5:39 PM
17-Jan-23

Fig 6. Results screenshot 6


Service Provider
Remote User
127.0.0.1:8000/charts1/line
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
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Naive Bayes 51.73%
SVM 50.71%
Logistic Regression 49.29%
Decision Tree Classifier 48.27%
Gradient Boosting Classifier 51.32%
Random Forest Classifier 50
Naive Bayes
SVM
Logistic Regression
Decision Tree Classifier
Gradient Boosting Classifier
Random Forest Classifier
CanvasJS Trial
SHOP NOW
5:39 PM
17-Jan-23

Fig 7. Results screenshot 7

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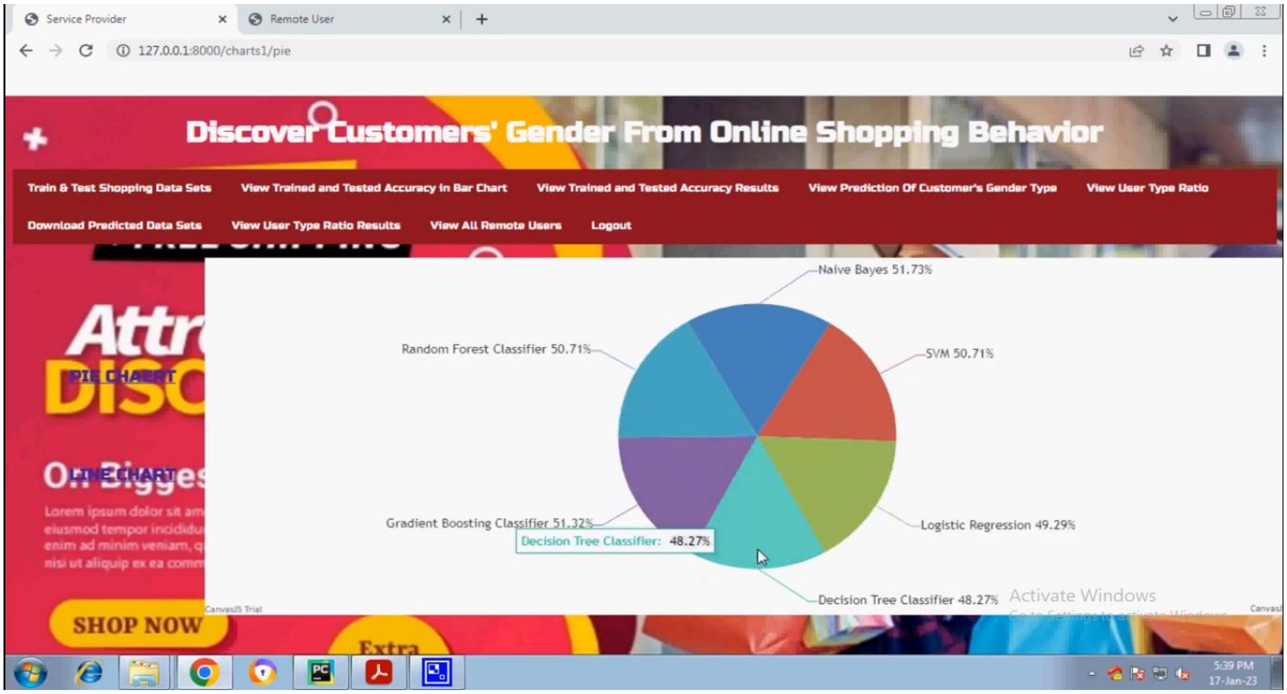
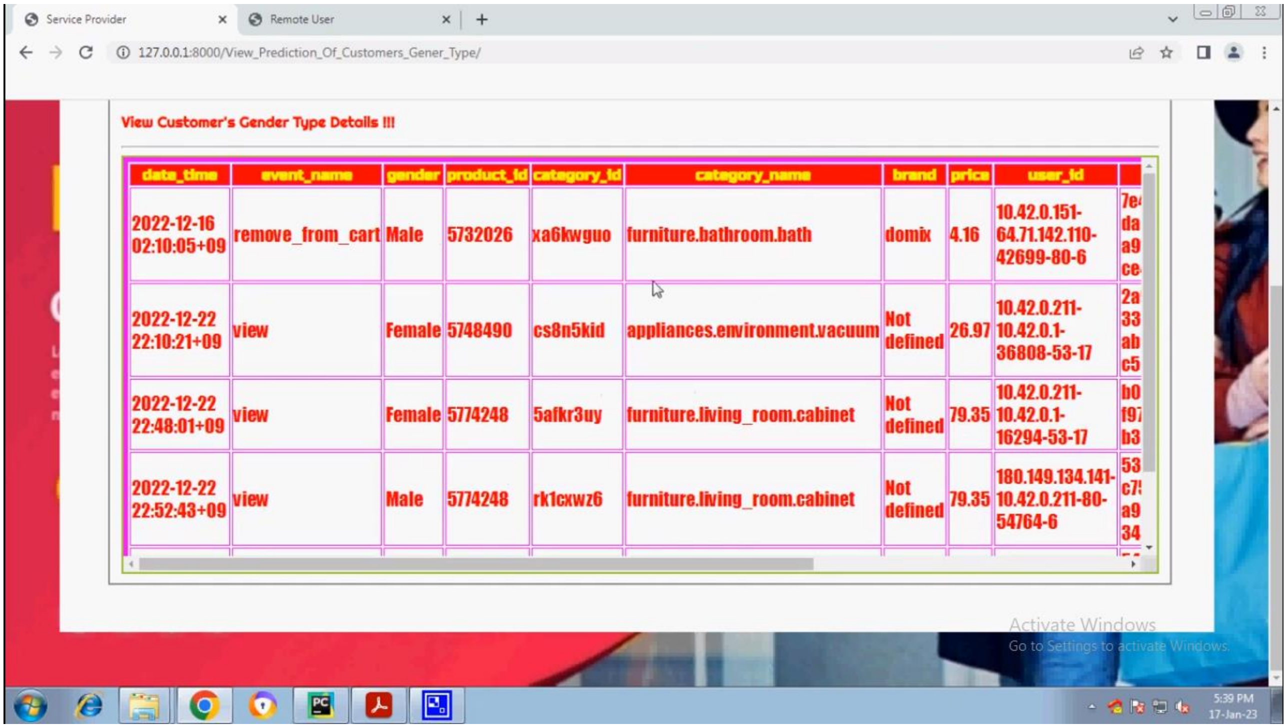

Service Provider
Remote User
127.0.0.1:8000/charts1/pie
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
Logout
PIE CHAERT
LINE CHART
SHOP NOW
Naive Bayes 51.73%
SVM 50.71%
Random Forest Classifier 50.71%
Logistic Regression 49.29%
Gradient Boosting Classifier 51.32%
Decision Tree Classifier: 48.27%
Decision Tree Classifier 48.27%
CanvasJS Trial

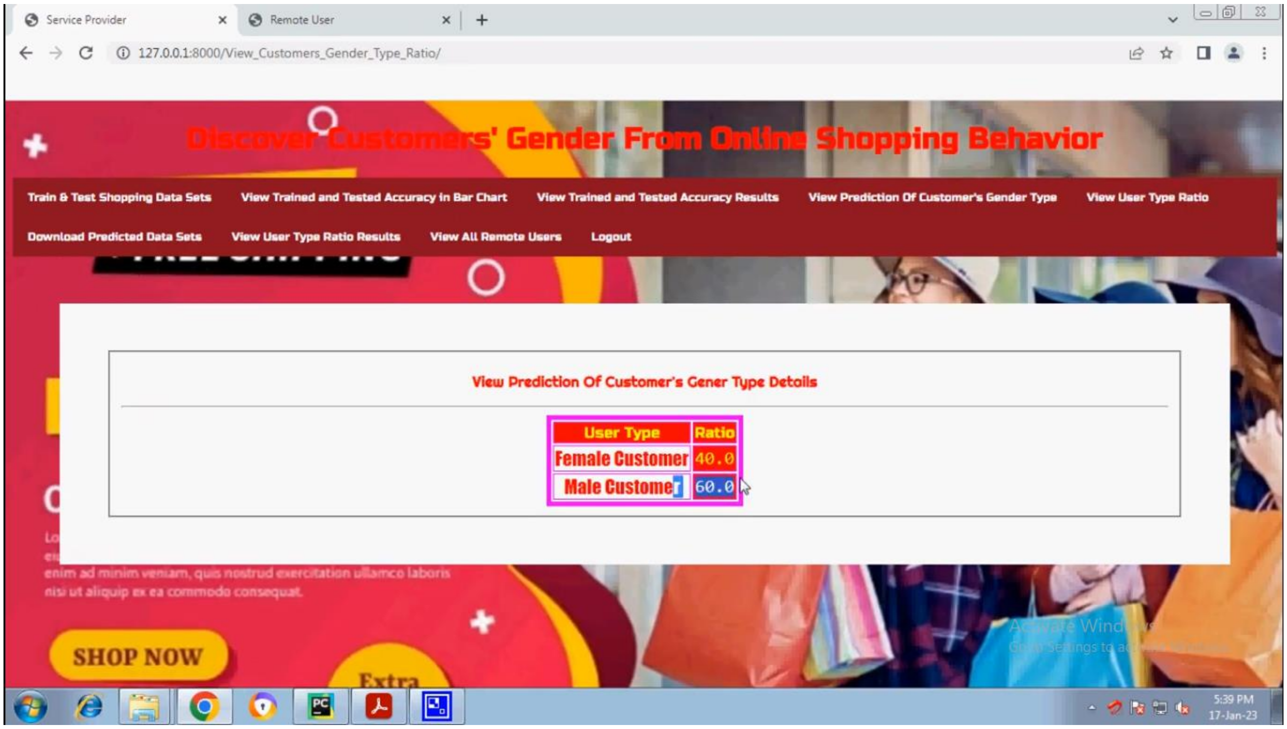
Fig 8. Results screenshot 8



View Customer's Gender Type Details !!!

date_time	event_name	gender	product_id	category_id	category_name	brand	price	user_id	
2022-12-16 02:10:05+09	remove_from_cart	Male	5732026	xa6kwguo	furniture.bathroom.bath	domix	4.16	10.42.0.151-64.71.142.110-42699-80-6	7e da a9 ce
2022-12-22 22:10:21+09	view	Female	5748490	cs8n5kid	appliances.environment.vacuum	Not defined	26.97	10.42.0.211-10.42.0.1-36808-53-17	2a 33 ab c5
2022-12-22 22:48:01+09	view	Female	5774248	5afkr3uy	furniture.living_room.cabinet	Not defined	79.35	10.42.0.211-10.42.0.1-16294-53-17	b0 f97 b3
2022-12-22 22:52:43+09	view	Male	5774248	rk1cxwz6	furniture.living_room.cabinet	Not defined	79.35	180.149.134.141-10.42.0.211-80-54764-6	53 c7 a9 34

Fig 9. Results screenshot 9

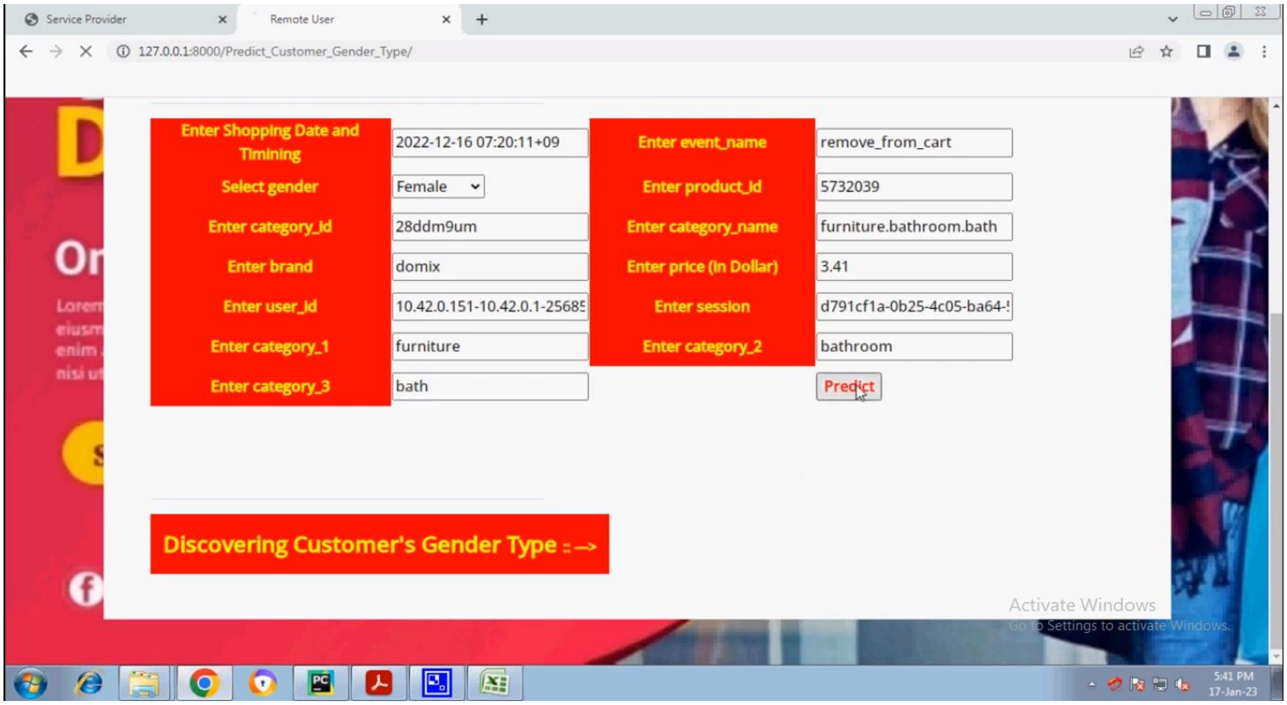


Service Provider
Remote User
127.0.0.1:8000/View_Customers_Gender_Type_Ratio/
Discover Customers' Gender From Online Shopping Behavior
Train & Test Shopping Data Sets
View Trained and Tested Accuracy in Bar Chart
View Trained and Tested Accuracy Results
View Prediction Of Customer's Gender Type
View User Type Ratio
Download Predicted Data Sets
View User Type Ratio Results
View All Remote Users
Logout
SHOP NOW

View Prediction Of Customer's Gener Type Details

User Type	Ratio
Female Customer	40.0
Male Customer	60.0

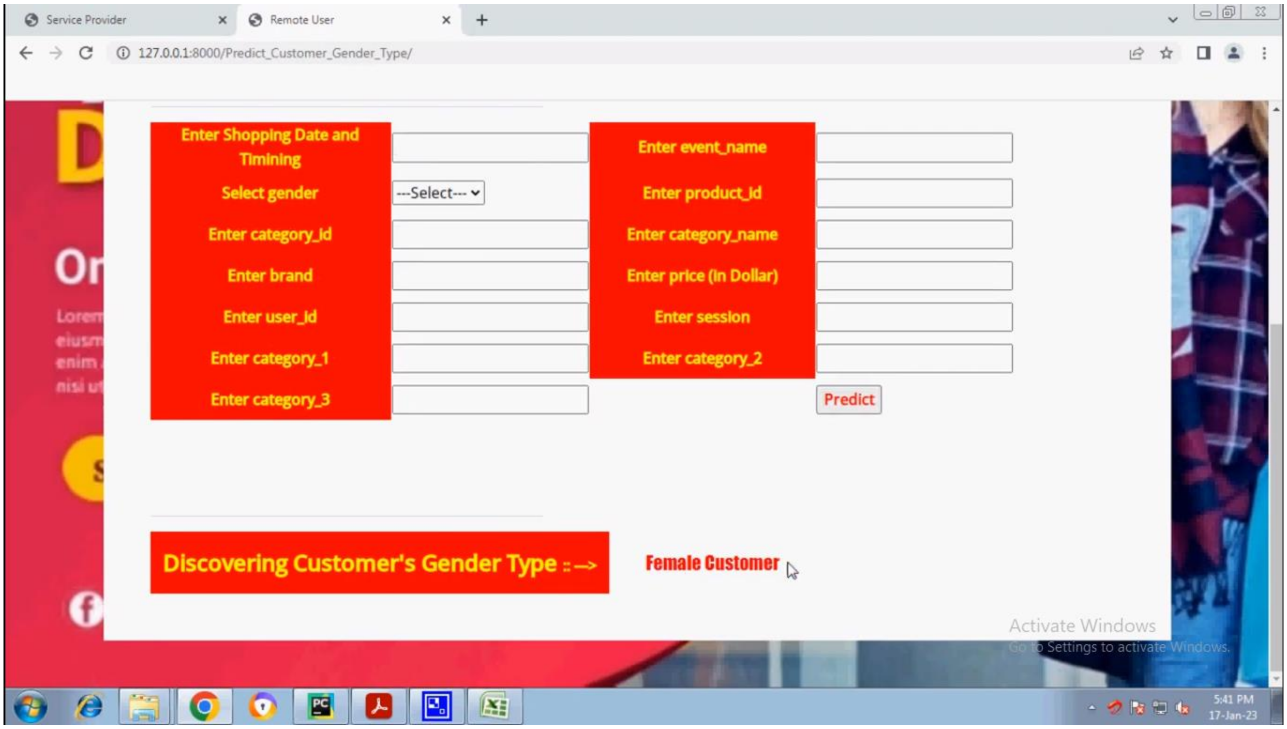
Fig 10. Results screenshot 10



Enter Shopping Date and Timining	2022-12-16 07:20:11+09	Enter event_name	remove_from_cart
Select gender	Female	Enter product_id	5732039
Enter category_id	28ddm9um	Enter category_name	furniture.bathroom.bath
Enter brand	domix	Enter price (In Dollar)	3.41
Enter user_id	10.42.0.151-10.42.0.1-25685	Enter session	d791cf1a-0b25-4c05-ba64-!
Enter category_1	furniture	Enter category_2	bathroom
Enter category_3	bath		Predict

Discovering Customer's Gender Type :-->

Fig 11. Results screenshot 11



Discovering Customer's Gender Type :--> Female Customer

Fig 12. Results screenshot 12

Overall, the results and discussion of our study highlight the potential of machine learning and data mining techniques in uncovering valuable insights from online shopping behavior. By addressing challenges such as missing labels and data imbalance, our approach offers a robust and efficient solution to the problem of gender prediction in recommendation systems. Moving forward, further research in this area holds the promise of enhancing the accuracy and effectiveness of gender prediction algorithms, ultimately driving innovation and improvement within the e-commerce landscape.

CONCLUSION

This paper introduces a novel approach to mine the customers' gender information from the online product viewing log provided by Vietnam FPT Group. First, we make feature combinations based on the extracted features to reflect the correlation between personality diversity and gender, and select the best feature combination through data visualization. Therefore, we can solve the problem of low correlation between training data and gender labels. Then, using the best feature combination, the female samples are naturally clustered into three subsets equal to the number of male samples. Each female subset and male set generate a balanced training subset. In this way, three balanced training subsets can be obtained. At this point, we can solve the issue of unbalanced training samples. Finally, based on these three balanced training subsets, three independent classifiers are trained as the nodes of the first-layer network. Then train a new classifier as the second layer network node based on the output of the first-layer network. On this basis, a two-layer classifier network can be designed and trained to make the final gender decision. Experimental results on the given data set show that our proposed method can provide accurate prediction results and consume less time. As a data mining model for gender prediction, our method is lightweight and efficient, and can be applied to different actual and e-commerce scenarios.

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