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# Data Mining-based Real-Time User-centric Recommender System for Nigerian Tourism Industry

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# Data Mining-based Real-Time User-centric Recommender System for Nigerian Tourism Industry

***Abstract*— The tourism information system in Nigeria is not novel. What is novel is the need to develop reliable real-time recommender systems that can adequately aid tourists in their decisions. Several researchers have proposed various models. However, there are still issues about the applicability, effectiveness, efficiency, and reliability of the existing recommenders in the Nigerian tourism sector. This work is aimed at developing an improved model for real-time tourism recommender in Nigeria based on a data mining model. The objectives include the development of a data mining model for real-time reliable user-centric tourism recommendation and evaluation of the recommender system. To achieve these, a supervised machine learning-based classifier is modelled. The classifier system is evaluated using four thousand (4,000) datasets acquired from online and physical Nigerian tourism sources. Nine machine learning algorithms are compared during the testing process based on accuracy and other standard performance metrics. Experimental results show that the PART algorithm outperforms all other algorithms with an accuracy of 91.65%, F-Measure of 0.917, true positive rate of 0.913, the false-positive rate of 0.029, and the precision of 0.917, and recall of 0.917. In terms of efficiency, it also records the least time-to-model of 0.02 seconds. The rules generated from this algorithm are incorporated into the design of a prototype to test the recommender. The usefulness and efficiency scores based on test cases involving 20 participants prove that the recommender system would be a veritable tool for tourism in Nigeria.**

***Keywords- Tourism, Nigeria, Recommender, Data mining, Classifier system.***

## I. INTRODUCTION

Natural and historical monuments all contribute to Nigeria's economic growth [1]. There are around 142 tourism spots dispersed across the federation's 36 states. Some tourist attractions are natural, while others are man-made. Many tourist attractions contain appealing features that are unknown or underutilized because they are not easily accessible to the general public. Although, these tourism potentials are sufficient to make Nigeria a well-known tourist destination, yet tourism remains an untapped source of revenue in several underdeveloped countries, such as Nigeria.

The tourism industry has recently experienced significant growth and noticeable transformation, garnering widespread international attention as a result of its benefits [2]. According to [3], tourism is defined as a process or set of actions that involves someone traveling to and staying in locations beyond their immediate area for the sake of recreation, relaxation, vacation, or other purposes. Because of its multiplier effect on other areas of the economy, it has become an alternative revenue source, producing a large number of jobs for both skilled and unskilled labour [4]. It provides a variety of economic and social benefits, and it is attracting more attention [5]. Tourism has become a key source of revenue and an economic backbone in many developed countries. It has emerged as a primary driver of socioeconomic progress in Western civilization, as well as a viable alternative strategy for economic sustainability and diversification [1]. It has provided a significant amount of revenue to numerous economies [6].

However, the tourist business in Nigeria has been derided over the years [3]. Tourism does not operate in some places, despite large investments, due to bad management, one of which is in the areas of increased awareness and user satisfaction. With advancements in information technology, much may be accomplished in addressing the challenges by leveraging historical data and preferences of users to assist tourists in making decisions. To create a User-Centric Tourism System, Data Mining, a Computational technique that relies on Machine Learning and Statistical tools to extract meaningful information from historical data, is used.

Since the goal of recommender systems is to tackle the problem of information overload while personalizing the user experience by making accurate, specific item recommendations based on the user's interests [7], a recommender is proposed to address the problem. More also, a recommender system can also estimate whether a set of things will be valuable to a user based on the information provided [8]. Some are content-based recommender systems, which rely on item qualities to make predictions; collaborative recommender systems, which rely on user or item similarities; and hybrid recommender systems, which incorporate both content-based and collaborative recommender designs.

In this study, a user-based collaborative-based recommender system is proposed to provide tourism assistance to tourists from historical records of different tourists. This will provide information to assist intended tourists during the planning of their trip to Nigeria. The remaining part of the paper is organized as follows: Section II discusses the Nigerian tourism industry, Section III presents the related works, Section IV discusses the methodology used in achieving our results, Section V shows the results and discusses the efficiency of our model, while Section VI concludes.

## II. NIGERIAN TOURISM INDUSTRY

Nigeria is one of the world's countries with abundant natural and human resources. The country is naturally endowed with a diverse range of natural resources, making it one of the world's most scenic countries. There are several tourist sites in the country that are just waiting to be discovered. People can now travel far from home to take part in an event that interests them in tourist destinations both within and outside their

country. Nigeria, as a coastal country on the South Atlantic Ocean, boasts of a diverse assortment of beaches and other natural wonders.

Tourism growth in Nigeria began in 1962, with the establishment of the Nigerian Tourism Association (NTA). In 1964, NTA was granted membership in the International Union of Official Travel Organizations (IUOTO). The International Union of Tourism Organizations was later called the World Tourism Organization (WTO). In 1971, African Development Bank was instituted in Nigeria to investigate the country's tourist potential and sustainability. According to the findings, Nigeria has enormous tourism potential. The government decided to replace the NTA with the Nigerian Tourism Board as a result of the research. The Nigerian Tourism Board started operation in 1978 [9] after the establishment of Decree No. 54 of 1976. Its responsibilities include the following: grading and classifying hotels in Nigeria in accordance with prescribed standards, providing tourism information and advisory services, promoting and conducting tourism research, enhancing the provision and improvement of tourist amenities and facilities in Nigeria, including ancillary facilities, and encouraging Nigerians to spend their money in the country.

The Federal Government of Nigeria began to view tourism as an industry that needed to be promoted in 1989, after realizing the enormous potential it offered. Several conferences were held in order to harness the enormous opportunities offered by tourism, including the seventh National Conference on Tourism held on the 15th of March, 1989. It was recognized at the conference that the NTB's operational capability needed to be reorganized and supported. The government thereafter approved the conference and the Ministry of Trade was renamed the Ministry of Trade and Tourism, resulting in the establishment of the Department of Tourism within the Ministry [2].

The tourism system is expected to capture tourism components and procedures that will attract and aid prospective tourists in their search for information about tourist destinations in the country and guide them in making the best decision possible when organizing their travels. Badagry Beach, The First Story Building, Kuramo Beach, Olumo Rock, Erin-Ijesha Waterfall, and Ikogosi Water Spring are just a few of Nigeria's tourism attractions.

## III. RELATED WORKS

Several works have been done on a tourism information system, but the few works that focused on a tourism recommender system are presented below.

Umanets et al. [10] developed GuideMe to provide quality recommendations for user tourists. The system was based on Mahout, which has different collaborative filtering algorithms. Slope One and three item-based collaborative filtering algorithms with different similarity measures such as Euclidean Distance, Log-Likelihood, and uncentred cosine were used to analyse the popular MovieLens datasets. For 500,000 entries divided into 80% training data and 20% test data, a mean absolute error of 0.7 was obtained. The authors also performed a usability evaluation using a survey delivered to 30 users based on the user's gender and age range; user experience with the mobile applications; usefulness and attractiveness of the interface; usage of the application in the future, and other comments. The result showed a majority of the users were satisfied with the features and design of the application.

In [11], an intelligent tourist recommender system for managing and recommending tourist places to collective profiles was developed. The work relied on similarity scores which estimated the level of similarity based on sub-profiles such as cultural, bio-ecological, adventure, urban, and sport to determine the suitable items for members of a group. The method was effective for group recommendation systems.

In Hassannia et al. [12], agent and web technologies were relied on to build a recommender system. The authors utilized a hybrid recommendation filtering for rating tourism centres. Evaluation based on two scenarios involving 100 customers illustrated that the proposed web application improved the rate of the recommendation for the customers. In the first scenario without disturbances, the rate was improved by 20%. In the second scenario with disturbances, the rate was improved by 30%. The latter supported real-time data communication.

Fatmawatie and Baizal [13] proposed the use of Case-Based Reasoning (CBR) to recommend tourist attractions to tourists. The authors focused the study on Bandung Raya Area in Indonesia. The CBR system provided recommendations based on solutions from previously solved cases, and matches between user requirements and available features. The similarity between solved cases and new cases was estimated and the most similar previous cases are recommended. The study obtained an accuracy of 91% and 92 % in the two evaluation scenarios. In addition, the level of acceptability based on the 35 respondents proved that the system met the needs of the users with an average acceptability score of 4.25 over a scale of 1 to 5.

## IV. METHODOLOGY

In achieving the objectives of the study, qualitative and quantitative research techniques were employed in the research design. The qualitative research method took a holistic picture into the data, while quantitative research considered specific aspects, resulting in few variables.

### *A. Data Collection and Pre-processing*

Dataset pertaining to the research work was collected from selected tourism centres in Nigeria and tourists' information was available online. Individual tourists' data totaling four thousand (4000) was collected using purposive and selective sampling techniques. The data format is presented in Table I.

**TABLE I. DATA FORMAT**

| S/N | Variable Name | Variable Format | Variable Type |
|---|---|---|---|
| 1 | Age | 28,30,42,50… | Numerical |

| | | | |
|---|---|---|---|
| 2 | Occupation | Student, Civil Servant, Public Servant | Categorical |
| 3 | Choice of Transport | Public, Drop…. | Categorical |
| 4 | Accommodation | Standard, Single, Double | Categorical |
| 5 | Gender | Male, Female | Categorical |
| 6 | Status | Single, Married | Categorical |
| 7 | Lifestyle | Sport, Smoking, Reading…. | Categorical |
| 8 | Tourist Centre | Aso Rock, Idanre Hill, Bar Beach, Olumu Rock, Zuma Rock……. | Categorical |

In developing the data mining model, the following steps were taken:

***1)*** Cleaned, formatted and normalize the dataset.

***2)*** Load the formatted and normalized datasets into the classifier application.

***3)*** Perform evaluation on the whole dataset using 10-fold cross-validation.

***4)*** Divide the dataset into two; 66% for training and 34% for testing.

***5)*** Perform training and testing experiments. If the result is satisfactory, stop modeling.

***6)*** Compare the algorithms based on the performance measures.

Waikato Environment for Knowledge Analysis (WEKA) classify library was used for the analysis [14]. WEKA is a collection of machine learning algorithms for data mining tasks. Machine learning algorithms evaluated in WEKA include PART, Random Forest, Random Tree, J48 (C4.5), JRIP, Multilayer Perceptron, Logistic Regression, Logistic, and SMO.

## V. RESULTS AND SYSTEM FRAMEWORK

### *A. Results*

In the experiment, attribute importance analysis was first carried out to evaluate the significance of the attributes used in the research work using the Information Gain attribute evaluator. In the ranking, Lifestyle was the most significant followed by Status, Age, Occupation, Choice of Transport, Accommodation, and Gender, in that order. However, all the attributes were used because 6 out of the 7 attributes importance scores were between 0 and 0.02. Figure 1 illustrates the ranking showing the significant difference in the height of lifestyle and other attributes and negligible differences among the heights of other attributes.

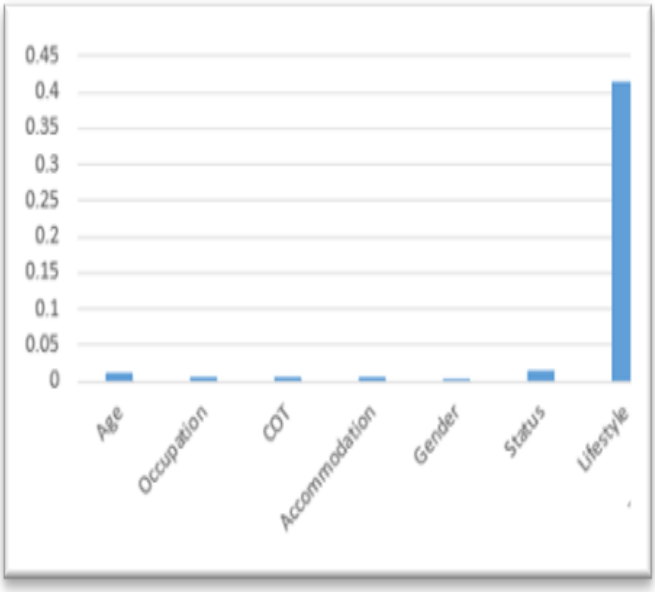


**Figure 1. Information Gain Ranking Chart**

Table II illustrates the classification accuracy and time-to-model performances of the nine (9) machine learning algorithms during testing, while Table III shows the results of other performance metrics. These results show that PART records an accuracy of 91.65% and the lowest time-to-model of 0.02 followed by Random Forest with an accuracy of 91.65% and a time-to-model of 0.27. The other classifiers recorded lower accuracy and higher time-to-model proving that PART was the best among the evaluated algorithms. From Table III, PART and Random Forest recorded the same TPR, Precision, Recall, and F-Measure of 0.917, 0.917, 0.917, and 0.917, respectively, which were the best in the evaluation. However, PART recorded a lower FPR of 0.029 compared to 0.030 of the Random Forest. Both values were lower compared to the remaining algorithms. Thus, PART was the best in terms of TPR, FPR, Precision, Recall, and F-Measure.

**TABLE II. CLASSIFICATION ACCURACY AND TIME-TO-MODEL**

| S/N | Classifiers | Accuracy | Time taken to build model |
|---|---|---|---|
| 1 | PART | 91.65 | 0.02 |
| 2 | Random Forest | 91.65 | 0.27 |
| 3 | Random Tree | 91.25 | 0. 61 |
| 4 | J48 | 90.87 | 0.09 |
| 5 | JRIP | 70.32 | 7.83 |
| 6 | MLP | 67.10 | 37. 41 |
| 7 | Simple Logistic | 54.67 | 3.71 |
| 8 | Logistic | 54.37 | 2. 03 |
| 9 | SMO | 53.32 | 5.93 |

**TABLE III. THE PERFORMANCE OF THE ALGORITHMS IN TERMS OF TPR, FPR, PRECISION, RECALL, AND F-MEASURE**

| S/N | Algorithms | TPR | FPR | Precision | Recall | F-Measure |
|---|---|---|---|---|---|---|
| 1 | PART | **0.917** | **0.029** | **0.917** | **0.917** | **0..917** |
| 2 | Random Forest | **0.917** | 0.030 | **0.917** | **0.917** | **0.917** |
| 3 | Random Tree | 0.913 | 0.032 | 0.913 | 0.913 | 0.912 |
| 4 | J48 | 0.909 | 0.038 | 0.909 | 0.909 | 0.909 |
| 5 | JRIP | 0.703 | 0.126 | 0.745 | 0.703 | 0.700 |
| 6 | MLP | 0.671 | 0.126 | 0.670 | 0.671 | 0.668 |
| 7 | Simple Logistic | 0.547 | 0.175 | 0.550 | 0.547 | 0.534 |
| 8 | Logistic | 0.544 | 0.176 | 0.544 | 0.544 | 0.534 |
| 9 | SMO | 0.533 | 0.816 | 0.565 | 0.533 | 0.495 |

*The best scores are highlighted in bold.

### *B. Real-Time User-Centric Recommender System*

The framework of the proposed real-time user-centric recommender system is presented in Figure 2.

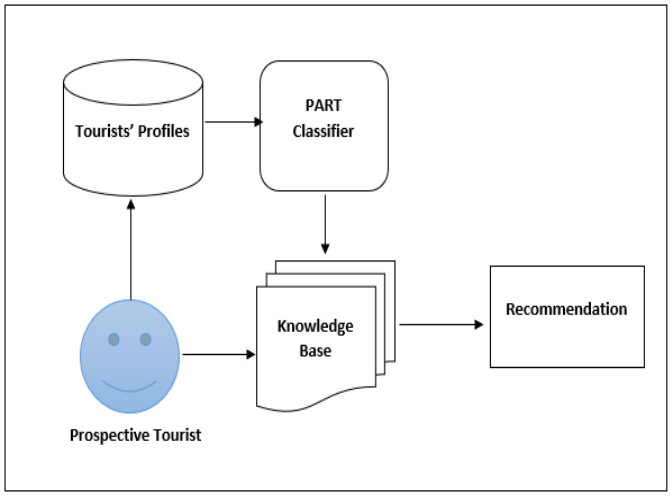


**Figure 2. Framework for Real-time User-centric Recommender System**

The system contains a database of tourists' profiles. The PART classifier module, which is embedded in the system is used to classify and generate decision rules, which form the knowledge base. Prospective tourists interact with the system by login into the system and submit their profiles. The recommendations are drawn from the knowledge base. The usability evaluation based on the two questions of usefulness and efficiency of the system for 20 prospective tourist respondents on a scale of 1 to 5 is presented in Table IV. The results showed that 85% of the respondents agreed that the system's usefulness is above average and 95% of the respondents agreed that the system's efficiency is above average. The illustrations of the Login, Registration, and Recommendation pages are presented in Figure 3, Figure 4, and Figure 5, respectively.

**TABLE IV. USABILITY EVALUATION**

| Criteria | 1 | 2 | 3 | 4 | 5 | %Above Average Acceptability |
|---|---|---|---|---|---|---|
| Usefulness | 0 | 1 | 2 | 5 | 12 | 85 |
| Efficiency | 0 | 0 | 1 | 4 | 15 | 95 |

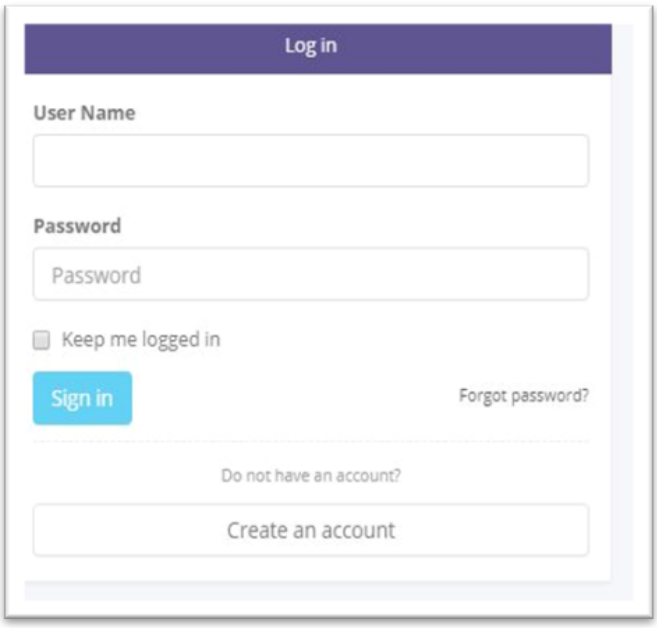


**Figure 3. Login Page**

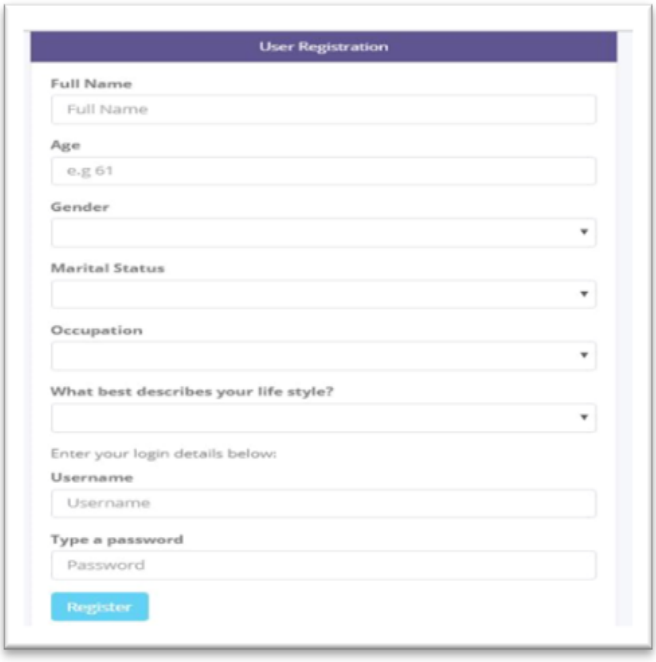


**Figure 4. User Registration page**

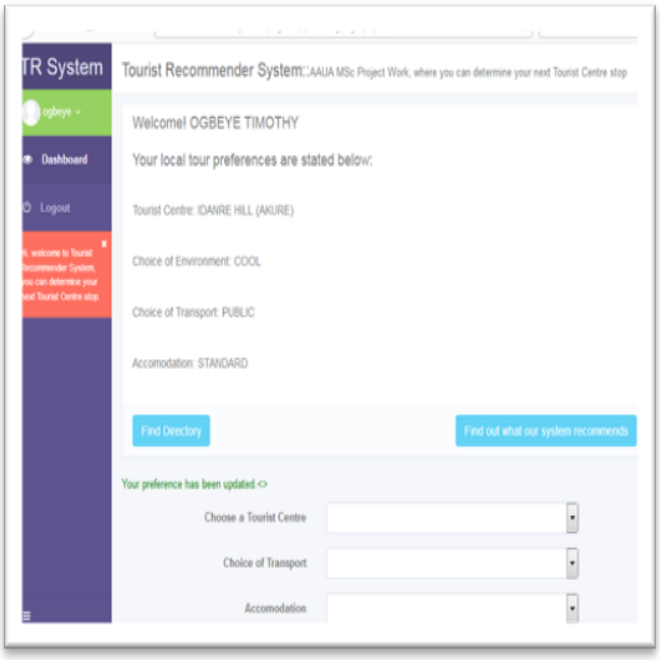


**Figure 5. Recommendation Page**

## VI. CONCLUSION

The research work has developed a data mining-based real-time user-centric recommender system for the Nigerian tourism industry. The WEKA PART algorithm is able to predict and recommend suitable tourist attractions for tourists in Nigeria. The research work proffers solutions to the limitations associated with the existing models in terms of reliability and efficiency. The data mining model and system prototype presented in this research work are highly recommended for tourist site selection. In the future, Web Ontology Language (OWL), Mahout, and a larger dataset (like Hadoop distributed file system) that can integrate all tourism databases will be explored.

## REFERENCES

[1] E. Akpan and C. Obang, "Tourism: a strategy for Sustainable Economic Development in River State, Nigeria," Int. J. Bus. Soc. Sci., vol. 3 no. 5, 2012, pp. 124-129.

[2] O. Ekundayo and O. Yusuf, "Strategic Development and Sustainability of Tourism Industry in Nigeria," 2014, 1-49.

[3] J. S. Ojo, "Managing Tourism for Socio-Economic Development in Nigerian Local Government: A Case Study of Idanre Local Government," 2014, pp. 3-7.

[4] D. Ayeni and O. Ebohon, "Exploring Sustainable Tourism in Nigeria for Developmental Growth," Eur. Sci. J., vol. 8, no. 20, 2012.

[5] S. M. Abdulhamid, and U. Gana, "Destination Information Management System for Tourists," Computer Science and Telecommunications, Georgian Electronic Scientific Journal, vol. 6 no. 29, 2010.

[6] N. A. A. Ahmad, A. Habibah, J. Hamzah, and Y. H. Mohd, "The Roles of Tourism System towards Development of Tourist Friendly Destination Concept," Canadian Center of Science and Education, vol. 8, no. 6, 2012, pp. 146-151.

[7] N. Vaidya and A. R. Khachane, "The need of the Ecommerce Era," ICCMC, 2017, pp. 100–104

[8] Z. Fayyaz, M. Ebrahimian, D. Nawara, A. Ibrahim and R. Kahef, "Recommendation Systems : Algorithms, Challenges, Metrics, and Business Opportunities," Applied sciences, 2020, pp. 9–14.

[9] B. Olarewaju, "Developing tourism in Nigeria. An Introduction to Tourism Management," in L. Merton & C. Morley. (ed.), England: Longman Publishers, 2009.

[10] A. Umanets, A. Ferreira, and N. Leite, "GuideMe - A Tourist Guide with a Recommender System and Social Interaction," Conference on Electronics, Telecommunications and Computers, Procedia Technology 17, 2013, pp. 407 – 414.

[11] R. Hassannia, A.V. Barenji, Z. Li, and H. Alipour, "Web-Based Recommendation System for Smart Tourism: Multiagent Technology," Sustainability, vol. 11, no. 323, 2019; doi:10.3390/su11020323

[12] M. A. B. Barrios, "Intelligent Tourist Recommender System Focused on Collective Profiles," Master Thesis, Department of Electrical and Electronics Engineering, Universidad del Norte, 2017.

[13] B. D. Fatmawatie, and Z. K. A. Baizal, "Tourism recommender system using Case-Based Reasoning Approach (Case Study: Bandung Raya Area)," The 2nd International Conference on Data and Information Science, Journal of Physics: Conf., Series 1192 012050, 2019.

[14] WEKA, Waikato Environment for Knowledge Analysis, 2019. http://weka.org