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Machine Algorithm-based Journey Assistant: An Intelligent Interface for Tourism Website

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Abstract. Tourism is an important sector, serving as an avenue to show the natural resources of a country and inhabitants' hospitality. This sector creates several opportunities for building a potential market and enhancing economic activities where tourist spots and activities flourish. Despite the numerous benefits, tourism still requires significant improvement, particularly in the Philippines, where there are abundant beautiful places. Therefore, this study aimed to develop a recommender system based on users and content collaborative filtering to provide local and foreign tourists with viable information for experience improvement. The investigation focused on improving tourist satisfaction based on three aspects such as preferences, ratings, and reviews that add options for tourist spots, activities/itineraries, destinations, and others. The machine algorithm-based journey assistant (MAJA) was designed as an interface and agent in providing help to tourists. The mean average precision (MAP) and recall were used as evaluation metrics to better understand the ability of MAJA to offer personalized experiences to unique users. The results showed that integration of the system into tourism provided a smart platform for enhancing tourist experience and destination competitiveness. Consequently, successful implementation of the system is measured by two criteria, namely the degree of tourists' pleasure during trip and the capacity of MAJA to effectively transfer tourism to less popular and less "accessible" sector.

Keywords: Collaborative filtering; E-Tourism; Machine learning; Recommender system; Smart platform

1. Introduction

Tourism is an essential sector, serving as an avenue to show the natural beauty of a country and hospitality to inhabitants. Currently, the majority of people depend on online services for trip planning due to the volume of information available, despite its veracity and accuracy. Among these information sources for tourists include travel companies, book guides, and website. During trip planning, tourists are required to select a destination and the various areas of interest, with the majority depending on non-personalized recommendations based on the number of visits or the average rates provided by previous users. This is because some of the common activities are very challenging and time-consuming, such as accessing huge volumes of information about destinations, leisure activities, and previous reviews of other travelers (Kbaier, Masri, and Krichen, 2017).

Tourists often aim to extend beyond simply visiting well-known attractions, learning

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about local culture, expressing preferences, and enjoying the variety of hidden restaurants. Furthermore, tourists have different preferences, some are attracted to local foods and traditional places, others by region or by continent cityscape or uniqueness of an area (Cho *et al.,* 2022). However, the typical prominent guided tours usually struggle to accommodate a large quantity of customers. Due to the recent advancement of ICT, personalized tours have become more accessible, but the task of selecting and gathering relevant information remains significant. Therefore, custom tours catering to small and medium groups of tourists deliver an itinerary based on personal preferences and provide the proper instruction while considering travel costs and travel mode choices *(*Garanti, 2023; Zhou *et al.,* 2024). Some countries like South Korea promotes its culture and tourist destinations through their Imagine Korea Virtual Reality which has a potential for helping tourists design their itinerary routes and local attractions (Drianda, Kesuma, and Lestari, 2021). Despite the potential benefits, the development of this itinerary takes enormous manpower and cost to maintain and build based on human experience and knowledge. To address the challenge, services such as TripAdvisor have performed several studies and developed tourists' information system using a recommender engine. This system offers various functionalities, including searching for travel-related services such as lodging and flights (Hirakawa *et al.,* 2015). In fact, it was revealed in some studies that factors impacting satisfaction of tourists in online platforms are those positive experiences such as discounts, product quality, user experience, and customer support (Felix and Rembulan, 2023).

Furthermore, others use advanced techniques such as the application of Deep Reinforcement Learning where tourist's reward depends on the specific spatial and temporal context in which itineraries has to be performed, predicting tourists' sentiments, and even deep learning promoting better offerings to tourists through forecasting (Dalla-Vecchia *et al.,* 2024; Essien and Chukwukelu, 2022; Martin *et al.,* 2018). However, there is a need to consider the demands of users who have difficulty using technology, prioritizing comfort and security to enhance tourism (Sustacha *et al.,* 2023; Xiong, Luo, and Lu, 2023). Low-quality tourism websites without analytics have also been considered unattractive to tourists and poor online customer services adds more to e-complaints in tourism industry (Nazli, 2020; Zvaigzne *et al.,* 2023). Therefore, smart tourism technologies are required to provide overall tourism satisfaction, particularly for tourists loyalty as a significant thrust towards developing better relationships (Arbidane *et al.,* 2023; Safitri and Abdurrahman, 2023).

Several strategies have been adopted to increase service levels and enhance communication by helping people during online searches. These strategies include filtering the best options considering users' profile such as interests, circumstances, characteristics, and improving service value on tourists site through advancements in technology (Preko *et al.,* 2023; Simo, 2012). Some tourists have identified smart hotels as tourism agenda, providing a more sustainable gain and human interaction (Casais and Ferreira, 2023). Some smart cities are leveraging on the use of digital technology to help the city achieve its goals and improve their quality life which would in turn provide much better safe and productive spaces and even help tourism managers make informed decisions through algorithms (Berawi, 2022; Kolaee, Jabbarzadeh, and Al-e, 2024). Previous studies have also identified personalization as a key element of effectiveness, added value, and commercial success in tourism industry. Personalization system originally found popularity in e-commerce sites that offered product recommendations and information to customers in decision-making about purchasing goods or services. The implementation of safe and secure models of technology in tourism has enhanced trust and facilitated tourists experiences (Tiwari, Mishra, and Tiwari, 2023). Several innovations such as VR (Virtual Reality) have focused on

stimulating mental imagery and parasocial interactions, as well as game-based interactive tourism (Arif *et al.*, 2023; Zhu *et al.*, 2023). However, the majority still express a preference to personally experience the adventure in a place which is also why destination quality plays an important role through the personal lens of the tourists (Sancho-Esper *et al.*, 2023; Arismayanti *et al.,* 2020). In fact, it was pointed out that 1% increase in the costs of introducing digital technologies corresponds to the rise of tourists which lead to the idea that the development of domestic tourism correlates with the spread of digital technologies (Arteeva *et al.*, 2022).

In suggesting content to consumers, "Recommendation Systems" are developed based on information filtering such as films, books, news, web pages, etc. Among these systems, collaborative filtering is commonly applied to data obtained from users' actions and preferences, known as personal profile. This strategy is recognized as the most widely used and efficient technology for web recommendation systems (Kenteris, Gavalas, and Mpitziopoulos, 2010). Although advanced machine learning methods, such as deep learning, ChatGPT, and large language models for tourism (Nicart, Chan, and Medina, 2018; Carvalho and Ivanov, 2023; Mich and Garigliano, 2023) can be used to handle classification issues. These methods are also compatible with recommender system and e-travel websites, offering numerous benefits and risks. Therefore, this study focused on collaborative filtering algorithm aimed at locating users with similar preferences, suggesting the recommendation of an item set to target users based on scores of the closest neighbors. The similarity of two users' rating histories tells us how similar their tastes are. This strategy, known as "people-to-people correlation," is the most popular and extensively used in recommendation systems (Casillo *et al.*, 2023).

In the Philippines, the Department of Tourism is responsible for developing and promoting the local and foreign tourism industry along with affiliated agencies as well as other government instrumentalities. Serving as the implementing and regulatory agency, the Department of Tourism requires improvement, due to the abundance of scenic locales in the Philippines (Department of Tourism Philippines, 2009). Therefore, this study focused on developing a recommender system using collaborative filtering of users and content, providing accessibility to local and foreign tourists. The results are expected to provide valuable insights for tourists to obtain adequate information and improve overall experience (Liu et al., 2024; Kenteris, Gavalas, and Mpitziopoulos, 2010).

The initiative aimed to improve tourists' satisfaction based on three important aspects, including preferences, ratings, and reviews that add options for travel destinations, activities/itineraries, attractions, and others. To provide tourists with an interface and assistance, machine algorithm-based journey assistant (MAJA) was developed. Evaluation metrics such as mean average precision (MAP) and recall were used to better understand the capacity of MAJA to offer unique experiences to different consumers. Therefore, MAJA is expected to serve the purpose of providing the most important tourism section in Camarines Norte with intelligent website system to promote tourist spots and biodiversity.

2. Methods

MAJA is a recommender system designed to consider user preferences, serving as a practical platform for tourists and similar demographics. This system is focused on providing tourists the information about the intended destinations and to recommend additional itineraries by using a chatbot or a dialogue flow created to handle the conversation. This developmental study is organized and divided into several phases, including analysis, design, development, as well as a try-out and assessment (Balmeo and

Vinluan, 2019). Other phases are also included such as analysis, prototype development, and testing, as well as final prototype revision and retesting.

2.1. System Architecture

The framework shows that there are two main users of the system, namely tourists and the provincial tourism office. Users are expected to access the online platform using several devices, while the provincial tourism office updates and maintains all data as well as information. When a visitor asks a question, the chatbot acts as a human-like interface, allowing the provision of input data. Through MAJA program, the chatbot offers suggestions in response to visitor's requests, and inquiries are properly handled by competent recommendations based on the item-based collaborative filtering recommendation system (Simo, 2012). Based on collaborative filtering, a recommender system makes recommendations in line with the similarity of terms between users. Specifically, collaborative system recommends items that other users with similar interests appreciate.

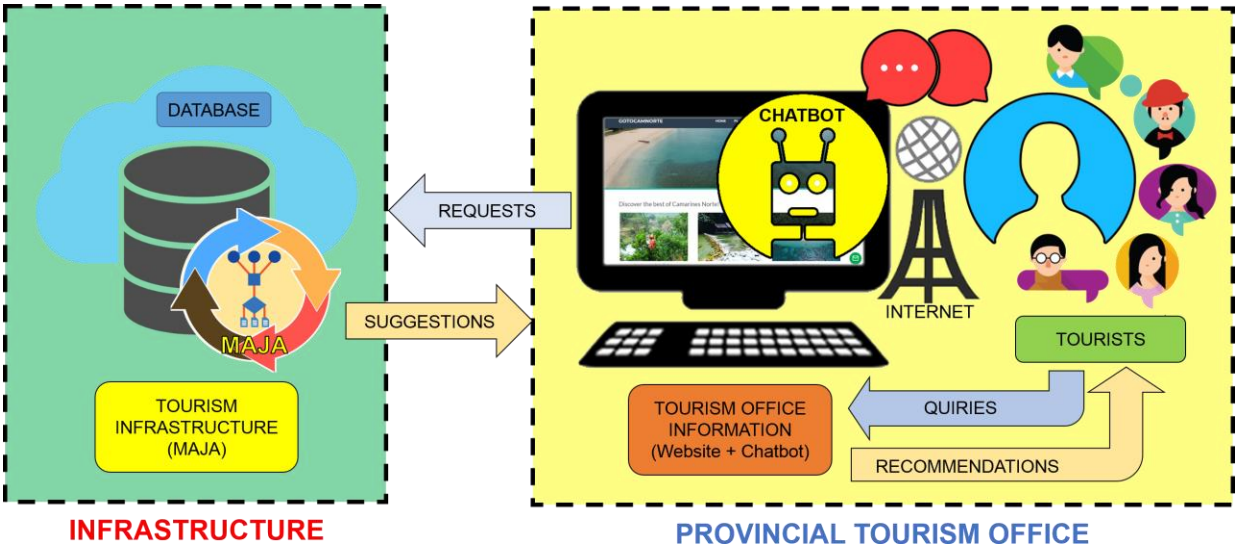

Figure 1 MAJA Recommender System Architecture

2.2. Dataset

Tourism website is expected to have counter mechanisms depending on visitor preferences as well as an inbuilt user rating and review system. Structured data is created from the information on the e-tourism website, with a web crawler obtaining data on products, users, reviews, and evaluations of products. After collection, the data are immediately exported in CSV format to Microsoft Excel. Subsequently, the retrieved data are cleaned up and pre-processed to ensure compatibility with a recommender system. Data in CSV format are transformed by the SQL Server Integration Services (SSIS) and loaded into the database (Kbaier, Masri, and Krichen, 2018).

2.3. Tourism Recommender

The assumption that tourists with similar interests have the potential to prefer the same items forms the basis of collaborative filtering-based bots. By maintaining an up-to-date database on the preferences of visitors, there is a possibility to identify nearby tourists who have interests by evaluating the preference data. Subsequently, recommendations can be provided to tourists based on the interests of others. The information is divided into four major tables before pre-processing, comprising users (id, login, age, gender, origin, region, travel style, and sub-profile category), activities (id, activity name, category, price, latitude, and longitude), rating (activity id, user id, rating), and review (activity id, user id, review).

The recommendation process of collaborative filtering-based bots has three stages. The first stage includes the representation of tourists' information, which entails analyzing and modeling past visits to attractions. The second stage is the generation of neighbor tourists by calculating similarity according to visiting records and the collaborative filtering algorithm. Meanwhile, the third stage is the generation of top attractions recommendation through the system. After logging in, the system also creates and keeps track of the users' lists of recommendations for the various attractions based on travel experiences (Jia, Gao, and Shi, 2016).

According to the procedures, fundamental users' data and previous travel behavior can be used to determine the list of neighbors, which is recorded user's database. Furthermore, users can receive recommendations for tourism spots based on the travel experiences of neighbors as shown in the system experiences (Jia, Gao, and Shi, 2016). Figure 1 depicts the process of suggestion, where the system estimated neighbors when offline for each visitor to enhance efficiency. The calculation of user's similarity is the focus of collaborative filtering system. Initially, the system must obtain all ratings that visitors T_i and T_j have given to attractions, and calculate their similarity with others using models abbreviated as sim (T_i,T_j). The Cosine, Correlation similarity, and Adjusted Cosine methods are majorly used for determining the similarity between tourists.

In this study, the Cosine method was used, viewed as a vector in an n-dimensional term space, tourist ratings. The rating was set to 1 when tourists have ever been to the attractions and otherwise assigned a value of 0 when text or documents are increasingly dissimilar (Sovina et al., 2024). Additionally, the angle between the vectors was used to calculate the cosine similarity among tourists. Several methods have been established to determine the similarity between tourists T_i and T_j:

$$sim(T_i, T_j) = \frac{R_{T_i} \cdot R_{T_j}}{\|R_{T_i}\| \times \|R_{T_j}\|} \quad (1)$$

The simplest method for determining recommendations for certain tourists is to select the items preferred by others. Since new tourists have no previous visits to the system, there is typically not enough data to provide recommendations after entry. To address this problem, the common method is to assess the comparability of users' personal information, including age, sex, occupation, vehicle, income, etc. (Jia, Gao, and Shi, 2016).

2.4. Evaluating MAJA tourism effectiveness

This study used local tourism website to understand the effectiveness of MAJA recommender system. The website runs for almost two weeks to provide enough data that could be used for establishing visitor reviews and inputs. To determine the software product produced based on performance, the ISO/IEC 25010: Software Product Quality Evaluation System was used. This framework would answer the usability of MAJA as an intelligent interface for tourism website. Subsequently, a questionnaire, based on the ISO quality models, was used as the main data instrumentation to determine the effectiveness of the system. This questionnaire was used to support the specification and evaluation of software from different perspectives through ISO 25010 which combined internal and external quality models. The product quality comprises eight characteristics such as functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. Additionally, quality use consists of five characteristics, namely effectiveness, efficiency, satisfaction, freedom from risk, and context coverage. These qualities can be measured and evaluated based on the extent to which software meets specific user needs in an actual, specific context of use.

3. Results and Discussion

3.1. MAJA System Performance

Contextual information has been identified as an essential component for making sound recommendations (Achmad *et al.*, 2017). Therefore, this study characterized and divided individual profiles of tourism topology into segments. This process facilitated the identification and classification of various activity-related events in line with several descriptions provided, which are restricted to the five domains of cultural, bioecological, adventure, rurality, and sports (Barrios, 2017). Additionally, preferences were based on the distinct characterization created for the intelligent tourist's website that performed prediction according to the results obtained. These various segmentation methods were initially created to categorize different types of tourists based on preferences. This would also improve localization of preferences with which would help better identification.

Table 1 Recommendation based on Sub-profile

Sub-profile	Description	Activities
Cultural	Cultural tourists are more interested in traditional life, language, and local habits. Inside this segment, tourists observe and participate in various festivals, folklore, and other typical activities of the community.	1. Museums, and monuments. 2. Art, handicrafts, galleries, festivals, cultural events, and theme parks. 3. Music and dance. 4. Religious ceremonies and pilgrimage. 5. Human settlements and ethnic groups.
Bioecological	Bioecological tourists visit green areas in a responsible way with the purpose of enjoying, appreciating, and studying natural attractions like landscapes, flora, and fauna.	1. Natural parks. 2. Hiking. 3. Inspection of fauna and flora. 4. Camping 5. Natural attractions 6. Farms
Adventure	Adventure tourists search for new and different sensations continuously, crossing limits for enjoyment, freedom, and experiences.	1. Mountain climbing, strolling, parade, bicycle touring, mountain biking, hunting, climbing, rappelling, and speleoloism (descent in caves). 2. Diving, rafting, and kayaking. 3. Paragliding
Rural	Rural tourists are attracted by services of the province, way of life, leisure, and relaxation places	1. Shopping and restaurants. 2. Relaxation, spa, club, and beach
Sport	Sport tourists search for active or passive participation in tourists' activities for commercial or business reasons	1. Sport activities participation. 2. Sport tourist attractions. 3. Sport events

The bioecological sub-profile comprises of tourists who visit green places responsibly to enjoy, appreciate, and study natural features such as landscapes, flora, and fauna. Cultural tourists investigate the traditional life, language, and local customs while adventure-seeking tourists are constantly searching for new experiences by crossing for fun, independence, and different sensations. Meanwhile, the province services and the rural way of life draw in rural tourists. The final category of tourists are those who engage in sport attractions, searching for spontaneous or planned engagement in activities for financial or professional gain (Barrios, 2017).

Generally, every circumstance fitting each sub-profile was evaluated using a test website, where the real chatbots with a recommender system were set up. Additionally, Table 2 shows the system's Mean Average Precision (MAP) according to the test that was run. The bioecological and rural sub-profile characterization could be shown to have the

highest accuracy and recall. This was attributed to the majority of locations and activities in Camarines Norte that corresponded with sub-profile, including natural parks, hiking, beaches, and natural attractions. Specifically, Camarines Norte surrounded by natural forests and water resources such as Bagasbas Beach, offers several options for the system and tourists.

Table 2 The Mean Average Precision Result of MAJA Recommender

Subprofile	Freq	MAP Value
Cultural	9	0.90
Bioecological	20	0.92
Adventure	18	0.88
Rural	2	0.91
Sport	4	0.81

Furthermore, the use of the recommendation system as an intelligent computer-based system could provide a wide range of boosts to the natural environmental destination of tourists through valuable suggestions (Sarkar et al., 2023). Aside from this, it can promote various areas and activities Camarines Norte has to offer through the chatbot and the web interface powered by the MAJA system.

3.1.1. Mean Average Precision (MAP) Result

The use of the Python code to provide a simulated system enabled the generation of necessary tests, specifically (MAP). This test was programmed and the results were shown in a graphical format. The chart below best represents the selected sub-profile assessed for average precision. In the graph, recall values are on the x-axis, and precision values are on the y-axis. As recall increases, we can observe how precision changes. Remember that a higher mAP indicates better model performance, so we aim for a curve that stays close to the upper-left corner of the graph.

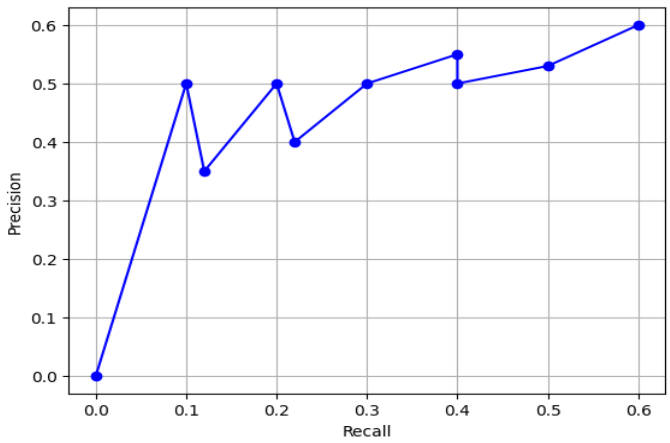

Figure 2 MAJA Mean Average precision-recall curve

According to the results, a growing tendency was observed for the system to deliver recommendations based on the users' preferences provided by the simulated chatbot and scaled in MAP. The scenario provided showed the effectiveness of MAJA recommender system in giving better predictions for tourists who prefer visiting places and interacting with locals in Camarines Norte.

3.2. Effectiveness of MAJA on a Tourism Website

Based on the results, the system effectiveness based on ISO 25010 software quality overall average was found to be 4.73. This showed that the proposed system passed the

required software standard metrics. According to the summary usability ratings of the system in Table 3, all indicators were interpreted as “Strongly Agree”. The highest ISO 25010 software quality factor on the system functionality had a weighted average of 4.81, while the least was on maintainability with a weight of 4.55.

Table 3 ISO 25010 Summary Ratings of the System

ISO 25010 Software Qualify Indicators	Weighted Average	Verbal Interpretation
Functionality	4.81	SA
Reliability	4.72	SA
Usability	4.59	SA
Performance Efficiency	4.65	SA
Compatibility	4.71	SA
Maintainability	4.55	SA
Portability	4.73	SA
Total Average	4.73	SA

Legend: 4.51-5.00 Strongly Agree (SA), 3.51-4.50 Agree (A), 2.51-3.50 Somewhat Agree (SW), 1.51-2.50 Disagree (D), 1.00-1.50 Strongly Disagree (SD)

The metrics contributed to the understanding of the system developed, namely MAJA. The system served as an intelligent interface for tourism website, possessing high-quality characteristics ready for full implementation.

4. Conclusions

In conclusion, this study showed the potential benefits of deploying an intelligent internet interface designed for tourism and engagement with the LGU sector. This innovation was developed to improve the service and performance of Camarines Norte while mapping various cultural treasures and golden opportunities within the locality. Moreover, the implementation of MAJA as a visitor assistance system offered significant benefits for tourists and provided support for marketing efforts. Further development included incorporating the technology into website in Camarines Norte and for various forms of regional tourism nationwide to attract different tourists. Consequently, successful implementation of the system depended on two criteria, namely the degree of tourist’s satisfaction during trip and the capacity of MAJA to effectively transfer tourism to less popular and less "accessible" sectors. The incorporation of this method into tourism industry would provide smart platform for enhancing the tourists' experience and destination competitiveness.

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