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Design and Implementation of a Tourism Recommendation System

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ABSTRACT
Travel software is a new type of application software that has emerged with the development of the tourism industry and advancements in science and technology. In today's era of rapid technological progress and economic globalization, an increasing number of people are becoming fond of tourism. Based on the market and functional requirements of travel software, we conducted a comparison and analysis of existing travel software. Through our research, we found that although existing travel software has comprehensive information collection about tourist attractions, it also has a significant drawback. The abundance of information implies increased difficulty in searching and selecting, posing a challenge when faced with a myriad of options. This paper proposes an architecture and module design of WeChat mini-program for tourism recommendation system. Users can input their preferences for attractions, and the software employs clustering algorithmto analyze user demands, helping users quickly and accurately find suitable attractions. Additionally, a cross-national policy module is integrated through web crawler, displaying information on entry and exit requirements, embassy announcements, and other relevant details for users with specific needs. The software also offers practical features such as destination introductions, ticket purchasing, user interaction, weather queries, transportation guides, and food recommendations. Overall, the newly designed and practical travel mini-program with intelligent recommendation features and integrated cross-national information can meet the diverse needs of different users, providing new application scenarios for the development of the tourism industry.
KEYWORDS: Tourism recommendation; Clustering algorithm; Web crawler; Mini-program

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I. INTRODUCTION

The development of the Internet has led to the gradual emergence of many emerging industries, with numerous traditional offline sectors transitioning to online platforms. Traditional tourism, being one of the offline service industries, has witnessed a shift to online services, giving rise to the market for travel and tourism apps. A fully-featured travel app that considers user perspectives is inevitably favored by people. In the early stages of the rise of travel apps, people had modest requirements, and apps providing functions such as online booking, discounted shopping, and hotel reservations were deemed sufficient. However, with changing times, people's demands for travel apps have continuously increased. Simultaneously, due to intensified competition in the tourism market, expectations from travel apps have also elevated. Some traditional travel apps may no longer meet the normal needs of travelers. For example, during the global COVID-19 pandemic, different provinces and cities in China had varying entry and exit policy requirements that changed with the evolving situation. These scattered policy updates on the internet posed significant inconveniences for individuals with inter-provincial travel needs. Similarly, different countries had ever-changing entry and exit policy requirements for citizens, and these policies were dispersed across various websites, creating significant inconveniences for individuals with international travel needs.

Currently, there are many travel and tourism apps on the market. While these apps have comprehensive information collection about tourist attractions, they simultaneously overlook the inconvenience caused to users when searching and selecting destinations that meet their specific needs. Users often waste a considerable amount of time in the process of finding and choosing their preferred destinations. Additionally, for users with international travel needs, these apps lack information on the different entry and exit policy requirements for Chinese citizens in various countries and regions. This paper, based on these considerations, explores the design and implementation of travel and tourism apps. Combining the advantages and disadvantages of existing travel apps on the market, we have designed a new and practical travel app that features intelligent attraction

recommendations and integrates information on international policies. This aims to provide better support and services for the development of the tourism industry and the travel needs of tourists.

The tourism app developed in this study incorporates machine learning algorithms to recommend attractions based on users' daily preferences. Additionally, users can quickly and accurately find their desired attractions by inputting specific requirements. This feature enables users to conveniently access relevant information about the desired travel destinations, ultimately saving them a significant amount of time. The application also employs web scraping technology to collect information on entry and exit policies for Chinese citizens in various countries and regions. This data is processed, stored, and made available to users for entry and exit policy inquiries based on their needs. The app further supports information subscription and news notifications, effectively meeting the travel planning and destination selection needs of individuals in the post-pandemic era.

II. RELATED WORKS

As the number of mobile applications continues to rise, the framework for tourism systems is transitioning from informatization to intelligence. Traditional software design alone cannot support innovative applications in today's era of massive users and data. Before 2012, literature on the design of mobile tourism interfaces was still limited, and there was also a scarcity of research on applications, web-based tourism program interfaces, and related studies. An analysis of master's theses and literature from nine journals before 2017 reveals that research on the design of mobile tourism applications in China was notably lacking. In recent years, with the innovative development of technology, various new technologies have gradually been applied to travel software. In the early stages of travel software development, domestic applications primarily offered services such as online ticket booking, discounted shopping, and hotel reservations. With the development of mobile internet, the competition among travel software in the diversified stage has become fierce, and various segmented markets continue to emerge. Technologies are mainly concentrated in areas such as AI technology, voice recognition, natural language processing, and artificial intelligence-guided tours. Overall, with continuous technological innovation, the development trend of domestic travel software has expanded from a single field to multiple aspects.

In the international arena, tourism software has also undergone continuous innovation and updates with technological advancements. In 2016, the Tourism Information Management research group at the University of Washington in the United States developed an intelligent tourism system called "Smart Tour." This system integrates technologies such as recommendation algorithms, information visualization, and big data, aiming to provide personalized tourism services and experiences [1]. In 2017, the Intelligent Data Analysis research group at City, University of London, focused on the application of technologies such as data mining, natural language processing, and big data in travel [2]. Their system, "Smart Tourist," is capable of providing personalized tourism suggestions and recommendations based on users' preferences, intentions, and historical behavior [3]. In 2019, the iVisTA Analytics group at Leiden University's School of Information and Computer Science focused on the application of information visualization and big data technologies in tourism. They developed the "Tour Crafters" system, which combines the analysis and visualization of data from multiple sources to provide market and competitive intelligence to tourism professionals [4]. In recent years, there has been a continuous integration of the latest technologies into tourism software development. For example, representative voice recognition technologies and voice assistants such as Google Assistant and Amazon Alexa have been applied. Through artificial intelligence and natural language processing technologies, these systems provide intelligent voice interaction experiences for tourists, facilitating rapid completion of tasks such as reservations, queries, and navigation [5]. Additionally, blockchain technology has been used to build tourism identity authentication and payment systems, enhancing transaction transparency and reliability, protecting the privacy and security of travelers, and thereby increasing the security and credibility of tourism software [6].

Unlike traditional tourism software, this project innovatively incorporates technologies such as web scraping and clustering algorithms in the research and design of tourism software. Additionally, a lightweight application, specifically a WeChat Mini Program, is employed.

A web crawler, also known as a web spider or web scraper, is a program designed to automatically navigate or "crawl" the internet and extract information such as web pages, images, and more. Typically, web crawlers operate by following specified rules or algorithms to systematically retrieve information from specific websites on the internet. The collected data is then saved, processed, or presented as needed. In the case of the tourism software designed in this study, web scraping technology is employed for the integration of policy information. This involves collecting and processing information using web crawlers, and ultimately presenting it to the users.

A WeChat Mini Program is a lightweight application designed to run within the WeChat ecosystem. It has the following characteristics: users can directly access and use WeChat Mini Programs within the WeChat app without the need for downloading or installation, making them easy to use and share. Developed using web

technologies, WeChat Mini Programs can run on various platforms, including iOS and Android. They are characterized by their small file size, fast development, and suitability for simple and practical applications. WeChat Mini Programs are created using the WeChat Developer Tools, an integrated development environment (IDE) for developing both WeChat Mini Programs and public accounts. The user frontend of the tourism software designed in this study is based on the WeChat platform's Mini Program, providing users with a convenient and accessible interface.

Cluster algorithm is a type of machine learning algorithm that aims to group data from a large dataset into different clusters or categories. The main applications of clustering algorithms include data analysis, data visualization, recommendation systems, and more. Different clustering algorithms are suitable for different datasets and application scenarios. This project specifically utilizes clustering algorithms for the recommendation feature. K-Means is one such clustering algorithm. Its main idea is to partition the dataset into K clusters based on the similarity between samples, where each cluster represents a category, and the center of each cluster represents the features of that cluster. K-Means algorithm is easy to understand and implement, and it is fast. Additionally, K-Means performs well in handling large-scale datasets, demonstrating good scalability for scenarios with a large number of data points and features. The intelligent recommendation feature in the tourism software designed in this study is implemented based on the K-Means algorithm. The steps for intelligent recommendation using the K-Means algorithm in this software are as follows: data cleaning and preprocessing, feature selection and extraction, setting the number of clusters K for the K-means algorithm, training the K-means algorithm, and integrating the model into the client-side. When users interact with this software, they can input their preferences and interests regarding attractions. The model, based on user preferences, recommends attractions from the same cluster or similar clusters.

III. SYSTEM ARCHITECTURE DESIGN

The front end of the travel application designed in this project is developed using the WeChat Developer Tools, while the back end is developed using Java language in the IntelliJ IDEA software. The back end is responsible for data updates and maintenance, and the data collection module gathers data through manual downloads and web scraping. Detailed design and project code writing are required during development, implemented, debugged, and tested on both the WeChat Developer Tools and the IDEA platform. The project involves building the user interface, refining various functionalities, and utilizing a MySQL database to create a repository for storing relevant data.

3.1 Overall Module Design

Overall Design Modules of the Tourism Travel Software as Illustrated in Figure 1.

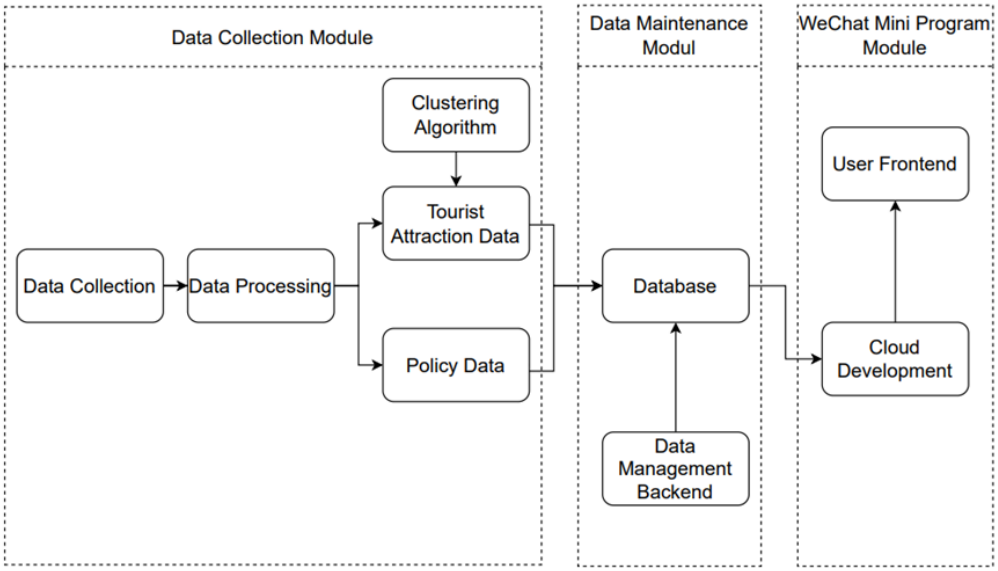


Figure 1: Overall Module Diagram

This tourism travel software is primarily structured into three major modules: the Data Collection Module, the Data Maintenance Module, and the WeChat Mini-Program Module. The Data Collection Module is responsible for the collection and processing of data, subsequently storing the processed data into the database. The Data Maintenance Module comprises a database and a data management backend. The database is utilized for storing data imported by the Data Collection Module, while the data management backend is employed for

the maintenance and updating of database data. The WeChat Mini-Program Module consists of the User Frontend and the Cloud Development Console. The User Frontend constructs the user interface, presenting the software's functionalities, while the Cloud Development Console facilitates access to the database data. Together, these modules seamlessly collaborate to ensure efficient data collection, maintenance, and presentation of functionalities through the WeChat Mini-Program interface.

3.2 Data Collection Module Design

Attraction Data Retrieval

Collecting and storing tourism attraction datasets from various platforms involves the following steps: confirming data requirements, searching for data resources, filtering data, downloading datasets in Excel or CSV format, performing initial data processing, applying the K-Means algorithm to process attraction data, and finally storing and organizing the data. The specific implementation is as follows:

Confirm Data Requirements: Clearly define the requirements for the collection of the tourism attraction dataset, specifying the needed data, corresponding data formats, data update frequency, etc.

Search for Data Resources: Explore various open data platforms, data marketplaces, data sharing platforms, tourism attraction portals, etc., to discover available data resources.

Filter Data: Preliminarily filter the identified data resources and further refine the selection based on specific criteria. For example, filter data based on dimensions such as country, city, attraction type, attraction level, cost, historical ratings, etc., to meet the specified requirements.

Download Datasets: Once the target dataset is chosen, initiate the download by clicking download buttons or locating download links. Some platforms allow direct browsing and downloading, while others may require platform account login following the provided user instructions.

Initial Data Processing: Perform data cleaning and processing on the downloaded data. Use tools like Excel to clean, deduplicate, convert formats, annotate, etc.

Apply K-Means Algorithm to Data: After initial processing, conduct a detailed data cleansing, removing unnecessary and outlier data. Extract features for each attraction based on information such as name, location, foot traffic, ratings, etc. Group all attractions based on similarity, generate feature vectors, and input them into the k-means clustering algorithm. Set the number of clusters (k) according to the desired clustering results. Use the k-means algorithm to analyze and cluster all attractions, assigning each attraction to its respective cluster.

Store and Organize Data: Store the processed data in the desired format, such as Excel files or databases like MySQL, based on specific requirements.

Policy Data Acquisition

The process of obtaining policy information data through web scraping involves several steps:

To begin, relevant libraries are imported in Python, with the requests library facilitating web page requests, BeautifulSoup and other HTML parsing libraries enabling code analysis, and pandas used for Excel file operations. The next step is to retrieve the web page source code, accomplished by utilizing the requests library to fetch the source code of the target website. Specifically for embassy announcements, data can be scraped from the official website of the corresponding country's embassy or consulate in China. Subsequently, the web page is parsed using BeautifulSoup to analyze the source code. The goal is to identify HTML tags (e.g., div, ul, li) containing information about the announcements, extracting the necessary titles and link details. The final step involves storing the acquired data, which undergoes processes like cleaning and preprocessing. The formatted data is then stored in Excel files using the pandas library, providing the option to both read from and write to Excel files.

3.3 Design of Data Maintenance Module

Database

Firstly, when creating the database to store the corresponding information, a table named "strategy-info" is required to store strategy information. Secondly, to store the crawled cross-border policies, a table named "policy-info" is designed to store cross-border policy data. Additionally, a table named "spot-info" is needed to store information about tourist attractions.

The structure of the detailed policy information table is as shown in Table 1.

Table 1: Detailed Structure of Policy Table

Name	Type	Length	Allow Nulls	Primary Key
id	int	11	No	Yes
country	varchar	255	No	
title	varchar	255	No	
www	varchar	255	No	

The structure of the detailed attractions table is as shown in Table 2.

Table 2: Detailed Structure of the Attraction Table

Name	Type	Length	Allow Nulls	Primary Key
id	int	11	No	Yes
name	varchar	255	No	
type	varchar	255	Yes	
position	varchar	255	No	
score	varchar	255	Yes	
price	varchar	255	No	
province	varchar	255	No	

Data Maintenance Backend

The overall design of the data management backend is as shown in Figure 2.

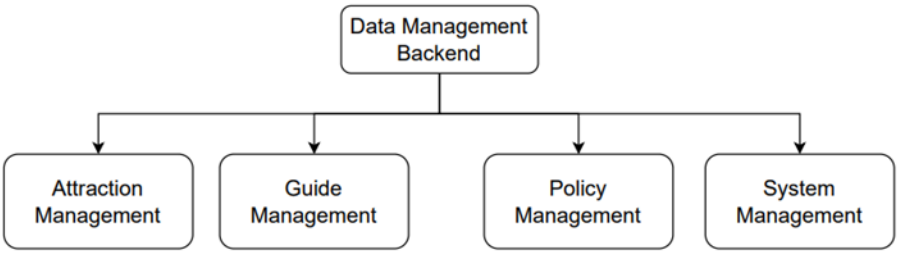


Figure 2: Management Backstage Module Diagram

The data management backend is divided into four major modules: Attraction Management Module, Strategy Management Module, Policy Management Module, and Backend System Management Module. In the Attraction Management module, administrators can add new attractions to the system, modify relevant information for existing attractions, and delete incorrect attraction information after logging into the backend. The Strategy Management module allows administrators to add new strategies to the system, beautify and modify existing strategies, view specific strategies, and delete ineffective ones. The Policy Management module, accessible to administrators upon login, enables the addition of new policy notifications to the system and the updating of relevant information for corresponding countries. The System Management module is used for logging out of the system.

3.4 WeChat Mini Program Module Design

Overall Design of Mini Program

The mini-program modules are divided into two sections: User Interface and Cloud Development, as illustrated in the following Figure 3.

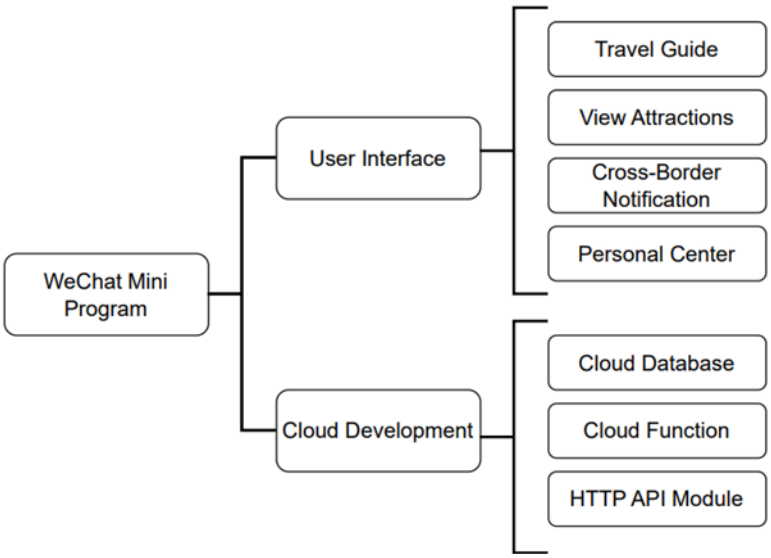


Figure 3: Mini Program Module Diagram

User Interface

The user interface is divided into four Tabbar interfaces at the bottom: Travel Guide, Sightseeing, Cross-Border Notifications, and Personal Center. The Travel Guide recommendation interface includes the following features: Recommending travel destinations, attractions, and recreational activities based on user interests, hobbies, and historical itineraries; Recommending the most popular travel destinations, attractions, accommodations, etc., based on seasonal trends and popular searches; Providing accommodation, dining, and activity recommendations based on user-selected destinations and itineraries, along with route planning and transportation guidance; Suggesting a complete itinerary including tourist attractions, accommodations, and dining based on user-selected departure time, itinerary length, destination, etc. In the Sightseeing Information interface, users can view detailed information about various attractions, quickly view attractions based on the first letter, use the search button for rapid attraction retrieval, and receive intelligent recommendations based on selected preferences. In the Cross-Border Policy interface, users can conveniently check the policy requirements of various countries according to their needs and quickly view various notices issued by embassies in recent times. In the User Center interface, users can modify their information, settings, view their collection of tourist attractions, and check their ticket purchases and preferred destinations.

Mini Program Cloud Platform

The mini-program cloud platform primarily utilizes three major modules: cloud functions, cloud databases, and HTTP APIs.

The cloud functions module is used to deploy Node.js code to the cloud development server, enabling access to a MySQL database on the cloud. Within the cloud functions module, the MySQL module is employed to connect to the MySQL database, and operations on the database are implemented using encapsulated APIs (such as SQL statement execution and query result processing). The cloud database module is used to store sensitive information like MySQL database account credentials. While it allows for CRUD operations on the database, these operations can be complex, so a data management backend is introduced to manage and maintain the data. The HTTP API module is utilized to enable data interaction between the mini-program and the MySQL database through the invocation of HTTP APIs.

The combined use of the three cloud development modules allows the WeChat Developer Tools to access data in a MySQL database. The following steps outline the process of connecting to the MySQL database: Access the cloud development console in the WeChat Developer Tools and create a new cloud development environment. In the cloud development console, enable and configure the database service to obtain database connection information, including hostname, port number, username, password, etc. In the cloud development's cloud functions or mini-program pages, import the 'Database Module.' Create a connection to the MySQL database. Execute SQL statements.

IV. MODULE DETAILED DESIGN

In Chapter 3, the design process of the three major modules of our travel and tourism software—data collection module, data maintenance module, and WeChat Mini Program module—was introduced. This chapter explains the construction processes for each module.

4.1 Data Collection Design

The Data Collection Module is mainly divided into three major steps: data collection, data processing, and data storage. The module implementation process is illustrated in Figure 4.

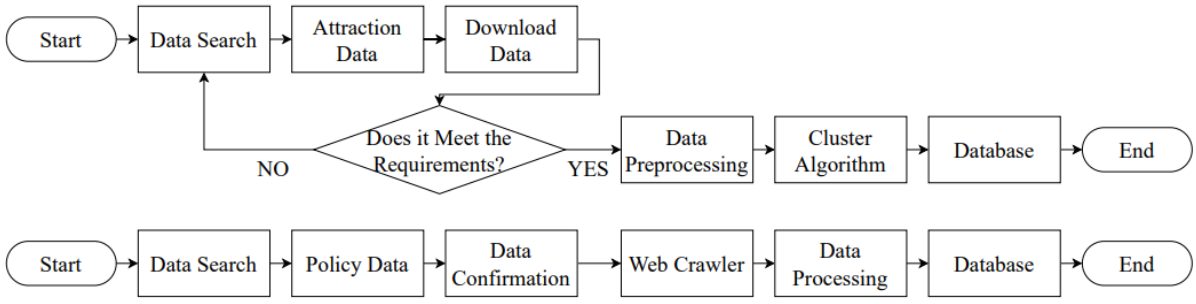


Figure 4: Data CollectionProcess Diagram

In the Data Collection Module, there are two types of data to be collected: attraction data and policy data. Both types of data are searched, processed, and then stored separately.

The first step involves searching for the required attraction data, such as in Excel or CSV format, on various platforms such as CSDN, Baidu, etc. After finding and downloading the attraction datasets from these major websites, the datasets are reviewed to determine if they meet the requirements. If the dataset does not meet the criteria, another search and download process is initiated until a suitable dataset is found. Once a suitable dataset is identified, it undergoes preprocessing, followed by the application of the K-means clustering algorithm for dataset processing. Finally, the processed data is imported and stored in a MySQL database.

For policy data, the process begins by searching for relevant websites such as the official websites of Chinese consulates, embassies, etc. After confirming the required data for collection, web scraping techniques are employed to extract the titles and URLs of announcements issued by consulates or embassies. Crawling the URLs is done in a way to preserve the native format of the announcements and prevent disruption. Finally, the collected data is processed and imported into the database.

4.2 Data Maintenance Design

The Data Maintenance Module primarily involves establishing a data maintenance management backend, connecting to the database, and maintaining and updating information related to attractions, policies, etc. The module's implementation process is illustrated in Figure 5.

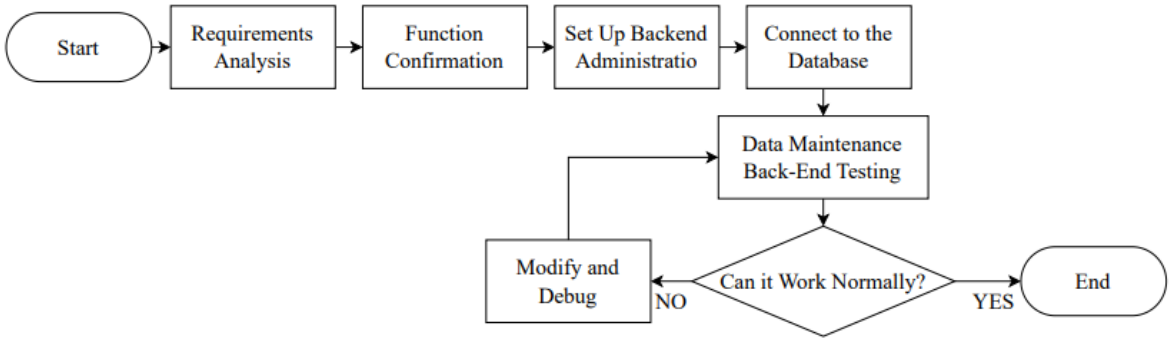


Figure 5: Data Maintenance Process Diagram

The implementation process of the Data Maintenance Module is mainly divided into two stages: the construction of the maintenance management backend and the access, maintenance, and updating of database data. During the construction of the management backend, the first step involves analyzing and confirming the functional requirements of the backend. Subsequently, the backend is constructed, and the connection to the database is established. Once the database access is completed, functional testing is conducted on the management backend. If the functions operate correctly, the module construction is considered complete. In case of any issues during functional testing, adjustments to the code and modifications are made until the management backend can successfully perform its tasks.

4.3 WeChat Mini Program Design

The construction of the WeChat Mini Program module is primarily divided into two major components: the implementation of the user interface and the access to data through the cloud platform. The overall process is illustrated in Figure 6.

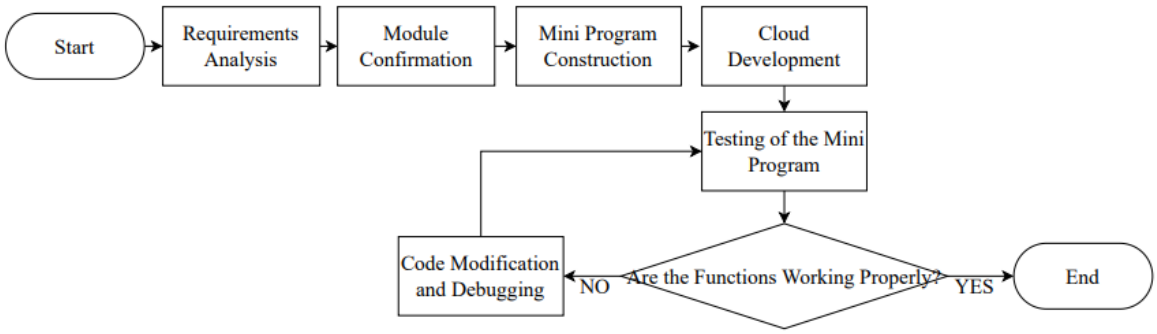


Figure 6: Flowchart of Mini Program Modules

In the implementation process of the WeChat Mini Program module, the initial step involves analyzing the requirements of the mini-program. Following this, the functionalities of various interface modules within the

mini-program are determined. The development of these functionalities is carried out using the WeChat Developer Tools, a software for mini-program development. The interfaces of each module are then implemented. Once the construction of the interfaces for all modules is completed, the WeChat Developer Tools are utilized to connect to the MySQL database through the cloud development feature. This enables access to the database, showcasing the data on the user interface. Each module's functionality is tested to ensure completeness and accuracy. In cases where functionalities are incomplete or incorrect, code modifications and updates are made, followed by retesting. This process is repeated until all functionalities are complete and correct. Upon successful testing, the construction of the WeChat Mini Program module is considered finished.

V. SYSTEM FUNCTIONAL TESTING

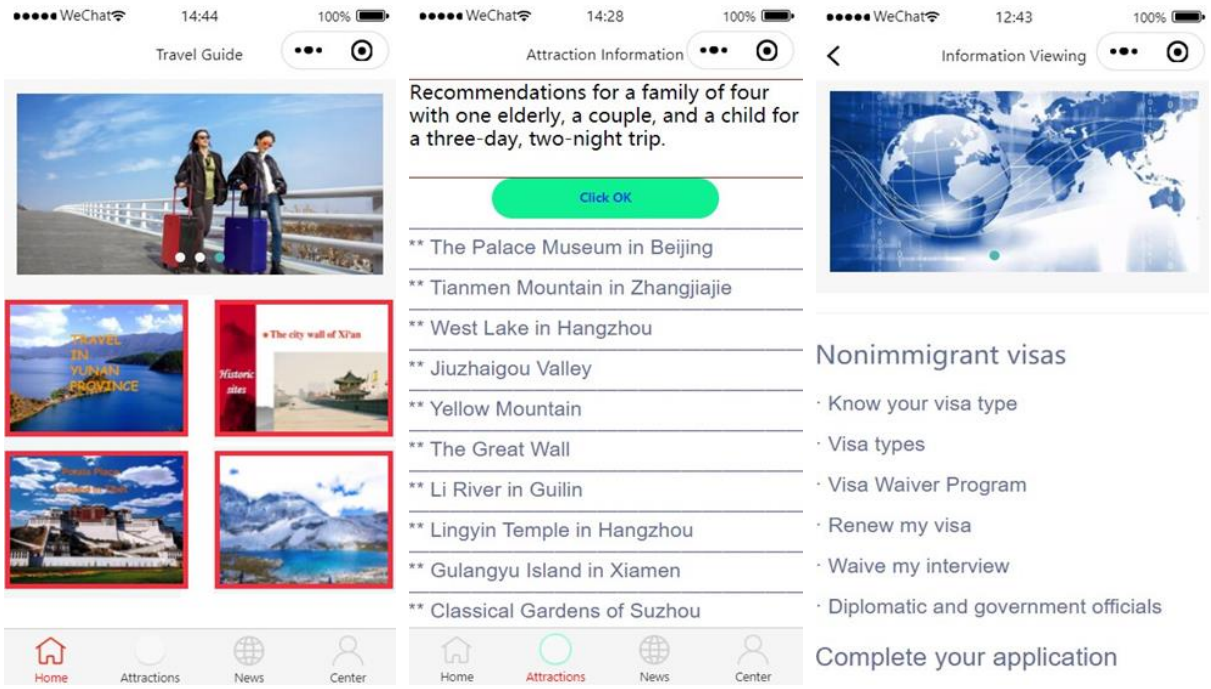
Chapters three and four respectively elaborate on the system architecture design and the detailed construction process of each module of the travel software. This chapter focuses on the functional testing and refinement of the software after its construction.

By establishing the data collection module, data is gathered using web crawlers and downloaded from various platforms in formats like Excel and CSV. The collected tourism attraction datasets undergo initial preprocessing. After applying the k-means algorithm to process the attraction data, the results are stored in a database, as illustrated in Figure 7.

id	name	type	position	score	price	province
1	Taierzhuang Ancient Town	5A	Huaxing Road East Section, Taier:	4.9	145	Shandong Province
2	Mount Tai	5A	54 Hongmen Road, Taishan Distri	4.9	28	Shandong Province
3	Qingdao Haichang Polar O(	4A	60 Donghai East Road, Laoshan D	4.8	110	Shandong Province
4	Qingdao Underwater Worlc	4A	2 Laiyang Road, Shinan District, Q	4.9	64.9	Shandong Province
5	Baotu Spring Park	5A	1 Baotu Spring South Road, Lixia	4.9	28	Shandong Province
6	Qingdao Forest Wildlife Wc	4A	Xiaozhu Mountain Scenic Area, H(	4.9	38	Shandong Province
7	Qianfoshan	4A	18 Jingshi Road, Lixia District, Jina	4.9	28	Shandong Province
8	Laoshan	5A	Inside Laoshan, Laoshan District, (	4.8	70	Shandong Province
9	Penglai Pavilion	5A	7 Yingbin Road, Penglai City, Yant	4.8	105	Shandong Province
10	Liugong Island	5A	101-2 Haibin North Road, Weihai	4.9	31	Shandong Province
11	Qingdao Beer Museum	4A	Qingdao Beer Factory, 56 Dengzh	4.9	42.5	Shandong Province
12	Quancheng Euro-American	4A	7 Travel Road, Huanghe Internatic	4.9	180	Shandong Province
13	First Spring Under Heaven S	5A	271 Minghu Road, Lixia District, Ji	5	28	Shandong Province
14	Three Confucian Temples	5A	Minggu City, Qufu City, Shandong	4.9	50	Shandong Province
15	Navy Museum	3A	8 Laiyang Road, Shinan District, Q	4.8	13	Shandong Province
16	Longkou Nanshan Tourist A	5A	Nanshan Tourist Area, Dongjiang	4.9	55	Shandong Province
17	Changdao	4A	Changdao Scenic Area, Changdac	4.8	80	Shandong Province
18	Weihai Huaxia City Scenic A	5A	1 Huaxia Road, Weihai Economic	4.9	80	Shandong Province
19	Taian Fantawild Adventure	4A	Mingtang Road North First, East I	4.9	180	Shandong Province
20	Daming Lake	4A	271 Daminghu Road, Lixia District	4.8	28	Shandong Province

Figure 7: Example of Data Storage in the Database

By utilizing the WeChat Developer Tools, the user interface for the frontend was constructed. On the homepage, users can view various recommendations for tourist attractions. The testing result is shown in Figure 8(a). Through intelligent recommendations, user requirements are analyzed to help users quickly find suitable attractions. After entering their preferences, users can rapidly receive backend-recommended attractions. Clicking on a specific attraction allows users to view detailed information about that attraction, as shown in Figure 8(b). On the News page, users can find the necessary information and introductions for traveling to the corresponding countries, as shown in Figure 8(c).



(a)(b)(c)

Figure 8:Functions of the Tourism Recommendation System

After system testing, the conclusion can be drawn that all the functions of this system can run normally. The data collection module can collect and process data and store it in the database. The data maintenance module allows users to log in to the data management background to update and maintain the data in the database. The WeChat mini-program module can display the user interface, presenting the functions designed for the mini-program. Overall, the researched and designed travel mini-program in this paper can achieve the basic functions of travel software. It also adds a recommendation feature for users to find suitable attractions and introduces new features such as checking cross-border policies. It provides a reliable travel mini-program for travelers to meet their daily needs.

VI. CONCLUSION

Traveling is a great way for people to relax, and the tourism industry serves as a significant driver for the development of many regions and employment opportunities for people. It is an evergreen industry. To ensure that travelers have a relaxing and enjoyable journey, it is necessary to design various travel plans. The designed travel software in this project has a certain degree of personalized recommendation functionality. It can provide users with personalized travel recommendations based on their interests, hobbies, and real-time location, making it easier for users to find travel routes and attractions that meet their needs. The software includes features such as viewing travel guides and information about various attractions, helping travelers save time and energy, and enhancing the overall travel experience. For users with international travel needs, it provides functions such as checking international policies, viewing announcements, etc. It is a new and highly practical travel service tool, greatly facilitating travel enthusiasts. The software is a combination of utility and innovation in the field of travel applications.

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