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Solo Culinary Recommendation System Use Web-Based Collaborative Filtering Method

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ABSTRACT

The development of a culinary recommendation system for the city of Solo through the utilization of collaborative filtering techniques is outlined in this investigation. This approach was selected based on its capacity to enhance user preferences through comparison with individuals sharing similar values. The dataset utilized in this study comprises feedback from users and evaluations of restaurants obtained from Google Maps. Collaborative filtering methodologies, particularly those centered on users, are employed to construct recommendation frameworks that offer personalized and pertinent advice to users. The initial phase of system development involved aggregating data from Google rankings and implementing a recommendation model. Findings from this research indicate that the system effectively delivers precise culinary suggestions, thereby facilitating users in discovering suitable dining options in Solo. The anticipated outcome of implementing this system is to bolster the promotion of local culinary specialties, enhance the culinary tourism experience, and contribute positively to the local economy of Solo. This study offers insights into the application of collaborative filtering and underscores the significance of recommendation technologies in enhancing the quality of culinary experiences and user satisfaction.

1. Introduction

A recommendation system predicts an object and delivers it to users in the form of useful information based on rating values. This recommendation system can be applied to food place recommendations. A commonly used method in this system is User-Based Collaborative Filtering. This technique predicts an item that a user might like based on similar ratings through a user-to-user approach [1].

Several studies have been conducted to address recommendation system issues, including a web-based job search recommendation system using hybrid-based recommendation (Nurul, 2013), which combines content-based and collaborative filtering methods using decision trees and nearest neighbor algorithms to generate recommendations. Furthermore, studies are implementing multicriteria rating using hybrid (content-based and collaborative filtering) in antivirus software recommendation systems [2].

User-Based Collaborative Filtering means that in order to find interesting items using a good method for a specific user, one uses the approach of finding other users who have similar interests or desires. Initially, user-based CF can identify nearest neighbors (user neighbors) by finding users who are similar (user similarity), and then each rating obtained from these nearest neighbors will be used as a recommendation basis for the active user. On the other hand, item-based collaborative filtering follows a scheme or pattern similar to that of user-based CF. While user-based CF seeks correlation relationships between users, item-based CF seeks correlations among items that are favored by other users of the system. Items that correlate with each other [3].

The advancement of science and technology needs to be optimally utilized to preserve Bali's distinctive culinary delights through both print and electronic media, particularly the Internet. The design of a recommendation system for recommending authentic Balinese culinary establishments can

utilize the concept of personalization recognized by researchers. Personalization systems have been successful in supporting e-commerce by influencing consumer purchasing decisions. This system is known as a recommender system [4].

With the increasing number of visitors to the city of Malang, a problem arises both out-of-town visitors and residents of Malang experience confusion when exploring culinary tourist destinations, particularly when finding the addresses of these places. This confusion is exacerbated by the abundance of culinary tourism spots that constantly introduce new dishes, leaving many visitors uninformed about these offerings. Therefore, to address this issue, an idea has emerged on how visitors can easily find the locations of these culinary destinations. To solve this problem, providing addresses and maps of culinary tourism locations, along with the routes to get there, will help travelers navigate easily to their desired culinary spots. Additionally, to further assist visitors in deciding where to dine, a recommendation system will be implemented. With this recommendation system, visitors can easily choose their desired culinary destinations [5].

Recommendation systems have been widely applied in various fields, such as tourism, studied by Rizkie and Fachurrozi (2020), where the recommendation system is implemented to provide suggestions or recommendations regarding tourist destinations based on visual matching and user input. In this study, recommendations will be provided in the form of news obtained based on the patterns or behaviors of users using the system [6].

Efforts need to be made to assist consumers in solving their problem of choosing or deciding on culinary venues they want to visit according to their preferences without feeling confused or afraid of dissatisfaction with their choice. The solution is to build a recommendation system using collaborative filtering methods. A recommendation system is an application model derived from observations of customer conditions and preferences. Therefore, a recommendation system requires an appropriate recommendation model to ensure that the recommendations align with customer preferences and to facilitate customers in making informed decisions regarding the products they will use [7].

Recommendation systems themselves have been widely used across nearly every business area where a consumer needs information to make a decision. There are two common approaches typically used in creating recommendation systems: content-based filtering and collaborative filtering [8].

The recommendation system, also known as a recommender system, began to receive attention with the emergence of collaborative filtering research in the mid-1990s. Comparisons between the two approaches in collaborative filtering have been conducted previously. In those studies, it was concluded that the item-based algorithm performs better than the user-based algorithm in terms of performance, and at the same time, the item-based algorithm also provides better prediction quality compared to the user-based algorithm [9].

In an era where social media has become part of everyday life for both children and adults, many use social media to sell goods. Besides using social media, there are also those who use various other applications such as Shopee, Tokopedia, Bukalapak, and others. In every e-commerce application, whether using social media or other apps, a recommendation system is implemented. However, recommendation systems are not only used for buying and selling goods but also for other purposes, such as recommending friends, recommending hotel rentals, recommending tourist destinations, and more. A recommendation system aims to predict information that is interesting to users and helps users make decisions. In this study, the recommendation system used focuses on the case of food sales, specifically for micro, small, and medium enterprises (UMKM) in Solo City [10].

There are two main approaches in recommendation systems: Content-Based Filtering and Collaborative Filtering. This research implements both approaches, each having its own advantages and disadvantages. The advantage of the Content-Based Filtering (CBF) method over Collaborative Filtering (CF) is that it can recommend new items to the target user based on the similarity of features contained in previously liked items by the user by looking at the positive ratings of those items. In contrast,

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collaborative filtering heavily relies on rating calculations from other users. The Apriori Algorithm is used to analyze the patterns of item combinations in this research. The advantage of association rules with Apriori is that they are simpler and can handle large datasets [11].

The development of information technology has made accessing information easier. Information sought can be obtained quickly and effortlessly and can be used for personal or group purposes. This information can be utilized for various purposes, one of which is to provide recommendations to help in selecting items from the many available options. One significant advancement in information technology is the implementation of recommendation systems. These systems simplify the decision-making process for users by providing recommendations [12].

A scientific article is a form of scholarly work specifically intended for publication in academic journals. There are various types of scholarly works with diverse topics. Due to this diversity, writers often face difficulties in finding articles that match their needs. Therefore, a recommendation system is needed to assist writers in searching for and recommending articles that align with the topics they are seeking [13].

Recommendation systems are commonly used to help users find interesting items on e-commerce websites in a personalized manner. Examples of items that can be recommended include products to purchase on e-commerce sites, music to listen to on streaming platforms, or friend suggestions on social media [14].

2. Methods

2.1. Type and Source of Data

The types and sources of data used for the research are as follows:

a. Primary Data

The primary data used in this research consists of the latest Google ratings at the time of this study.

b. Secondary Data

The secondary data is obtained from literature studies or books, research journals from other researchers that are relevant to the theme of this study.

2.2. Data Collection Methods

The data collection methods used in this research are as follows:

a. Observation

The observation method is used to collect data from Google to obtain information related to the research.

b. Literature Study

This literature study method is used to find references from previous research, journals, and reports related to the Collaborative Filtering Recommendation System.

2.3. Development Method

The Software Development Life Cycle (SDLC) stages, or what is more commonly known as the waterfall model, will be used by the author for the development of the Collaborative Filtering Recommendation System on the Solo culinary recommendation website. The Waterfall method itself has the following stages:

Below is a more detailed explanation of the design of the Collaborative Filtering Recommendation System for Solo culinary:

a. Requirement Analysis

In this stage, the researcher needs to analyze what is required for the system development, such as the necessary features on the website, tools to be used, website design, and so on.

b. System Design

The next step is to design and create a mock-up interface as well as develop the Solo Culinary Recommendation System website using the Collaborative Filtering method. In this process, the system is designed using HTML, including CSS, Python, and JavaScript.

i. Implementation

After completing the requirement analysis and system design, the next stage is implementation, where the designed system is applied in the form of a website. The website in this research is built using Native HTML programming language.

Implement and test the collaborative filtering method with the following steps :

1. Processing rating data from an item to obtain data on users who have rated the item.
2. Calculating the similarity between one item and another using the cosine similarity method based on the rating given by the user [15]. The following is the formula used to calculate cosine similarity in this research:

$$Cosine\ Similarity = \frac{\sum_i^n \ A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \cdot \sqrt{\sum_{i=1}^n \ B_i^2}} \quad (1)$$

where A and B are two vectors being compared, $A_i B_i$ are the i-th elements of vectors A and B, and n is the number of dimensions in the vectors.

ii. Maintenance

The system is hosted and used by users who wish to find the best dining place references according to their preferences and desires. Utilizing advanced technology, often called gadgets, this system allows users to find restaurants or other dining places that meet specific user criteria. Thus, users can easily find the perfect dining place for any occasion, whether for a romantic dinner, a business meeting, or a casual hangout with friends.

3. Results and Discussions

This research effort is focused on creating a recommendation system-based solution that can help users determine places to eat or restaurants according to user preferences accurately using the collaborative filtering method.

The appearance of the website is created using coding procedures involving HTML, CSS, and JavaScript. Since its inception, this gastronomic website has been developed with a focus on a one-page format that is abundant in content, requiring the creation of only one page in design. The website consists of two main sections, specifically the Home section and the Register section.

The initial segment of a website that users encounter and evaluate is known as the front-end or interface. Therefore, the website interface design should be built around a specific concept and should allow for simple customization. The front-end design process usually involves a minimum of two stages.

This culinary website has a structure that is similar to that of websites in general and follows established standards. The initial page loaded is Index.php, covering different parts of the website such as header, footer, and page sections. The system segment that defines the template path is placed inside the functions.php file.

Inside functions, there are files that can be called. Each individual file is assigned a specific role that ultimately determines the trajectory of the website as a whole, namely:

a. Theme-support.php: useful for adding general configuration, for example, menus, image thumbnails, and declaring default support.
b. Theme-options.php: The functions section is useful for theme settings.
c. Menu.php: post type that organizes content with menu types.

To be able to provide restaurant recommendations using the collaborative filtering method, data on ratings from each user who has rated an item or restaurant is needed. From these rating data, the similarity value will be calculated using the adjusted cosine similarity algorithm, and the prediction

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weighting will be calculated using the weighted sum algorithm. Here are the steps or processes of calculation using the collaborative filtering method.

The way to know if a user has given a rating is to perform calculations using Python. Once all users have provided their ratings, the author can perform calculations using the collaborative filtering formula to find the cosine similarity value.

3.1. Website Implementation

a. Homepage

This is the initial display for users when they successfully enter the Solo culinary website.

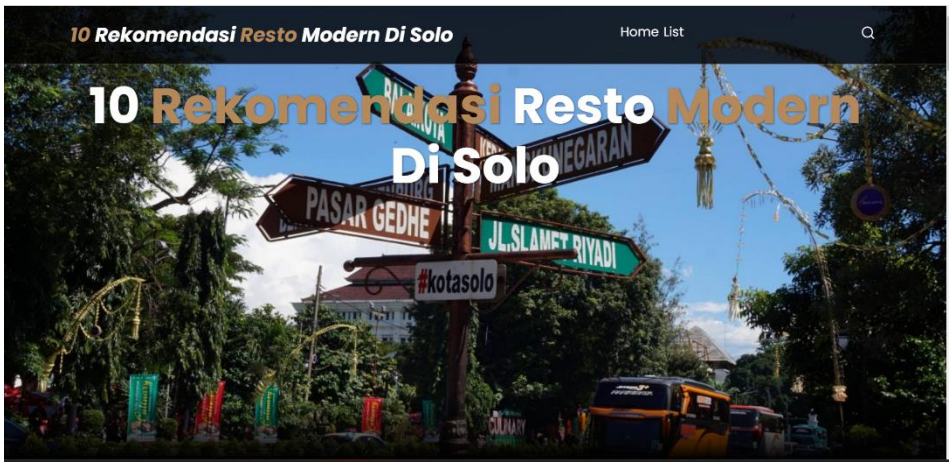

Figure 1. Initial Appearance of the Website

b. List Section

This is the core part of this culinary website, because it contains a list of restaurant recommendations that have been provided for users who visit this website.

Figure 2. Display of Website Section List

3.2. Data collection

The data for this research was obtained by sampling from Google and looking at the Google ratings of each restaurant. The ratings used in this research are numerical, on a scale of 1-5. Table 1 presents the dataset of restaurants that will be used.

3.3. Table Presentation

The following is a table presentation of the results of collaborative filtering calculations to recommend places to eat or restaurants in Solo for users. Below is the data used.

Table 1. Restaurant Data

Item	Name
1	Tiga Ceret

Item	Name
2	Rumah Makan Oh La Vita
3	Mang Engking Solo
4	Level One Solo
5	Par Four Cafe
6	Epice Restaurant
7	Tirai Bamboe Restaurant
8	Palm Ethic Solo
9	Alama Resto
10	Canting Londo Kitchen

The following is a user x item matrix table between item ratings between user1's item ratings and other users.

Table 2. Table of User1 Ratings with Other Users

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Average
User 1	5	4	3	-	-	-	-	-	-	-	4
User 2	4	-	-	5	2	-	-	-	-	-	3.6
User 3	-	-	-	-	-	4	5	4	-	-	4.3
User 4	4	-	-	-	-	-	-	-	3	5	4
User 5	-	5	-	-	-	-	4	-	3	-	4

After the rating data is formed, the next step is to calculate the similarity value between items using the adjusted cosine similarity algorithm. The following are the steps in calculating the similarity using the adjusted cosine similarity algorithm. The formula used in adjusted cosine similarity is:

$$sim(i,j) = \frac{\sum_{u \in U}(R_{ui} - \bar{R}_u)(R_{uj} - \bar{R}_u)}{\sqrt{\sum_{u \in U}(R_{ui} - \bar{R}_u)^2 + \sum_{u \in U}(R_{uj} - \bar{R}_u)^2}} \quad (2)$$

where $sim(i,j)$ is similarity value between item i and item j, $u \in U$ is the set of users u who rated item i and item j, R_{ui} is user rating u on item i, R_{uj} is rating user u pada item j, $\bar{R}_u$ is average user rating value u. The following is the calculation of the adjusted cosine similarity algorithm:

$$sim(1,2) = \frac{(5-4)(4-4)}{\sqrt{(5-4)^2 + (4-4)^2}} = 0 \quad (3)$$

From these calculations, the similarity value between item 1 and item 2 is 0. So continue doing this until all items have been calculated and produce a table as below:

Table 3. Similarity Between Items

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Item 1	-	0	-	0.38	-	-	-	-	0	-
Item 2	-	-	0	-	-	-	0	-	-	-
Item 3	-	-	-	-	-	-	-	-	-	-
Item 4	-	-	-	-	1 .1	-	-	-	-	-
Item 5	-	-	-	-	-	-	-	-	-	-
Item 6	-	-	-	-	-	-	0 .27	-	-	-
Item 7	-	-	-	-	-	-	-	0 .27	0	-
Item 8	-	-	-	-	-	-	-	-	-	-
Item 9	-	-	-	-	-	-	-	-	-	0 .7
Item 10	-	-	-	-	-	-	-	-	-	-

3.4. Presentation of Formula

The following is a presentation of the cosine similarity formula from calculating the similarity values between items in the table above:

a. Cosine similarity value of item 2 and item 3

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$$sim(2,3) = \frac{(4-4)(3-4)}{\sqrt{(4-4)^2+(3-4)^2}} = 0 \quad (4)$$

b. Cosine similarity value of item 1 and item 4

$$sim(1,4) = \frac{(4-3{,}6)(5-3{,}6)}{\sqrt{(4-3{,}6)^2+(5-3{,}6)^2}} = 0{,}38 \quad (5)$$

c. Cosine similarity value of item 4 and item 5

$$sim(4,5) = \frac{(5-3{,}6)(2-3{,}6)}{\sqrt{(5-3{,}6)^2+(2-3{,}6)^2}} = 1{,}1 \quad (6)$$

d. Cosine similarity value of item 6 and item 7

$$sim(6,7) = \frac{(4-4{,}3)(5-4{,}3)}{\sqrt{(4-4{,}3)^2+(5-4{,}3)^2}} = 0{,}27 \quad (7)$$

e. Cosine similarity value of item 7 and item 8

$$sim(7,8) = \frac{(5-4{,}3)(5-4{,}3)}{\sqrt{(5-4{,}3)^2+(4-4{,}3)^2}} = 0{,}27 \quad (8)$$

f. Cosine similarity value of item 1 and item 9

$$sim(1,9) = \frac{(4-4)(3-4)}{\sqrt{(4-4)^2+(3-4)^2}} = 0 \quad (9)$$

g. Cosine similarity value of item 9 and item 10

$$sim(9,10) = \frac{(3-4)(5-4)}{\sqrt{(3-4)^2+(5-4)^2}} = 0{,}7 \quad (10)$$

h. Cosine similarity value of item 2 and item 7

$$sim(2,7) = \frac{(5-4)(4-4)}{\sqrt{(5-4)^2+(4-4)^2}} = 0 \quad (11)$$

i. Cosine similarity value of item 7 and item 9

$$sim(7,9) = \frac{(4-4)(3-4)}{\sqrt{(4-4)^2+(3-4)^2}} = 0 \quad (12)$$

The calculations above indicate the level of similarity or proximity between various items based on the given data.

4. Conclusions

By using data from other users who have similar tastes, the system can provide culinary recommendations that are more personalized and tailored to individual interests. This increases user satisfaction and enriches the user's culinary experience.

As a result, users will receive more relevant and accurate recommendations tailored to their tastes and habits. For example, if user A and user B both like Italian cuisine and often leave positive reviews for a particular restaurant, then the system will be more likely to recommend that restaurant to other users who also show an interest in Italian cuisine.

With this approach, the user's culinary experience becomes not only more personalized but also more satisfying. Users will find it easier to find new places to eat that suit their tastes, reducing the risk of disappointment and enriching their culinary exploration. Additionally, it helps restaurants target a more precise audience, increase their business opportunities, and create stronger relationships with customers.

Overall, the use of data from other users to provide culinary recommendations that are more personalized and tailored to individual interests is an innovation that can increase user satisfaction and enrich their culinary experience. This is a real example of how technology can be used to make everyday life more enjoyable and efficient.

Implementation of the collaborative filtering method has been proven to increase recommendation accuracy compared to non-personalized approaches. This is proven through testing and evaluating system performance carried out in this research.

The collaborative filtering method works by analyzing the behavioral patterns and preferences of a large number of users to identify similarities and relationships between fellow users. This system then uses this information to provide more relevant and personalized recommendations to each user. For

example, if two users have a history of leaving positive reviews for the same type of food, the system will suggest similar food choices to users who show similar preferences.

This research opens up opportunities for further development, such as integration with other methods (hybrid systems) or the use of more complex algorithms to overcome existing limitations.

In addition, the use of more complex algorithms, such as deep learning and deep learning, can further improve the system's ability to understand user preferences in more depth. These algorithms can process larger and more diverse data, such as text reviews, food images and user behaviour patterns on the platform. For example, sentiment analysis of user reviews can provide additional insight into how satisfied users are with their culinary experiences, while image analysis can help the system identify the visual characteristics of foods that users like.

Not only that, integration with the latest technology, such as artificial intelligence, which is able to learn from data in real time, can also bring significant improvements. For example, the system can continuously learn and adapt to changing user tastes and preferences over time so that the recommendations provided are always relevant and up-to-date. The use of location data can also enrich recommendations by offering dining options that suit the user's current location, making it more practical and contextual.

This research also opens up opportunities to address more complex challenges in personalization, such as overcoming bias in recommendation data and addressing user privacy concerns. By using differential privacy techniques or data encryption, systems can ensure that user's personal information is properly protected while still being able to provide useful and personalized recommendations.

Overall, the potential for further development in this field is vast and promising. Integration with other methods and the use of more complex algorithms will not only increase the accuracy and relevance of recommendations but will also pave the way for new innovations in more personalized and satisfying culinary experiences. This will bring great benefits to users and the culinary industry, creating an ecosystem that is more dynamic and responsive to individual needs.

The advice the author can give is to determine whether to use user-based or item-based collaborative filtering based on data characteristics. User-based is suitable if the user's preference patterns are similar, while item-based is suitable if the items (culinary) have similar rating patterns. Considering using techniques such as cosine similarity (CS) to increase accuracy in data processing is also suggested by the authors.

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