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Application of Item-Based Collaborative Filtering Method for Skincare Recommendation System

Almaranda Aisyanissa Hidayat[*1)], Joni Maulindar[2)], Ratna Puspita Indah[3)]
[1,2,3)] Department of Informatics Engineering, Duta Bangsa University, Surakarta, Indonesia
[1*]202021009@mhs.udb.ac.id, [2]joni_maulindar@udb.ac.id, [3]ratna_puspita@udb.ac.id

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ABSTRACT

Skincare refers to skin care products. These products have different purposes depending on the user's skin type. Over time, public awareness and interest in skincare will increase, leading to a rapid growth of skincare products. Therefore, an Item-Based Collaborative Filtering (CF) method is used to develop a skincare recommendation system. This method will provide personalised recommendations by leveraging the behaviour data of other users with similar preferences and characteristics. This study uses user ratings and preferences for skincare products as data. This data is then used to build a CF model, which will be analysed to calculate user similarity patterns using the cosine similarity matrix. The application of the CF method demonstrates its effectiveness in matching user preferences, resulting in the most relevant product recommendations. This system not only increases the accuracy of recommendations but also helps users find products that meet their skin care needs, as the error rate in the system is 0.245.

1. Introduction

Skin is the body's outermost layer, covering almost the entire body. Its primary function is to protect the underlying organs from external factors and serve as an excretion site for sweat. Individual skin types usually vary depending on certain factors. These factors include activities, humidity, temperature, pollution, sun exposure, and daily eating habits. Generally, skin types are categorised into three main groups: normal skin, dry skin, and oily skin [1]. The diversity of facial skin types often causes individuals to make mistakes when choosing skincare products [2]. According to an expert from the Department of Dermatology & Venereology, FKKMK UGM, skincare refers to products used to maintain and enhance skin condition. These products offer benefits such as soothing, restoring, repairing, and protecting the skin. Caring for the face through a skincare routine is essential to a healthy lifestyle, just as important as exercising [3].

The wide variety of skincare products on the market poses challenges for users in identifying the most suitable products for their skin type, condition, and problems. As a result, many individuals make mistakes when purchasing inappropriate products [4], [5]. To address these issues, the author has developed a skincare recommendation system to assist users in selecting products suitable for their skin type [6]. The system uses Collaborative Filtering (CF) to provide web-based skincare product recommendations based on user ratings. This technique evaluates user preferences by leveraging the opinions of others [7]. This technique filters user data to collect information and generate personalised recommendations [8].

Previous research has explored the application of the CF method in various fields. For example, a study on a coffee shop recommendation system in Yogyakarta utilised the CF method in a web-based application. The results showed that the system effectively helped consumers by providing information about coffee shops that met their preferences [9]. Similarly, research on a skincare recommendation system using the Content-Based Filtering method and the Apriori Algorithm demonstrated that the system reduced errors in selecting inappropriate skincare products [10]. Meanwhile, this study's results

present a skincare recommendation system that generates outputs describing products recommended based on user preferences. This system enables users to select skincare products that best suit their skin type, thereby improving the accuracy and efficiency of the selection process.

2. Methods

The methods used in this study include collaborative filtering (CF) and waterfall methods. CF is applied to collect information about user ratings for previously used products. This information is then used to analyse similarities among users and skin types and to generate predictions about rated products. Meanwhile, the Waterfall method is employed to develop the skincare recommendation system systematically.

2.1. Collaborative Filtering (CF) Method

Data collection in this study involved observation and literature review methods. The observation method was used to gather data by observing various parties regarding skin types and examining several skincare products to identify their ingredients. In addition, the literature review method was employed to obtain references from journals, scientific articles, and relevant websites related to applying Collaborative Filtering (CF) methods for skincare recommendation systems. Figure 1 below illustrates the flow of the Item-Based CF method:

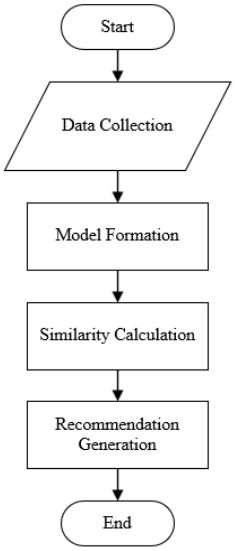

Figure 1. Flowchart of Collaborative Filtering Method

The first step involves collecting skincare data, including user preferences for items such as ratings. Other necessary data includes item attributes, such as product category, product name, and skin type. Table 1 below presents the skincare category and skin type data required for developing the recommendation system.

Table 1. Skincare Category and Skin Type

Skincare Category	Skin Type
Facial Wash	Normal
Moisturizer	Dry
Mask	Oily
Toner	Sensitive
Sunscreen	Combination

Step two involves constructing a matrix model representing user preferences for all items. Each row corresponds to an individual user in the dataset, and each column represents a specific attribute or variable within the dataset. The values in this matrix are ratings of the products, using a scale of 1, 2, 3,

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4, and 5, where one indicates less suitable and five indicates highly suitable. A rating of 0 in the table signifies that the user did not use the product. Table 2 below presents the rating data in the matrix model.

Table 2. Table Rating Data

	COSRX	Elsheskin	Safi	Npure
User 1	5	0	4	2
User 2	0	0	2	5
User 3	4	1	4	0
User 4	0	5	2	5
User 5	0	4	0	0

Step three involves calculating the similarity values using Equation 1 [11].

$$S(i,j) = \frac{\sum_{u \in U}(r_{u,i} r_{u,j})}{\sqrt{\sum_{u \varepsilon U} r_{u,i}^2} \sqrt{\sum_{u \varepsilon U} r_{u,j}^2}} \quad (1)$$

Where S = similarity value, $r_{u,i}$ = rating given by user u for item i, $r_{u,j}$ = rating given by user u for item j and U = set of users who have provided ratings for both items i and j. The final step is to obtain recommendation results by predicting user preferences for items they have not consumed or rated, based on the nearest neighbours.

2.2. Waterfall Method

The development method used for the skincare recommendation system is the Waterfall method. The development process in this model follows a sequential flow from one stage to the next, similar to a waterfall [12]. The first stage in the Waterfall method is requirements analysis. In this stage, the necessary data for system design is identified and analysed. The required data for the skincare recommendation system includes 20 skincare products and five skin types. The next stage is system design after analysing the data and system requirements. This stage involves designing the system, beginning with UML design, which provides a visual representation for system modelling. This is followed by database design, which defines the system's storage medium, and finally, interface design for the system is developed. The subsequent stage is implementation. The designed system is translated into executable code using a programming language in this phase. Once the implementation process is complete, the next stage is testing. Comprehensive testing is conducted on the entire system to identify potential errors. The final stage of the Waterfall method is maintenance, also known as upkeep. This stage is crucial for addressing any undetected errors from previous stages and minimising the occurrence of future issues.

3. Results and Discussions

3.1. Implementation of Collaborative Filtering (CF) Method

Item-Based Collaborative Filtering (CF) is a method used to provide recommendations by evaluating item choices based on the values of related items [13], [14]. The initial step in this method involves determining the average rating for products that users have rated. Table 3 below shows the manual calculation of these averages.

Table 3. Calculation of Averages

	COSRX	Elsheskin	Safi	Npure	Mean
User 1	5	0	4	2	3,67
User 2	0	0	2	5	3,5
User 3	4	1	4	0	3
User 4	0	5	2	5	4
User 5	0	4	0	0	4

Next, the similarity value between Elsheskin (i1) and Safi (i2) products is calculated using the formula from Equation 1.

$$Sim\ (i1, i2) = \frac{(1-3)(4-3)+(5-4)(2-4)}{\sqrt{(1-3)^2+(4-3)^2}\sqrt{(5-4)^2+(2-4)^2}} = -0{,}8$$

Based on the example calculation above, the next step is to calculate the similarities between other items until the final calculation. This process determines the similarity between items, as illustrated in Table 4 below, which shows the calculation of similarity values.

Table 4. Calculation of Similarity Values

Product 1	Product 2	Similarity Value
Elsheskin	Safi	-0,80
Safi	Npure	-0,37
COSRX	Safi	0.74
COSRX	Elsheskin	0,65
Elsheskin	Npure	0,17
COSRX	Npure	0,86

After obtaining the similarity values, the next step is to predict the rating for items users have not yet rated, using a formula like Equation 2 below.

$$P_{u,i} = \frac{\sum_{j \epsilon Rated(u)}(sim\ (i,i) \times r_{u,j})}{\sum_{j \epsilon Rated(u)}|sim\ (i,i)|} \quad (2)$$

Where: $P_{u,i}$ = predicted rating for user u on item i, $Rated(u)$ = set of items rated by user u, $sim(i,i)$ = similarity between item i and item j and $r_{u,j}$ = rating given by user u for item j.

$$P_{(user\ 1, elsheskin)} = \frac{\big(5 \times (0{,}65)\big) + \big(4 \times (-0{,}80)\big) + (2 \times 0{,}17)}{|0{,}65 + (0{,}80) + 0{,}17|} = 0{,}24$$

Based on the calculation, the predicted rating for User 1 towards the Elsheskin product is 0.24. The next step involves calculating predicted ratings between other users and items until all calculations are complete. This process determines the predicted ratings between users and items, as shown in Table 5.

Table 5. Prediction Calculation

User	Item	Prediction Value
User 1	Elsheskin	0,24
User 2	COSRX	1,76
User 2	Elsheskin	2,52
User 3	Npure	1,52
User 4	COSRX	4,01
User 5	COSRX	1,15
User 5	Safi	1,67
User 5	Npure	0,42

After obtaining the predicted values, these values are rounded to the nearest integer, as the rating scale ranges from 1 to 5. Table 6 below shows the resulting prediction values.

Table 6. Prediction Ratings

	COSRX	Elsheskin	Safi	Npure
User 1	5	0	4	2
User 2	2	3	2	5
User 3	4	1	4	2
User 4	4	5	2	5
User 5	1	4	2	0

Table 7 below presents the data on user skin types input into the system.

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Table 7. User Skin Type

User	Skin Type
User 1	Sensitive
User 2	Dry
User 3	Sensitive
User 4	Normal
User 5	Oily

Based on the calculations above, selecting COSRX products will recommend Safi, which is suitable for sensitive skin types. On the other hand, choosing Elsheskin products will recommend COSRX and Npure products, as both are suitable for standard skin types.

The final step involves assessing the Mean Absolute Error (MAE) to gauge prediction accuracy. This step includes determining the disparity between the average predicted outcomes and the actual ratings, as described in Equation 3 [15].

$$MAE = \frac{1}{N}\sum_{u,i}\left|r_{u,i} - \hat{r}_{u,i}\right| \quad (3)$$

Where: N = total number of predictions, $r_{u,i}$ = actual rating given by user u for item i, $\hat{r}_{u,i}$ = predicted rating for user u on item i. An example of the MAE calculation is shown below, using Table 8, which compares the predicted and actual ratings.

Table 8. Comparison of Predicted Ratings with Actual Ratings

Item *i*, User *u*	Prediction Ratings	Actual Ratings
Item 2, User 3	2,52	3
Item 1, User 4	4,01	4

$$MAE = \frac{1}{2} \times (|2{,}52 - 3| + |4{,}01 - 4|) \ = 0{,}245$$

The testing of the error rate conducted in this study, based on the Mean Absolute Error (MAE) calculation, indicates that the implemented system has an error margin of 0.245 or, in percentage terms, 24.5%. This represents the average discrepancy between the predicted values and the actual ratings, suggesting that the system has high accuracy in providing skincare recommendations.

3.2. System Implementation

a. Login Page

The login page is the gateway for users and administrators to access and log into the system by entering their email address and password into the designated fields. Figure 2 illustrates the interface of the login page for a clearer understanding.

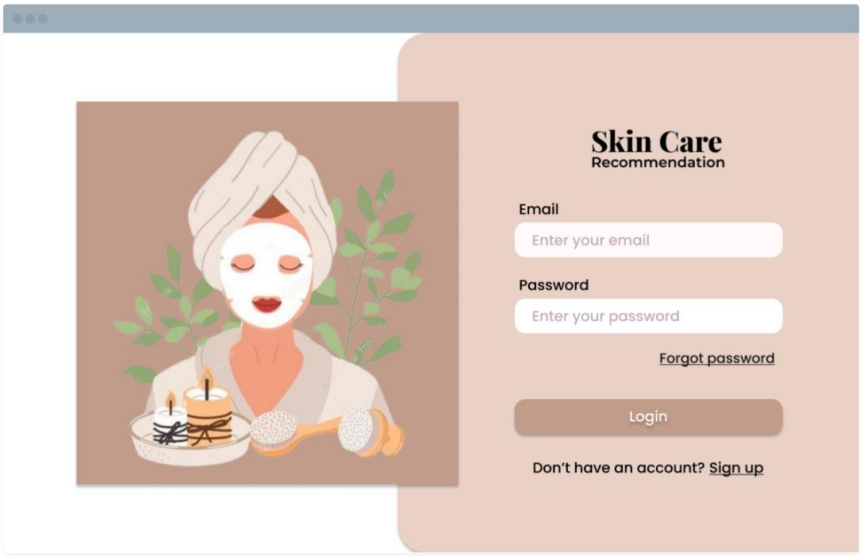

Figure 2. Login Page

b. Question Page

This page guides users through selecting their skin type from five distinct categories. To proceed to the next step in the system, users must choose the category that best describes their skin type. For better clarity, Figure 3 below displays the skin type selection page interface.

Figure 3. Question Page

c. Rating Data Page

After answering the questions related to their skin type, users are prompted to rate several products they have used. Once users provide their ratings, this data is entered into the admin system. Figure 4 below shows the user rating data entered into the system.

Product Rating

Name	Product	Rating
User 1	COSRX AC Collection Calming Foam Cleanser	5
User 1	Safi Acne Clarifying 2In1 Cleanser	4
User 2	NPURE NONI PROBIOTICS "CLEANSE ME SOFTLY" GEL CLEANSER	5
User 3	Elsheskin Oily Cleanser Wash	1
User 3	COSRX AC Collection Calming Foam Cleanser	4
User 4	Safi Acne Clarifying 2In1 Cleanser	2
User 4	NPURE NONI PROBIOTICS "CLEANSE ME SOFTLY" GEL CLEANSER	5
User 5	Elsheskin Oily Cleanser Wash	4
..		
User n	Azarine Hydrasoothe Sunscreen Mist	4

Figure 4. Rating Data Page

d. Recommendation Page

After processing the rating data, recommendations for several skincare products suitable for the user will be generated. These products are recommended based on the skincare data rated by the user. Figure 5 below shows the results of the skincare recommendation.

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Figure 5. Recommendation Page

4. Conclusion

Based on the findings of this study, the Collaborative Filtering method is effective in facilitating the selection of skincare products for users by leveraging its low error rate of 0.245 or 24.5%, as demonstrated in the testing results. The system utilises user-provided ratings for products they have used, enabling it to generate recommendations based on product similarities and evaluations from other users. Using cosine similarity to predict values, the system identifies similarities and evaluation scores for each product, thereby enhancing the recommendation process's accuracy and efficiency. This approach demonstrates the system's high accuracy in helping users choose skincare products.

References

[1] A. Rahmawaty, "Peran perawatan kulit (skincare) yang dapat merawat atau merusak skin barrier," *Berk. Ilm. Mhs. Farm. Indones.*, vol. 7, no. 1, pp. 5–10, 2020.

[2] A. Asbullah, P. Wulandini, and Y. Febrianita, "Faktor-faktor yang mempengaruhi terhadap timbulnya acne vulgaris (jerawat) pada remaja di Sman 1 Pelangiran Kabupaten Indragiri Hilir tahun 2018," *J. Keperawatan Abdurrab*, vol. 4, no. 2, pp. 79–88, 2021.

[3] Vivianisa, "Skincare: Definisi, Jenis-Jenis, hingga Urutan Pakai," 2023. https://glints.com/id/lowongan/skincare-adalah/ (accessed May 18, 2025).

[4] S. D. Kusumaningrum, "Kajian pustaka dalam penentuan tipe dan permasalahan kulit wajah," *J. Sains, Nalar, Dan Apl. Teknol. Inf.*, vol. 1, no. 1, pp. 17–21, 2021.

[5] M. R. Farhan, A. W. Widodo, and M. A. Rahman, "Ekstraksi Ciri Pada Klasifikasi Tipe Kulit Wajah Menggunakan Metode Haar Wavelet," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 3, no. 3, pp. 2903–2909, 2019.

[6] I. A. Lubis and A. H. Hasugian, "Sistem Pendukung Keputusan Dalam Pemilihan Skincare Berdasarkan Jenis Kulit Menggunakan Metode SAW," *Progresif J. Ilm. Komput.*, vol. 20, no. 1, pp. 65–79, 2024.

[7] S. A. Zulvian, K. Prihandani, and A. A. Ridha, "Perbandingan Metode Msd Dan Cosine Similarity Pada Sistem Rekomendasi Item-Based Collaborative Filtering Comparison of Msd and Cosine Similarity Methods in the Item-Based Collaborative Filtering Recommendation System," *J. Inf. Technol. Comput. Sci.*, vol. 4, no. 2, p. 2021, 2021.

[8] H. Februariyanti, A. D. Laksono, J. S. Wibowo, and M. S. Utomo, "Implementasi Metode Collaborative Filtering Untuk Sistem Rekomendasi Penjualan Pada Toko Mebel," *J. Khatulistiwa Inform.*, vol. 9, no. 1, 2021.

[9] B. Hermanto, "Sistem Rekomendasi Kedai Kopi dengan Metode Collaborative Filtering di Kota Yogyakarta Berbasis WEB," 2020.

[10] D. A. N. Safitri, R. Halilintar, and L. S. Wahyuniar, "Sistem rekomendasi skincare menggunakan metode Content-Based Filtering dan algoritma apriori," in *Prosiding SEMNAS INOTEK*

(Seminar Nasional Inovasi Teknologi), 2021, vol. 5, no. 2, pp. 242–248.

[11] E. Ayuningrum, Y. Azhar, and G. I. Marthasari, "Sistem Rekomendasi Produk Skincare Korea Berbasis Web Menggunakan Metode Collaborative Filtering," *J. Repos.*, vol. 4, no. 4, 2022.

[12] K. J. Tute, "Perancangan Sistem Informasi Perpustakaan Berbasis Web Menggunakkan Metode Waterfall," *SATESI J. Sains Teknol. dan Sist. Inf.*, vol. 2, no. 1, pp. 47–51, 2022.

[13] M. I. Mi'roj, "TA: Penerapan Metode Item Based Collaborative Filtering untuk Membangun Sistem Rekomendasi Pariwisata (Studi Kasus Kabupaten Sidoarjo)." Universitas Dinamika, 2023.

[14] H. Hartatik, S. D. Nurhayati, and W. Widayani, "Sistem rekomendasi wisata kuliner di Yogyakarta dengan metode item-based collaborative filtering," *J. Autom. Comput. Inf. Syst.*, vol. 1, no. 2, pp. 55–63, 2021.

[15] A. T. Nurani, A. Setiawan, and B. Susanto, "Perbandingan kinerja regresi decision tree dan regresi linear berganda untuk prediksi bmi pada dataset asthma," *J. Sains Dan Edukasi Sains*, vol. 6, no. 1, pp. 34–43, 2023.

 DOI: https://doi.org/10.52435/jaiit.v7i1.588