OPEN ACCESS
Indo-JC Indonesia Journal of Computing
ISSN 2460-9056
socj.telkomuniversity.ac.id/indojc

Ind. Journal on Computing
Vol. 6, Issue. 2, September 2021. pp. 33-42
doi:10.34818/indojc.2021.6.2.575

Multi Criteria Recommender System for Music using K-Nearest Neighbors and Weighted Product Method

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Abstract

Currently, the music industry has grown rapidly which has led to an information overload that hinders users from finding the music they want, because everyone has their own unique characteristics. In a previous study, the Recommender System converted music lyrics into digital values using Lexicon's Non-Commercial Research (NRC) and K Nearest Neighbors (KNN) to look for similarities between music. However, this system only uses lyrics to recommend music, so it doesn't pay more attention to user preferences. Therefore, in this study adds criteria from users using the Weighted Product Method (WPM) to weight the music criteria with the input criteria from users. In this study uses a music dataset from 2000 to 2019 taken from the Kaggle website. The purpose of this study was to measure user satisfaction using the System Usability Scale (SUS). In this case, the user is free to answer 10 questions regarding the results of the recommendations provided by the system. Based on the results of the questionnaire, the SUS score was 83.65. This score is included in the EXCELLENT category with grade A scale.

Keywords: K-Nearest Neighbors, Music, Recommender System, Weighted Product Method

Abstrak

Saat ini telah berkembang pesat industri musik yang menyebabkan kelebihan Informasi sehingga membuat terhambatnya pengguna dalam menemukan musik yang diinginkan, karena setiap individu memiliki karakteristik unik masing-masing. Pada penelitian sebelumnya, sistem pemberi rekomendasi mengkonversi lirik musik menjadi nilai digital menggunakan Non-Commercial Research (NRC) Lexicon dan K Nearest Neighbors (KNN) untuk mencari kemiripan antara musik. Namun, sistem ini hanya menggunakan lirik untuk merekomendasikan musik, sehingga tidak memperhatikan preferensi pengguna dengan lebih menyeluruh. Oleh karena itu, penelitian ini menambahkan kriteria dari pengguna menggunakan Weighted Product Method (WPM) untuk melakukan pembobotan kriteria musik dengan kriteria masukan dari pendengar. Penelitian ini menggunakan dataset musik dari tahun 2000 sampai 2019 yang diambil dari website Kaggle. Tujuan penelitian ini adalah mengukur kepuasan pengguna menggunakan System Usability Scale (SUS). Dalam hal ini pengguna bebas menjawab 10 pertanyaan mengenai hasil rekomendasi yang diberikan oleh sistem. Berdasarkan hasil kuesioner didapatkan skor SUS sebesar 83,65. Nilai skor ini masuk dalam kategori EXCELLENT dengan grade scale A.

Kata Kunci: K-Nearest Neighbors, Musik, Sistem Pemberi Rekomendasi, Weighted Product Method

Received on Mei, 2021. Accepted on September, 2021

I. Introduction

Music can convey one's feelings in the form of matched tone and lyrics, thus forming entertainment that can be heard and enjoyed. The purpose of making music is to convey feelings and can be used as a business [1]. Music has become a necessity for people to entertain themselves. There is a lot of music data in this world, starting from music provider sites and applications, causing information overload. Meanwhile, users need help to get the music they want. Currently, the music industry has grown rapidly and there are many applications that provide music such as Spotify and SoundCloud. However, this application only recommends music based on ratings and does not use information about the desired music content. Because naturally people like their own musical character. It causes new problems, because users will be difficult to find music that suits their tastes. In this study, we are designing a Recommender System based on lyrics and input criteria from users to make it easier to find the music they want. This system is called as Multi Criteria Recommender System (MCRS), which uses the criteria of users and music as variables that are considered in recommending music that suits the user [2][3].

Recommender System music using emotion and sentiment analysis found in music lyrics. On research [4] converts music lyrics into digital values using the NRC Lexicon method and then carry out the classification process using K-Nearest Neighbors (KNN), the evaluation of this study by adjusting the music to the genre obtained 20.87% according to the pop genre, 10.46% according to the rock genre, 9.03% according to the country genre, and 2.01% according to the dance/electronic genre. However, this study did not pay attention to user preferences comprehensively and does not evaluate system performance against users. Therefore, in our study we added the Weighted Product Method (WPM) method to calculate the weight given by users in finding suitable music. We use WPM because this method can calculate user criteria input by means of weights raised to the power of each music criterion and will produce results that are in accordance with the user's desire. In addition, our research uses the NRC Lexicon method to convert lyrics into the digital value of emotion and sentiment. This aims to allow the system to use the digital value of the music lyrics that will be processed by KNN to find similarities between the music. After getting the output from the KNN, then the system performs the weighting using WPM. WPM is usually used to process criteria and facilitate decision making in finding relevant data [5]. This research dataset has 8 attribute criteria (romantic, communication, spiritual, sadness, feelings, danceability, valence, energy). The function of this attribute is to adjust the criteria desired by the user. The result of WPM is a list of music based on ranking that is ready to be recommended for users.

In this study enhances previous research [4] by adding the WPM method using music criteria for decision making based on input criteria from users, as well as ranking the results obtained. In this research utilizes an English-language music dataset from 2000 to 2019 and uses 3 genres such as Pop, Rock, and Jazz. The dataset consists of 1987 music taken from the Kaggle website. MCRS is a method that can use user criteria thoroughly based on many criteria that users want. With this research, we hope that users will be more satisfied with the music recommendations provided by the system. Therefore, we tested using the System Usability Scale (SUS).

II. Literature Review

Recommender System (RS) works more effectively when it has more user information [6]. The Recommender System provides recommendations that have specifications, for example recommending music by genre [7]. The Multi-Criteria Recommender System uses more user input to support the system in making decisions that are appropriate for the user. Recommender system techniques that take advantage of user preferences are very useful and have been developed in recent years [8][9]. The type of Recommender System that is well known today is Collaborative filtering and Content-based filtering, this system collects data about customers, habits, or user preferences and makes recommendations to other users based on similar patterns in previous users [10][11].

The Multi Criteria Decision Making method uses a multiplication technique to connect attributes values, these attributes must be raised to the power of the corresponding attribute weights [12]. In this study uses WPM for music criteria data processing because this method is considered to have a short time to perform calculations [5]. The Recommender System approach relies on a single criterion rating or overall rating as a source for processing the Recommender System. However, this single rating is not effective for satisfactory

performance because the overall rating cannot predict user desires [13]. In this study uses NRC Lexicon based on Emotion Analysis to create values contained in music lyrics, this method is based on adjusting emotional words or phrases from the human language lexicon because computers cannot understand human language [14]. Paul Ekman is considered one of the foremost psychologists of the 20th century, he said that human emotions can be divided into eight senses. These emotions can be divided into anger, anticipation, disgust, fear, joy, sadness, surprise, and trust [4]. Every music lyric contains emotion, meaning that music is usually classified using the genre that is one of the elements of the music. In this study utilizes the emotions of music lyrics which are then converted into numerical values.

Machine Learning provides an automated system that can learn and improve itself from experience without being explicitly programmed [15][16]. The Recommender System can use classification using KNN to find similarities between data and can provide recommendations as many as K music that has similarities [17]. There are several other reasons this study uses KNN. First, KNN has a simple and easy-to-implement algorithm. Second, KNN performs well in numerical classification. Third, there is no parameter limit used as the surrounding number. In this study evaluates the results of user satisfaction using the Recommender System using the user-based System Usability Scale (SUS) method, this method has 10 questions 5 positive and 5 negative, each question uses a Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5) [18].

III. RESEARCH METHOD

This Multi Criteria-based Recommender System uses input in the form of music lyrics and user preferences. When the user inputs the lyrics and music criteria, then the lyrics will be converted into a Lexicon NRC digital value, then the digital value is processed using the KNN algorithm, then the output results will be weighed again using the weighted product method in the form of weighting the user's preferences which will then be evaluated against the results obtained. obtained. Figure 1 shows the system diagram.

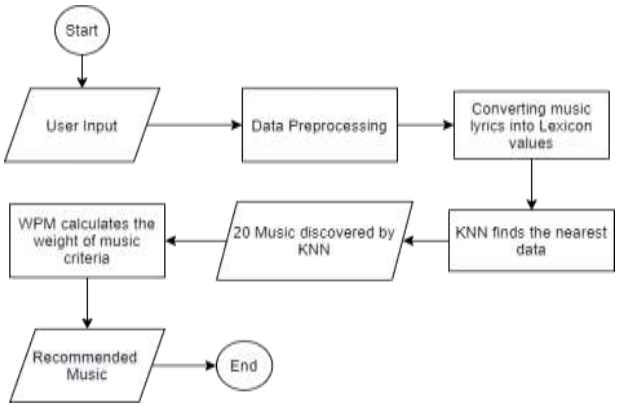

Fig. 1. System Diagram

1) Data Preprocessing

The system takes advantage of the music criteria so that the system can adjust the recommended music to the user's needs. Therefore, the author uses a dataset obtained from the Kaggle website and has the required attributes. In this study, the music lyrics will be used as the NRC Lexicon value based on the emotions contained in the music, at least from the total attributes contained in the dataset, 10 attributes will be added.

Preprocessing is done to get good results and to reduce noise in the dataset. This stage is an important step in the process of manipulating the raw dataset so that it can be processed by the system. The data set must be clean to avoid blank data, duplicate data, remove all punctuation marks in music lyrics, and check if important attributes are not empty. if there is empty or duplicate data then the data must be deleted to avoid errors when processing the dataset.

2) Extracting Lyrics into Emotional Value

In this study uses the NRC Lexicon as the basis for music quantification. We use NRC Lexicon among many Lexicons because NRC Lexicon is different from ordinary Lexicon, Lexicon NRC distinguishes

words with a total of 10 characteristics such as anger, anticipation, disgust, fear, joy, sadness, surprise, trust, positive, and negative [4]. Sentiment analysis: the study of extracted information to identify reactions, attitudes, contexts, and emotions. This means that Sentiment analysis describes a word or phrase as a positive or negative word like the example words in Table I.

TABLE I
SENTIMENT WORD EXAMPLE

Positive	Neutral	Negative
Love	Who	Abduction
Ability	Are	Sad
Absolute	You	Yelp

NRC Lexicon found the emotional value contained in music lyrics because it extracts words into 10 characters [4]. Each lyric will calculate the emotion value of the word, so it will get an emotional value. Table II has shown that each word has its own emotional value. This research is useful for the emotional value of the lexicon in music lyrics.

TABLE II
EXAMPLE OF NRC EMOTION LEXICON

Word	Anger	Anticipation	Disgust	Fear	Joy	Sadness	Surprise	Trust	Negative	Positive
Dislike	1	0	1	0	0	0	0	0	1	0
Happy	0	1	0	0	1	0	0	1	0	1
Abject	0	0	1	0	0	0	0	0	1	0
Abuse	1	0	1	1	0	1	0	0	1	0
….	…	….	…	….	…	….	…	….	…	….

It should be noted that the NRC Lexicon can be used if the word has emotions, for example the lyrics I love you so much I cannot sleep and think about you all my time, the word love has joy and positive emotions, the word time has the emotion of anticipation. Another word devoid of emotion based on your NRC Lexicon. Calculating a digital value is to add each emotion and sentiment value of a word, it can be seen to get an emotion value in equation 1 and get a sentiment value in equation 2.

$$Emotion = \sum_{i=1}^{n} \text{The Emotion of a song} \tag{1}$$

$$Sentiment = \sum_{i=1}^{n} \text{The Sentiment of a song} \tag{2}$$

3) K Nearest Neighbors

After the system has changed all the music lyrics into the form of digital values of the NRC Lexicon, the next step is to look for similarities between the values of the lexicon. KNN can search for K neighbors as much as possible, for example the user enters music lyrics, the algorithm will search for as many as 20 music that is similar to user input [19]. In this study, KNN will process around 1987 music data to find the similarity of music lyrics to the lyrics input by users. KNN has 3 steps are as follows:

1. Determine the number of neighbors (K) that will be used to find the similarity of the data.
2. Calculate the distance of each data using Euclidean Distance using the equation 3.

$$distance = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \tag{3}$$

n is the number of dimensions or features, x_i is the i feature on the data test and y_i is the i feature on the data train.

3. Take the data with the closest distance from the calculation result of Euclidean distance.

4) Weighted Product Method

In this Research uses the weighting criteria of user input, in this process WPM will process the output data from KNN, KNN produces 20 data, then WPM will produce 10 weighted data at most to be recommended to users. In this research dataset is very supportive because music has its own criteria, therefore we use it to calculate the weight of the criteria. Our dataset has as many as 8 criteria such as (romantic, communication, spiritual, sadness, feelings, danceability, valence, energy). Each criterion attribute has a value of 0 to 1, during preprocessing we normalize the criterion value to avoid outliers. Based on [20] how to calculate WPM are as follows:

1. Determine the criteria used.
2. Calculate the preference value for each alternative i -th with the equation 4.

$$S_i = \prod_{j=1}^{n} x_{i_j}^{\bar{w}_j} \tag{4}$$

Where the value of $\bar{w}$ is positive if the criteria are favorable.

3. Calculate the relative preference value of each alternative against all alternatives using equation 5.

$$V_i = \frac{S_i}{\sum_{i=1}^{M} S_i} \tag{5}$$

4. The higher the value of V means the better the alternative.

For example, user input the relative weight of each criterion ($\bar{w}_j$) thus calculated as 0.3, 0.19, 0, 0.1, 0, 0.6, 0.12, and 0 for C1 to C8, respectively. In this study using criteria C1 to C8 to calculate WPM using equations 4 and 5. An example of WPM calculation is shown in Table III.

TABLE III
WPM CALCULATION SAMPLE

Alternative	C1	C2	C3	C4	C5	C6	C7	C8	S_i	V_i	Rank
	0.3	**0.19**	**0**	**0.1**	**0**	**0.6**	**0.12**	**0**			
A	0.01	0.1	0.01	0.53	0.01	0.40	0.42	0.57	0.246	0.106	1
B	0.1	0.0	0.08	0.00	0.00	0.45	0.27	0.82	0.170	0.074	2
C	0.00	0.0	0.0	0.00	0.00	0.60	0.47	0.63	0.037	0.016	5
D	0.01	0.3	0.01	0.01	0.01	0.71	0.50	0.34	0.137	0.059	4
E	0.00	0.2	0.00	0.11	0.00	0.55	0.24	0.75	0.142	0.061	3

5) Evaluation

The research evaluation uses the System Usability Scale (SUS) because this method can measure user satisfaction in using the application. SUS has 10 questions and 5 answer choices, the answer choices consist of strongly disagree to strongly agree. SUS has a minimum score of 0 and a maximum score of 100. SUS in its original language uses English [21]. SUS has a question template that cannot be changed and the context of the question cannot be modified. The rules for calculating SUS, odd-numbered questions the user's score will be deducted by 1, even-numbered questions, the final score are obtained from a score of 5 minus the question scores obtained from the user, and the SUS score is obtained from the sum of the scores for each question which is then multiplied by 2.5. The score calculation rule applies to 1 respondent. For further calculations, the SUS score of each respondent is sought for the average score.

IV. Results And Discussion

We use a total of around 1987 music. This music source comes from the Kaggle website database, music generated using the application to generate criteria. Table IV shows that each music has a different emotion score. In this study, the system has a user interface shown in Figure 2. In this system user interface has 3 steps that need to be done as follows:

1. Users must input English music lyrics consisting of more than 20 words.
2. Users determine the criteria used, 8 criteria have been provided, the value of each criterion consists of 0 to 1.
3. Users press the Recommended button to see the results of music recommendations.

TABLE IV
EXAMPLE OF NRC LEXICON VALUE ON MUSIC

Music	Anger	Anticipation	Disgust	Surprise	Positive
	4	2	4	3	3
A	**Fear**	**Joy**	**Sadness**	**Trust**	**Negative**
	4	1	11	2	11
	Anger	**Anticipation**	**Disgust**	**Surprise**	**Positive**
B	2	8	0	1	8
	Fear	**Joy**	**Sadness**	**Trust**	**Negative**
	3	8	0	7	1

Fig. 2. User Interface

For example, user input the lyrics *'I can make you fall in love with me Even if you don't love me give me a little time Let love come because you're used to it Save the rose I gave Maybe its scent inspires you to know me first Before you spit on me Before you tear my heart'* and criteria (Romantic: 0.5, Feelings: 0.3, Sadness: 0.15), then the output shown in Figure 3.

Fig. 3. Output Recommender System

As shown in Figure 4, the system displays 10-best music by ranking. Then users can search for the artist and title of the music on the internet, for example, search for music on Spotify.

1. *Measuring User Satisfaction*

In this research uses the System Usability System (SUS) method to measure user satisfaction. SUS has 5 positive questions and 5 negative questions, each odd numbered question is positive and odd numbered question is negative, a total of 10 questions. SUS respondents are given a choice of a scale of 1-5 to answer based on how much they agree with each statement on the product or feature we are testing, a score of 1 (strongly disagree) and a value of 5 (strongly agree). The evaluation of this study involved more than 60 participants (students and workers) aged between 20-23. Users are asked to input the desired lyrics and music criteria, after the user presses the Recommend button, the system will issue a list of 10 artists and music titles based on their ranking order. After that, users can search for music recommended by the system on the internet. If the results of the recommendations are in accordance with what they want, then the user gives a positive satisfaction value. Figure 3 is an example of the scores of 15 participants, there are SUS RAW Score and SUS Final Score. SUS Final Score is obtained from SUS Raw Score multiplied by 2.5. The results of the analysis of 60 participants obtained an SUS score of 83.65 and were included in the EXCELLENT category with grade scale A.

Fig. 3. System Usability Score

To make the SUS score more meaningful, it is necessary compared to something. With 30 years of usage benefits and data from over 10,000 responses and hundreds of products [22]. We interpret SUS in 4 ways. Figure 4 summarizes acceptability, adjective, and grades services. Table V gives the value of the chart in Figure 4.

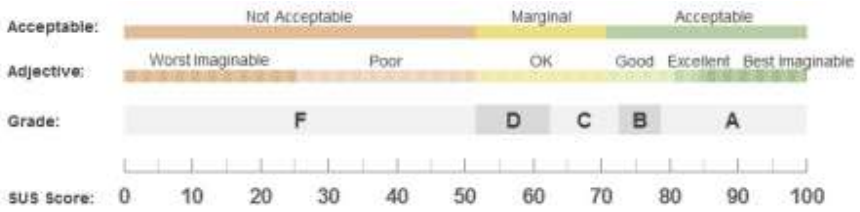

Fig. 4. Acceptability, Adjective, and Grades categories associated with raw SUS scores.

TABLE V
PERCENTILE, GRADE, ADJECTIVE, AND ACCEPTABLE TO DESCRIBE THE SUS SCORE

Grade	SUS	Percentile range	Adjective	Acceptable
A+	84.1-100	96-100	Best Imaginable	Acceptable
A	80.8-84.0	90-95	Excellent	Acceptable
A-	78.9-80.7	85-89		Acceptable
B+	77.2-78.8	80-84		Acceptable
B	74.1 – 77.1	70 – 79		Acceptable
B-	72.6 – 74.0	65 – 69		Acceptable
C+	71.1 – 72.5	60 – 64	Good	Acceptable
C	65.0 – 71.0	41 – 59		Marginal
C-	62.7 – 64.9	35 – 40		Marginal
D	51.7 – 62.6	15 – 34	OK	Marginal

a) Percentiles
SUS scores can be converted into percentile ratings. Percentile ratings tell you how well raw scores are produced compared to others in the database. The average score on the 50th percentile is 68, that means SUS scores over 68 are above average and less than 68 are below average. In the results of this study, we obtained a SUS score of 83.65 which means above average and has a percentile range of 90-95 based on Table V.

b) Grades
Closely related to percentile rankings are grades. Values range from A, indicating superior performance, to F for failing performance and C indicating average performance. In the results of this study obtained grade A.

c) Adjectives
This adjective is used to define system performance results. For example, a score above 85 was associated with Excellent, Good only above average at 71 and OK for a score at 51. The adjective "Terrible" was not significantly different from the other adjectives and was excluded.

d) Acceptability
Another variation on using words to describe SUS is to think about what Acceptable or Unacceptable is Set this term when SUS is well above average or well below average.

V. CONCLUSION

The Multi Criteria Recommender System offers a method of how to thoroughly use user preferences. In this study, users are free to use their own music lyrics and enter music criteria from the 8 criteria offered. Interestingly, by using the NRC Lexicon music lyrics have emotions in the form of digital values contained in them, so this study can utilize these values as data that will be processed by KNN to look for similarities between music. WPM plays an important role and delivers significant results. Because each music criterion used will give different results. The conclusion of this research focuses on the results of user satisfaction who have tried and used this music recommendation system. The SUS score of 83.65 was obtained from the results of an analysis involving 60 participants. Based on the interpretation of the SUS Score In terms of Acceptability Range, this system is in the Acceptable category, the Grade Scale is in Grade A and the Adjective Rating is in

the Excellent position. While the assessment with percentile rank on the average score of 83.65 lies in Grade A.

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