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Music Recommendation System based on Listening History Data

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Abstract: ***The ease of accessing music as well as the fast growing numbers of new musical pieces has made music listeners spend more time to choose music pieces in order to make a suitable playlist. Music recommendation can help music listeners to make a suitable playlist with just a minimum effort and time. There are various music features that have been used to produce music recommendations, such as music content, music context, user properties, and user context. In the current research, context features that are more related to user properties will be used to create a playlist of music recommendations. The features used are demographic features such as age, gender, and country. Listening history from users are also collected, so it is known what type of music is often listened to at certain times. These features are expected to make music playlists more user-friendly when compared to only using music content features. The Self Organizing Map method will be used to classify the listening history data. Music in the same cluster (having many similarities) will have a higher chance being in the same playlist. The recommendation system built in this research has an average precision of 0.606. The precision value obtained is not high, it is necessary to add a recommendation feature that is closer to each user's personalities, such as musical genre preferences to increase the value of precision.***

Keywords: context-aware, listening history, music information retrieval, music recommendation

1. Introduction

Technology developments have changed how music listeners listen to their favorite pieces of music. Roughly thirty years ago, music listeners have to listen to the radio, go to musical events, or buying cassettes to listen to their favorite music. At that time, music listeners did not have direct ability to decide which piece of music is going to be played next or music composition in a playlist (in a cassette or other media). In the 2000s, music listeners can listen to music digitally using devices such as computers or mp3 players and finally have a direct ability to create playlist and decide which music is going to be played. Today, music can easily be accessible by anyone, anytime and anywhere as long as there is a working internet connection.

The ease of accessing music as well as the fast growing numbers of new musical pieces has made music listeners spend more time to choose music pieces in order to make a suitable playlist. Music recommendation can help music listeners to make a suitable playlist with just a minimum effort and time. There are various music features that have been used to produce music recommendations, such as music content[1], music context, user properties, and user context[2].

Recent researchuses music listening history data to produce music recommendations based on the cultural backgrounds of listeners from different countries[3].In this research, context features that are more related to user properties will be used to create a playlist of music recommendations. The features used are demographic features such as age, gender, and country. Listening history from users are also collected, so it is known what type of music is often listened to at certain times. These features are expected to make music playlists more user-friendly when compared to only using music content features. The Self Organizing Map method will be used to classify the listening history data. Music in the same cluster (having many similarities) will have a higher chance being in the same playlist.

2. System Overview

This system is accessible from a laptop browser (such as Google Chrome), with an internet connection. The system is implemented in the form of a website, so that it can be accessed by more than one user simultaneously from different places. Figure 1 illustrates how the system works.

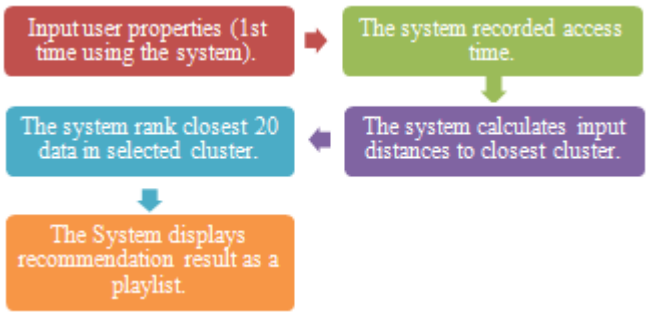


Figure 1: System Overview

The system can display music recommendations in the form of music playlists composed of 20 pieces of music. Inputs given by the user for the first time using the system are called user properties, consisted of age, gender, user preferences for new music, and user preferences for mainstream music. Next, every time the user log in to the system, the system just record the system access time to determine recommendation.

Music recommendations are generated when the user enters the application. When the user enters, the system will automatically record the time input and the system will automatically provide music recommendations by calculating the input distance to the closest cluster, than rank data in the cluster which are closest to the input. Previously, music in the system would be clustered using the self-organizing map algorithm.

3. Research Methods

This section explains how the data is collected, self-organizing map method, and system evaluation method.

3.1 LFM-1b Dataset

The dataset used in this study is LFM-1b listening history dataset. LFM-1b Dataset is a dataset with more than one billion listening events (or listening history) created by more than 120,000 Last.fm users[3]. Each listening history consists of artist, album, music title, and time / hour when the user listens to the music.

Only a portion of the data in the LFM-1b dataset was used in this study. The amount of data used in this study are 869,652 listening histories data from users in 10 different countries/continent, namely the USA, Russia, UK, Brazil, Indonesia, Japan, Australia, China, Canada, and Argentina. Users in this research dataset are 16 to 40 years old. Each user has 500 to 2,000 listening history data.

In clustering using the Self Organizing Map method, the user properties data used consists of user_id, country, age, gender, novelty_artist_avg_year, and mainstreamness_global. The listening history data consists of listening_events_id, user_id, artist_name, album_name, track_name, and timestamp.

3.2 Self-Organizing Maps

The self-organizing map (SOM) algorithm is used to group listening history data into clusters. The SOM network uses an unsupervised learning method that maps data from any dimension into a two-dimensional map[4]. The SOM network consists of two layers, namely the input layer and the output layer. Each neuron in the input layer is connected to each neuron in the output layer. Each output layer neuron represents a cluster of given inputs.The SOM network produces projections of data space onto a two-dimensional space map in such a way that similar data items are located close to each other on the map[5].

The networks used as experiments in this study are network with 9 output neurons (3x3 neighborhoods), 16 output neurons (4x4 neighborhoods), 25 output neurons (5x5 neighborhoods), 36 output neurons (6x6 neighborhoods), 49 output neurons (7x7 neighborhoods), 64 output neurons (8x8 neighborhoods), 81 output neurons (9x9 neighborhoods), and 100 output neurons (10x10 neighborhoods). One network with the best clustering results will be selected and used in the recommendation system.

3.3 System Evaluation

A recommendation system recommends items based on the likelihood that the item will meet the preferences of a specific user. The user is the only person who can determine whether an item meets its preferences. Therefore, the relevance of an item is more subjective in a recommendation system compared to the traditional document retrieval system[6]. Precision value calculation can be used to evaluate recommendation system. Precision is defined as relevant data that has been retrieved[7]. Precision in the recommendation system is calculated by Equation 1 [8].

$$Precision = \frac{tp}{tp+fp} \quad (1)$$

True positive (tp) in information retrieval is a relevant item produced by the system as a recommendation (in this research it is indicated by the presence of the recommended music in user's listening history), while false positive (fp) is an irrelevant item produced by the system as a recommendation(in this research it is indicated by the absence of the recommended music in user's listening history).

4. Research Results

The research results described below consist of self-organizing map clustering result, user interface implementation, and system evaluation result.

4.1 Self-Organizing Map Clustering Result

Clustering experiments was done using several neighborhoods mentioned in section 3.2. Figure 2 shows clustering results for 3x3 neighborhoods (9 clusters). The numbers in the middle are showing total data inside the cluster.

Figure 2: Clustering result of network with 9 neurons

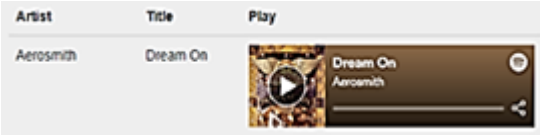
The best cluster is chosen by calculating the distance between clusters' centroid. The best cluster is the cluster with the largest distance between centroids. This shows that the cluster members are well separated. Table 1 shows the distance between centroids of each cluster in the network with neighborhoods 3x3 to 10x10. The network with the largest cluster distance is the 3x3 neighborhood. So that the cluster used to provide recommendations consists of 9 clusters.

Table 1: Cluster Separation

Neighborhood	*Cluster Separation*
3x3	0.366573598
4x4	0.341938561
5x5	0.309635905
6x6	0.311112171
7x7	0.297086301
8x8	0.280940552
9x9	0.277438399
10x10	0.271560246

4.2 User Interface Implementation

The results of the user interface implementation can be seen in Figure 3. The recommendation information obtained is the name of the artist, the title of the music, and the preview of the music that can be played.



4.3 System Evaluation Result

Music recommendations are given to 100 users from 10 different countries/continents which are used as test data. Figure 4 shows the average precision of each country/ continent. The highest average precision value is in the Australian Continent with an average precision value of 0.76, while the lowest value is in the country of Japan, with an average precision value of 0.385. The average total recommendation system for the whole region is 0.606 or in other words 60.6% of the recommendations are considered relevant according to user preferences.

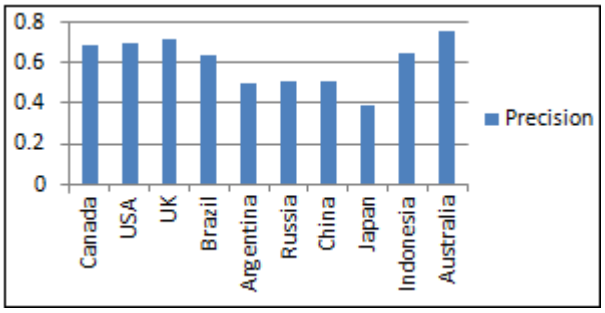


Figure 4: Precision Value Average for Each Country/Continent

The precision value is not too high, it could be caused by the features used (age, gender, user preferences for new music, and user preferences for mainstream music) to recommend music is not enough to differentiate users. So that some of the recommendation given in this research is not suitable for the users. Additional recommendation features are needed to get a higher precision value. The features should be able to describe/differentiate users better, making it more personal, such as music genre preferences.

5. Conclusion and Suggestion

This research concluded that a music recommendation system can be built based on context data in listening history and self organizing map methods. The self organizing map network with cluster number = 9 (3x3 neighborhood) has the best centroid distances in this research with an average centroid distances of 0.36. The recommendation system that was built has an average precision of 0.606 based on testing result of 100 test data from 10 different countries/regions.

Additional recommendation features are needed to get a higher precision value. The features should be able to describe/differentiate users better, such as music genre preferences.

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G. A. Vida MastrikaGiri, S. Kom., M.Cs. received her bachelor degree in Computer Science Department, Udayana University, Indonesia in 2012. She received her master degree in Computer Science from GadjahMada University, Indonesia. She is interested in recommendation system, information retrieval, and artificial intelligence. Now she is working as a lecturer at Informatics Department, Udayana University, Indonesia.

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