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Application of the K-Nearest Neighbors Algorithm in Anime Recommendation System Based on Genre Preferences and Web-Based Ratings

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Abstract

The rapid growth of the anime industry has resulted in an increasing number of anime titles being released every year. The large variety of available anime often makes it difficult for users to find anime that match their interests and preferences. The process of searching for anime manually requires considerable time, as users need to review genres and ratings individually. Therefore, a recommendation system is needed to assist users in finding suitable anime more quickly and efficiently. This study aims to develop a web-based anime recommendation system using the KNearest Neighbors (KNN) algorithm based on users' genre and rating preferences. The dataset used in this research was obtained from the Anime Recommendations Database available on Kaggle, consisting of 12,294 anime records. The research process includes data collection, data cleaning, attribute selection, data transformation, KNN algorithm implementation, and web-based system development. The KNN algorithm is applied to calculate the similarity between user preferences and anime data using the Euclidean Distance method. The results of this study indicate that the developed system is capable of providing anime recommendations that match users' preferences based on selected genres and ratings. The system also provides features for anime data management, recommendation searches, anime detail views, and a watchlist feature for saving anime that users intend to watch. The implementation of this system helps users find suitable anime more easily, quickly, and efficiently compared to manual searching methods.

Keywords: *Recommendation System, Anime, K-Nearest Neighbors (KNN), Genre, Rating, Web-Based System.*

1. Introduction

As the popularity of anime grows around the world, the number of anime titles available also continues to grow. Users, especially new viewers, often have difficulty determining which anime suits their preferences. This creates the need for a system that can help recommend anime automatically and relevantly.

Anime is a very popular form of entertainment among the global community, especially the younger generation. With a wide variety of genres such as action, drama, comedy, horror, and fantasy, anime offers a diversity of content that is able to attract the attention of audiences with different preferences. Along with the rapid growth of the anime industry, the number of anime titles available on various platforms has also increased dramatically[1].

The recommendation system is an important solution in dealing with this problem. This kind of system can intelligently filter information based on user preferences, either explicitly (e.g. based on *ratings*) or implicit (such as *frequently* watched genres). Thus, users can save time in searching for anime that suits their tastes.

One of the methods that can be used in building a recommendation system is the *K-Nearest Neighbors* (K-NN) algorithm. K-NN is a An instance-based learning algorithm that classifies new data based on its similarity to previous data. In the context of the anime recommendation system, K-NN can be used to search for anime that have similarities in terms of *genre* and *ratings*, and then recommend anime that most closely match the user's preferences[2].

Genre and *ratings* are two important attributes in the anime recommendation system. *Genres* reflect the categories of stories and themes that users are interested in, while *ratings* reflect how well the anime is received by other users. By utilizing these two attributes, the recommendation system can provide more personalized and relevant results[3].

However, the main challenge in designing a recommendation system is how to effectively measure similarities between anime and ensure the system can work efficiently even with large amounts of data. Therefore, the application of the K-NN algorithm to the anime recommendation system based on *genre* and *rating* is the main focus of this study[4].

Research conducted by Almas, Susanti, and Handjayani shows that the K-NN algorithm in *content-based filtering* is able to provide food recommendations with a low error rate[5]. Research conducted by Anshori, Mardi, and Tibyani shows that the K-Nearest *Neighbor* method can help students provide recommendations for their study interests in Informatics Engineering[6]. Research conducted by Cherlina Helena shows that the K-Nearest *Neighbor algorithm* can help potential travelers who will travel to Labuan Bajo in determining the choice of tour packages according to their wishes[7].

Based on the above background, the researcher is interested in conducting research with the title "**Application Of The K-Nearest *Neighbors Algorithm* In The Anime Recommendation System Based On *Genre* And *Web-Based Ratings*".**

2. Literature Review

2.1. Recommendation System

The recommendation system using collaborative filtering has two stages, namely, similar user search and prediction calculation. In similar user search, there are two popular methods that are usually used, namely, Spearman Correlation and Pearson Correlation. Both methods serve different purposes. Spearman correlation that prioritizes data monotony will be more appropriate to be used in data with low variability but still with high correlation quality than Pearson correlation which is linear. Because of this, researchers will use Spearman Correlation in the creation of the system. For the calculation of the prediction of the rating score, it will be calculated using the weighted sum average. These two methods will later be applied to the recommendation system and then to calculate the level of accuracy, an evaluation will be carried out using mean absolute error (MAE)[8].
The recommendation system in this study is a web-based recommendation system and uses Python by taking movie datasets through Kaggle. Kaggle is a community website that has a collection of datasets[9]

2.2. Data Mining

Data Mining is the process of extracting useful information and patterns from a very large amount of data. The data mining process consists of data collection, data extraction, data analysis, and data statistics. It is also commonly known as knowledge discovery, knowledge extraction, data/pattern analysis, information harvesting, and others[10]. There are several techniques that data mining has based on the tasks that can be done, namely:

1. Description
   Researchers usually try to find ways to describe patterns and trends hidden in the data.
2. Estimation
   Estimation is similar to classification, except that the objective variable is more numerical than category.
3. Prediction
   Predictions have similarities to estimates and classifications. However, the predicted outcome indicates something that has not yet happened (possibly in the future). Classification In the classification of variables, objectives are categorical. For example, income will be classified into three classes, namely high-income, medium-income, and low-income.
4. Clustering
   Clustering is more towards grouping records, observations, or cases in a class that have similarities.
5. Asosiasi
   The association function identifies the relationship between various events that occur at a time[11].

2.3. K-Nearest Neighbros Algorithm

K-Nearest Neighbor (K-NN) is a method of classification of new objects based on training data that has the closest neighbor distance from the new object. The proximity or distance of a neighbor is usually calculated based on Euclidean distance. The following are the steps of the K-NN algorithm:

1. Determine the value of K. The value of K can be calculated using the following equation 1:

$$k = \sqrt{N}$$

   N is the number of samples in the training data
2. Calculate the distance value (Euclidean distance) for each given data object. The formula for calculating Euclidean distance can be seen in equation 2.

$$di = \sqrt{(xki - xkj)2 + (xki - xkj)2 + \ldots + (xki - xkj)2}$$

   Description :
   di = jarak euclidean
   SakAI = Data Training K-1
   XKJ = Data Testing K-1
1. Perform data grouping according to the calculation of distance (Euclidean distance)
2. Classify data according to the value of the nearest neighbor or based on data that has the smallest Euclidean distance.
3. Choosing the majority of the nearest neighbors as a result of the classification. [12].

2.4. Website

The spread of anime through online media makes the audience have a sense of curiosity more than existing anime, so a website-based information system is needed. With a website-based information system , it will be petrified in data collection and make it easier for users to find information. A website that is a page to display information in the form of text, images, videos, or a combination of the whole, can be fixed (static) or variable (dynamic) and form a connected series[13].

A website is a place on the Internet, which presents information pages with various data formats such as text, images, and even videos and can be accessed using various client applications so as to allow for a more interesting and dynamic presentation of information with organized management. There are several things related to the website, namely:

1. Internet
   The Internet is a set of networks that are global in scale. No single person, group or organization is responsible for running the internet. The working mechanism of the internet is not based on humans but is an electronic work mechanism. Each

network is connected to each other by communicating using specific protocols, such as Transmission Control Protocol (TCP) and Internet Protocol (IP).

2. Web Browser
   A web browser is a software that is used to display information from a web server. This software has now been developed using a graphical user interface, so that users can point and click to move between documents. It can be said that there are currently only a few popular web GUI browsers: Internet Exploler, Opera and Mozilla firefox. Some of these browsers compete to grab the user by trying to get close to the HTML document specification standards recommended by the W3C (Word Wide Web Consortium).
3. Web Server
   Web Server is the website pages that are accessed by the user through a browser stored on the web server. For this reason, a special program is needed so that the website created can be well received by clients. There are several software that can be used, both free (Open Source) and commercial, including: Netscape Server, Microsoft IIS, Xitami Webstar and others. An example of a web server is Apache[14].

3. Research Methods

3.1. Problem Analysis

This research procedure is used as a work stage in applying the *K-Nearest Neighbors* (KNN) algorithm to a web-based anime recommendation system based on genre preferences and ratings. Figure 1 shows *a flowchart of* the research procedure that illustrates the flow of activities from the initial stage to the end:

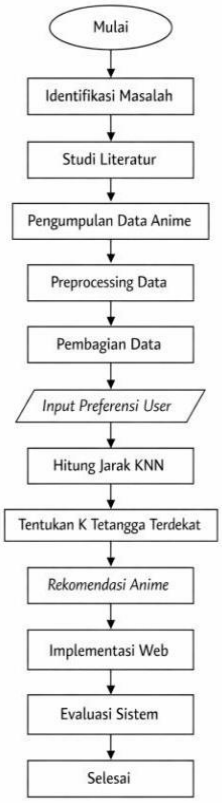

Figure 1: Flowchart Research

Procedure Stages The procedure in the research conducted can be seen below:
The flow of this research procedure is described in the form of a flowchart which aims to facilitate the systematic understanding of the research process. The following is a brief procedural explanation of the *flowchart* in Figure 1, including:

1. Get Started
   The initial stage of research is marked by the start of a whole series of research activities that will be carried out to build an anime recommendation system.
2. Problem Identification
   At this stage, the problem is identified, namely the difficulty of users in finding anime that suits their preferences and desired ratings. From these problems, a recommendation system is needed that can help users choose anime.
3. Literature Studies
   The literature study stage is carried out by studying theories and references related to the recommendation system, *the K-Nearest Neighbors* (KNN) algorithm, data processing, and relevant previous research as a basis for system development.
4. Anime data collection
   Data collection is done by taking anime datasets that contain information such as anime titles, genres, and ratings. This dataset is used as the main data source in the calculation and recommendation process.

5. Preprocessing Data
   The data that has been collected is then processed first through the preprocessing stage. This stage includes data cleaning, incomplete data removal, and transformation of genre data into numerical form so that it can be processed by the KNN algorithm.
6. Data Sharing
   At this stage, the data is divided into training data and test data. The training data is used for the distance calculation process in the KNN algorithm, while the test data is used to test the results of the recommendations generated by the system.
7. User Preference Input
   Users enter their preferences in the form of anime genres and desired ratings through the web-based system interface. This input data will be used as comparative data in the recommendation process.
8. K-NN Calculation
   The system calculates the distance between user preferences and anime data using the K-Nearest Neighbors algorithm. The distance calculation method used, such as Euclidean Distance, aims to determine the degree of similarity between data.
9. Determining Nearest Neighbor K
   Based on the results of the distance calculation, the system determines the number of anime Ks with the closest distance to the user's preference. K-values are predetermined to produce optimal recommendations.
10. Anime Recommendations
    Once the nearest neighbor K is obtained, the system generates a list of anime recommendations that have the highest level of similarity to the user's preferences.
11. Web-Based Implementation
    The results of anime recommendations are then displayed to users through a web-based system that has been designed so that it is easy to access and use.
12. System Evaluation
    The evaluation stage is carried out to measure the performance of the recommendation system, both in terms of functionality and the level of suitability of the resulting recommendations with user preferences.
13. Finish
    The final stage of research is marked by the completion of the entire research process and the anime recommendation system has been successfully built and tested.

3.2. Research Instruments and Variable Measurement

The data used in this study is sourced from https://www.kaggle.com/datasets/CooperUnion/anime-recommendations-database with the name anime data. *The dataset* is downloaded directly through the page on Kaggle and contains information about anime lists, genres, global ratings, and user preference data for anime that have been watched and rated. *The dataset* used in this study amounted to 12,294 anime with 11,194 training data and 1,100 testing data. *Data training* is used for the recommendation model training process, while *data testing* is used to test the system's performance in providing anime recommendations to users. All anime data in this study is grouped based on several main genre categories, including:

1. Anime Genre *Action*
   This category includes anime that have elements of combat, adventure, and intense action. This genre data is used to identify the preferences of users who like anime with fast tempos and high conflicts.
2. Anime Genre *Romance*
   This category contains anime that focus on the emotional relationships between characters. The romance genre is used as an indicator of users' preferences for stories that are dramatic and romantic.
3. Anime *Comedy Genre*
   The comedy category includes anime with elements of humor and light entertainment. This data helps the system in recommending anime with a relaxed feel according to the user's interests.
4. Anime Genre *Fantasy* dan Sci-Fi
   This category includes anime that have elements of an imaginative world, futuristic technology, or supernatural powers. This genre is often used as a additional parameters in the analysis of the similarity of user preferences.

In addition to genre data, this study also uses user rating data on anime on a scale of 1–5 as an indicator of user likability. The rating is one of the main features in the distance calculation process using the K-Nearest Neighbors algorithm to determine the most relevant anime recommendations.The data collection stage in this study is known as *Data Acquisition*, which is the process of retrieving and processing anime data and user preferences that will be used as input data in a web-based recommendation system.
The data sources in this study were obtained through two methods, namely:

1. The observation method was carried out to determine and select the dataset to be used in the research. The observation process is not carried out directly in the field, but through observation and evaluation of various datasets that are publicly available on *dataset provider platforms*, such as Kaggle.
2. The literature study method is carried out by collecting, studying, and analyzing various references relevant to the research topic. References used include books, scientific journals, research articles, and other academic sources.

The dataset contains anime data collected from the *MyAnimeList* website, which is one of the largest anime information providers' platforms.The data used are quantitative and categorical data, with a focus on attributes directly related to the recommendation system. This study uses only some attributes from the dataset, according to the limitations of the problem that has been set.
The data attributes used in this study are shown by the following table 1.

Table 1: Data Collection

No	Attributes	Remarks
1	Anime_id	Anime unique codes
2	Name	Anime title
3	Gender	Genre anime (Action, Comedy, Drama, dll.)
4	Rating	Anime rating rating rating
5	members	Number of users watching (optional, for additional information)

However, the main attributes used in the recommendation calculation process are simply genre and rating. *Members attributes* are only used as supporting information and are not directly involved in the calculation of the K-Nearest Neighbors (K-NN) algorithm.

Before being used in the recommendation calculation process, the research data goes through several stages of processing, namely:

1. Data Cleaning, to remove missing value data and duplicate data.
2. Attribute Selection, by selecting genre attributes and ratings according to the needs of the research.
3. Data Transformation, in which genres are transformed into binary vector forms (one-hot encoding).
4. Normalization of the Rating, so that the rating value is on a uniform scale.

The results of this data processing are then used as inputs in *the K-Nearest Neighbors* algorithm to generate anime recommendations that match the user's preferences

3.3. Developed Methods

In this subchapter, an in-depth analysis of the method applied in the research, namely *the K-Nearest Neighbors* algorithm to produce an anime recommendation system based on the level of similarity in genre attributes and ratings. The KNN algorithm was chosen because it has a simple concept, is easy to implement, and is able to provide personalized recommendations based on the proximity of data characteristics. In this study, each anime data is represented in the form of *a numerical vector* consisting of genre attributes that have been transformed using *the one-hot encoding* technique and normalized rating values. Next, the system calculates the distance between user preferences and anime data using *the Euclidean Distance method* to determine the degree of similarity between the data. Based on the results of the distance calculation, the system will select a number of K data with the closest distance as the nearest neighbor, which is then used as the basis for generating anime recommendations that most relevant to the user's preferences. At this stage, it is described in more depth regarding how the method works, including:

1. How the K-Nearest Neighbors *Algorithm Works*

   The KNN algorithm is a method used to determine results based on the proximity or similarity between new data and existing data (data training). The basic principle of this algorithm is that data that have similar characteristics tend to be in the same group. The following is the formula from knn:

   $$d = \sqrt{((x1 - y1)^2 + (x2 - y2)^2 + ... + (xn - in)^2)}$$ Keterangan Symbol

   d = distance between two data
   x = Value of the Training Data Attribute (anime)
   y = value of the testing data attribute/user preference
   n = number of attributes (genre + rating) meaning of *the anime recommendation system* formula: e.g. attribute:

   a. Action
   b. Comedy
   c. Drama
   d. Romance
   e. Rating

   So the formula becomes:

   $$d = \sqrt{((Action\_user - Action\_anime)^2 + (Comedy\_user - Comedy\_anime)^2 + (Drama\_user - Drama\_anime)^2 + (Romance\_user - Romance\_anime)^2 + (Rating\_user - Rating\_anime)^2)}$$

   Brief Example:
   User:
   (1, 0, 1, 1, 9.0)
   Anime:
   (1, 0, 1, 1, 9.3)
   K-NN Calculation:
   $d = \sqrt{((1-1)^2+(0-0)^2+(1-1)^2+(1-1)^2+(9.0-9.3)^2)}$ $d = \sqrt{(0+0+0+0+0+0.09)}$
   d = 0.3
   meaning:
   This anime is very similar to user preferences.

2. How K Value Determination Works

   The K-value in the K-Nearest Neighbors (KNN) algorithm indicates the number of closest neighbors used as a reference in the classification, prediction, and recommendation process. The selection of the K value has a great influence on the results obtained, because the K value determines the amount of data considered in the decision-making process.

In general, there is no absolute standard formula to determine the optimal K-value. However, as an initial approach, the value of K can be determined using the following formula:

$$K = \sqrt{N}$$

Description:

1. K = number of nearest neighbours

2. N = amount of training data Example calculation:
K = √100 K = 10

Notes:

the initial K value used is 10

3. Result and Discussion.

4.1. Result

This web-based anime recommendation system based on genre preferences and ratings uses an anime *dataset* from Kaggle, namely *the Anime Recommendations Database* which contains 12,294 anime data, with the main attributes used being *genre* and *rating*. After the *data cleaning* process, element selection, data transformation using *one-hot encoding*, and rating normalization, data that is ready to be used in the calculation process using the *K-Nearest Neighbors* (K-NN) algorithm is obtained. The following are the overall results of the system, including:

4.1.1. User Login Page View

The *login* page is the initial page that the user uses to log in to the system. On this page, users enter their Email Address and *password* to be able to access the anime's recommendation system features, as well as the Start Link button. This view serves as the initial gateway before the user can access the features available in the system. Figure 2 shows the results of *the login* view.

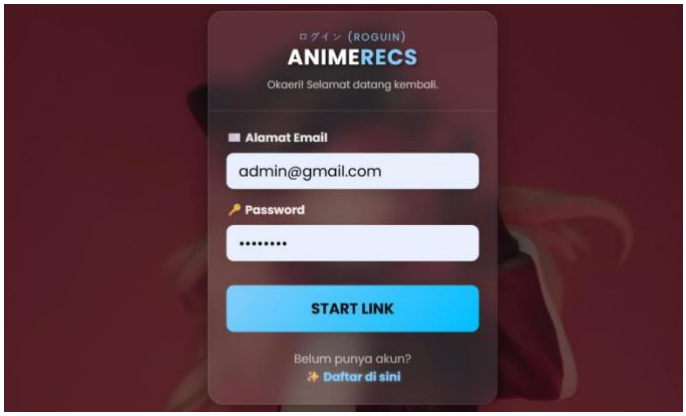

Figure 2: Login Page

4.1.2. Dashboard Page View (Admin)

The admin dashboard is used as a data monitoring center in the content-based filtering anime recommendation system. This page displays key statistics such as the number of anime, the number of *genres*, the number of users, the distribution of the most genres, as well as the proportion of anime types based on the show format. This visualization helps administrators understand the characteristics of the *dataset* and ensure the quality of the data before the recommendation process is carried out. Figure 3 shows the Dashboard View.

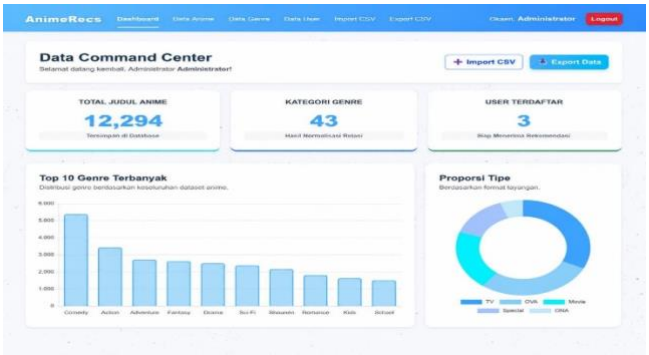

Figure 3: Dashboard Display Page *(*Admin)

4.1.3. Anime Data Display Page (Admin)

The anime data page is used by administrators to manage all anime data contained in the system. On this page, admins can add, change, or delete anime data. Figure 4 shows Anime Data (Admin)

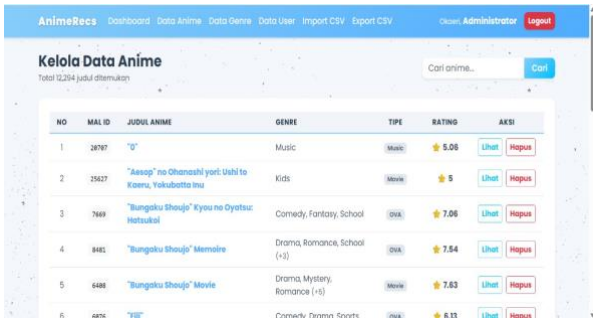

Figure 4: Anime Data Page (Admin)

4.1.4. Genre Data Page (Admin)

The genre data page is used to display and manage the anime *genre* categories available in the system, such as *Action*, *Comedy*, *Romance*, *Drama*, *Fantasy*, and others. *Genre* is one of the key attributes in the recommendation system because it is used as a basis for calculating the degree of similarity between user preferences and anime data. Figure 5 shows *the Genre* (Admin) Data

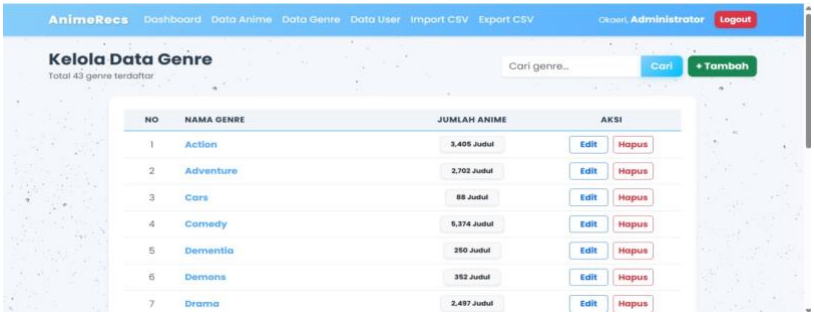

Figure 5: Genre Data Page (Admin)

4.1.5. User Data Page (Admin)

The user data page is used to view the data of users who have been registered in the system. Admins can monitor the number of active users using the anime recommendation system. This user data assists administrators in the overall management of the system. Figure 6 shows Data *User* (Admin)

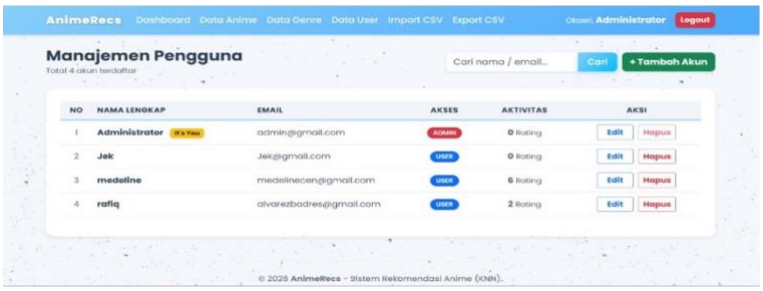

Figure 6: User Data Page (Admin)

4.1.6. CSV *Import* Page

The CSV import page is used to make it easier for administrators to automatically enter anime datasets into the system via CSV files. This feature helps the data input process to be faster than manually entering data one at a time. Figure 7 shows the CSV import.

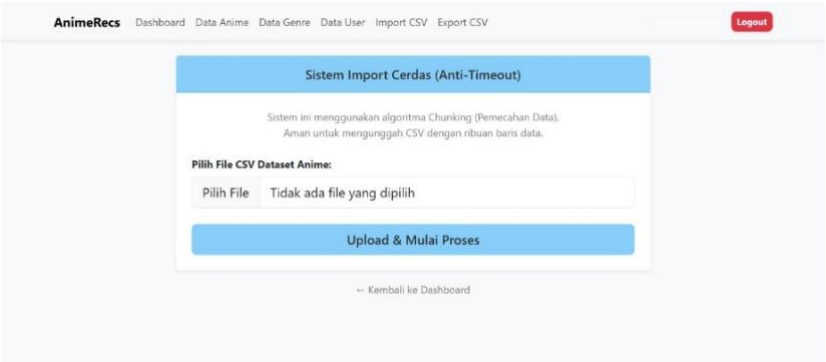

Figure 7: shows CSV import

4.1.7. Halaman *Export* CSV

The CSV export page is used to export the anime data contained in the system into the form of a CSV file. This feature makes it easier for admins to backup data and further data processing if needed. Figure 8 shows *Export* CSV.

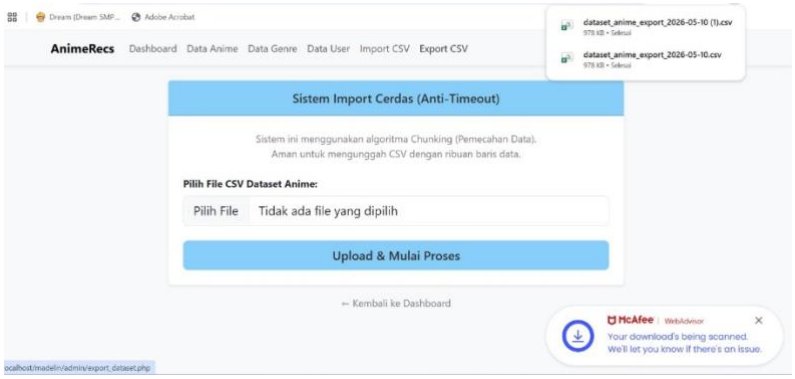

Figure 8: CSV *Export* Page

4.1.8. Home *(*User*)* Results Page

Once the calculation process is complete, the system displays a list of recommended anime based on the smallest distance value. The anime with the smallest distance value is the main recommendation for users. Figure 9 shows the anime (*user*) recommendation.

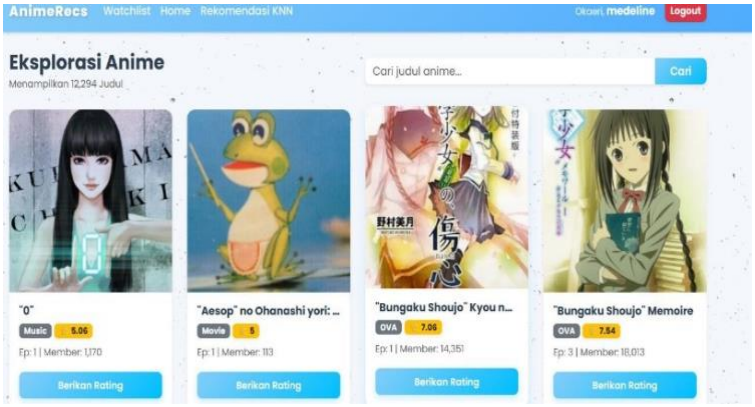

Figure 9: Anime Recommendation Page (*User*)

4.1.9. Anime Detail Page (*User*)

The Anime Details page is an advanced page that is displayed after the user selects one of the anime from the list of recommended results. This page serves to provide more complete information about recommended anime so that users can consider whether the anime matches their desired preferences. Figure 10 shows Anime (*User*) Details.

Figure 10: Anime Detail Pages (*User*)

4.1.10. Halaman *Watchlist* (*User*)

The *watchlist* page is used to store a list of anime that users want to watch. This feature helps users not to forget about recommended anime that they find interesting. *Watchlists* also make the system more interactive and useful for users. Figure 11 shows *the watchlist* (*User*).

Figure 11: Watchlist Page (User)

4.1.11. KNN Recommendation Page

This page has genres that perfectly match user preferences, namely *Action*, *Comedy*, *Adventure* and *Drama*, and has a high rating so the system places it as one of the best recommendations. Figure 12 show the KNN Recommendation.

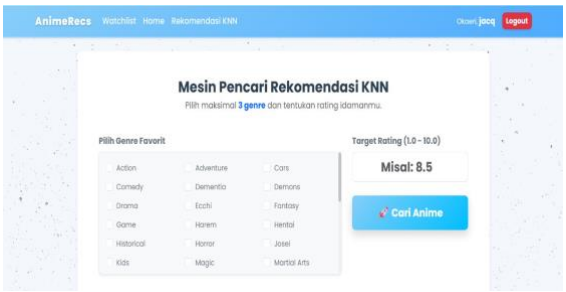

Figure 12: KNN Recommendations

4.2. Discussion

Based on the results of the system implementation, the K-Nearest *Neighbors* (KNN) algorithm has proven to be able to be used in the anime recommendation system based on genre and ratings. The use *of genre* and *rating* attributes provides quite relevant recommendations because these two attributes are the main factors that users use most often in choosing anime. *Genres* describe users' primary interest in the type of story, while *ratings* reflect the quality of anime based on general judgment.

4.2.1. Pros

The advantages of the system built are:

1. The system interface is designed with a simple appearance that makes it easier for users to understand the flow of using the system. It doesn't take users long to learn how the system works because the available menus are clear enough.
2. Admins can manage anime data through the features of adding datasets, CSV imports, and CSV exports . This feature is very helpful in speeding up the data processing process compared to if it is done manually.
3. The results of anime recommendations are displayed directly along with important information such as anime titles, genres, ratings, and detail buttons.
4. The watchlist feature is a plus because users can save the anime they want to watch in the future.

4.2.2. Cross

The shortcomings built are in the form of:

1. Although it is easy to use, the system still looks simple and does not have a modern visual design. The use of colors, icons, and visual elements is still limited, making it less attractive from an aesthetic point of view.
2. The system display is still more optimal for use on desktop or laptop devices. If accessed through a smartphone, there may still be a display that is not neat or uncomfortable to use.
3. The system does not provide a detailed anime search feature such as by year of release, studio, number of episodes, or anime status.
4. On the recommendation results page, the system focuses more on text data such as title, genre, and rating. The look will be more interesting if you add an anime poster or visual image of each anime.

5. Conclusion and Suggestions

5.1. Conclusion

Based on the results of the design, implementation, and testing of the system that has been carried out, it can be concluded that the K-Nearest *Neighbors* (K-NN) algorithm for anime recommendation *for genre* preferences and *ratings has* been successfully developed and can function according to the research objectives. A number of conclusions that can be drawn as the end result of the application of the anime recommendation system in *genre preferences* and web-based *ratings* As for the conclusions that can be drawn are:

1. Anime recommendation system based on *genre* and *web-based ratings.*
2. Apply the K-NN algorithm into a web-based anime recommendation system based on genre and ratings.

5.2. Suggestion

Even though the application has run well, there are still several aspects that can be further developed to make the system more optimal. The suggestions for the development of this research in the future are:

1. It is necessary to create a system that has a modern visual design supported by the use of colors, icons, and visual elements is still limited so that it is less attractive from an aesthetic perspective.
2. It is necessary to create a system display that is more optimal for use on desktop or laptop devices. If accessed through a smartphone, there may still be a neat and comfortable display for users.
3. It is necessary to develop a system that provides a detailed anime search feature such as by year of release, studio, number of episodes, or status of the anime.
4. Preferably on the recommendation results page, the system focuses more on text data such as title, genre, and rating. The display will be more attractive if you add anime posters or visual images of each anime.
5. A system that provides a search history feature or previous recommendation history is needed, so users cannot see the results of recommendations that have been obtained before other than through the watchlist.

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