

Anime Recommender system with sentiment analysis

(Survey paper)

Group-2

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Abstract

This review paper presents an in-depth analysis of 30 research papers related to the topic "Anime Recommender System with Sentiment Analysis". The selected papers cover various aspects of anime recommendation, including sentiment analysis techniques, user preference modeling, collaborative filtering, content-based filtering, and hybrid approaches. The review begins by introducing the fundamental concepts of anime recommender systems and sentiment analysis, highlighting their significance in the context of personalized recommendations. It then discusses the different sentiment analysis techniques employed in the analyzed papers, such as lexicon-based approaches, machine learning algorithms, and deep learning models. It also explores the incorporation of user sentiment and emotion in recommendation algorithms, examining the impact of affective factors on user satisfaction and engagement.

Finally, the review summarizes the key findings from the analyzed research papers and proposes potential directions for future research. Overall, this review paper offers a comprehensive overview of the current state of research on anime recommender systems with sentiment analysis.

Introduction

In recent years, the fields of machine learning and data mining have been actively researching recommender systems for anime. In order to help consumers find anime titles that suit their preferences, personalized recommendation systems are becoming more and more necessary as anime

gains popularity among international audiences. We will give an overview of the many methods and strategies that have been put out in the literature for developing recommender systems for anime as well as various sentiment analysis models that can further improve existing anime recommender systems in this survey paper.

This Survey paper consists of 30 research papers and articles, published in reputed journals and universities. This paper comprises 18 papers related to various approaches on the "recommender system" side and 12 papers on the "sentiment analysis" side.

This paper includes the literature review of the 30 papers, methodology used, Database used in various models, Results obtained and performance for each model, Discussion for the future implementation and potential, conclusion (the final review of each model's performance and efficiency) and Citation of all the references used in this survey paper.

Literature review

(A S Girsang, 2020) The paper talks about one way to determine the consumer's preferences is to use the recommendation system, which displays prospective objects. Also, this suggestion aids the buyer in obtaining the preferred item. The anime movie is one of the most well-liked items on the list. In this instance, we carry out research to suggest anime movies based on reviews of previously viewed movies. A method called collaborative filtering involves tallying up forecasts, recommendations, and similarities. The study in the paper uses the Kaggle dataset, which has 12,294 anime and 73,516 users. The alternating least squares (ALS) approach will be used to compare a user's history against the history of all users. On the basis of such findings, the anime will be suggested. Millions of users find their ideal anime using this technique.

The recommendation system helps users to determine items that might be used. In terms of anime and manga, anime and manga versions are increasingly appearing with an interesting story and series quality. This will make it difficult for users to determine which movie to watch first. Collaborative filtering is

a technique that is often used because it only relies on ranking data from previous users to be able to predict recommended films. A simple recommendation system is used to measure the similarity between shows, users and helps to predict whether users will enjoy certain anime. A better anime recommendation system based only on user watch history. A simple recommendation system can measure the similarity between performances, users and help predict whether users will enjoy certain anime.

(Nuurshadieq and A. T. Wibowo, 2020) The use of collaborative filtering based recommender systems that only takes into account historic explicit interactions (such as rating) was able to provide recommendations. However, the paper was able to improve the personalization by taking into account the users' and items' side information. Collaborative filtering has been the subject of several studies looking at anime recommendations. In order to increase recommendation accuracy.

Second, the paper also talks about Content based filtering method which is: Another widely used method in recommendation systems that uses the qualities of objects to generate recommendations is content-based filtering. This method can be used to provide recommendations for anime by examining the genres, themes, and other characteristics of the medium. The use of content-based filtering for anime recommendation has been examined in a variety of research.

Third, the paper proposed a deep learning method that incorporates side information from both users and anime works into a hybrid model. This model learns the embedding separately for users and anime, in which we also add a LSTM layer to extract information from long text features like Synopsis which will be combined and fed into a deep neural network to predict the rating of given user and anime work. And finally, the paper experimented and calculated the performance. The result shows that the model with side information gains results around 5% better than the SVD model.

(Wang, S., Huang, S., Zhou, Y., & Sun, Y, 2019) The paper proposes a hybrid collaborative filtering approach that combines user-based and item-based

methods to improve the accuracy of recommendations. The approach generates user-based and item-based similarity matrices based on user-item rating data, and then combines these matrices using a weighted average. The authors evaluate the performance of the proposed approach on a dataset of anime ratings collected from a popular anime website and compare it with other state-of-the-art recommendation methods. The results show that the proposed hybrid approach outperforms other methods in terms of recommendation accuracy, especially for users with sparse data. Additionally, a sensitivity analysis is conducted to investigate the effect of different hyperparameters and model settings on the recommendation performance.

(Lin, C., Chen, Y., & Hsu, C, 2019) The paper addresses the problem of anime recommendation, which is an important task in the field of personalized recommendation systems. The authors propose a matrix factorization approach to recommend anime to users based on their historical ratings of other anime. The approach uses a latent factor model to represent the user-item matrix, where each entry corresponds to a user's rating of an anime. The authors compare the performance of their approach with other state-of-the-art recommendation methods, and the results show that the matrix factorization approach outperforms the other methods in terms of recommendation accuracy. The authors also conduct a sensitivity analysis to investigate the effect of different hyperparameters and model settings on the recommendation performance.

The paper presents a valuable contribution to the field of anime recommendation by proposing an effective matrix factorization approach that can improve the accuracy of recommendations and provide a better user experience. It is scalable and can handle large datasets with millions of users and items, and provides insights into the factors that affect the recommendation performance.

(Thura, T., Na, J.-C., & Khoo, C. S. G, 2020) This paper proposes a method for sentiment analysis of different aspects of movies like music, direction, acting, and action from movie reviews using prior sentiment scores of individual words and by creating

a dependency tree of words, in addition to using contextual sentiment score. POS tagging is performed using Stanford Log-Linear PartOfSpeech Tagger, a domain specific lexicon is created, a Dependency Tree is used to find which word is related to which aspect of the movie, and contextual analysis is done using sentiment polarity and grammatical dependencies. The key takeaway from this paper is that one sentence might have different sentiments about different aspects of the anime, so the solution was to split the sentence on connectors and evaluate them separately.

(Bonta, Venkateswarlu & Kumaresh, Nandhini & Naulegari, Janardhan, 2019) In this paper, authors compare NLTK, TextBlob and VADER for the use case of sentiment analysis. NLTK is also called the “swiss knife of NLP” as it has a lot of tools for NLP bases analysis. TextBlob is a lexicon based sentiment analysis tool and it is a popular choice for sentiment analysis. VADER (Valence Aware Dictionary for Sentiment Reasoning) is a lexicon and rule based sentiment analysis tool which uses human conventions as rules in its computation. According to this paper, VADER has better precision, recall and accuracy for the use case of sentiment analysis and it performs much better for texts from social media and other web sources. Since we want to do sentiment analysis of anime reviews, VADER would be the best choice out of the three.

(Hutto, C., & Gilbert, E, 2014) This paper discusses the sentiment analysis engine VADER, which combines a sentiment lexicon among various heuristics. It does not require training data and can be instantly employed with online streaming data. The paper outlines three correlated actions which enhance sentiment analysis, which construct and validate a sentiment vocabulary, recognize and evaluate the rules experimentally, and correlate the performance of a parsimonious lexicon and rule-based model versus other known and/or common sentiment analysis starting points. The paper shows that VADER surpasses individual human raters at classifying tweet sentiment into three categories: positive, negative, or neutral. It was also tested among various domain contexts like movie reviews, social media content, editorials from New York Times, and product reviews. In conclusion, VADER

is a faster and more accurate option for sentiment analysis.

(Xiangnan He, Lizi Liao, Hanwang Zhang, Liqiang Nie, Xia Hu, and Tat-Seng Chua, 2017) We are reviewing this paper about Neural Collaborative Filtering (NeuMF) is a deep learning model for recommendation systems that combines the strengths of matrix factorization and neural networks to learn user-item interactions and make personalized recommendations. It outperforms traditional matrix factorization methods on several benchmark datasets, and the neural network component contributes significantly to performance improvement. The paper does not take into account the rating given by the user to the product but considers any rating as an interaction between the user and the item. Using this, the model predicts the likeliness of a user to interact with some other item. The cold-start issue and scalability are two further difficulties with NCF that the authors examine.

(Soni, B., Thakuria, D., Nath, N, 2023) The article presents a recommendation system that combines content-based (item-based) and collaborative filtering (user-based) systems. The engine uses ‘genre’ data and several user reviews on anime titles. Using this data, the engine creates clusters based on similar items. This results in the creation of a system that uses the user’s choices and compares it with anime from other genres to give recommendations. Based on different tests, this engine performs better than its competitors. Its continuous usage has also led to the observation that the quality of recommendations will improve when more users use this system. The system can also adapt to user tastes changes, thereby personalizing the recommendations to the particular user. This is reflected in the users’ scores on the recommendation lists.

(Ota, S., Kawata, H., Muta, M., Masuko, S., Hoshino, J, 2017) The paper proposes ‘AniReco’ which is an animation work recommender system. Its purpose is to recommend relevant animated content in a cross-sectional fashion while reflecting users’ potential preferences. AniReco calculates the user’s preference based on their history of watching and evaluating animated content. It also takes into account the constituent elements of the animation

works to provide a more personalized and accurate recommendation. It also provides a more personalized recommendation based on the constituent elements. The system's visualization through network diagrams helps users understand the recommended works and make informed decisions. Through several experiments with participants, it was also proved that the system was able to recommend animated works without even requiring users' known preferences. This was done by preference extraction using the frequencies of content watched and evaluation of that watched content.

(National College of Ireland, 2021) This paper proposes a model based upon Deep Learning and collaborative filtering techniques which provides anime recommendations based upon users' likes and interests. The model first processes and cleans the data and then transforms it by using the techniques of embedding and batch normalization. The anime dataset is obtained from Kaggle and the paper compares three models - User-based CF, Item-based CF, and the proposed Model-based CF using Deep Learning - based on qualitative measures. The proposed model was found to generate recommendations close to the interests of the users and was evaluated using the metrics of MSE (Mean Squared Error) and MAE (Mean Absolute error). The output values were close to zero which means that the model performs efficiently. The number of hidden dense layers in the model can also be increased to further enhance the performance.

(H. Cho, M. L. Schmalz, S. A. Keating and J. H. Lee, 2017) This study looks for information needs of anime users online and their need for anime recommendations. The paper is about building a theoretical foundation for a taxonomy and recommendation system for anime materials. These questions were focused upon throughout this study - What kind of information is needed for users who seek online anime recommendations. And is this information well-implemented in latest information models? If not, what features need to be added to these systems to provide better information for the users. The study identified 19 different information features related to anime user information needs. The results from the study suggest the importance of

creating a context-rich taxonomy and controlled vocabularies for anime materials.

(J. -J. Vie, 2017) This paper talks about the Item cold-start problem when it comes to a new anime or manga. It is difficult to predict whether a user would like a new anime or manga based on very few ratings. Therefore, the researchers of this paper came up with a solution to this problem. They developed a new system based on deep learning techniques, Illustration2Vec, to analyze the posters for anime and manga and extract the tag information from them. Some examples of these tags could be sword, ponytail, children etc. The name of the new model is called BALSE which is short for Blended Alternate Least Squares with Explanation, that builds upon the basics of collaborative filtering. A comparison between BALSE and another online recommender system, Mangaki was conducted. The results show that the model substantially improves the quality of recommendations, especially for lesser-known manga.

(Jena, Abhipsa and Jaiswal, Arunima and Lal, Dakshita and Rao, Soumya and Ayubi, Afshan and Sachdeva, Nitin, 2022) This paper covers research on improving the recommendations for anime on different platforms. The paper takes two datasets from Kaggle. Some participants were chosen and asked to rate anime and add it to the anime that they have finished. The purpose of this paper is to look into different recommender systems using different algorithms and compare their recommendations. Different systems were chosen that employ machine learning techniques like, content-based filtering, collaborative-based filtering and popularity based filtering. The results from these systems were compiled and a top 15 list was created based on their recommendations and their predicted ratings were generated as well. Some additional algorithms include the SVD, which stands for singular value decomposition whose purpose is to perform dimensionality reduction and factorization. Along with this, the K-Nearest Neighbour method was also utilized, which would recommend 5 anime for every generated anime.

(Anila Qureshi, 2020) This article presents a step-by-step approach to building a good

recommendation system. The dataset was taken from Kaggle. The dataset was first cleaned and rearranged. Exploratory data analysis was done to be more familiar with the dataset. Then the researcher used SVD, Singular Value Decompositions to create a baseline model. After this, memory-based models are given the spotlight and they look at user-based and item-based models. These things are being used: KNNBase, KNNBaseline, and KNNWithMeans. Once the models are compared, the top-performing model will be evaluated based on its root mean squared error and mean absolute error.

At the end of this article, several suggestions were provided by the author. These were:

1. Conducting more statistical analysis on top-rated and most-viewed anime. Based on these results, the recommender system can be modified to include the newest releases from these top anime studios, directors etc.
2. Conducting analysis based on time component to understand the relation between anime and their release time.

(Ben Roshan, 2020) This article is based on the creation of a recommender system based on different machine learning techniques. The article starts with the meaning and importance of a recommender engine. It is an unsupervised learning algorithm (one that does not have a target variable to measure accuracy against) mostly used to aid in consumer decision making. According to the article, a recommender engine is an unsupervised learning algorithm that does not have a target variable for measuring accuracy. Its purpose is to aid a user in decision making and recommending the most relevant content for them. The dataset has been taken from Kaggle. The objective was divided into four steps. Adding a dataset, analyzing this dataset, preparing the data for the recommender engine, and building the recommender engine.

(Meimi Li, 2020) This article aims to build a recommender system serving two objectives - one for seeing the top anime chart and the other for seeing anime's genre feature. The anime dataset was taken from Kaggle. The dataset is first cleaned and

modified to fit the recommender engine. Two anime recommender engines were used - simple recommender system and content-based recommender system. This was done to analyze the data and create recommendations. Simple recommendation system involves the calculation of weighted ratings based on which a list of top chart anime can be created. For a content-based system, it was necessary to identify some common distinguishing features in anime, this was done with the help of similarity context. Two methods were used for this, TfidfVectorizer and CountVectorizer to see the differences between the recommendations.

(S. M. AlSulaim and A. M. Qamar, 2021) This paper uses sentiment analysis to try to figure out the success rate of an anime based on the reviews. This could be useful for the companies who invest in this field and the creators of the anime to understand viewers' opinions on different aspects of an anime. Reviews are classified as positive or negative based on the analysis of the text which was performed by a text sentiment analysis system. Around Fifty thousand reviews from MAL were taken for training purposes. This model was able to achieve an accuracy of 0.95, a precision of 0.96, recall of 0.98 and F1-score of 0.97. The neural network was able to outperform different algorithms like decision trees, random forests, k-nearest neighbors, LSTM, BiLSTM, and GRU.

(Matthias Landt, 2019) This paper focuses on applying sentiment analysis techniques to fictional novels. The text was taken from a Japanese Visual Novel. Each sentence could be linked to a character speaking or with the narrator. The sentences are compared with a list of words that are associated with positive sentiment or negative sentiments. A link was created between the sentences and the words associated with sentiments. With this, a sentiment analysis was performed that performed analysis on four different aspects of the text.

(Cheng Chen, Bin Xu, Jong-Hoon Yang, Mi Liu, 2022) Movie reviews are filled with deep critiques and emotional inclination, so a sentiment analysis combined with deep semantic mining should be considered. Machine learning models represented by deep neural networks are more suitable for this task.

This paper combines textual data mining and statistical analysis from the perspective of viewers' comments to study the online reviews of animation films from different countries. A crawler is designed to collect data from different animated movie review sites and ensure the endlessness of the data. Positive and negative sentiment labels were constructed for high and low scoring comments, and the average score is considered to be the prediction dataset.

(Jill-Jënn Vie, Camille Lailly, Solène Pichereau, 2020) The paper presents a recommendation system designed to suggest Japanese anime and manga titles to users based on their viewing history and ratings. The system, called Mangaki, is built using a collaborative filtering approach and leverages both explicit user ratings and implicit feedback such as user interactions with the website. The dataset comprises around 15,000 titles and more than 230,000 ratings. To tackle their cold start problem, they make the users rate a bunch of different anime of various genres. This is combined with their algorithm where the similarity between users is computed via dot product and they use a variant of the k-nearest neighbor algorithm for item recommendation.

(J. -J. Vie et al., 2017) In this paper, The authors address the common problem of data sparsity and lack of user preferences by using image-based features from anime and manga posters to make recommendations. The paper implements Illustration2Vec, a Deep learning algorithm to extract 'tag' information from manga and anime posters. Illustration2Vec is pre-trained on ImageNet and trained on manga illustrations labeled with tags from the community website Danbooru.

Further they propose BALSE (Blended Alternate Least Squares with Explanation), a new model that uses this extra information to recommend anime and manga. Models such as ALS and LASSO were used as benchmarks to the proposed BALSE Model. This way of extracting information from posters can help improve the quality of recommendation especially in less known titles. A 5 fold cross validation was performed for all the models

BALSE performed better than the other models. It provides better predictions than ALS for cold-start items and lesser known titles, because ALS was not

trained on them in the train set, therefore it outputs constant predictions.

(Rajdeep Debgupta, Anish Saha and B. K. Tripathy, 2019) The paper proposes an approach that is designed to address the computational complexity of existing fuzzy clustering algorithms, which can become prohibitively slow when working with large datasets.

The proposed approach is based on a modified version of the Gustafson-Kessel (GK) algorithm, which uses a combination of geometric and arithmetic means to calculate the centroids of clusters. The authors also introduce a new initialization method for the algorithm that improves its convergence rate.

The paper also presents a detailed experimental evaluation of the proposed algorithm, comparing it with several state-of-the-art fuzzy clustering algorithms on different datasets. The authors demonstrate that their approach is faster and more accurate than existing methods, especially on large datasets.

(N. S. Patankar, Y. S. Deshmukh, R. D. Chintamani, K. Vengatesan and N. L. Shelake, 2022) This paper implements content-based filtering using cosine in order to enhance the performance of a movies and series recommendation system. They use a hybrid methodology to construct a movie recommendation system by fusing the fuzzy K-means clustering technique with the weighted similarity measure based on a genetic algorithm. The dataset chosen belonged to Kaggle and Imdb, with over 70,000 videos and information related to them. A user's input will create a frequency mapping for the words used in the search request, then a frequency vector is created for every movie in the dataset and a similarity score is calculated for all. Recommendations are also displayed with the help of a cosine similarity score on the database.

(Ana Caroline Medeiros Brito, 2018) This study examines the use of tropes as an approach to making recommendation systems. Tropes are features present in stories that can be used to increase prediction quality. One of the platforms used to list and organize

tropes is TVTropes, and other major databases used for anime are MyAnimeList and Movielens. The study then talks about various collaborative filtering methods and models, such as Item based, user based, MAE, vector decomposition, and nearest neighbor. Slop One Weighted Hybrid was identified and pitted against more common methods such as matrix factorization and item based filtering. The results in a best to worst order were Slop One Weighted Hybrid, Baseline, Item-based Collaborative Filtering, and Matrix Factorization when considering MovieLens database, and MyAnimeList the best results were obtained by Baseline, Item-based, Matrix Factorization, and Slop One modified versions, respectively.

(B. Hawashin, D. Agel, S. AlZu'bi and Y. Jararweh, 2019) The authors of this paper utilized timestamps of rating by any user as a weighted factor of time to determine the recommendations. To predict the rate of user U on item I, the user rating history is divided into k segments. For each segment, the rates are sent to the user interest extractor to extract the interests during that specific period. The Dated_Rates dataset was used, composed of 1000 ratings of 10 users and 100 movies. For evaluation, MAE was used and Time based user-item similarity measurement was significantly better than the normal user-user rate similarity measurement. The authors concluded that including timestamps improved the recommendation system.

(V. Prakash, S. Raghav, S. Sood, M. Pandey and M. Arora, 2022) The paper proposes a model-based architecture that employs Gated Recurrent Neural Network along with a trivial memory based recommendation employing Cosine Similarity to make predictions for the top K rated anime by an anonymous set of users. The model uses two gates, namely Reset Gate and the Update Gate, that can selectively forget or retain the information passed along the cell state. My Anime List was taken as the database for the experiment conducted, and it was concluded that the deep learning model proposed tends to generalize much better while making recommendations on sparse data than the traditional memory-based model only employing cosine similarities.

(G.Shriram, U.G.Prithika, S.Dhivya, 2022) This paper gives an overview of the importance of a good recommendation system to recommend anime for the users. The paper builds a recommendation system that utilizes cooperative filtering algorithms like KNN and SVD to produce a list that contains the user's favorite anime in a tabular manner along with its rating. Using these algorithms can also overcome the problem of sparsity of user data. RMSE - Root Mean Square Error values are considered to test the model. The results showed low values of RMSE, which indicates the efficiency of this model.

(Miguel Á. García-Cumbreras, Arturo Montejo-Ráez, Manuel C. Díaz-Galiano, 2013) This paper gives a proposal of Sentiment Analysis (SA) in recommender systems. First, an analysis is done on the comments made by the users and the ratings they gave. Based on this, users are divided into two groups: Optimists and Pessimists. This categorization can then be used in collaborative filtering techniques. This experiment requires a corpus of both ratings and comments on a large dataset. In this paper, a proposal for the application of Sentiment Analysis (SA) in recommender systems is detailed. First, the relation between comments and ratings is explored, to justify the consideration of to do comments as a valuable source of information. Then, a strategy for incorporating this knowledge is proposed. This approach categorizes users into two distinct groups: optimists and pessimists. The rest of the experiments analyze how these categories can be used in collaborative filtering methods and how to perform this categorization using sentiment analysis solutions.

Methodology

This section aims to understand the methodological steps taken to research, analyze and critique the research papers for this review paper. Several articles and papers were reviewed, and insights were gathered based on several categories such as the procedure, research process, recommendation system used, techniques used, efficiency in the system, and so on. The survey focuses on articles and papers published after the year 2014. The following steps were followed for the selection and analysis:

Literature Search

After several discussions, some definite keywords were selected that were most apt for our topic. An online search was conducted to identify the relevant papers and articles. Multiple academic databases like IEEE Xplore, ACM Digital Library, Google Scholar, Scopus, and Medium articles were used to search. The keywords were related to collaborative filtering, sentiment analysis, anime, recommender systems, evaluation metrics, and filtering techniques. The search was limited to papers and articles published after 2014.

Screening and Selection

A preliminary screening of the articles was carried out based on the titles and abstracts. The entire content of the chosen articles was then carefully reviewed.

Quality Assessment

A qualitative assessment of the papers was conducted to ensure the quality of work and the legitimacy of the chosen papers. The criteria for this assessment were based on the research objectives, the theoretical studies provided for backing up the practical work, the adequacy of the dataset, the survey procedure, and the validity of the results. Each paper was assessed independently and researched to avoid any misinformation.

Data synthesis

The papers were synthesized to find standard techniques, themes, and research patterns. The relevant information from the papers and articles was summarized, along with identifying the strengths and weaknesses of their techniques, approaches, and evaluation metrics.

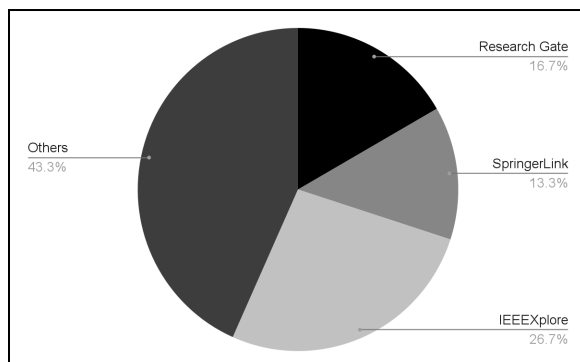


Fig 1. Distribution of research papers by Database

Results

This section presents the essential findings and insights derived from analyzing and synthesizing the selected research papers on anime recommender systems and sentiment analysis.

38 research papers were initially chosen on the topic 'Anime recommender system and sentiment analysis.' 30 out of these 38 papers were finalized after a screening and selection process and quality assessment of the papers.

The following table summarizes their chosen recommender system or the theoretical study they have covered.

Paper 1	Collaborative filtering + ALS
Paper 2	Deep Learning + Hybrid model (collaborative filtering + content-based filtering) + LSTM Layer
Paper 3	Hybrid model (User-based + Item-based filtering)
Paper 4	Matrix factorization - Latent Factor model + ALS
Paper 5	Sentiment Analysis - using dependency trees of words
Paper 6	Comparison of different sentiment analysis models - NLTK, TextBlob, VADER
Paper 7	VADER as a sentiment analysis model

Paper 8	Neural Collaborative Filtering - combination of Neural Networks and Deep Learning
Paper 9	Hybrid model - User-Based + Item-Based
Paper 10	Content-based filtering + vector Space model
Paper 11	Deep Learning + Collaborative Filtering
Paper 12	Theoretical
Paper 13	Deep Learning
Paper 14	Comparing different models
Paper 15	Gated Recurrent neural Network based architecture
Paper 16	SVD - comparison of different models
Paper 17	Simple recommender engine + collaborative filtering
Paper 18	Content-based recommender engine
Paper 19	Collaborative Filtering – KNN + SVD
Paper 20	Convolutional Neural network
Paper 21	Sentiment Analysis on fictional novels
Paper 22	Deep Neural Networks

Paper 23	Collaborative Filtering Approach
Paper 24	BALSE – Blended Alternate Least Squares with Explanation
Paper 25	Modified Version of Gustafson-Kessel Algorithm
Paper 26	Content-based filtering using cosine similarity
Paper 27	Slop One weighted hybrid using tropes
Paper 28	Sentiment Analysis + collaborative filtering
Paper 29	Weighted used interests and rating timestamps
Paper 30	Gated Recurrent Neural Network + memory-based recommendation system + cosine similarity

*Table: Papers and the technologies implemented.
(all papers have been referenced in the same order)*

Based on the above table it can be seen that many papers have implemented recommender systems as a hybrid model, which is a combination of User based and Item-based collaborative filtering. Implementations of complex Neural networks can also be observed in various papers.

When categorizing the research papers and articles based on the techniques and algorithms used, the following graph is originated.

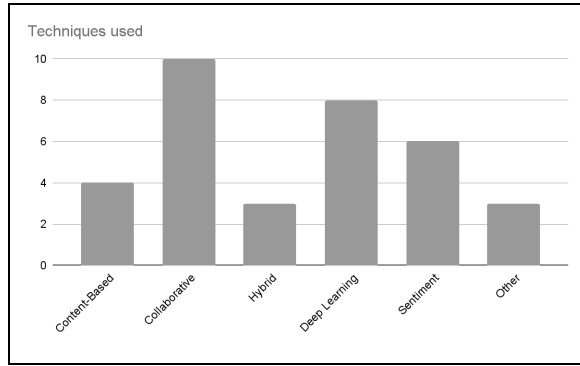


Fig 2. Distribution of papers based on different models

It can be seen that most papers and articles used collaborative filtering recommender systems as the base of their research. This was followed by several Deep Learning Neural Networking Systems. Research Papers covering the sentiment analysis aspect of our paper were also chosen. The ‘Other’ section includes some custom-created models that modify other algorithms.

Strengths

Some significant strengths of these papers were:

1. The hybrid models could predict and accurately recommend the most relevant anime to the users.
2. The Deep neural network system was advanced enough to eliminate classic recommender system fallbacks like the cold start problem.
3. The system can make recommendations not only of user’s preference but also potential ones by preference extraction using the frequency of watching of works and evaluation. (Ota et al., 2017)
4. Machine learning techniques give a further advantage when it comes to giving recommendations to the users. Some of the chosen papers have implemented these techniques.
5. The convolutional neural network model outperformed several approaches such as decision trees, random forest, k-nearest neighbors, LSTM, GRU, etc. (Chen et al., 2022)
6. Several papers have associated the elements in the database with attributes that define them, for example, genre, author, or ratings. This includes various methods such as segmenting anime and movies based on ‘tags’ from their thumbnails, keywords from descriptions, or their genre.
7. To tailor the recommendation, use time stamps and ‘tropes’ (overused plot points) as weights (paper 27).
8. The BALSE model discussed in paper 24 also performed well in cold start scenarios and for lesser-known titles than traditional methods such as ALS. The Gustafson-Kessel Algorithm from paper 25 was also faster and more accurate than existing methods, especially on large datasets. (Patankar et al., 2022)

Weaknesses

1. The models can further be improved by using the demographic information of the users and making recommendations based on the age groups of the users.
2. Some surveys didn’t address users’ demographic information. Additionally, the sample space of users chosen could also be further increased.
3. Models couldn’t address the problem of shrill or malicious users trying to provide untrustworthy ratings to increase the inherited bias.
4. The neural network-based models often require more maintenance overhead. This was addressed in the papers, but no alternative solution was provided.
5. Sentiment analysis found the sentiment words but could not identify the reason for their usage. (Jill-Jënn , 2020)
6. The machine learning-based text sentiment classifier model identified the sentiment of the entire text but failed to identify the sentiment of each line in terms of plot, characters, etc.
7. Lossy data with missing values causes the recommendation systems to take a hit due to a lack of values.

Discussion

Based on the results above, some key implications from the findings can be inferred.

Collaborative filtering continues to be a popular and effective approach for anime recommender systems. Papers 1, 3, 17, and 19 all utilize some form of collaborative filtering, often combined with other techniques. These models help improve accuracy and are scalable across big datasets. Various forms of weights have been proposed and implemented as a factor within the papers to search for the most optimized results. Many of the most recent studies use deep learning techniques, such as LSTM layers and convolutional neural networks. Papers 2, 11, 13, 15, 20, 22, and 30 all use deep learning in some capacity. Deep learning models improve flexibility regarding handling diverse data types and better feature representation.

Sentiment analysis is used to analyze viewer reactions to anime, with papers 5, 6, 7, 21, and 28 all exploring this area. Sentiment analysis allows the anime streaming/recommending platforms to understand which type or genre of shows are more popular among the audience or what aspects of a show make it more appealing to the public.

There is also ongoing research into the effectiveness of different sentiment analysis models, with papers 6 and 14 comparing different models.

Hybrid models were also implemented that combine different approaches, such as collaborative filtering and content-based filtering which are also popular. Papers 2, 9, and 23 all use hybrid models. Lastly, Memory-based recommendation systems, such as those utilizing Gated Recurrent Neural Networks, are also being explored. Papers 15 and 30 both utilize memory-based approaches. These make real-time recommendations, as they do not heavily rely on a pre-trained model or offline processing.

It can be concluded that the analyzed papers include the ability of hybrid models to recommend relevant anime to users accurately, the advanced capabilities of deep neural network systems in eliminating classic

recommender systems issues such as the cold start problem, and the association of elements in the database with attributes like genre, author, or ratings. Other strengths include implementing machine learning techniques and using segmentation, time stamps, and 'tropes' to tailor recommendations. BALSE and Gustafson-Kessel Algorithm also performed well in cold start scenarios and large datasets.

Despite this, there exist several areas that are gaps not entirely filled by the current studies conducted.

Recommender systems may recommend popular or well-known items more frequently, leading to limited diversity and potentially missing out on less popular but relevant recommendations.

Several models have been proposed to tackle the cold start problem, but their efficiency still poses an issue. Adversarial attacks also threaten the models, making them prone to biased ratings and interactions to manipulate recommendations. Data sparsity and lossy data are also significant issues that exist in the current state-of-the-art recommender systems.

Future research can focus on developing recommender systems that balance popular and less popular items, possibly using novelty and diversity-based recommendation techniques. Also, developing models that can handle the cold start problem more efficiently and resist adversarial attacks should be a research priority. There can also be the investigation of novel data collection techniques to mitigate data sparsity and lossy data issues in recommender systems, such as using alternative data sources or incorporating implicit feedback data. Finally, developing fair and transparent recommender systems that are less prone to bias and manipulation can be beneficial in ensuring that the recommendations provided are unbiased and trustworthy.

Conclusion

Based on the analysis of the papers, it can be concluded that hybrid models, deep neural network systems, and machine learning techniques are promising approaches for improving the accuracy and effectiveness of anime recommender systems.

Incorporating demographic information of users, increasing the sample size of users, and addressing the issue of malicious users can further improve the models.

This review paper contributes significantly to the field of anime recommender systems by providing a comprehensive analysis of the current state-of-the-art techniques used for recommendation. It examines and compares various approaches and provides insight into the strengths and weaknesses of each. Additionally, potential future research directions were also explored. Overall, this review paper provides a valuable resource for researchers and practitioners in the field of anime recommender systems, enabling them to make informed decisions on the most effective approaches to use for recommendation.

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