Exploration on News Recommendation Model under Machine Learning and Knowledge Graph Technology

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Abstract—Conventional news recommendation systems rely on generic factors like popularity, similarity, or trending topics to suggest content, overlooking the personalized requirements and preferences of individual users. As a result, there is a lack of wide-ranging and diverse news suggestions, which means users' individualized reading preferences are not being adequately catered to. To tackle these challenges, the article employs cutting-edge techniques like machine learning and knowledge graph technology to construct a model that accurately depicts the new problem. Furthermore, it extensively collects and preprocesses a significant volume of news data, meticulously cleansing and transforming it. In parallel, the article harnesses feature extraction methods like the bag-of-words model, Term Frequency Inverse Document Frequency (TF-IDF), and word embedding to convert the news text into numerical feature vectors. This allows for the comprehensive representation of the news, capturing its underlying semantics and crucial information. Through rigorous experimentation, the integration of machine learning and knowledge graph technology within the news recommendation model has proven to be exceptionally effective, delivering exceptional results in terms of accuracy and user satisfaction. Achieving an impressive accuracy rate of up to 95%, this approach has surpassed expectations. Through the integration of machine learning algorithms and knowledge graphs, this article empowers itself to offer more precise and personalized news recommendations tailored to users' interests and preferences. It doesn't stop there, though. By consistently training and optimizing the underlying models with valuable user feedback, the article continues to enhance its recommendation algorithms, ensuring an increasingly accurate and satisfactory user experience.

Keywords—news recommendation model, machine learning, knowledge graph technology, sports news

I. INTRODUCTION

As the Internet continues to evolve at a breakneck pace and news content multiplies exponentially, the challenge lies in devising methods to offer personalized and reliable suggestions amidst this vast reservoir of information. In order to cater to people's reading preferences, recommendation systems have become an essential tool for accessing news content. In this particular scenario, news recommendation models that utilize machine learning and knowledge graph techniques have come into play, with the goal of delivering a news recommendation experience that is both precise and varied, satisfying the needs of the users.

Scholars have dedicated considerable attention to studying news recommendation models, and a noteworthy proposal in this field was made by Qi *et al.* [1] introduced a groundbreaking attention-enhanced hotspot-aware news recommendation model, which capitalizes on the advantages offered by the attention network deep neural network. This model effectively manages and exploits personalized interests and the trending nature of news.

Liu et al. [2] devised a sophisticated news recommendation model that integrates deep features, providing a thorough understanding of users and extracting more nuanced features of the news. Through the integration of the attention mechanism, the model ensures a comprehensive and non-repetitive representation. Notably, the experimental findings affirm the positive impact of incorporating the attention mechanism and temporal module. Zhang et al. [3] put forward a news recommendation model that relies on Transformer and heterogeneous graph neural network. The model's efficacy was demonstrated through practical experiments on real datasets, thereby verifying its effectiveness. The present research still has a few lingering issues and limitations. The conventional approach to recommendation models often fails to effectively capture users' interests and preferences, which ultimately leads to a lack of comprehensive and diverse recommendations.

This paper seeks to present a novel approach to news recommendation, utilizing machine learning and knowledge graph technology. The objective is to overcome the challenges and drawbacks associated with current recommendation models and provide a more effective solution. By incorporating machine learning algorithms and knowledge graphs into the model, it becomes capable of gaining a deeper understanding of the user's interests and preferences. Consequently, it offers a personalized and diverse news recommendation experience, ultimately leading to heightened user satisfaction. The contribution of this article is that (1) The model can more accurately understand the needs of users and recommend relevant

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news content. (2) System diversity can meet the different interests and needs of users, and increase user satisfaction with the recommendation system. (3) It has brought important reference significance to follow-up researchers. The questionnaire survey was utilized to elucidate the predominant modalities and inclinations of individuals in accessing sports news, encompassing both contemporary social applications and conventional media platforms. Conversely, knowledge graph construction leveraged machine learning techniques and knowledge graph technology to discern entity and relational insights through the aggregation of news datasets and the application of natural language processing methodologies. This approach facilitated the construction of a comprehensive knowledge graph delineating entities and their interrelations, thereby augmenting the semantic comprehension of news content within the context of enhancing the efficacy of news recommendation models.

The structure of this article is as follows: Section I summarizes the research and related research in this article, Section II describes the traditional news model and existing problems, and Section III proposes a news recommendation model based on machine learning and knowledge graph technology to solve existing problems. Section IV tests the system and compares it with the traditional system.

II. NEWS RECOMMENDATION MODEL

A. News Recommendations

Through the application of advanced computer algorithms and state-of-the-art technology, news recommendation services have evolved to cater to users' specific interests, preferences, and personal traits. This innovative approach involves sifting through an extensive range of news content to extract the most pertinent and valuable information, ultimately delivering personalized news recommendations that truly resonate with individual users. Currently, users have the ability to select and browse news articles that capture their interest. However, as the Internet continues to evolve and news information expands exponentially, users are now confronted with the challenge of being overwhelmed by the sheer volume of available information [4, 5]. To address this issue, a news recommender system was introduced, designed to optimize users' reading efficiency and contentment. By employing automated filters and personalized recommendations, it efficiently delivers news articles of interest to users, enhancing their overall experience. By harnessing the power of machine learning, natural language processing, and data mining, news recommendation systems sift through copious amounts of data to uncover valuable insights. These insights are then used to build recommendation models tailored to individual preferences, ensuring personalized news recommendations. By scrutinizing the user's prior internet activity, reading choices, social network associations, and additional data, these models are capable of generating a personalized compilation of news suggestions that align with each user's preferences. The objective is to deliver a range of news articles that cater to the user's specific interests and informational requirements, ensuring both relevance and diversity in the content. By utilizing the recommendation system, users can stay updated with the most recent news, concentrate on specific areas and subjects they find interesting, and even uncover fresh content to enrich their reading journey [6, 7]. The efficacy and integrity of news recommendation systems hinge upon the judicious navigation of myriad challenges spanning user feedback mechanisms, information constriction, the cold start problem, and algorithmic opacity. By embracing a holistic approach encompassing technological innovation, user empowerment, and ethical oversight, stakeholders can chart a course towards the realization of news recommendation systems that not only cater to users' informational needs but also uphold the principles of transparency, diversity, and democratic discourse in the digital age.

B. Current Situation of Sports News

Large-scale news stories often overwhelm readers, presenting them with an excessive amount of information that's hard to navigate and discern their personal interests from. Due to the varying interests and personal preferences people hold regarding sports news, conventional platforms such as radio, television, and print media are unable to fulfill the unique needs of every reader. Given the timesensitive nature of news, certain sports updates may become obsolete by the time readers come across them, thus failing to offer the most up-to-date information. By leveraging the user's specific interests and preferences, the news recommendation model customizes sports news recommendations for each user, enabling them to effortlessly discover and engage with the content that resonates with their personal tastes. By leveraging the recommendation algorithm, users can effortlessly sift through an extensive range of sports news, effectively combating the challenge of being bombarded with excessive information. This feature not only helps users save valuable time and energy but also enhances their overall browsing experience [8, 9]. The news recommendation system has the ability to swiftly update its suggested content by taking into account real-time data and user feedback, guaranteeing users are always in the loop with the latest sports news information. Furthermore, the platform offers a diverse range of sports news recommendations, encompassing multiple sports, events, and athletes. The goal is to enhance users' reading experience by providing them with an enriching variety of content [10, 11]. In the realm of research, there exists a tendency towards narrowness and a lack of innovation in perspectives. Scholars ought to foster greater interdisciplinary collaboration and discourse, continuously expanding the academic boundaries of inquiry. This entails pursuing interdisciplinary and cross-cultural integration to illuminate multifaceted dimensions of investigation. For instance, within the study of sports fans and other demographic groups, there is a prevailing emphasis on group homogenization, neglecting the nuanced stratifications stemming from underlying social and cultural factors. Moreover, there is a pressing need for paradigmatic reevaluation to propel novel advancements in sports news and communication research. This entails a thorough consideration of both the inherent characteristics of the research subject and the mediating role of media tools, integrating research content with broader sociocultural contexts. Additionally, a paradigm shift in research methodology is imperative, necessitating exploration of new methodological avenues. Currently, qualitative research predominantly relies on documentation methods, while quantitative research predominantly employs content analysis. However, there is underutilization of alternative qualitative methods such as ethnography, in-depth interviews, and discourse analysis. Hence, diversification and experimentation with novel research methodologies are warranted to enrich the methodological toolkit and enhance the depth and breadth of scholarly inquiry.

C. Data Collection

A survey tailored for sports news enthusiasts was meticulously crafted to understand their information access habits. It probed mediums used, frequency of engagement, and motivations. After refinement, it was distributed to a diverse sample, facilitating a systematic analysis of consumption behaviors. Surveys can be utilized to gather both quantitative and qualitative data, providing insights into readers' media consumption habits, including platform preferences, frequency of use, and content preferences. Moreover, in-depth analysis involves the examination of data obtained from sports news websites, mobile applications, and social media platforms. This includes assessing indicators such as user traffic, visit duration, page views, and more [12, 13]. By examining these data, we can gain valuable knowledge about the channels and preferences that users utilize to access information. Stay in the loop with the various subjects and conversations circulating on social media platforms to get a deeper understanding of how individuals get their fix of sports news through these channels. This entails observing the accounts they follow, the discussion groups they actively participate in, and so on [14, 15].

To illustrate, questionnaires were distributed to obtain insights into the methods individuals used to access sports news throughout the Asian Games. The collected results are depicted in Fig. 1.



Fig. 1. Survey on different methods for accessing sports news.

The results of the questionnaire survey reveal that the primary means through which people access sports news is via two social apps, namely TikTok and Weibo. Traditional media channels such as TV, radio, and newspapers also play a significant role in keeping sports enthusiasts informed. With the rapid advancement of news dissemination mediums, newspapers are gradually becoming obsolete, preferred mostly by the elderly population. The primary factor that makes Tiktok and Weibo appealing to the majority of users is their utilization of a comprehensive preference recommendation system. This system gathers information about the types of videos and pictures that users typically enjoy, allowing it to generate a multitude of personalized recommendations in the background [16, 17].

III. IMPROVED NEWS RECOMMENDATION MODEL

A. Knowledge Graph Construction

Within the news recommendation model, which utilizes machine learning and knowledge graph technology, the creation of a knowledge graph is an essential phase. This process greatly assists the model in grasping and arranging the semantic connections present in news content. To begin with, the knowledge graph relies on the collection of news data, which encompasses a wide range of information obtained from news organizations, online news websites, social media platforms, and more. This data includes both structured and unstructured formats. The information contained within this dataset can encompass a variety of details, ranging from news articles, titles, tags, authors, and release dates, among others. Through the application of natural language processing techniques, the news data undergoes entity recognition, allowing for the identification of entities such as individuals, places, organizations, events, and beyond. Discern and extract the associations between various entities within the news data. Uncover the various associations between individuals (e.g., cooperative versus competitive ties), the interplay between different locations and events (e.g., where events take place), and other related aspects. The extraction of relationships can be seamlessly accomplished by utilizing sophisticated algorithms and models tailored for relationship extraction tasks. Entities and relationships within the knowledge graph are systematically arranged for efficient organization. The graph consists of nodes that symbolize entities, while the connections between these nodes represent the relationships. To construct and store knowledge graphs, graph databases and graph representation learning techniques are employed [18, 19]. By constantly gathering up-to-the-minute news data and employing sophisticated entity recognition and relationship extraction techniques, the knowledge graph continually incorporates new entities and connections. This dynamic approach ensures the graph's content stays current and continues to evolve. The application of the constructed knowledge graph extends to the news recommendation model. The knowledge graph's entity and relationship information can be leveraged during the recommendation process to enhance the model's comprehension of semantic connections within news content. As a result, this enables the delivery of more precise and tailored recommendation outcomes. In terms of the scoring function, it can be outlined as follows:

$$f_r(h,t) = ||h+r-t||_2^2$$
(1)

In this context, the scoring function operates within the range of the news head entity vector and the tail entity vector, calculated based on three factors: h denotes the news head entity vector, r represents the entity relationship vector, and t signifies the tail entity vector.

B. Machine Learning Model Design

The collected data was processed and the original text data was processed and transformed using natural language processing techniques. Cleansing and feature scaling were performed on text data, and information entropy was used to measure the degree of uncertainty or confusion in the data. The formula is as follows:

$$Entropy(s) = \sum (p(x) \times \log 2(p(x)))$$
(2)

p(x) represents the proportion of samples belonging to category x in dataset S.

By employing the bag-of-words model-based approach to represent word frequency, the text is converted into a compilation of words from a vocabulary list. This representation disregards the sequence and grammatical arrangement of the words. Consequently, a feature vector is generated by computing the occurrence and frequency of each word in the text. Representing the bag-of-words model can be achieved through vectorization methods such as One-Hot coding or Term Frequency (TF). In conclusion, the labels for the recommendation task encompass various factors such as the user's interests, clicking patterns, ratings, and more. The categorization of labels in news recommendation can fall into three categories—binary, multiclassification, or regression problems, depending on the desired outcome [20].

C. System Implementation

This article constructs a knowledge graph that includes entity, relationship, and attribute information in the news field. Using natural language processing techniques, entities and relationships were extracted from news texts and stored in a knowledge graph. The model was trained using a neural network, and the neural network parameters were set as shown in Table I.

TABLE I. NEURAL NETWORK PARAMETER SETTINGS

Parameter	Description	Example Value
Input Dimension	The dimensionality of the input data, typically the length of the feature vector	100
Number of Hidden Layers	The number of hidden layers in the neural network	2
Hidden Layer Dimension	The number of neurons in each hidden layer	256
Activation Function	The activation function used in the neurons of the neural network	ReLU
Output Dimension	The dimensionality of the output in the neural network, typically the number of classes or target variable dimension in classification or regression tasks	10 (classification task)
Learning Rate	The step size for parameter updates	0.001
Batch Size	The number of samples used for each parameter update during training	64

After inputting the vector representation, release time, news labels and other features of the news text, supervised learning is performed using the labeled dataset, or unsupervised learning methods are used for clustering or collaborative filtering. Historical user behavior and feedback information such as click history, ratings, preferences, etc., are considered for personalized recommendations. The trained model is deployed into a real-time recommendation system, receiving user requests and generating recommendation results.

IV. MODEL EVALUATION EXPERIMENT

A. Evaluation Methods

The experimental evaluation endeavors to ascertain the efficacy of the news recommendation model rooted in machine learning and knowledge graph technology in augmenting recommendation accuracy and user satisfaction. The experimental setup adhered to meticulous specifications: Python programming language served as the foundational software, complemented by a machine learning framework, the Neo4j knowledge graph tool, and the Pandas data processing and analysis tool. Hardware requisites necessitated a computer endowed with ample memory capacity. The methodological framework of this study delineated the model under investigation as the experimental group, juxtaposed against methodologies delineated in attention-based news recommendation model and deep feature-integrated news recommendation model, which were designated as control groups for comparative analysis. Throughout the experimentation phase, evaluation criteria encompassed both the precision of model recommendations and user satisfaction metrics. This involved rigorous testing of the three models across these dimensions to discern their comparative performance. To facilitate comprehensive analysis and presentation of results, graphical representations and tabulated data were employed. Graphs were generated to visually depict trends and disparities in recommendation accuracy and user satisfaction scores across the experimental and control groups. Statistical analyses, leveraging appropriate tests such as t-tests or Analysis of Variance (ANOVA), were conducted to discern statistically significant differences among the models. Moreover, tables were utilized to succinctly present numerical data, facilitating a clear comparison of performance metrics across the experimental and control groups. The software employed for data visualization and statistical analysis adhered to industry standards and best practices in academic research. Graphical representations were crafted using data visualization libraries in Python, such as Matplotlib or Seaborn, ensuring clarity and interpretability. Statistical analyses were executed using established packages within the Python ecosystem, supplemented by rigorous validation procedures to ensure the robustness and reliability of findings. In sum, the experimental evaluation not only elucidated the comparative performance of the proposed news recommendation model but also adhered to rigorous methodological standards inherent in scholarly research. Leveraging appropriate software tools and methodologies, the study yielded nuanced insights into the efficacy of machine learning and knowledge graph-based approaches in enhancing news recommendation accuracy and user satisfaction, thereby contributing to the burgeoning literature in the field.

B. Experimental Results and Discussion

The experimental results are as follows: Fig. 2 shows the accuracy comparison test, and Fig. 3 shows the user satisfaction survey results.

Five experiments were conducted to test the accuracy. In these five experiments, the accuracy test results of the method model in this paper were between 90%–95%. The accuracy of the model in attention-based news recommendation model was between 87%–94%, and the accuracy of the model in deep feature-integrated news recommendation model was between 85%–93%. Accuracy is an indicator for evaluating the accuracy of model recommendation results, which reflects how much of the recommendation results provided by the recommendation system are news that users are truly interested in. When the accuracy is higher, it indicates that the recommendation system has more news that meets the user's interests and preferences, which means that the model can more accurately understand the user's needs and recommend

relevant news content. The high accuracy representation model can effectively filter out news that users are not interested in, improving user experience and satisfaction. At the same time, it also means that the recommendation system can more effectively avoid recommending incorrect news and reduce users' misunderstandings or dissatisfaction with the recommendation results. By improving accuracy, users can increase their trust in the recommendation system and increase their acceptance of recommendation results.





Fig. 3. Questionnaire survey results.

The survey results showed that the number of people with a model level of A in this article's method was 66, which was the highest among the three methods. The evaluation level of the model in attention-based news recommendation model was A for 43 people, and the model in deep feature-integrated news recommendation model was 49 people. In the evaluation level E, the number of people in the method model of this article was 1. The number of people in the model of attention-based news recommendation model was 23, and the number of people in the model of deep feature-integrated news recommendation model was 16. The user experience satisfaction rate of this method was the highest and the evaluation was the highest. High satisfaction means that the

recommendation system can provide diverse news recommendation results, covering news from different themes, fields, and sources. This diversity can meet the different interests and needs of users, increasing their satisfaction with the recommendation system. At the same time, it implies that the recommendation system can provide a personalized recommendation experience, that is, customize recommendation content for each user based on their historical behavior, interests, and preferences. Personalized recommendation can improve user satisfaction with the recommendation system, making users feel understood and cared for.

V. CONCLUSIONS

Machine learning and knowledge graph technology have demonstrated significant effectiveness in enhancing accuracy and increasing user satisfaction within news recommendation models. By comprehensively utilizing machine learning algorithms and knowledge graphs, these models provide more accurate and personalized news recommendations aligned with users' specific interests and preferences. The model ensures a solid foundation for subsequent feature extraction and model training through the meticulous collection and preprocessing of a large volume of news data. Leveraging the bag-of-words model, TF-IDF word embedding, and various other feature extraction techniques, the model successfully captures the semantic meaning and crucial details within the news text. This approach leads to a substantial improvement in the recommendation model's accuracy.

Employing advanced methodologies and algorithms, the model demonstrates an enhanced capacity to discern users' interests and preferences with greater precision, thereby facilitating a personalized and diversified news recommendation environment, which in turn augments user satisfaction. In contrast to conventional paradigms, which often fail to capture user preferences effectively and result in a lack of comprehensive and diverse content recommendations, the integration of machine learning and knowledge graph technologies within news recommendation frameworks engenders a more nuanced understanding of user requirements. This integration allows the model to achieve heightened granularity in comprehending user interests and preferences, resulting in a more precise and varied news recommendation ecosystem and ultimately culminating in elevated user satisfaction metrics. The constructed knowledge graph enriches the model's understanding by providing extensive contextual knowledge specific to the news domain, encompassing information about entities, relationships, and attributes. The synergy between machine learning and knowledge graph techniques enhances the precision and comprehensibility of recommendation outcomes. By iteratively training models and optimizing them using valuable user feedback, the recommendation algorithms continuously improve, leading to greater accuracy. Incorporating user feedback, such as click history, ratings, and preferences, further personalizes and customizes recommendations based on individual user interests, thus enhancing user satisfaction and increasing their engagement with the suggested news articles.

In conclusion, a news recommendation model that integrates machine learning and knowledge graph methodologies emerges as a distinctly superior solution, demonstrating significant advancements in accuracy and user satisfaction compared to conventional approaches. The efficacy of this approach is underscored by its ability to surpass the anticipated outcomes of traditional methodologies, solidifying its position as an advanced and effective tool in the domain of news recommendations.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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