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Jason C. Hung
Neil Yen
Jia-Wei Chang *Editors*

Frontier Computing on Industrial Applications Volume 2

Proceedings of Theory, Technologies and Applications (FC 2023)

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Lecture Notes in Electrical Engineering 1132

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Editors

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Contents

Diagnosis and Optimization of Marketing Strategy Based on Association Rule Mining Algorithm

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Abstract. In marketing, can not leave the *sup*. of modern information technology means. Through the Internet database, enterprises use big date mining (DM) technology to analyze the massive data collected, and provide scientific data *sup*. For marketing decision-making. DM will also help enterprises to achieve more accurate segmentation and positioning of customers, and accurately obtain the needs of potential customers. In this article, we will take the most classical Apriori algorithm of association rules as the research object, and the classical algorithm has also completed the parallelization implementation in the MapReduce framework. This article draws on the domestic and foreign marketing research theory, analyzes the inside and outside environment of Xiaomi smart mobile phone, starts from the marketing 4P theory, studies the current marketing strategy, and on this basis, formulates targeted optimization plan, and has been preliminarily confirmed. At the same time, in view of the current domestic market mobile phone product homogeneity phenomenon is serious, consumer demand diversification and other status quo. Combined with the Apriori algorithm under the association rules, this article deeply studies the influence of DM on the consumer behavior and personalized marketing of Xiaomi smart mobile phone customers, as well as the new marketing strategy.

Keywords: Association Rule Mining Algorithm · Apriori Algorithm · Mapreduce Framework · Marketing and Marketing · Diagnosis and Optimization

1 Introduction

The massive user data in the Internet platform contains a lot of useful information. If the rules and associations hidden in data sets can be analyzed and extracted through data technology, and applied to different industries, it will help users make development decisions that change the present and adapt to the future.

Association mining is widely used in various field, which can not only investigate the knowledge mode formed in the industry for a long time, but also find out new hidden rules. Scholar Chiang W Y [1] conducted an empirical study on the coffee house industry in Taiwan and proposed a new mining method of association rules to tap valuable markets for online CRM marketing strategies. Scholar Shokyar S [2] analyzed the reasons behind

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the loss of customers in the mobile communication market through association rules, and on the basis of this article, draw up requiring marketing policy for each group of clients. Scholar Wang S C [3] conducted data analysis through association rules and determined the company's most valuable customers. Then, through the customer's past transaction records, the correlation relationship between the products purchased by the customer is found. It can be found that the research of domestic and foreign experts and scholars on marketing strategy has been very in-depth, involving various fields and having different characteristics.

Therefore, this article will analyze the marketing status of Xiaomi smart mobile phone through 4P marketing theory, and then optimize the marketing of Xiaomi smart mobile phone in view of the improved Apriori algorithm -- MR_Apriori algorithm.

2 Relevant Theoretical Concepts

2.1 Concept of Association Rule Mining Algorithm

Association rule mining algorithm is mainly used to find out the potential association relationship between items in data sets [4]. Association analysis is also called shopping basket analysis, and the information found is usually represented by association rules or frequent term lists. Association rule mining algorithms include: Apriori algorithm; Partition algorithm; FP-GA; DHP algorithm. This article mainly uses the classical Apriori Association rule mining algorithm in association rules.

The association rule mining step consists of two stages, as shown in Fig. 1:

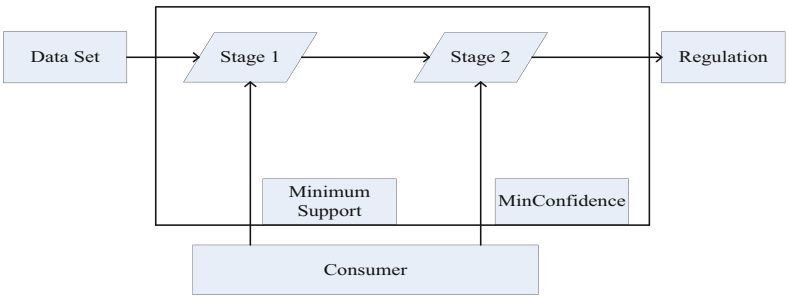

Fig. 1. Association rule mining model

Among them, *sup.* And *conf.* Are important concepts in association rules [5]:

If the $X \rightarrow Y$ association rule can be satisfied in the data set M, the formula of *sup.* is:

$$S = Support(E \rightarrow F) = P(E \cup F) \tag{1}$$

Similarly, the formula of *conf.* Can be expressed as:

$$C = Confidence(E \rightarrow F) = P(E|F) \tag{2}$$

2.2 Apriori Association Rule Mining Algorithm

Apriori algorithm is still the most widely used and classical frequent itemset mining algorithm, which uses the prior nature of relevant term lists to realize DM [6]. The Apriori algorithm uses k term lists to explore (k + 1) term lists. Firstly, Apriori algorithm is used to scan the data and find all frequent 1 term lists. Then, the frequent 1 term list is used to find all the frequent 2 term lists, the frequent 2 term list is used to find all the frequent 3 term lists, and so on.

Apriori algorithm association rules are defined as follows: Suppose a data set sum to M, $M = \{M_1, M_2, ..., M_n\}$, $M_p = \{J_1, J_2, .., J_n\}$. Where M_p is a transaction, J_n is also a transaction, and J is the list of all transaction items in the data set M. The association rule can be shown as:

$$Support(E \Rightarrow F) = \frac{count(E \cup F)}{|M|} \tag{3}$$

$$Confidence(E \Rightarrow F) = \frac{support(E \cup F)}{support(E)} \tag{4}$$

2.2.1 Defects of Apriori Algorithm

Apriori algorithm with the increase of data, the efficiency of algorithm processing will become low. The traditional algorithm has the following shortcomings [7]: ①Generate a large number of candidate term lists;.②Memory shortage due to huge amount of data.③A large number of redundant rules are generated.

2.3 Apriori Algorithm Under MapReduce Framework

MapReduce is a distributed file system that can access application data with high throughput [8, 9]. In order to improve Apriori algorithm, we introduce Mapper and Reducer functions in MapReduce framework into Apriori algorithm and name the improved algorithm after MR_Apriori [10]. The implementation process of MR_Apriori algorithm is introduced from two parts: "Generating frequent term lists" and "generating association rules". The specific process is shown in Fig. 2:

In general, MR_Apriori algorithm improves the defects of the traditional Apriori algorithm. Compared with the traditional Apriori algorithm, MR_Apriori algorithm has the following advantages: first, it makes up for the shortcomings of the traditional Apriori algorithm's single platform memory shortage and poor processing performance; Then, the Apriori algorithm needs to scan the data set for many times to improve the algorithm execution efficiency [11, 12].

2.4 4P Marketing Theory

The 4P theory is to analyze the marketing strategy of an enterprise from four aspects: product, price, place and promotion. These four factors are factors that enterprises can take measures to control, and are initiatives that enterprises can change according to market conditions and characteristics.

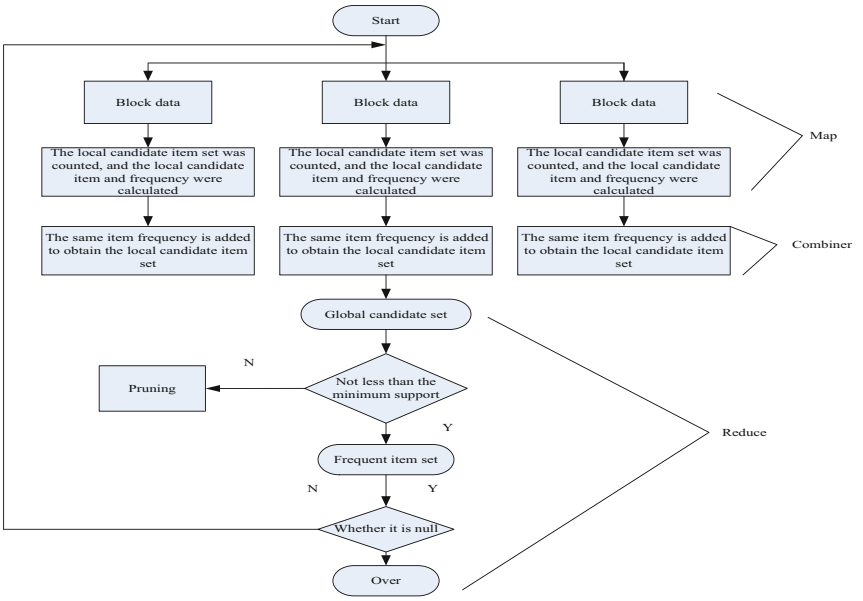

Fig. 2. Flowchart of the algorithm for producing part of frequent term lists

3 Analysis on the Marketing Status of Xiaomi's Smart Smart Mobile Phone

3.1 External Marketing Environment of Xiaomi's Smart Mobile Phone Market

As the world economy becomes more and more connected to the Internet, it also brings great opportunities for smart mobile phone marketers to locate overseas markets. Canalys released the global smart mobile phone market share data in 2022, as shown in Table 1:

Table 1. Global smart mobile phone market share data for 2022

Smart mobile phone shipments and growth in the word		
Canalys Preliminary Smart Mobile Phone Market Pulse:2022		
Brand	2021die Absatzbeteiligung	2022die Absatzbeteiligung
Samsung	20%	22%
Apple	17%	19%
Xiaomi	14%	13%
OPPO	11%	9%

(*continued*)

Table 1. (*continued*)

Smart mobile phone shipments and growth in the word		
Canalys Preliminary Smart Mobile Phone Market Pulse:2022		
vivo	10%	9%
others	28%	28%
Note:data are estimates		
Source: Canalys estimates (sell-in shipments),smart mobile phone Analysis, January 2023		

From the global smart mobile phone market share data in 2022 released by Canalys in Table 1, it can be seen that Xiaomi's global market share in 2022 reached 13%, down 1% compared with 2021, but ranking third in the world.

3.2 Internal Marketing Environment of Xiaomi's Smart Mobile Phone Market

1) In terms of product strategy: the concept of Xiaomi mobile phone was born for the sake of fever, and its customers are positioned as enthusiasts who grow up with the Internet. The strategy has bolstered Xiaomi's customer loyalty, but led to a low brand value for its smart smart mobile phone.
2) In terms of pricing strategy: Xiaomi focuses on cost performance and is cheaper than other smart mobile phone brands. This value strategy promotes the sales of Xiaomi smart mobile phone, but it makes the status of Xiaomi mobile phone brand in the eyes of consumers lower.
3) In terms of sales channels: Xiaomi sells its smart mobile phone directly through B2C network to avoid profit distribution with physical stores and distributors, avoid redundant expenses, and partially reduce the incidence of fake goods. However, this channel is too single.
4) In terms of promotion strategy, Xiaomi mobile phone uses event marketing, hunger marketing and social media marketing. These promotional strategies help Xiaomi attract many potential users. But Xiaomi's after-sales service has been repeatedly complained about by consumers.

4 Experimental Analysis

4.1 Optimize System Operation Test

The MR_Apriori algorithm is selected as the mining algorithm. The experimental platform is Hadoop cluster platform, and Ubuntu16.04.3 is used as the virtual machine system version. The min *sup.* Threshold min_sup = 15% and the mini *conf.* Threshold min_conf = 75% are set, and the data set is the purchase data of Mi 1–4 series, Redmi series, Redmi note and Mi note.

It can be known from the mining performance and operation efficiency comparison of MR-Apriori algorithm and Apriori algorithm in Table 2 and Fig. 3. With the increase of transaction volume, the difference between the efficiency and speed of MR-Apriori algorithm and Apriori algorithm in mining association rules will be larger.

Table 2. Compare the efficiency of MR-Apriori algorithm and Apriori algorithm

		MR_Apriori Algorithm	Apriori algorithm
Volume of Business	Min-Sup	Time (min)	Time (min)
10K	(0.5,0.2,0.15.0.15)	2.1	3.6
50k	(0.5,0.2,0.15.0.15)	7.7	12.5
100k	(0.5,0.2,0.15.0.15)	15.3	28.9
150K	(0.5,0.2,0.15.0.15)	22.5	34.7
200K	(0.5,0.2,0.15.0.15)	29.6	45.1

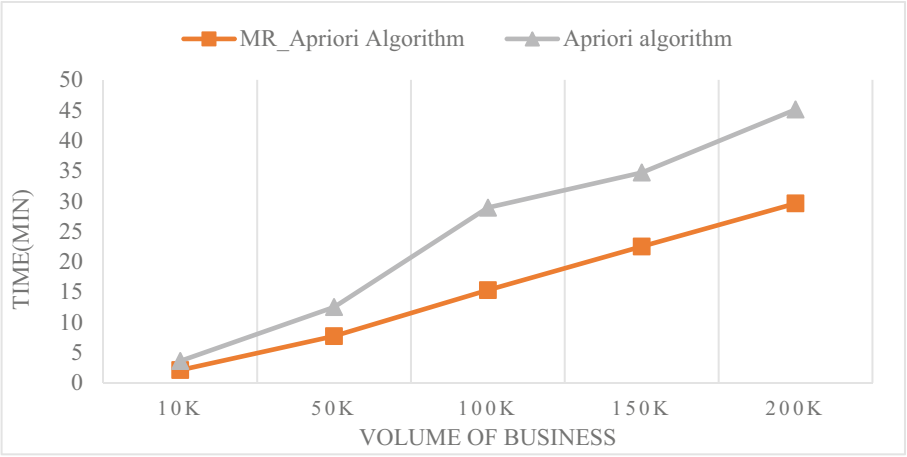

Fig. 3. MR-Apriori algorithm and Apriori algorithm mining performance analysis

4.2 Research on Marketing Optimization of Xiaomi Data on Account of MR_Apriori Association Rule Mining Algorithm

MR_Apriori algorithm is applied in the analysis of customer information of Xiaomi offline platform. By mining some useful data, such as basic personal information of users, product information, etc., it summarizes the commonalities and personalities of users who use Xiaomi smart smart mobile phone, so as to realize the precise marketing of Xiaomi smart mobile phone users.

4.2.1 Use Personalized Marketing for Xiaomi Smart Mobile Phone Users on Account of MR_Apriori Association Rule Mining Algorithm

Taking Xiaomi smart smart mobile phone and Xiaomi hardware products as the research objects, joint DM is carried out to achieve information sharing, which is beneficial to both parties and gives full play to the potential value of their stored customer data. Xiaomi Forum is equivalent to the communication between customers to find loopholes

in the system, improve the superiority of the system, and drive the potential sales of Xiaomi smart mobile phone.

4.2.2 Send Customized Promotional Information

Because the needs of different people are different, different genders are also different, and they change over time. This makes enterprises need to consider more factors and requirements when designing products. Therefore, it is important to make comprehensive analysis with the help of DT to find out the main needs. At present, product production is seriously homogeneous, and in DT marketing, product marketing should be differentiated, which is an important course.

4.2.3 Cross Marketing Using MR_Apriori Association Rule Mining Algorithm

The steps of cross-marketing are divided into:i Model the consumption behavior of individuals. ii Scoring using predictive models. And on this basis, the comprehensive satisfaction of each individual is calculated. Iii is processed by the score matrix optimization. Among them, customer preference as the guidance, select a number of products and services, cross marketing. In cross-selling, one or more target markets are first determined according to customer needs, then different service combinations are selected according to the target market, and finally this series of combinations is output as the final result.

4.2.4 Evaluate Product Performance on Account of MR_Apriori Association Rule Mining Algorithm

Marketers can use DM tools to find the trend of sales, costs and profits of products, regions or markets to understand the effect of a promotion campaign or the reaction of a new product in the market, providing reliable information *sup*. For Xiaomi's R&D team to improve the decision-making of the next step.

5 Conclusion

DM is one of the rapidly developing fields in the computer industry. It is a data analysis and processing technology aiming at prediction and description. This article studies a very important technical association rule mining in DM, combining DM technology with Xiaomi smart mobile phone marketing to mine customer data. On account of the systematic review of DT, marketing and other related concepts, combined with the current situation of Xiaomi mobile phone, this article studies the relevant application of DT marketing in Xiaomi mobile phone, and mainly draws the following conclusions: (1) On the basis of MR_Apriori Association rule mining algorithm, the optimization research on millet data marketing is carried out, which can make marketing more accurate and grasp the specific needs of users more accurately. (2) MapReduce framework can complete large-scale parallel data processing. Therefore, it is an effective method to introduce association rule mining algorithm in Xiaomi Enterprise.

References

1. Chiang, W.Y.: Applying DM for online CRM marketing strategy: an empirical case of coffee shop industry in Taiwan. Brit. Food J. **120**(3), 665–675 (2018)
2. Shokyar, S., Saeidpour, P., Otarkhani, A.: Predicting customers' churn using DM technique and its effect on the development of marketing applications in value-added services in telecom industry. Int. J. Inf. Syst. Serv. Sect. **10**(4), 59–72 (2018)
3. Wang, S.C., Hsiung, W.S., Yan, K.Q., et al.: Use the relevance of product segmentation to enhance the competitiveness of enterprises. Int. J. Inf. Technol. **12**(2), 1–10 (2018)
4. Ariestya, W.W., Supriyatin, W., Astuti, I.: Marketing strategy for the determination of staple consumer products Using FP-growth and apriori algorithm. J Ilmiah Ekonomi Bisnis **24**(3), 225–235 (2019)
5. Berka, P.: Comprehensive concept description on account ofassociation rules: a meta-learning approach. Intell. Data Analysis. **22**(2), 325–344 (2018)
6. Martin D, Martinez-Ballesteros M, Garcia-Gil D, et al. MRQAR: a generic MapReduce framework to discover Quantitative Association Rules in DT problems. Knowledge-Based Systems, 2018, 153(AUG.1):176–192
7. Jabbour, S., Mazouri, F., Sais, L.: Mining negatives association rules using constraints. Procedia Comput. Sci. **127**(1), 481–488 (2018)
8. Menon, S., Ghoshal, A., Sarkar, S.: Modifying transactional databases to hide sensitive association rules. Inf. Syst. Res. **33**(1), 152–178 (2022)
9. Yang, H.J., Wu, Z.S., Cao, F., et al.: Rule of prescribing traditional Chinese medicine in the treatment of pneumoconiosis basedon association rules and k-means clustering algorithm. J. of Hainan Med Coll.: English edition **28**(10), 1–49 (2022)
10. Tong, C., Zhang, Y., Zhou, M., et al.: Online monitoring data processing method of transformer oil chromatogram on account of association rules. IEEJ Trans. Electr. Electron. Eng. **17**(3), 354–360 (2022)
11. Souza, C.R., Maia, V.A., Aguiar-Campos, N., et al.: Tree species consistent co-occurrence in seasonal tropical forests: an approach through association rules analysis. Forest. Syst. **30**(2), e006-e014 (2021)
12. Antomarioni, S., Ciarapica, F.E., Bevilacqua, M.: Association rules and social network analysis for supporting failure mode effects and criticality analysis: Framework development and insights from an onshore platform. Saf. Sci.. Sci. **150**, 105711 (2022). https://doi.org/10.1016/j.ssci.2022.105711

Short Video Creation Mode Based on Interactive Multi-objective Optimization Algorithm

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Abstract. This paper proposes a short video creation mode based on an interactive multi-objective optimization algorithm. By adopting a multi-objective optimization algorithm, this mode can balance multiple objectives to obtain the optimal balance point. At the same time, it also uses interactive feedback, allowing users to choose and adjust optimization solutions to achieve a better user experience. Specifically, the mode includes steps such as determining optimization objectives, generating initial optimization solutions, user feedback, and repeating the optimization process. The advantage of this mode is that it fully utilizes users' personalized needs and creativity to achieve better creative results and user experience. Moreover, it can continuously improve the optimization solution through iterations to achieve the optimal solution.

Keywords: Interactive · Short Video Creation · Objective Optimization Algorithm

1 Introduction

Hort videos have quickly taken over the mobile screens of network users and established themselves as one of the most significant social platforms in the "Internet + era" as a new carrier of social culture [1]. Abstract With the advent of the era of short video, people can receive more information easy to be read and understood in a short time [2]. Short video creation resource optimization refers to the selection and optimization of multiple resources such as materials, audio, music, and editing during the short video production process to achieve the best balance between video quality and user experience. The interactive multi-objective optimization algorithm is an algorithm that can balance multiple objectives and continuously adjust the optimization solution through multiple interactive feedbacks to obtain better results. By combining the two, a short video creation resource optimization model based on interactive multi-objective optimization algorithm can be obtained.

Short video has become an important part of current life, which brings new thinking to filmandtelevision media talents [3]. As an emerging form of media, short video has become widely popular on social media platforms and has become an important way for people to quickly obtain information and entertainment. Unlike traditional videos, short videos are more innovative and diverse in their creation and content presentation,

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covering various themes and types such as comedy, food, lifestyle, education, music, fashion, and more. Therefore, short video creation needs to be optimized from different perspectives to improve video quality and attract more users to watch and interact.

2 Problems Faced by Short Video Creation in the Era of Intelligent Media

Nterest in mobile short-video platforms as a new social network service tool has surged in recent years [4]. With growing popularity of mobile phones, mobile only short video sharing social media applications appeared on the market [5]. The challenges faced in short video creation include but are not limited to: a lack of high-quality material resources, requiring effective screening and editing; considering the needs and preferences of different platforms and audiences to gain better exposure and user feedback; creating high-quality and attractive video works within a limited time, requiring rapid editing and effects processing. To improve the quality and effectiveness of short videos, it is necessary to explore an effective resource optimization model and method.

3 Definition and Characteristics of Short Video

Currently, there is a limited amount of research data on the frequency of interactive and short video creation in the CNKI database in China. There are a total of five Chinese language papers from 2021 to 2023, mainly covering applied research, development research, and technical research, as shown in the figure below, As show in Table 1 and Table 2.

Table 1. Statistics of research levels

year	2021	2022	2023
number of publications	2	3	4

Table 2. Statistics of Published Articles

Research level distribution	Applied research	development research	Technical research
number of references	1	1	1

The main topics include: image building, short video services, marketing and promotion strategies, etc. Sub-topics include: communication channels, Chinese culture, etc. Research is conducted from the perspective of creative methods and content, As show in Fig. 1 and Fig. 2.

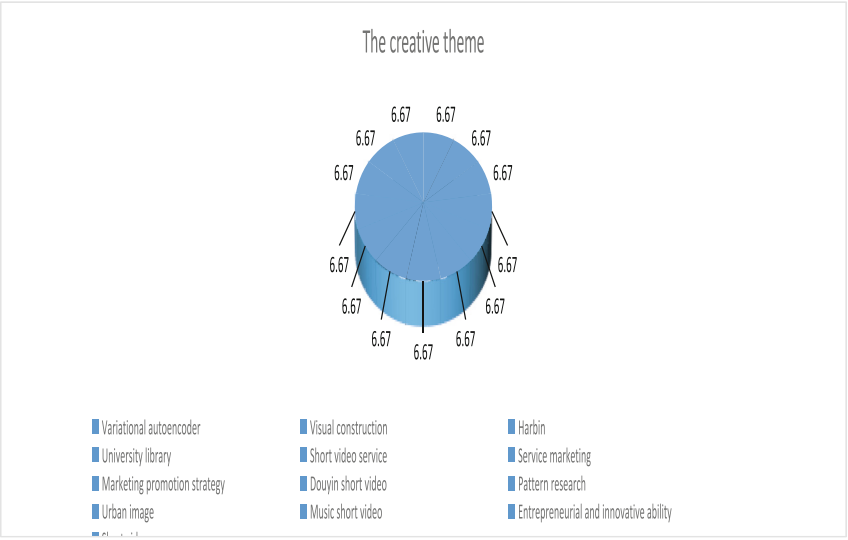

Fig. 1. Creative theme

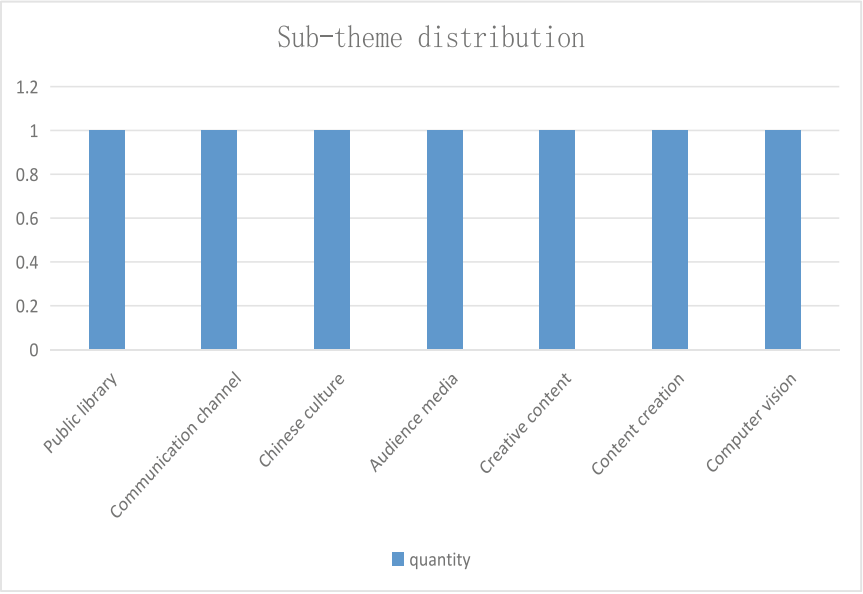

Fig. 2. Sub-theme distribution

4 Practice of Interactive Multi-objective Optimization Algorithm in Short Video Creation

Hort video is short video, which mainly relies on mobile intelligent terminal to realize fast shooting and beautification editing, and can be shared in real time and seamlessly connected on social media platform [6]. The interactive multi-objective optimization algorithm-based short video creation model is a method of optimizing short video creation resources using multi-objective optimization algorithms and user interactive feedback mechanisms. The goal of this model is to improve the quality and creativity of short videos while meeting the needs of different users and audiences, thereby enhancing user experience and satisfaction.

The implementation process of this model includes the following steps:

(1) Determine optimization objectives: by researching and analyzing user needs and audience groups, determine the optimization objectives and weights. These objectives may include video quality, creativity, duration, audience groups, etc.
(2) Generate initial optimization solutions: based on the determined optimization objectives and weights, generate initial optimization solutions. This can be achieved by using existing video materials and creative elements or by algorithm generation.
(3) Multi-objective optimization: optimize the initial solutions through multi-objective optimization algorithms. This process can utilize existing multi-objective optimization algorithms such as NSGA-II, MOEA/D, etc.
(4) User feedback: allow users to select different optimization solutions and evaluate and provide feedback on them. Users can choose the optimization solutions that best suit their needs and preferences and evaluate and provide feedback on them.
(5) Repeat optimization process: by continuously repeating the above steps and optimizing the solutions, the optimal solution can be achieved.

In concrete operations, the short video creation mode can be optimized by collecting the following data:

(1) User usage data analysis: Collect user usage data for this short video creation mode, including user click-through rate, usage duration, usage frequency, etc., to understand user feedback and preference for the mode.
(2) System performance data analysis: Collect system performance data under different user usage conditions, such as response time, resource consumption, etc., to evaluate the mode's system performance and stability.
(3) Video quality data analysis: Conduct quality data analysis for short videos created using the mode, such as video resolution, frame rate, color saturation, etc., to evaluate whether the created videos meet user expectations.
(4) Short video creation data analysis: Analyze the short videos created using the mode, such as video length, views, likes, comments, etc., to understand the videos' impact and influence among users.
(5) User satisfaction data analysis: Collect user satisfaction data for the mode through surveys or questionnaires, including user evaluations of the mode's preference, usability, efficiency, and overall feedback, to understand the user's overall evaluation and feedback for the mode.

5 The Influence of Short Videos on Teenagers

By June 2020, the number of short-form video APP users in China was 818 million, accounting for 87% of the total Internet users, that is, 87% of the online population used short-form video APP and among these users college students and other youth groups occupy a large proportion [7]. Taking the example of teenage users, their usage behavior and preferences in short video applications can be determined through factors such as their usage time and frequency, preferred video types and content, interactive behavior such as commenting, liking, sharing, as well as personal information and setting preferences such as profile pictures, usernames, and privacy settings.

For instance, statistical analysis can be conducted on the usage time and frequency of teenage users in short video applications, based on a sample size of 1000. The following conclusions can be drawn from the data analysis on teenage user behavior in short videos:

Average usage time: 45 min per day.
Longest usage time: 3 h per day.
Shortest usage time: 10 min per day.
Usage frequency: 60% use daily, 25% use weekly, and 15% use monthly.

Anging from a few seconds to a few minutes, the short video has become a popular form of learning and sharing creative skills such as drawing, photography, and crafting [8]. With the advent of the digital age, short videos have become one of the important ways for the public to obtain information. Based on the characteristics of high dissemination, wide content coverage, and concise content, this paper explores the impact of short videos on adolescents [9]. We can create related short video themes based on the statistical results, corresponding to the creation of short video content that young users prefer, based on their usage habits. In the era of self-media, the fast dissemination and strong interactivity of short videos should be fully utilized to create a good growth environment for adolescents and contribute to the healthy development of online platforms [10].

Overall, interactive multi-objective optimization algorithms for short video creation should consider multiple optimization objectives and allow users to select and provide feedback on optimization schemes. This can result in more personalized and user-oriented optimization schemes, enhancing user experience and satisfaction. The resource optimization model for short video creation based on interactive multi-objective optimization algorithms provides an effective resource optimization method for short video creators, making creation more efficient and targeted, and providing support and assurance for the sustainable development of the short video industry.

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References

1. Li, F.: Dilemma and Solution of copyright justice system for health short video under network big data environment monitoring. J. Environ. Public Health **2022** (2022). DOI:https://doi.org/10.1155/2022/9640574
2. Liu, L., Yu, M., Feng, X.: Some characteristics and innovative development counter-measures of short weather video: a case study of the first award-winning excellent short weather video in hubei province meteorological and environmental research. Cranston **12**(3), 34–37 (2021). DOI:https://doi.org/10.19547/j.issn2152-3940.2021.03.010
3. Qiu, S., Liu, Y.: Research on the mode of short video project teaching and media talent training in colleges and universities under 5G industry chain based on multimedia technology. J. Phys. Conf. Ser. **1992**(2) (2021). DOI:https://doi.org/10.1088/1742-6596/1992/2/022057
4. Choi, Y., Wen, H., Chen, M., Yang, F.: Sustainable determinants influencing habit formation among mobile short-video platform users. Sustainability Basel **13**(6), 3216 (2021). DOI:https://doi.org/10.3390/su13063216
5. Aliaksandra, S.: Case Study of TikTok; Home social computing and social media. In: Participation, User Experience, Consumer Experience, and Applications of Social Computing Conference paper User-Generated Short Video Content in Social Media. A Case Study of TikTok ; Conference paper First Online (10 July 2020)
6. Wang, Y.: Content characteristics and limitations of original short video based on depth data. J. Phys.: Conf. Ser. **1881**, 042070 (2021)
7. Xu, X., Jia, F., Du, T.: Examining the factors influencing college students'continuance intention to use short-form video APP. Alternate title: Short-form video APP. Mou, Aslib J. Inform. Manag. Bradford **73**(6), 992–1013 (2021). DOI:https://doi.org/10.1108/AJIM-03-2021-0080
8. Zhou, Q.: Understanding User Behaviors of Creative Practice on Short Video Sharing Platforms –A Case Study of TikTok and Bilibili; search.proquest.com (2019)
9. Yao, T., Lin, Z.: Analysis on the impact of short videos on adolescents' physical exercise. Journal of Sports Goods and Technology (15 January 2023)
10. Liang, J., Li, F., Hu, C.: Seeing long-term benefits in the short-term" - the impact of short video development on adolescents' Physical and Mental Health in the Digital Economy Era. Talent and Intelligence (19 October 2022)

Research on Earthquake Detection Based on Machine Learning

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Abstract. Accurate and efficient detection of each earthquake is an important foundation for earthquake work. However, at present, due to the lack of observation data information, the accuracy of parameter estimation is low, especially for seismic detection of major projects, the current situation of sparse station layout makes it impossible to use multiple averages like dense network seismic detection to reduce the discreteness of parameter estimation, and the accuracy of seismic detection parameters based on a single station needs to be improved. In recent years, there has been an increasing focus on how machine learning can be used to improve seismic detection performance. In this paper, the principle of AI seismic detection and waveform mask matching is analyzed, and then a new deep learning method, TransQuake, is proposed based on the frontier sequence model Transformer for seismic wave detection. TransQuake combines STA/LTA algorithms for feature enhancement of seismic waveform data and interpretable model learning using a multi-head attention mechanism. To validate the performance of the model, this paper conducts an extensive evaluation on the 2008 Wenchuan MW7.9 earthquake aftershock dataset. The results show that TransQuake can achieve the best detection performance beyond the baseline of leading-edge algorithms.

Keywords: Machine Learning · Seismic Detection · Deep Learning · Event Identification

1 Introduction

Earthquakes are devastating wherever and whenever they are. As one of the countries prone to earthquakes, China has experienced great threats to the safety of people's lives and property caused by earthquakes [1]. Accurate determination of earthquake location, intensity and parameters is an important basic work of earthquake science research, and an important prerequisite for achieving future earthquake forecasting, disaster prevention and mitigation [2]. As the volume of seismic data has grown exponentially over the past few decades, it is becoming increasingly important to develop efficient and highly generalizable automatic identification technologies. As detection techniques have improved, more and more signals previously considered as noise have been re-determined as microseismic or ground tremor, a change that, in addition to reducing the completeness of the

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catalogue, has revealed that the detection rate of these tiny earthquakes is highly consistent with the fault slip rate and reflects fault activity at a much higher resolution than GPS. This is undoubtedly the best solution to the problem of seismic detection with a large amount of available marker data [3]. Therefore, based on machine learning methods, the analysis and processing of the waveform data of the Chinese mainland near station before the strong earthquake in recent years to obtain the missed micro-earthquakes not only has a good supplementary effect on the earthquake catalog, but also has important indicative significance for studying the change of earthquake frequency or the anomaly extraction before the large earthquake.

2 Seismic Detection

2.1 AI Seismic Detection Principle

When dealing with highly complex and non-linear separable seismic datasets, neural network-based methods, especially deep learning, show better solving ability for complex problems and are most widely used in seismic detection research. From the original data, each layer of neural network can extract different levels of features [4].

The model of this paper is based on the attention mechanism. The attention mechanism is to imitate the visual selective attention of the human brain, the most typical example is the human eye watching the web page, the human eye will selectively observe certain areas in the web page [5].

The component of long-head attention is the zoom dot product attention mechanism. Multiple zoom dot attention mechanisms calculate input features multiple times at a time, and each zoom dot attention mechanism is calculated in the samse way. A diagram of the structure of the scaling dot product attention mechanism is shown in Fig. 1.

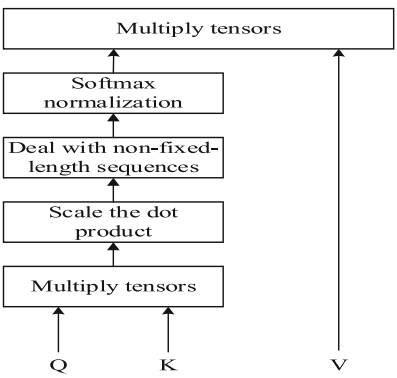

Fig. 1. Zoom dot product attention mechanism structure

Among them, K, Q, and V represent key, query, and value, respectively, and all three are matrices. The constituent vectors corresponding to K and V are a pair of key-value pairs, which are one-to-one correspondence [6]. The scaling dot product attention

mechanism first performs a dot product calculation on Q and K, and adds a scaling layer(softmax) after the calculation result to avoid model underfitting caused by excessive Q and K values [7, 8]. The calculation formula for the zoom dot product attention mechanism is shown in Eq. (1).

$$Attention(Q, K, V) = softmax(\frac{QK^T}{\sqrt{d_k}})V \tag{1}$$

Figure 2 shows the structure of the bull's attention. The multi-head attention mechanism maps the dimensions of K, Q and V through a variety of different mappers, and then repeats the h attention operation, and obtains the output of the final multi-head attention mechanism after a linear change [9]. The specific calculation formula is shown in Eq. (2).

$$\begin{cases} MultiHead(Q, K, V) = Concat(head_1, \ldots, head_h)W^o \\ head_i = Attention(QW_i^Q, KW_i^k, VW_i^V) \end{cases} \tag{2}$$

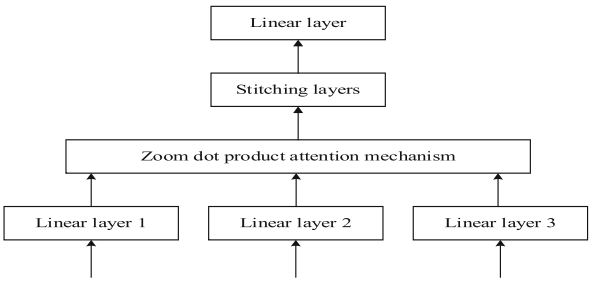

Fig. 2. Structure of the bullish attention mechanism

2.2 Waveform Mask Matching Principle

The underlying logic of the waveform mask matching technique is that the adjacent seismic waveforms recorded by the same station are similar. By superimposing the cross-correlation of template waveforms and continuous waveforms, missing events around the template can be identified [10]. The basic principle of the waveform mask matching method is as follows:

Suppose $\omega_{N,\Delta t}(t_0)$ is a continuous sampling of the N component of the nonzero time series $\omega(t)$:

$$\Omega_{N,\Delta t}(t_0) = [\omega(t_0), \omega(t_0 + \Delta t), \ldots, \omega(t_0 + (N-1))\Delta t]^T \tag{3}$$

where t_0 represents the time of the first sampling point and Δt represents the sampling interval. Make the inner product of the two time series of the above equation $\omega_{N,\Delta t}(t_w)$ and $V_{N,\Delta t}(t_v)$:

$$[\vartheta(t_v), \omega(t_W)]_{N,\Delta t} = \left[\vartheta(t_v)_{N,\Delta t}, \omega(t_w)_{N,\Delta t}\right] = \sum_{i=0}^{N-1} \vartheta(t_v + i\Delta t)\omega(t_W + i\Delta t) \tag{4}$$

The normalized correlation number can be expressed as:

$$C[\vartheta(t_v), \omega(t_W)]_{N,\Delta t} = \frac{[\vartheta(t_v), \omega(t_W)]_{N,\Delta t}}{\sqrt{[\vartheta(t_v), \vartheta(t_v)]_{N,\Delta t}[\omega(t_W), \omega(t_W)]_{N,\Delta t}}} \tag{5}$$

In Eq. (5), the value range of C is [−1,1]. The higher the value, the higher the degree of similarity between the two signals [11]. The number of correlations between the template and the continuous signal is expressed as $Cw(t)_{N,\Delta t}$, where $\omega(t)$ represents the seismic signal. Let the signal appear from the t_M moment:

$$C_{\omega}(t)_{N,\Delta t} = C[\omega(t), \omega(t_M)]_{N,\Delta t} \tag{6}$$

The basic workflow of the waveform template matching method includes: (1) preparing continuous waveforms, including preprocessing, shift start time, and bandpass filtering. (2) Use the seismic catalog to cut the template waveform and calculate the signal-to-noise ratio. (3) The continuous waveform and the catalog are cross-correlated to obtain the number of mutual relations. (4) Superimpose the number of correlations and calculate the average (CC) to measure the similarity of detected new events and templates.

3 Seismic Detection Model Based on Attention Mechanism

3.1 Model Network Structure

As shown in Fig. 3, the most advanced sequential model in the NLP domain is Transformer, based on which a new seismic detection model, TransQuake, is proposed in this paper.

Since seismic waves are continuous waveforms, in order to accommodate continuous waveform data, this paper proposes a new method to obtain the input of the encoder. The classification of seismic waves is based on whether the waveform contains seismic P-waves or not, and the results are obtained by softmax and linear layers based on the modified Transformer encoder. The shape of the reshaped waveform is shown in Fig. 3, after the STA/LTA process. The relationship between each position of the vectors is analysed using a fully connected layer before the PC is added to obtain the input to the encoder.

When reshaping each waveform, two factors need to be analysed. These two factors are: the size of the attentional model and the combination of the 3 components at each position. Therefore, when reshaping, each waveform is reshaped from 3×5000 to $k \times 3T$, where $k = (3 \times 5000)/3T$. Finally, they are fed in parallel to the PC layer and the FC layer. And in the FC layer, each neuronal cell is connected into a new new cell by Eq. (7).

$$y_m = \sum_{n=1}^{3T} W_n x_n \tag{7}$$

In Eq. (7), y_m is value of the new cell, where the range of values of m is [0, d], d represents the dimension of the hidden cell; w_n is the weight to be trained; x_n is the value of the original cell.