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Cross cultural Comparative Study on Emotional Analysis of Social Media

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Abstract

With the popularization of social media and the acceleration of globalization, cross-cultural social media research has become an increasingly important research field. This article takes cultural differences as the starting point to explore the use and impact of social media in cross-cultural environments. The study used a combination of quantitative and qualitative methods to collect social media data from users from different cultural backgrounds, and conducted data analysis and comparison. Research has found that users from different cultural backgrounds have significant differences in social media usage behavior, content expression, and interaction methods. At the same time, the use of cross-cultural social media will also have different impacts on users' cultural identity, social relations and mental health. The research results have certain reference value for promoting cross-cultural communication, enhancing cultural understanding, and improving the effectiveness of social media usage.

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1. Research background

With the acceleration of globalization, people's frequency and scope of communication in different cultural backgrounds are becoming increasingly widespread. According to statistics, as of the end of 2022, the number of global social media users has exceeded 4.62 billion, accounting for 58.4% of the global population. This provides enterprises with a massive amount of information about consumer needs and preferences. In addition, according to a 2018 study, over 80% of consumers check online reviews and comments before shopping. In this case, social media has become an important channel for consumer communication. The valuable information provided by comments and feedback on social media not only helps consumers understand the advantages and disadvantages of products or services, but also helps them make more informed purchasing decisions and achieve a better shopping and customer service experience. At the same time, it will also help enterprises timely understand market trends and customer needs, improve products or services, enhance brand image and reputation, and enhance market competitiveness. Therefore, it is necessary to conduct cross-cultural comparative research on emotional analysis on social media.

Electronic consumption is one of the most active industries on social media, and consumers often express emotions and opinions in online comments in these fields. For enterprises in these industries, understanding customer comments and feedback on social media is crucial for improving customer satisfaction, improving product and service quality, and enhancing brand loyalty. Cross cultural comparative research can help companies better understand the needs and preferences of consumers in different cultural backgrounds, and develop market strategies that are more suitable for different cultural backgrounds. Therefore, different scholars have conducted research in these fields, using existing text mining techniques to extract useful information from social comments, understand consumers' opinions and attitudes towards products or services, and help enterprises improve their products and services. Li et al. [1] used text mining methods and econometrics to analyze 600, 686 online comments from 300 restaurants

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in Yelp, and studied the impact of emotional intensity on perceived comment usefulness. Similarly, Sutherland et al. [2] by analyzing online reviews from Airbnb accommodation, we aim to uncover the themes that consumers are most concerned about when choosing accommodation. This paper analyzes the moderating effect of perceived empathy and cognitive effort potentially contained in emotional content of electronic products on the impact of product reviews on purchase decisions.

These studies utilize existing text mining techniques for data analysis of online product reviews, with the advantage of being able to process large-scale data in a short period of time, understand user needs and preferences, identify potential patterns and trends in text, and help companies better adjust their corporate strategies. For example, Amazon can automatically extract users' emotional information about products through text mining technology, and discover their opinions and suggestions on different aspects of the product, helping Amazon improve product quality and user experience, increase sales and customer satisfaction. However, existing research has overlooked situational factors in cultural backgrounds, lacking a multicultural perspective, and unable to understand the characteristics and differences of emotional expression in different cultures on a global scale, ultimately leading to limitations and biases in the analysis results. Therefore, this article will start from the perspective of multiculturalism, and more accurately grasp consumer behavior preferences by connecting the emotional expression and cultural psychological characteristics of different cultures, thereby helping enterprises make better decisions. The academic contributions of this article are as follows.

- Exploring the characteristics and patterns of emotional expression in different cultures from a new perspective, and gaining a deep understanding of the essence and diversity of consumer emotional behavior in different cultures.
- A social media sentiment analysis framework that comprehensively considers cultural factors has been proposed. This framework not only considers the differences in emotional expression under different cultural backgrounds, but also considers the impact of cultural backgrounds on emotional recognition and classification.
- Aiming at the diversity and openness of social media, a standardized method for data collection, processing, and analysis has been developed to collect data from different platforms and fields, ensuring the reliability and effectiveness of research.
- A new fine-grained sentiment analysis method has been proposed, which extracts aspects of comments, opinions, and emotions simultaneously within the same framework, in order to gain a more detailed understanding of consumers' emotional expression in different cultural backgrounds.

2. Related research

Online product reviews can not only help companies improve their products or services [3, 4, 5], but also greatly increase user engagement [6, 7, 8]. This requires better data mining methods to quickly and accurately mine user preferences and improve the conversion rate of target behaviors [9]. Yin et al. [10] proposed a novel collaborative filtering ranking framework is used to mine users' preferences for items. The author fully extracts users' preferences and potential interests by embedding the random variables of minimizing related problems into the representation of users and items. Park et al. [11] A deep learning model based on knowledge graph was proposed, which utilizes a multi-layer attention mechanism based on triple layers to extract the distribution of users' preferences for historical behavioral information, and ultimately successfully predicts users' behavioral preferences. Wu et al. [12] combined econometric analysis with text mining techniques to study the impact of online reviews on sales, the study found that subsequent reviews will have a positive impact on sales. Provide heuristic clues for online shopping decisions. Guo et al. [13] used LDA to model the theme of online comments, extract key topics of the product, and use sentiment analysis technology to conduct sentiment analysis on each online comment, compare the advantages and disadvantages of product attributes, and reveal key factors that affect user behavior experience.

However, these studies generally have a drawback, which is the neglect of situational factors in cultural backgrounds, the lack of a multicultural perspective, and the inability to understand the characteristics and differences of emotional expression in different cultures on a global scale, ultimately leading to limitations and biases in the analysis results. At the same time, these studies often use the fragmentation text mining technology to analyze the similarities and differences between topics and between attributes in a one-way way, without considering the relationship between topics, topics and attributes, and attributes and attributes. In order to better address these issues, there have also been some studies that integrate the above issues, attempting to use some comprehensive and applied text mining techniques to better analyze and mine consumer behavior preferences. Blei et al. [14] utilized theme modeling and sentiment analysis techniques to model online comments from domestic and foreign retail service platforms, and utilizing sentiment analysis techniques to analyze emotional differences between different countries and themes. Liu et al. [15] integrated feature extraction, theme modeling, sentiment analysis, and regression analysis, an intelligent sentiment analysis and marketing model for homestay consumption was constructed, analyzing

the influencing factors of experiential homestay tourism consumption intention, and providing countermeasures and suggestions for relevant enterprises.

Different from the above research, the research framework of this article is different, starting from different attributes of products, and at the same time, from the perspective of cultural diversity, conducting research from different fields, the connection between themes between different cultures, the emotional differences of users towards product attributes corresponding to themes, and formulating strategies through XX. In addition, this article will quantitatively analyze different indicators from different dimensions and visualize the results to enhance the interpretability of the model.

3. Research design

This paper mainly includes three steps. First, we use the Python web crawler method to crawl online comment data in the field of electronic consumption under different cultural backgrounds, and preprocess the data of the results to construct a cross-cultural social media sentiment analysis corpus. Then, the LDA topic clustering model and keyword network analysis are used to mine the themes that consumers care about in different cultural backgrounds. Finally, fine-grained emotional analysis is conducted on the theme words that consumers care about, and visual comparisons are conducted to explore the potential behavioral characteristics and similarities and differences among consumers from different cultural backgrounds.

3.0.1. Theme modeling model

LDA is a topic model based on probability generation, which was proposed by Bei et al [14] in 2003. It can automatically mine hidden topics from large-scale corpora, and is one of the most widely used topic model. The basic idea of LDA is to assume that each document is composed of multiple topics, and each topic is composed of multiple words. It extracts the distribution of text in the topic space through a random generation process and expresses the concept of the topic in the form of word distribution. As shown in Figure 1, LDA first uses the Dirichlet distribution α Generate the topic distribution of document i , followed by polynomial distribution θ_m generates the theme of the document in the m chapter, and at the same time, from the Dirichlet distribution β Distribution probability of generated words in Chinese θ_k . Finally, from φ_k Generate the final word w in $w_{m,n}$. The Dirichlet distribution is shown in formula (1).

$$p(\vec{p} | \vec{\alpha}) = \text{Dir}(\vec{p} | \vec{\alpha}) \frac{\Gamma(\sum_{k=1}^K \alpha_k)}{\prod_{k=1}^K \Gamma(\alpha_k) \prod_{k=1}^K p_k^{\alpha_k-1}} \quad (1)$$

The LDA model uses Gibbs sampling to calculate $Z_{m,n}, \theta_m, \varphi_k$ Potential variables such as k . The first choice is to assign a topic vector z to each document, and then train and calculate the number of occurrences and distribution probability p of the vector z in the document through continuous iteration. Finally, use this as a basis for sampling to obtain new topics. The sampling algorithm is shown in formula (2).

$$p(z_i = k | \vec{z}_{-i}, \vec{w}) = \frac{p(\vec{w}, \vec{z})}{p(\vec{w}, \vec{z}_{-i})} \propto \frac{n_{k,-i}^i + \beta_t}{\sum_{t=1}^V \frac{n_{k,-i}^{(t)}}{n_{k,-i}^{(t)} + \beta_t}} (n_{m,-i}^{(k)} + \alpha_k) \quad (2)$$

3.1. Aspect level emotional analysis

The sentiment analysis model based on bidirectional reading comprehension [15] is a pre trained model based sentiment analysis method. Compared with traditional sentiment analysis models, this model can automatically capture attributes, viewpoints, and emotions in sentences by learning the contextual semantic relationships in the text. This feature makes the sentiment analysis model based on bidirectional reading comprehension more suitable for complex contexts and texts that are difficult to accurately judge emotions, For example, sentences containing rhetorical devices such as satire and irony.

The model is mainly divided into three parts: sentence embedding layer, aspect recognition layer, and emotion classifier. The model first uses the pre training model to vectorization the sentence, then inputs the sentence vector into the aspect recognition layer, queries each attribute and opinion of the sentence in combination with the context semantic characteristics of the sentence, and finally predicts the corresponding emotion of the opinion according to the obtained attribute and opinion according to the Semantic information of the context, finally forming the attribute opinion emotion triad.

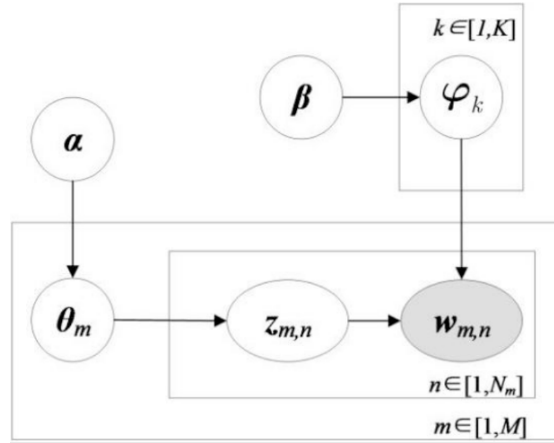


Fig. 1. Comprehensive analysis chart of domestic attention satisfaction

3.1.1. Word vector layer

Given the input sentence $S=\{w_1, w_2, w_3, \dots, w_n\}$, add special markers [CLS] and [SEP], and embed the output E_i , as shown in formula (3). Among them, "Ei" represents the E_i sentence, "Etoken" represents the word vector encoding of the sentence, "Segment" represents the positional information of each word in the sentence, and "Segment" represents the segmentation information between sentences. Finally, the pre trained BERT model is used to embed the word elements, position, and segment information of the input sentence in the form of word vectors.

$$E_i = E_{token} + E_{position} + E_{segment} \quad (3)$$

3.1.2. Aspect recognition layer

This layer mainly includes two types of queries: unrestricted query $Q^N = \{q_i^N\}_{i=1}^{|Q^N|}$ and restricted query $Q^R = \{q_i^R\}_{i=1}^{|Q^R|}$. This model first queries the set $A = \{a_i\}_{i=1}^{|A|}$ of entity attributes contained in sentences through non restrictive $A = \{a_i\}_{i=1}^{|A|}$ and the set of viewpoints $O_{a_i} = \{o_{a_i,j}\}_{j=1}^{|O_{a_i}|}$, and then use restrictive queries to match the attributes of each entity with the meaning of the viewpoint, forming an attribute viewpoint pair. In order to ensure the accuracy of the extracted attributes and views, the model uses formula (4) to minimize the loss of cross entropy. Where y_j^{start} represents the starting position of the prediction of attributes or viewpoints in a sentence, y_j^{end} represents the predicted position of an attribute or viewpoint in a sentence, and p represents the probability of prediction.

$$\begin{aligned} \mathcal{L}_N = & - \sum_{i=1}^{|Q^N|} \sum_{j=1}^N \left[p(y_j^{\text{start}} | x_j, q_i^N) \log \hat{p}(y_j^{\text{start}} | x_j, q_i^N) \right. \\ & \left. + p(y_j^{\text{end}} | x_j, q_i^N) \log \hat{p}(y_j^{\text{end}} | x_j, q_i^N) \right], \end{aligned} \quad (4)$$

3.1.3. Emotional recognition layer

This layer is a fully connected layer that maps the vector representation and aspect information of sentences to sentiment categories through the Softmax function, and continuously updates parameters through backpropagation algorithms to optimize the classification results. The Softmax function is shown in formula (5).

$$\text{Softmax}(z_i) = \frac{e^{z_i}}{\sum_{c=1}^C e^{z_c}} \quad (5)$$

4. Empirical analysis

4.1. Data collection and preprocessing

4.1.1. Data collection

In order to compare the differences in emotional expression under different cultural backgrounds, this article selected user reviews from the electronic consumption industry of two representative cultural backgrounds, domestic

Table 1. The Theme Words of Electronic Consumption in the Domestic Cultural Background

theme	feature words
Function Characteristics	earphon, mouse, fingerprint recognition, fingerprint key, lock screen, sensing, network connection
After-sale Service	customer service, returns to the factory, repair fees, returns, exchanges, warranty services
Purchase Experience	price, discount, coupon, delivery speed, return, guarantee, reputation
Product Use	network speed, motherboard, resources, type, image, storage, cpu
Celebrity Endorsement	ZhaoWei, ZhangShaohan, TangYan, WeiQi, HuangShenger, LiFeier, ZhouXun

and foreign, for data analysis. The main sources of data are from Amazon, Taobao, and others. We chose social media platforms for online reviews because they are globally renowned, electronic consumer review websites with a large amount of user comments and rating data, ensuring the reliability of the data.

4.1.2. Data preprocessing

In order to ensure the quality and consistency of the data, we conducted two stages of data preprocessing on the collected data: data cleaning and text preprocessing. Data cleaning aims to remove noise, errors, and inconsistencies from the dataset, in order to improve the quality and reliability of the data. To this end, we will remove some meaningless and repetitive online comments to ensure the quality of online comments. Text preprocessing aims to transform the original text data into structured data that can be used for analysis and modeling. Text preprocessing usually includes removing noise data such as special characters, stop words and numbers, performing text normalization operations such as stemming, word shape restoration, and emotional vocabulary marking. These operations help reduce noise and inconsistency in the dataset, improve data quality and reliability, and also help extract key information and features from the text to support subsequent analysis and modeling work. After completing these two stages, data from different cultural backgrounds were ultimately obtained.

4.2. Topic mining results

Due to the need for a certain prior estimation to determine the optimal number of topics, combined with relevant literature on electronic consumption [12], this article sets the number of topics for this experiment to 5 and selects feature words with a frequency greater than 8 as representatives. The clustering results of themes are shown in Table 1. Consumers from domestic cultural backgrounds are most concerned about topics such as After sale Service, After sale Service, Purchase Experience, Product Use, and Celebrity Endorsement. Consumers from domestic cultural backgrounds are most concerned about topics such as After ale Service, Applicable Scenarios, Innovativeness, and Brand Reputation.

Table 2. The Theme Words of Electronic Consumption in Foreign Cultural Background

theme	feature words
Function Characteristics	extended functionality, peripheral support, speech recognition, software, data storage, fingerprint identification
After-sale Service	maintenance, upkeep, after-sales, consulting, hotline, response speed, commission
Applicable Scenarios	office, factory, school, hospital, family, outdoors
Innovativeness	technology, idea, concept, innovation, design, ecosystem
Brand Reputation	word of mouth, service, satisfaction, brand, promises, market share

From the results, we found that consumers from different cultural backgrounds may have different concerns about electronic products. Consumers from domestic cultural backgrounds have a high level of attention on topics such as After sale Service, Purchase Experience, Product Use, and Celebrity Endorsement, while consumers from foreign cultural backgrounds pay more attention to After ale Service, Applicable Scenarios, Innovativeness, Brand Reputation, and so on. This indicates that domestic cultural consumers trust and favor products endorsed by celebrities more. Therefore, before purchasing, consumers will pay attention to electronic products endorsed by celebrities, including the brand, product characteristics, and marketing activities related to celebrity endorsements. During the purchase process, they hope to purchase their desired products through simple and convenient means and enjoy purchase discounts Gifts and other benefits, and after purchasing the product, I hope to receive a guaranteed after-sales system. Consumers in foreign cultural backgrounds often pay more attention to brand reputation before purchasing goods. They choose well-known brands or products or services with good brand reputation to ensure the quality and reliability of the products or services they purchase, and consider the applicable scenarios of the products or services to ensure that they meet their needs and purposes, in order to make better choices. In the process of purchasing

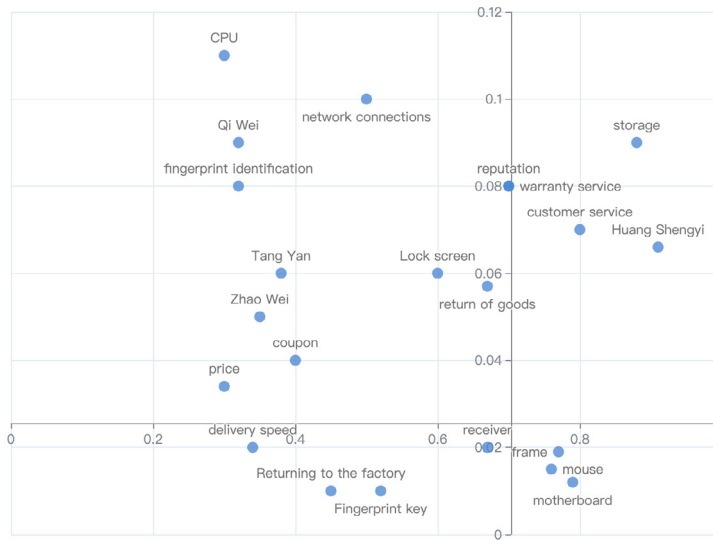


Fig. 2. Comprehensive analysis chart of domestic attention satisfaction

products, they pay more attention to their innovation. They believe that using the latest technology and design will result in a better user experience and value. After purchasing the product, they also hope to receive a guaranteed after-sales system to ensure that the product or service they purchase can receive a good user experience.

4.3. Fine Grain Tendency Analysis Results

In order to better explore user needs and identify the advantages and disadvantages of products or services, it is difficult to analyze them solely based on topic modeling. Therefore, we conduct attribute level sexy analysis of products to explore user satisfaction with segmented features, and visualize the attention and satisfaction of each feature attribute, making it more intuitive to understand customers' emotional tendencies. Among them, $\text{attention} = \frac{\text{number of feature word occurrences}}{\text{total number of feature word occurrences}}$, $\text{satisfaction} = \frac{\text{number of positive evaluations of feature words}}{\text{total number of feature word occurrences}}$. The results of emotional analysis under domestic and foreign cultural backgrounds are shown in fig. 2 and fig. 3.

From the perspective of attention, foreign consumers are most concerned about fingerprint recognition, office equipment, software, after-sales consultation, data storage and maintenance, while domestic consumers are most concerned about customer service, warranty services, reputation, network connectivity, and other aspects. Foreign consumers pay more attention to technological innovation and functionality of products, while domestic consumers pay more attention to service quality and after-sales service. This indicates that there are certain differences in the focus of consumers on products and services between the two countries. From the perspective of satisfaction, foreign consumers are most satisfied with home and office equipment, fingerprint recognition, software, and maintenance, while domestic consumers are most satisfied with storage, Huang Shengyi, customer service, motherboards, and mice. There are also certain differences in consumer satisfaction concerns between the two countries, but both emphasize the quality and performance of products and services. From the perspective of low attention and low satisfaction, foreign consumers pay less attention to products related to identification and certification (such as identification and certification, word of mouth, Edge device), while domestic consumers pay less attention to price and CPU. At the same time, foreign consumers are less satisfied with identification and certification products (such as identification and certification, word of mouth, Edge device), while domestic consumers are less satisfied with price and CPU. This indicates that consumers in both countries have low attention and satisfaction towards certain products or services. From the perspective of attention satisfaction, both foreign and domestic consumers attach great importance to customer service, but there are certain differences in other aspects. Foreign consumers are more concerned about software, fingerprint recognition, office equipment, etc., while domestic consumers are more concerned about storage, mice, motherboards, etc. At the same time, consumers in both countries have a high level of attention and satisfaction with after-sales consultation and maintenance, indicating the importance consumers attach to after-sales



Fig. 3. Comprehensive analysis chart of foreign attention satisfaction

support and quality of products and services. In summary, there are certain differences and similarities between foreign and domestic consumers' concerns and satisfaction with products and services. For the focus of products and services, foreign consumers pay more attention to technological innovation and functionality, while domestic consumers pay more attention to service quality and after-sales service; Regarding the focus on satisfaction, consumers in both countries emphasized the quality and performance of their products and services. When consumers have low attention and satisfaction towards certain products or services, the attention and satisfaction of consumers in both countries are relatively low.

5. Discussion of results

When considering consumer behavior and preferences both domestically and internationally, we need to pay attention to the differences in cultural and historical backgrounds between the two countries. These differences lead to different consumer concerns and satisfaction, which will also affect the product and service design, pricing and marketing strategies of enterprises in these two markets. Firstly, there are significant differences in cultural backgrounds both domestically and internationally. Foreign countries are a country of immigrants, and the influence of various cultures has led to an emphasis on individualism and freedom, as well as an emphasis on individual independent thinking and self-expression. In contrast, the domestic culture emphasizes collectivism and family values, and emphasizes interpersonal relationships and kinship. This difference has led to differences in the focus of consumers on products and services between the two countries. Foreign consumers place greater emphasis on technological innovation and functionality, while domestic consumers place greater emphasis on service quality and after-sales service. Secondly, there are also differences in consumer culture and habits both domestically and internationally. Foreign consumers tend to pursue high-quality and high-performance products and services, emphasizing quick satisfaction of personal needs, while domestic consumers pay more attention to cost-effectiveness and practicality, emphasizing long-term value and stability. This difference will also affect the product and service design and pricing strategies of enterprises in the two markets. Finally, the historical and social background at home and abroad are also important factors that affect consumer behavior and preferences. As an immigrant country, foreign consumption culture has been influenced by different cultures and has also promoted innovation and diversity. However, China has a long history and traditional culture, and consumers' attention to quality and reputation has also been influenced by historical and social backgrounds.

6. Strategy

1. Understand the consumer needs and preferences in different national markets. Enterprises need to understand the differences in the focus and satisfaction of domestic and foreign consumers towards products and services through market research and analysis. This helps enterprises to formulate product and service design, pricing and marketing strategies for different markets. 2. Customized product and service design. Enterprises need to design customized products and service design according to the needs and preferences of consumers in different countries. For example, in foreign markets, companies can emphasize the technological innovation and functionality of their products, while in domestic markets, companies can emphasize the practicality and cost-effectiveness of their products. 3. Consider pricing strategies for different national markets. The pricing strategies of enterprises in different national markets should also change. In foreign markets, companies can adopt a high price positioning strategy because foreign consumers are more willing to pay more for high-quality and high-performance products and services. In the domestic market, enterprises should adopt a mid to low price positioning strategy to meet the demand of domestic consumers for product cost-effectiveness. 4. Develop marketing strategies tailored to different national markets. Enterprises need to develop corresponding marketing strategies tailored to the needs and preferences of consumers in different national markets. For example, in foreign markets, companies can adopt digital marketing strategies such as online advertising and social media promotion, while in the domestic market, companies need to adopt more offline promotion and marketing strategies, such as store promotions and brand activities. 5. Invest in cross-cultural training and talent management. When enterprises are operating internationally, they need to involve cultural differences in different countries' markets, so they need to invest in cross-cultural training and talent management. This helps companies better understand the cultural background and consumption habits of different countries' markets, develop corresponding business strategies and management plans, and improve their competitiveness in cross-border markets.

7. Conclusion

This article uses LDA theme modeling technology and fine-grained sentiment analysis models to analyze and compare domestic and foreign social media data from the perspective of cultural differences. It explores the differences in user behavior and content expression under different cultural backgrounds, providing important theoretical guidance and practical reference for enterprise product services and product design under different cultural backgrounds.

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