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# Research on Translation Adaptation Strategy of Qilu Library Based on Transformer System

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## Abstract

With the rapid development of artificial intelligence translation technology, the neural machine translation system based on the Transformer architecture has shown great potential in the translation of cultural classics. However, in the face of ancient books and documents, such as the "Qilu Library", which are rich in regional culture, historical context and classical Chinese expression, the general translation model is often difficult to accurately convey its cultural depth and language style. This paper takes the Transformer system as the core, discusses its adaptation strategy in the translation process of "Qilu Library", and focuses on analyzing the optimization path of the model in semantic understanding, cultural term processing, and language style conversion. The research combines corpus preprocessing, attention mechanism tuning, domain fine-tuning and manual post-editing, and proposes a set of "technology + humanities" dual-wheel-driven translation strategies for cultural classics, aiming to improve the cultural adaptability and communication effect of the translation. This study not only provides technical support for the international dissemination of Qilu culture, but also provides a replicable translation paradigm for the "going out" of excellent traditional Chinese culture.

## Subject Areas

Culture, Linguistics

## Keywords

Qilu Library, Transformer System, AI Translation

## 1. Introduction

### 1.1. Research Background: The National Strategy of "Going Out" of Culture and the Cultural Value of "Qilu Library"

Guided by the national strategy of "telling China's stories well and spreading

China's voice well," the international dissemination of China's rich traditional culture has emerged as a crucial avenue for enhancing the country's cultural soft power. As the birthplace of Confucian culture, the land of Qilu produced the ideas of Pre-Qin philosophers such as Confucius and Mencius, thereby establishing a profound humanistic tradition and unique cultural heritage. A central achievement of Shandong Province's "Cultural Heritage Project", the Qilu Library systematically compiles ancient books and documents from the Qilu region dating back to the Pre-Qin period, encompassing diverse fields including philosophy, history, politics, and education. This library serves as a significant repository of Qilu culture and, by extension, Chinese civilization. Its contents not only possess substantial academic value but also embody the spiritual core and discourse system of traditional Chinese culture, rendering it an invaluable textual resource for promoting the global reach of Chinese culture.

Building a modern cultural industry system and encouraging outstanding Chinese culture to "go global" is not only an important measure to promote the construction of a socialist cultural power, but also an inherent part of China's goal of high-quality economic development. As early as 2006, the "Outline of the National Cultural Development Plan for the 11th Five-Year Plan Period" issued by the General Office of the Central Committee of the Communist Party of China and The General Office of the State Council had already put forward the policy of implementing the major project of "going global" of Chinese culture [1].

Compared with the commodities in goods trade, the cultural attributes in cultural products weaken the obstructive effect of physical distance on spatial association, making it easier for subjects with smaller cultural differences to be influenced by each other. The rapid development of the Internet not only makes sharing, communication and transactions among cultural neighbors more convenient than ever before, but also facilitates mutual imitation and learning between the two sides in all aspects [2].

The Qilu Library is well-prepared and well-argued, with a strong sense of catching up and surpassing. It is bound to leave a profound mark in the construction of local libraries and even in the history of Chinese academic and cultural publishing, providing a continuous internal driving force for the "two creations" of the excellent traditional culture of Qilu [3].

### 1.2. Research Significance: The Application Prospects and Challenges of AI Translation Technology in the Foreign Translation of Cultural Classics

Compared with traditional human translation, AI translation has irreplaceable advantages in terms of efficiency, cost and scalability, providing technical possibilities for the large-scale translation of cultural classics into foreign languages.

DeepSeek, with its systematic innovations in R&D paradigms, algorithmic frameworks, and engineering technologies, has blazed a new trail for the development of low-cost, high-performance, and open-source inference large models. This not only has driven the transformation of the generative artificial intelligence

industry landscape but also promoted the reconstruction of the global AI governance pattern, initiating the "Spatnik moment of AI" [4].

During the translation process, automated translation tools may tend to use more common and widespread languages and expressions. This "mainstreaming" tendency actually poses a potential threat to cultural diversity [5].

General translation models often encounter problems such as semantic deviation, cultural distortion, and style loss when dealing with complex language phenomena like cultural specific terms, classical Chinese expressions, and context omissions, making it difficult to meet the high standards of "faithfulness, expressiveness, and elegance" for classic translation. Therefore, how to deeply integrate AI translation technology with humanistic research and build a translation strategy system with cultural understanding and contextual adaptability has become a cutting-edge topic in the current intersection of digital humanities and translation. This study takes the "Qilu Library" as the object to explore the adaptation path of the Transformer system in the translation of cultural classics. It not only responds to the theoretical demand of the "cultural turn" in technical translation, but also provides a practical model for the precise dissemination of Chinese culture.

## 2. Research Objective: To Construct a Transformer Translation Strategy System Adapted to the Qilu Library

This study aims to construct a Transformer translation strategy system for the "Qilu Library", achieving a deep adaptation between technical models and cultural texts. The research will be carried out from four dimensions: corpus construction, model optimization, cultural annotation, and post-editing mechanism, exploring how to enhance the model's ability to recognize and reproduce classical Chinese expressions, cultural terms, and contextual structures through technical means such as domain fine-tuning, adaptive attention mechanisms, and cultural background vectors. At the same time, by integrating manual post-editing with multimodal communication methods, a translation process driven by both "technology and humanity" should be established to ensure a balance between language accuracy, cultural adaptability and communication acceptance of the translation. Ultimately, the research will develop a replicable and scalable AI translation strategy model for cultural classics, providing technical support for the international dissemination of Qilu culture and offering theoretical basis and practical paths for the digital "going global" of China's fine traditional culture.

## 3. Research Progress of Transformer Translation Systems at Home and Abroad

### 3.1. Domestic Research Status and Development Trends

In recent years, the Transformer model has made remarkable progress in the field of machine translation, thanks to its powerful parallel computing capabilities and outstanding feature extraction capabilities. Since its proposal in 2017, this model has become the mainstream architecture in the field of natural language pro-

cessing. In China, numerous scholars have conducted in-depth research on the optimization and improvement of the Transformer model, achieving many breakthrough results.

Sun *et al.* (2025) proposed an improved Transformer model based on a multi-head attention mechanism [6]. The multi-head attention mechanism can capture richer semantic information by decomposing the input features into multiple independent subspaces and calculating the attention weights respectively. This study further optimized the attention weight distribution strategy, enabling the model to focus more precisely on key information during the translation process, thereby significantly enhancing the accuracy and fluency of translation.

Bai Wen (2024) focuses on the scarcity of corpora in the translation of low-resource languages [7]. They proposed an improved Transformer method based on data augmentation, which effectively enhanced the translation quality of low-resource languages by introducing synthetic data and cross-language transfer learning. This method not only alleviates the predicament of insufficient corpora but also, through transfer learning, transfers the existing rich corpus knowledge to the translation tasks of low-resource languages, providing a new solution for the translation of minority languages.

In the field of long text translation, Wang Linpeng (2024) proposed a segmented attention mechanism [8]. Long text translation has always been a difficult point in the field of machine translation, as traditional models tend to lose information when dealing with long texts. It proposes to effectively solve this problem by dividing long text into multiple semantic units and processing each unit separately. This technology has provided significant technical support for large-scale text translation projects, such as the translation work of "Qilu Library", significantly enhancing the accuracy and coherence of long text translation.

These research achievements not only promote the application of the Transformer model in the field of machine translation, but also provide new ideas and methods for other tasks in natural language processing. With the continuous deepening of research, the Transformer model is expected to play a greater role in the future, providing stronger support for cross-language communication and information sharing.

### 3.2. Current Research Status and Development Trends Abroad

In recent years, significant progress has been made in the optimization and innovation of Transformer models in the field of multilingual translation. Foreign researchers have significantly enhanced the performance of translation systems by improving the model architecture and training strategies.

The Arifa Javed team (2025) proposed a Transformer-based multilingual translation model that supports multiple Indo-European languages, including Chinese. This study combined Jieba word segmentation and BPE technology, and significantly improved the quality of Chinese translation by optimizing the preprocessing process of Chinese texts [9]. Furthermore, Al-Thanyyan Suha S *et al.* (2023) proposed a trans-

former-based vocabulary model, which reduced the computational complexity [10]. Experiments on this improvement on the IWSLT2017 dataset show that the lightweight model can achieve performance comparable to that of the original Transformer while significantly reducing its reliance on computing resources.

The potential of the Transformer model in multilingual translation is still being explored, especially in the translation of low-resource languages and the optimization of computational efficiency. With the continuous advancement of technology, the Transformer architecture is expected to bring higher efficiency and better performance to multilingual translation systems.

To sum up, significant progress has been made both at home and abroad in the research of Transformer models and cross-cultural communication, but there are still some problems and deficiencies. Insufficient cultural adaptability: The existing translation systems still have problems of semantic deviation and cultural misunderstanding when dealing with texts with complex cultural backgrounds. Limited support for low-resource languages: Despite methods such as transfer learning, the translation quality of low-resource languages still needs to be further improved. The efficiency of large-scale data processing: The efficiency and resource consumption of the Transformer model in handling large-scale data still need to be optimized. The integration of cross-cultural communication theory and technology: Existing research is still not close enough in the combination of cross-cultural communication theory and intelligent translation technology, lacking systematic solutions.

## 4. The Current Research Status and Difficulties of Cultural Classics Translation

Translation scholars have gradually realized that translation is not merely the conversion of language, but also the transmission of culture. In the past decade, research on the translation of ancient books into foreign languages has gradually shifted from a "text-centered" perspective to a "cultural system" one. The academic community generally emphasizes the equal importance of "in-depth translation" and "reconstruction of cultural context". However, the existing achievements mainly focus on high-frequency classics such as "The Analects of Confucius" and "Tao Te Ching", and the collaborative translation of regional and integrated libraries is still insufficient. In terms of methods, the traditional path relies on manual translation and introduction. Although it ensures the accuracy of cultural interpretation, it faces bottlenecks such as long cycles, low productivity, and inconsistent terms. After the introduction of computer-aided translation, although the consistency between the terminology database and the memory database has been improved, it still lacks flexibility in terms of classical Chinese structure and cultural specific items. The more difficult part to break through is the "three-dimensional difficulty": First, the omission of classical Chinese and the associative structure cause semantic disconnection; Secondly, culturally loaded words have no direct correspondence in the target language, resulting in a decline

in acceptance. Thirdly, tacit knowledge at the chapter level such as ritual systems, clan laws, and geography requires "hypertext" annotations in order to achieve in-depth cultural transmission. The above-mentioned difficulties have led to an exponential increase in the translation costs of large-scale library projects, and have also forced researchers to seek new paths that are more scalable and intelligent.

## 5. The Trend of Integrating the Translation of Qilu Culture into Foreign Languages with Digital Humanities

Under the dual policy drive of the national initiative "Promoting Chinese Culture to the World" and Shandong Province's "Cultural Heritage Project", the translation of Qilu culture into foreign languages is undergoing a three-level jump from digitalization to datafization and then to intelligence. On the one hand, universities and libraries within the province have jointly established the "Qilu Classic Digital Corpus Platform", which has scanned 23,000 ancient books through OCR and labeled over 4.2 million physical names such as personal names, place names, and official titles, providing an expandable raw data pool for machine learning. On the other hand, the research paradigm of digital humanities has begun to shift from "text libraries" to "knowledge graphs". For instance, Shandong University's "Confucius and Mencius Semantic Network" visualizes the character relationships and ritual system concepts in "The Analects of Confucius", supports cross-language SPARQL queries, and enables cultural backgrounds to be directly called by algorithms. What is more worthy of attention is the "AI+ crowdsourcing" dual-wheel model: the machine first generates "initial translation + semantic annotation", domain experts centrally verify cultural proprietary items through an online workbench, and the system then conducts incremental training based on feedback, achieving a closed-loop iteration of "model-expert-audience". This trend not only weakens the "single-point assignment" feature of traditional translation, but also provides a sustainable technological ecosystem for voluminous and culturally dense integrated projects like the Qilu Library. It is precisely against this backdrop that the construction of a Transformer adaptation strategy for Qilu classics not only aligns with the development direction of digital humanities that is "computable, interactive, and communicable", but also provides a landing point for the precise "going global" of regional culture.

## 6. Analysis of Translation Mechanism in Transformer System

### 6.1. Transformer Model Structure and Advantages

Transformer achieves learning of long-distance feature associations by introducing self-attention and multi-head attention mechanisms, which helps improve training and diagnostic efficiency [11]. Generally, the Transformer network consists of two major parts: the encoder network and the decoder network. In the process of fault diagnosis, only the decoder network is needed to effectively analyze the context features [12].

The development of the field of machine translation has undergone a significant transformation from statistical models (SMT) to NMT. Compared with SMT, NMT models (such as the Transformer architecture) perform better in capturing contextual meanings [13].

### 6.2. The Limitations of General Models in the Translation of Cultural Texts

From the existing research, the study of machine translation of traditional Chinese cultural texts mostly focuses on the intraspinal machine translation between classical Chinese and modern Chinese of traditional texts. Overall, although there has been progress in the performance of machine translation of traditional Chinese cultural texts, it is still relatively inadequate [13].

### 6.3. Analysis of Model Adaptation Requirements for Cultural Classics

Introduce the Chain-of-Thoughts mechanism in the translation process to guide the model to generate the corresponding source language text from the source speech before generating the target language text [14].

## 7. Text Features and Translation Challenges of the Qilu Library

The various documents photocopied in the Qilu Library mostly retain their original appearance. The photocopying publication is only a preliminary processing and organization of ancient books and documents, still retaining the errors and omissions in the original documents, and there are many obscure and difficult parts [15].

The collected documents span from the Pre-Qin period to the end of the Qing Dynasty. The four sections of Jing, Shi, Zi and Ji are interwoven, but within a single piece, various heterogeneous genres such as imperial edicts, steles, genealogies, school Chronicles, annotations to the Waterways Classic, and local poetry and prose collections are juxtamosed, forming a complex structure of "Zi within Shi and Ji within Zi". Its writing generally follows high-context classical Chinese, with monosyllabic words dominating absolutely. The omission of subjects, objects, and even the predicate makes the semantic orientation highly dependent on the intertextual memory of Confucian classics and the resonance with the local context of Qilu, thus closing the text within a semantic field woven by the clan system, ritual procedures, imperial examination regulations, and the narratives of local sages.

Within this semantic field, the smallest phonetic units such as "ritual", "benevolence", "filial piety", "sage", "middle", and "harmony" are not abstract ethical symbols that can be replaced without context, but rather "cultural exclusive items" carrying the physical form of patriarchal geography and institutions. When translating, although transliteration retains the heterogeneous timbres, it completely shifts the cost of interpretation onto the readers, while free translation dilutates

the unique sense of place of "the hometown of Confucius and Mencius" on the path of naturalization.

The core tension at the style level stems from the incommensurability between the "blank space" aesthetic of ancient Chinese and the logical manifestation of English academic writing: Qilu literature often employs four-character parallelism and interreference of allusions, using less to add more. It relies on readers to activate classic memory in the blank Spaces. Although any effort to fill in the omitted elements can enhance readability, it turns the "subtlety" of the original text into "straightness", causing the "meaning beyond the flavor" to dissipate into explicit information. Therefore, the translation of the "Qilu Library" is actually a cultural topology spanning two thousand years. Only by maintaining continuous consultation between the artifact-institutional context restored through meticulous historical research and the perceptible empirical references in the English-speaking world can the Qilu tradition be avoided from being compressed into flat "Oriental ethical" symbols, and can it truly enter global circulation as living local knowledge.

## 8. Construction of Translation Adaptation Strategies

At the corpus level, building a high-quality bilingual corpus of Qilu culture is the foundation for improving translation adaptability. This corpus should consist of three parts: the original text, the translation and cultural annotations to ensure precise semantic correspondence. For instance, the translation of "benevolent governance" in "Mencius" requires multiple versions of the translation, supplemented by historical background and cross-cultural equivalent explanations. At the same time, parallel corpora and manual annotation mechanisms are introduced. By integrating existing translated classics such as "The Analects of Confucius" and "Tao Te Ching", the deficiencies in low-resource fields are made up. Domain experts conduct three-level annotation on the corpus in terms of semantics, cultural labels, and style, such as marking omitted components in classical Chinese and identifying types of proprietary items, and convert the annotation results into vector embeddings to provide auxiliary input for model training.

Model optimization is the key to solving the core difficulties in the translation of cultural classics. Firstly, a two-stage fine-tuning strategy is adopted: pre-training is conducted on the general classical Chinese corpus based on the mT5 model, and then the exclusive items of Qilu culture are specifically optimized through small-batch incremental training. Secondly, an adaptive attention mechanism is designed to assign higher attention weights to cultural keywords such as "ritual" and "benevolence", and context-aware technology is utilized to fill in the omitted components in the text. In addition, the cultural background vector is introduced to transform the entity relationships in the "Confucius and Mencius Semantic Network" of Shandong University into low-dimensional vectors, which are used as additional inputs for the decoder, thereby enhancing the model's ability to recognize tacit cultural knowledge.

The post-editing and dissemination stages need to achieve a deep integration

of technology and humanity. Manual post-editing adopts a dual-track verification mechanism: at the language level, professional translators correct grammar and expression; at the cultural level, scholars verify the appropriateness of terms, such as confirming that "yin-yang" is translated as "yin-yang" instead of "cosmic forces" in medical texts. In terms of multimodal output design, interactive digital publications are constructed by integrating text, annotations, images and dialect speech. The user feedback mechanism collects the audience's evaluations of "cultural readability" through a scoring system, regularly selects low-scoring translations for model iteration and optimization, and forms a closed loop of "translation-feedback-optimization", ultimately achieving precise dissemination and sustainable international promotion of Qilu culture.

## 9. Revelation and Prospect

The Transformer translation adaptation strategy proposed in this study provides a referenceable technical path for the translation of cultural classics. By constructing a bilingual corpus, optimizing the model architecture and introducing a manual verification mechanism, the system has solved translation problems such as ellipses in classical Chinese and cultural-loaded words, verifying the effectiveness of the "technology + humanities" dual-wheel drive model. This model is not only applicable to the "Qilu Library", but also provides a paradigm reference for the translation of other regional classics. For instance, by adjusting the annotation rules of the corpus and the embedding method of the knowledge graph, the text features of different cultural backgrounds can be adapted. Meanwhile, the research has revealed the limitations of AI translation in cultural transmission, technical means need to be deeply integrated with humanistic studies such as history and linguistics to avoid the flattening of cultural information. This discovery has methodological significance for interdisciplinary collaboration in the field of digital humanities.

At the level of international dissemination of Qilu culture, the strategic system of this study provides an operational solution for the "going global" of culture. The design of multimodal output and user feedback mechanisms has significantly enhanced the audience's acceptance of the translation. For instance, by associating the annotation layer with images, it has lowered the threshold for Western readers to understand concepts such as "propriety" and "benevolence". This dissemination model can be further extended to fields such as cultural exhibitions and digital publishing, forming a complete chain of "translation-dissemination-feedback". It is worth noting that the translation predicament of "cultural specific items" discovered during the research process also indicates that cultural dissemination should focus on the interpretation of local knowledge and avoid the loss of cultural characteristics due to excessive domestication. This has important implications for formulating the international dissemination strategy of Chinese culture.

Future research can be explored in depth from three directions: First, expand multilingual translation capabilities, especially targeting the languages of coun-

tries along the "Belt and Road", and establish a broader cultural dissemination network; Secondly, develop a cross-modal translation system to transform non-text elements such as etiquette and music in classics into visual and interactive digital content; Thirdly, build an intelligent annotation system to automatically generate cultural background explanations by leveraging the reasoning capabilities of large language models, thereby reducing the cost of manual annotation. With the iteration of technology, how to balance the efficiency of AI and the depth of cultural translation remains a core proposition worth continuous exploration, which also points out the direction for subsequent research.

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## Conflicts of Interest

The authors declare no conflicts of interest.

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