AIGC-Empowered Smart Library Development: Foundations, Characteristics, Scenarios, and Strategies (Postprint)

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Abstract

The emergence and development of Artificial Intelligence Generated Content (AIGC) will facilitate the creation of a new service paradigm for libraries, transforming them from traditional services to knowledge services and generative content services. Based on exploring the historical evolution of library content generation models, this article elaborates on the technical foundations and intrinsic characteristics of AIGC empowering smart library construction, as well as the application scenarios for the integrated development of AIGC and smart libraries. Finally, it proposes development strategies such as improving the construction of foundational corpora, training high-quality large language models, enhancing the digital literacy of relevant personnel, and upgrading smart library infrastructure, to help smart libraries create rich service application scenarios and meet users' diverse and personalized needs.

Full Text

Empowering Smart Library Construction with AIGC: Basis, Characteristics, Scenarios, and Strategies

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Abstract

The emergence and development of Artificial Intelligence Generated Content (AIGC) will facilitate the creation of entirely new library service formats, enabling libraries to transform from traditional services to knowledge services and generative content services. Based on an exploration of the historical evolution of library content generation modes, this article focuses on elaborating the technical foundations and intrinsic characteristics of AIGC-empowered smart

library construction, as well as the application scenarios for the integrated development of AIGC and smart libraries. Finally, it proposes development strategies including improving basic corpus construction, training high-quality large language models, enhancing the digital literacy of relevant personnel, and upgrading smart library infrastructure. These strategies aim to help smart libraries create rich service application scenarios that meet users' diversified and personalized needs.

Keywords: AIGC; Smart library; Smart services; Application scenario; Metaverse

1. Historical Evolution of Library Content Production Models

From the perspective of content producers, modern library content production modes can be classified into three categories: Professional Generated Content (PGC), User Generated Content (UGC), and Artificial Intelligence Generated Content (AIGC). The emergence and optimization of artificial intelligence technology have accelerated the transition from digital libraries to smart libraries, while also driving the evolution of library content production from the "PGC+UGC" model to the "PGC+UGC+AIGC" model. This transformation will reshape content production and propel the industry to new heights.

During the initial stage of digital library construction, the content production mode was primarily PGC. The internet at this time was static, with resources organized through classic directory-style classification. Content creation and publishing rights were mainly held by professionals who relied on traditional input devices such as mice and keyboards. Users could only browse official library webpages without participating in content production. While this model produced highly professional content, its production scale was limited and costs increased with content volume.

As libraries transitioned toward smart libraries, UGC became the main content production mode of this period. With the rise of mobile internet and social media platforms, content generation and publishing rights were transferred from experts to users. Users became the backbone of content production, creating content through voice operations, gesture recognition, and other methods. From their own needs, users generated personalized, diversified content that greatly enriched library resources. However, this model suffered from inconsistent content quality, and it became difficult for users to maintain both quality and originality while ensuring update frequency. Efficiency issues emerged as an urgent problem to be solved.

In the smart library development stage, AIGC has become the hallmark content production mode. Driven by artificial intelligence, machine-created content exhibits large-scale production characteristics. With the support of massive

computing power and strong algorithms, AIGC achieves low-cost automated content production. Compared to the "PGC+UGC" model, AIGC offers advantages of large production scale and low unit cost. As the model iterates and updates, smart library content will continue to innovate, and the marginal cost of content production will approach zero. The human-machine collaborative production model under AIGC can free up staff time and energy, allowing them to focus on deep innovation in service forms and content.

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2. Technical Basis for AIGC-Empowered Smart Library Construction

The technical foundation for AIGC empowering smart library construction cannot be separated from underlying support technologies such as natural language processing, computer vision, and multimodal large model technologies.

Computer Vision Technology Supporting Smart Library Digital Twins. Smart library digital twins refer to the digital mapping of physical libraries, including objects (size, material, etc.) and social attributes (subject behavior, relationships between subjects, etc.) from real libraries to virtual ones. This process requires intelligent enhancement and intelligent translation technologies from computer vision. Intelligent enhancement can eliminate problems such as data loss or damage during data collection, generating high-quality digital content from low-quality raw data. Intelligent translation technology focuses more on mutual understanding between different modalities of digital content, enabling conversion between modalities such as speech-to-text, text-to-speech, and even image-to-text or image-to-video.

Natural Language Processing Technology Supporting Smart Library Content Editing. Smart library content editing aims to edit the virtual world to directly affect the physical world through real-time feedback and interaction. This requires semantic understanding and attribute control technologies from natural language processing. Early semantic understanding technologies could not handle semantic entanglement issues, but with advances in natural language processing, generative model-based disentangled semantic learning technology has emerged. This technology enables deeper understanding of data content and can modify original digital content directly according to user-specified attributes. Attribute control technology can be applied to intelligent image editing, intelligent audio mixing, and other tasks to improve smart library digital content creation efficiency.

Multimodal Large Model Technology Supporting Smart Library Content Creation. Smart library content creation can be divided into imitation-based creation and concept-based creation. Imitation-based creation involves AI models observing human works, learning their external and internal features, and then creating imitative works. Concept-based creation goes beyond simple observation and imitation of specific work types, instead focusing on learning

abstract concepts from massive data and creating novel works through concept combination. This requires algorithmic models to understand multimodal data. The iterative upgrading of multimodal large model technology has brought significant opportunities for concept-based creation in smart libraries, enabling the discovery of corresponding relationships between different modalities and achieving mutual transformation and generation across modalities.

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3. Intrinsic Characteristics of AIGC-Empowered Smart Library Construction

Under AIGC technology support, smart libraries will achieve leapfrog development, demonstrating intrinsic characteristics such as upgraded user experience, high content production efficiency, and enhanced bidirectional real-time interaction.

Upgraded User Experience. When users' visual, auditory, and other multisensory experiences intertwine, user experience will be substantially enhanced. AIGC can generate large amounts of digital content in a short time, and when combined with virtual reality technology, can produce three-dimensional objects, scenes, and digital humans. Users can experience various cultural activities in virtual venues, touch three-dimensional books with their hands, and engage in real-time interaction with virtual avatars of various users. This creates an immersive experience that blends virtual and real worlds.

High Content Production Efficiency. AIGC can learn from massive data to identify complex patterns that humans cannot detect, potentially surpassing humans in content generation quality and scale. The marginal cost of content production approaches zero as production scale expands. The human-machine collaborative production model under AIGC can release staff time and energy, allowing them to focus on deep innovation in service forms and content, thereby continuously improving content production efficiency.

Enhanced Bidirectional Real-Time Interaction. From the perspective of AI practice achievements, most interactive products are "meaning-predefined," assisting users based on their habitual behavioral needs without significantly impacting the user interaction ecosystem. Content-generating products like ChatGPT, however, reshape the user interaction ecosystem structure. They can not only produce text but also engage in multi-round dialogues, question user queries, and provide multiple solutions. When smart libraries introduce AIGC, the immediacy and efficiency of user-machine interaction will be significantly improved, and the interaction mode between users and the machine environment will undergo major transformation.

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4. Application Scenarios for AIGC-Empowered Smart Library Construction

Smart Production System: Diversified Production. The smart production system of smart libraries includes two major components: first, the digital twin of existing collection resources, and second, the production of native digital resources. Smart libraries can use AIGC technology to digitally twin collection resources in virtual space, achieving perpetual preservation of physical collections in digital form. For native digital resource production, smart libraries need to rely on multimodal general large models, strong computing power, and massive training data. In this system, users can communicate with the system using natural language, and the system can effectively recognize user voice, behavior, and environment. The system can generate user-matched information in the most appropriate form and achieve conversion and generation across multimodal data content.

Smart Retrieval System: Generative Retrieval. In digital library information retrieval, users need to combine search terms through repeated trial and error to retrieve required answers, and most users' retrieval efficiency is not high. Smart libraries can use AIGC to build intelligent retrieval systems supported by natural language processing and data mining technologies. Users can input multimodal natural language queries such as text, images, and videos. The system first converts users' multimodal natural language into computable forms, then uses semantic analysis to accurately understand user intent, quickly searches for user-matched information through machine learning and computational reasoning, calculates the most intelligent answers based on knowledge in the corpus, and delivers them in visual form. The system can continuously optimize the model through multi-round human-machine interaction.

Smart Dissemination System: Precision Dissemination. Digital library information content dissemination mainly relies on librarians, but this dissemination mode is uncontrollable in service time, content, and quality. With the popularization of AI technology, libraries have developed various robots to undertake information dissemination tasks. However, such robots currently cannot handle complex user needs. The popularity of ChatGPT has drawn high attention to the effective combination of AIGC technology and robotics. Smart libraries can develop intelligent chatbots more suitable for specific service scenarios, using natural language processing and computer vision technologies to help users with interaction behaviors. These products have certain behavior guidance while respecting users' habitual interaction behaviors, fundamentally reshaping the user interaction ecosystem.

Smart Assessment System: Personalized Assessment. AIGC can assist smart libraries in creating intelligent learning assessment systems. Before learning begins, the AI system can generate visual user self-analysis reports to clarify users' existing knowledge structures. During learning, the system collects real-time data throughout the learning process, including expression data,

physiological response data, and psychological change data. Using big data analysis, data mining, and other technologies for association rule analysis, regression analysis, and cluster analysis, the system forms intelligent assessment reports and pushes them to users through cloud services, providing personalized learning suggestions. After learning, the AI system visually displays users' cognitive learning maps throughout the process. With human feedback reinforcement learning mechanisms, the system can even analyze users' reactions to assessment results, reshaping smart library evaluation models toward intelligence and smart development.

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5. Development Strategies for AIGC-Empowered Smart Library Construction

Content Production Level: Improving Basic Corpus Construction. The key to AIGC application lies in massive multi-source, multimodal data. Smart libraries, as data resource aggregation centers, not only possess static resources like books and patents but also include dynamic data captured in real-time by various sensors, such as library environmental state data and user borrowing data. These massive data resources will be integrated into the overall AIGC architecture as part of pre-training data. However, issues exist such as time-consuming data annotation, insufficient diversity, and privacy protection challenges in data acquisition and use. Synthetic data technology can help libraries solve these problems. Generated through computer simulation technology or algorithms, synthetic data can reflect real-world data at mathematical or statistical levels, serving as a substitute for real-world data to train models. Future smart libraries can incorporate synthetic data into basic corpus construction to improve model training speed and effectiveness, increase data diversity, and avoid user privacy leaks.

Content Retrieval Level: Training High-Quality Large Language Models. Training high-quality large language models using massive literature data is key to embedding AI models into smart library retrieval services. Language model training and learning are the core of text generation, and large language models possess scalability and can use massive unlabeled text for pre-training to achieve cross-modal knowledge understanding. Smart libraries can reference reinforcement learning from human feedback to build large-scale language models based on library literature data, user behavior data, and environmental data, enabling value in library retrieval services such as keyword generation and text similarity calculation. AIGC will reshape the new paradigm of smart library information retrieval.

Content Dissemination Level: Enhancing Relevant Personnel Digital Literacy. Improving content dissemination efficiency requires not only intelligent machines but also librarians and users with high digital literacy. Currently, not many library staff have AI professional backgrounds and related technolo-

gies. The deep integration of AIGC and smart libraries will raise issues such as technical risk cognition, personal privacy information protection awareness, and false information identification capabilities. Libraries need to cultivate digital literacy among staff and users through regular training and institutional arrangements, forming a composite talent team adaptable to various scenario applications. Libraries can also collaborate with relevant departments to develop a user digital literacy evaluation index system suitable for China' s local development, continuously optimizing digital literacy improvement paths through evaluation and feedback.

Content Assessment Level: Upgrading Smart Library Infrastructure. Infrastructure is the carrier for collecting, storing, processing, and utilizing data, and is the material basis for promoting smart library development. Upgrading library infrastructure is the foundation for building smart library assessment systems. AIGC applications in smart libraries have high computing power requirements—for example, training the GPT-3.5 model requires massive computing power that most libraries cannot independently afford. Libraries can leverage enterprise facilities and national projects to improve computing power, using cloud servers and API calls to build smart library infrastructure systems. Additionally, libraries should invest in smart wearable devices. The University of Rhode Island Library has introduced wearable technology, allowing users to read freely while the library collects multimodal data from wearable devices for comprehensive analysis and assessment using AI models, establishing powerful smart assessment systems.

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6. Conclusion

AIGC' s content creativity, cross-modal fusion, and cognitive interaction capabilities will further promote the transformation of traditional library service models, gradually realizing a smart service model of "AIGC + Library." Application scenarios in smart libraries will further expand, ultimately achieving deep integration between scenarios and constructing a new metaverse library service application ecosystem that blends virtual and real worlds. However, it must be acknowledged that AIGC technology is not yet mature, and its application in smart library construction still faces challenges such as intellectual property attribution and identification difficulties, false information and errors, user personal privacy information leakage, and algorithmic discrimination. In the process of smart library construction, a strategic development framework should be established to gradually promote overall development through single-point local construction, providing later professional learning and regular training.

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Note: Figure translations are in progress. See original paper for figures.