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Special topic: Artificial intelligence (AI) and national libraries

Current Status and Prospects of AI Application in Chinese Public Libraries

By LIU Jinzhe, National Library of China

Libraries in China have always focused on the research and application of modern information technology, and *the Law of the People's Republic of China on Public Libraries* clearly puts forward that "the application of science and technology in the construction, management and service of public libraries shall be encouraged and supported". With the deep application of artificial intelligence technology and closer integration with all aspects of library components, libraries are driven to "user-centered" document lending, resource customization, data sharing and other documentary services, information services, and further provide demand perception and delivery based on user behavior data mining analysis, knowledge generation and discovery, service strategy, and service management. The library will further provide demand sensing and delivery based on data mining and analysis of user behavior, knowledge generation and discovery, user feedback and optimization services, and realize the fundamental transformation to an "intelligent data computing-centered" library.

1. RFID and Big Data to Empower Library Business

In September 2008, the National Library of China (NLC) Phase II project opened the National Digital Library and launched a library based on the RFID-based integrated library system and self-service borrowing and returning service to improve the circulation of books and the efficiency of borrowing books. In addition, NLC has also launched an intelligent shelving navigation system, which provides readers with accurate navigation roadmaps and three-dimensional book shelving maps based on OPAC search results; launched a self-service card recharge system, which enables readers to apply for reader's cards and recharge them with their ID cards, supporting cashless transactions for readers within NLC building, self-service photocopying, self-service loan and return, identity verification through face recognition, scanning the barcode of the books through intelligent equipment; through SMS, cell phone portals, mobile reading platforms, apps, official account of WeChat or TikTok and other forms of service, providing readers with a flexible, convenient, anytime, anywhere, modernized service experience.

Public libraries are also actively exploring the expansion of the application of RFID technology. Several provinces and cities such as Beijing and Wenzhou have successively launched basic public cultural facilities such as "24-hour libraries" and "24-hour urban study rooms", using the RFID security access control system and self-service book borrowing and returning equipment, so that the public only with a reader's card or ID card, can enter and enjoy self-service borrowing, digital reading, and self-study reading services at any time, to build a highly efficient and convenient library reading service system, to achieve the maximization of the extension of the coverage of the library services, and to promote the community to enter the new era of ubiquitous reading.

The library combines RFID with big data, NFC and other Internet of Things technologies to greatly enhance the intelligent level of library management and services. For example, through big data analysis of business development trends and levels, and then optimizing the library's business processes, library development planning, and service policy adjustments to provide decision-making support and analysis of reader behavior information mining, to understand the reader's preference for resources and services and their changing patterns, and then guide the library to provide personalized, unique services. For example, Chongqing

Library's "big data wall" can show reading records and calculate the reading preferences, tailored to create reading recommendations for readers to provide more refined, personalized services.

2. Artificial Intelligence for Smart Library: Exploration and Practice

2.1 Building a Smart Library Service Platform

2021 Shanghai Library Intelligent Library Service Platform Project, builds the collection management application, realizes the integrated management of the whole life cycle of Shanghai Library's physical documents from the acceptance and registration of new books, movement, and elimination of the old ones, and includes the circulation system of users, collection, borrowing, returning, expenses, reservation and other applications, and provides strong support for the 24-hour drive-through book return kiosks, automatic sorting system, self-service borrowing and returning machines, reservation cabinets, intelligent bookshelves, service robots, inventory robots, cell phone book borrowing, in-library navigation, online borrowing and other intelligent service scenarios. The practice of Shanghai Library has also driven the application, promoting the transition of domestic libraries to the next-generation micro-service architecture and open library service platforms.

The Capital Library and Zhejiang Library have opened the construction of resource construction system, reader service system, operation management system, analysis and decision-making system, integrated office system, virtual library system, operation and maintenance management system and other business application systems to realize the digital and intelligent services of libraries, thus providing intelligent application of assets, facilities, energy efficiency, environmental space, etc., and to realize the integration of intelligent management and services of library operations.

2.2 Improvement of Intelligent Management

The introduction of intelligent warehousing and modern logistics technology automated transiting technology to build an intelligent three-dimensional library, as shown in Figure 1, including automated access system, collection management, circulation, order picking, and docking with the library management system and online lending system, together with a large-scale sorting system that collects, categorizes, and arranges books according to categories, to achieve high-density storage of books, high-efficiency utilization and precise distribution.

In 2019 Suzhou Second Library officially used the three-dimensional library which can hold a collection of more than 7 million books, and serves as the Suzhou library collection center and flow hub, promoting the sharing of documents throughout the city and improving the timeliness of service. The intelligent sorting and book return system of the Sino-Singapore Friendship Library, which was launched in June 2020, utilizes the latest robotic sorting and transfer technology and is more than 10 times more efficient than traditional manual sorting. After a reader returns a book, the sorting robot will follow the optimal path to the sorting grid according to the instructions of the back-end intelligent scheduling system to complete the book sorting, which greatly improves the efficiency of book sorting and readers' experience.

< Figure 1: Intelligent warehousing and online lending system
(Picture from https://www.szlib.com/ztgj.html?id=0) >

Zhongshan Library of Guangdong Province launched the "collection and editing Turing", the use of artificial intelligence, machine vision, industrial automation and other emerging cutting-edge technologies, to achieve the library's core business of collection and editing of the whole process of automation, data and intelligent reengineering and change, just batch placement of books to the book automatic supply desk, accurately identifying and automatically completing book information collection, gesture adjustment, label barcode printing and pasting and information reading and writing, turning pages and stamping the collection of more than ten operations, significantly improving the efficiency of collection.

2.3 Resource Datatization and Organization

Chinese public libraries actively introduce new concepts and technologies to carry out exploration and practice of new types of resources, and continuously extend the form and service functions of data resources, for example, using 3D modeling, VR/AR and other technologies to build immersive, human-computer interactive experience digital resources such as the Yongle Encyclopedia VR panoramic cultural canon, to provide a new reading experience that adapts to the digital network environment.

2.4 Providing a Smarter Service Model

Using 5G, Wi-Fi, iBeacon and other technologies to present users with a three-dimensional, interactive virtual space, whether the user visits the library physically or virtually. Based on the location of the user, visualization of the library facilities and services can be presented, so that users can easily understand the library. This enables users to easily understand the layout of the library and the details of each service, helps users to quickly and accurately find the target resources, and improves the efficiency of the service.

Through the analysis and mining of big data concepts and technologies, the library carries out accurate pushing of resources and contents based on the analysis of readers' borrowing behavior, supports service recommendation based on the characteristics of readers' groups, and carries out phase-by-phase operation based on the data of users' lifecycle, etc., so as to improve the quality of the library's services and users' satisfaction.

Integrate voice recognition, speech synthesis, text recognition, face recognition, voiceprint recognition and multi-round dialogue technology to create intelligent service robots, explore the realization of "artificial + intelligent" virtual consulting services based on third-party instant messaging software, providing bibliographic inquiries, activity recommendations, overdue reminders, WeChat registration and manual consultation. NLC and Baidu cooperated and jointly developed virtual reference librarians "Gu Zhaoxi", with

the technical support of "Wenxin Big Model", based on generative artificial intelligence technology, deeply integrating professional knowledge in the field of libraries, and focusing on NLC's resources query and basic services, aiming to provide readers with online consulting services and enhance readers' consulting experience in an intelligent way.

2.5 Creating a Smart Space That Blends Virtuality with Reality

Changing information environment and user needs are transforming the spatial innovation, from Information Commons, Learning Commons, Maker Space to Smart Space. Chinese public libraries utilize virtual reality (VR), augmented reality (AR), holograms, 5G and other technologies to create virtual simulation VR panoramic libraries and provide immersive digital reading experiences, so that libraries, can become places of cultural exchange and innovation.

NLC uses a cell phone app to scan AR bookmarks, so that you can learn encyclopedic knowledge and selected traditional cultural knowledge, such as "VR recite the classics", "VR to celebrate the New Year", and other cultural and creative achievements featured by NLC; to create a magical sensory interactive e-wall, the audience can enjoy on-site Chinese ancient books, 100 Classics, Republic of China periodicals, celebrity manuscripts, open classes, People's Stage, Village Spring Festival Gala, and other excellent cultural products that are popular.

The Sino-Singapore Friendship Library uses a waterfall flow e-checkout system to bring readers a new reading experience. It provides personalized service spaces such as recording rooms, audio-visual appreciation rooms, activity rooms, seminar rooms, etc. Meanwhile, it integrates artificial intelligence and other technologies, allocates appropriate information resources and equipment according to users' research or communication needs, and provides personalized resource request and interactive services.

3. The Future of Smart Libraries with Full Scenarios and Ecological Development

3.1 Generative Artificial Intelligence Empowers Whole-Scene Intelligence

Through the analysis of resource themes, relying on the subject matter analysis, through machine learning, the technology realizes the function of automatically assigning words or recommending related subject matter words, and carries out intelligent cataloging; for the future layout of knowledge services, using machine recognition, semantic understanding technology in the whole culture of the resource data, fragmented processing, realizing the knowledge meta-level identification, management and preservation, and generating high-quality, fine-grained knowledge collections, and exploratory introduction of the library field of knowledge of the big language model. Through automated knowledge integration, model training and content generation, it assists in summary analysis of collection and thematic and topical clustering, innovates the way of generating, organizing content, and empowers the intelligence of the whole workflow.

3.2 Building a Green and Sustainable Smart Library System

The smart library management system promotes the open sharing and intelligent interconnection among collections, various terminal devices, smart service spaces, online and offline smart activities. Under the strategic layout of the national intelligent library system, through the common construction and sharing of resources, platforms and services, it supports libraries to realize basic business management and resource management while building their own independent and characteristic services and applications, so as to realize the expansion of resources and services while maximizing the saving of individual libraries' operation costs, and ultimately enhance the overall integration of the industry. This will ultimately create a better platform and synergistic smart library system, and promote knowledge sharing and innovation.

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