Practice and Exploration of Smart Services for Ancient Tree Discipline in Agricultural Libraries in the Metaverse Context

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Abstract

This paper expounds on the inevitability of metaverse integration into intelligent services for ancient tree disciplines in agricultural libraries, reflects on the practice of intelligent knowledge services in agricultural libraries and the current state of intelligent knowledge services for ancient tree disciplines from the metaverse perspective, and further envisions the trends of intelligent knowledge services for ancient tree ecological protection in libraries within the metaverse paradigm.

Full Text

Practice and Exploration of Intelligent Services for Ancient Tree Disciplines in Agricultural Libraries from a Metaverse Perspective

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Abstract

This paper expounds on the inevitability of integrating the metaverse into intelligent services for ancient tree disciplines in agricultural libraries, reflects on the current practices of smart knowledge services in agricultural libraries and the status of intelligent knowledge services for ancient tree disciplines from a

metaverse perspective, and further prospects the future trends of intelligent knowledge services for ancient tree ecological protection in libraries within the metaverse framework.

Keywords: metaverse, ancient tree discipline, intelligent service

Ancient and famous trees, often called "green living fossils," hold significant research value for forest vegetation, landscapes, biodiversity, and germplasm resources. In recent years, China has continuously strengthened protection efforts, from the 2015 *Opinions on Accelerating Ecological Civilization Construction*—which mandated the protection of rare and endangered wildlife, ancient trees, and natural habitats—to the 2019 revision of the *Forest Law* by the National People's Congress, which included dedicated provisions for ancient tree protection. These policies have driven extensive research by scientists and forestry managers on ancient tree conservation and restoration, generating diverse scholarly outputs including papers, patents, technical standards, research projects, news, and reports. As cloud computing, digital twins, blockchain, 5G/6G, and XR technologies become deeply integrated, agricultural university libraries face a critical question: how can they seize the opportunities presented by the metaverse and artificial intelligence to proactively design intelligent service models for ancient tree disciplines, thereby achieving the convergence of ancient tree disciplinary resources with modern technology? This represents a vital component of future library transformation toward intelligent knowledge services.

1.1 The Metaverse as a Return to and Transcendence of the Freedom in Human-Nature Relations

In ancient agrarian societies, where science and technology were extremely underdeveloped, humans adopted a submissive and passive stance toward nature, completely subject to its whims. To awaken humanity's subjective freedom and will, the ancient Greek sophist Protagoras proposed the famous philosophical proposition in the 5th century BCE: "Man is the measure of all things, of the existence of things that exist and of the non-existence of things that do not." In other words, the existence of the world, truth, and laws are all measured by human perception. Similarly, Mencius's statement that "all things are complete in me" refers, from an ontological perspective, to something absolutely self-sufficient that exists independently and completely without relying on external objects—it constitutes its own universe. Modern humans, utilizing advanced science and technology, have fully exploited and transformed nature, greatly demonstrating human subjectivity and achieving tremendous liberation before nature. However, modern freedom is a freedom of conquest, built upon the assumption of infinite natural resources and space. Through mechanical and atomic thinking, nature is treated as an object to be dissected, controlled, dominated, and conquered, thereby harboring enormous potential for environmental destruction. If left unchecked, this inevitably leads to ecological crises, sharp antagonism in human-nature relations, ruptures in the essential unity between humans and nature, alienation of labor and technology, and ultimately, control

over humanity itself, resulting in unfreedom.

In the era of artificial intelligence, the natural and free state of humanity has the greatest potential for realization. Scholars' concept of metaverse civilization suggests that the metaverse represents a naturally open, self-organizing internet ecosystem—a process of moving from the freedom of conquering nature to the ecological freedom of harmonious coexistence with nature, representing both a return to and transcendence of the undifferentiated yet oppositional human-nature relationship in ancient and modern times. Broadly speaking, the metaverse integrates extended reality, digital twins, blockchain, big data, and artificial intelligence to provide users with immersive experiences, cross-virtual-reality interactions, open editing capabilities, and decentralized transactions, thereby achieving multi-level integration and transformation between virtual and real worlds in identity systems, social systems, and economic systems [1]. Su Jiajia [2], from the perspective of the relationship between civilization and the human "body," argues that the construction of future metaverse civilization stands on a unified dynamic system that integrates "biological body," "technological body," "environmental body," and "meaning body," capable of resolving the relationship between the metaverse and embodied cognition. Qin Zizhong [3], from a spatiotemporal interaction perspective, views the metaverse as an expression of quantum spacetime and a real existence. Guo Wenge [4], drawing on Popper's "three worlds" theory and media ecology theory, considers the metaverse an independent "World 3" entity that exists separately from the physical world, representing a space of "objective knowledge" that expresses cognition of the physical world.

1.2 Applications of Artificial Intelligence in Agricultural Development

As a form of artificial intelligence superimposed with new-generation metaverse information technology, "smart agriculture" is regarded as another agricultural technology revolution following the plant breeding and genetics revolution, fundamentally transforming the modern antagonistic relationship between humans and nature. It will play an increasingly important role in agricultural ecological civilization, cultural education, and smart agriculture. At the beginning of this century, AI applications in domestic agriculture began to emerge, including intelligent robots for plowing, planting, and harvesting, as well as intelligent systems for pest detection and soil moisture monitoring. In 2020, the Ministry of Agriculture and Rural Affairs and the Central Cyberspace Affairs Commission issued the *Digital Agriculture and Rural Development Plan (2019-2025)*, proposing to accelerate the research and application of agricultural AI. Recently, sensors, drones, and agricultural robots with independent intellectual property rights have become increasingly mature and appeared in more agricultural scenarios. Liao et al. [5] designed a smart agriculture AIoT system data processing platform based on a front-end and back-end separation architecture, enabling real-time multi-dimensional monitoring of crops, historical data queries, data visualization, and abnormal data alarms, providing effective data support for soil

environment monitoring systems and intelligent pest monitoring systems. Nascimento et al. [6] developed a handheld pest diagnosis tool using expert knowledge to assist in diagnosing important pests in commercial teak plantations.

2.1 Smart Knowledge Service Practices in Agricultural Libraries from a Metaverse Perspective

Beijing is a veritable "ancient tree capital," home to over 41,000 ancient and famous trees concentrated in historic urban architecture and rural villages, possessing profound cultural heritage and unique ecological value. In recent years, Beijing has promptly issued a series of documents including the *Opinions on Further Strengthening the Protection and Management of Ancient and Famous Trees in the Capital* and the *Work Plan for Inspection and Assessment of Ancient and Famous Tree Protection and Management in the Capital* (trial), providing strong policy support for building Beijing into an "ancient tree capital" and carrying out ancient tree rejuvenation and protection work. In 2021, Beijing University of Agriculture responded to the municipal directive to "bring ancient trees to life" by becoming the first institution in China to offer a forestry program specializing in ancient tree protection, focusing on training graduate and undergraduate students in this field and establishing an Ancient Tree Center to inject fresh professional talent into the ancient tree industry and conservation efforts.

Libraries are components of modern smart cities and ecological civilization and represent important application scenarios for the metaverse. At this critical juncture of ecological civilization construction and rural revitalization, agricultural libraries can leverage their profound and unique advantages in ancient tree ecology and academic resources, along with the metaverse's distinctive ecological value connotations, mature digital systems, and advanced technological methods, to enter the metaverse and provide decentralized, flattened, and dynamically updated intelligent knowledge services for ancient trees—this is the key to their transformation.

In recent years, with the establishment of the Ancient Tree Center, the Beijing University of Agriculture Library has utilized internet and information technologies to collect and organize domestic and international ancient tree literature, relevant biological omics data, patents, and related achievements. Through conducting surveys, improvements, and re-clustering of literature, standard systems, innovative rescue and rejuvenation technologies, biological environments, and genetic resources, the library has automatically generated thematized and specialized classifications. It has built and launched the "Two Databases"—the "Ancient Tree Thematic Literature Resource Service Database" and the "Ancient Tree Bioinformatics Database"—striving to create a "golden 名片" (golden name card) for ancient tree protection services in the capital. Since the establishment of the "Two Databases," the university has implemented an open knowledge service mechanism that enables classified querying and browsing of ancient tree information and online analysis, integrates and shares ancient tree

genomic data, provides more efficient, accurate, and diverse information for research users, and builds a bridge connecting ancient tree protection research with ecological culture promotion and ecological civilization advancement.

2.2.1 Low-Level Organization of Ancient Tree Digital Resources

Although AI has achieved applications in agriculture and other fields, problems such as scattered agricultural scientific data and low data quality persist. First, due to the relatively recent establishment of the ancient tree discipline, resources remain scattered across local chronicles, genealogies, news reports, patents, and historical archives. Second, the multi-source heterogeneous characteristics of ancient tree information resources mean that library collections include both physical and digital resources, lacking knowledge organization at the semantic level. Third, while ancient tree information organization aims to enable effective retrieval, traditional retrieval models operate at the syntactic level of text string matching, lacking semantic analysis for knowledge representation, processing, and understanding, making it difficult for researchers to quickly and efficiently obtain effective information.

2.2.2 Fragmented, Isolated, and Compartmentalized Ancient Tree Resource Information Service Models

Although Beijing University of Agriculture Library has built and launched the "Two Databases" to provide ancient tree literature retrieval and query services, it remains difficult to achieve critical breakthroughs in supporting ancient tree protection and rejuvenation research. Traditional ancient tree identification and protection methods primarily rely on literature tracking and written evidence identification, which involve consulting local chronicles, genealogies, scientific literature, news reports, and historical archives to obtain relevant written evidence for estimating tree age and determining whether a tree qualifies as a famous ancient tree. Evidently, this fragmented, isolated, and compartmentalized information service model can no longer meet the development needs of the ancient tree discipline or China's ancient tree ecological protection requirements.

[Figure 1: see original paper] Ancient Tree Restoration Professional Knowledge Concept Map [Figure 3: see original paper]. Prospects for Intelligent Knowledge Services for Ancient Tree Ecological Protection in Libraries from a Metaverse Perspective

3.1 Ontology-Based Knowledge Organization for Ancient Tree Disciplinary Digital Resources

The application of AI in agriculture presents both opportunities and challenges for innovative ancient tree protection research. Agricultural libraries should leverage their strengths in knowledge organization and retrieval to further integrate into ancient tree protection innovation scenarios and embed themselves

throughout the entire lifecycle of ancient tree innovation under the empowerment of metaverse and AI technologies.

Improving the knowledge organization system for localized full-text ancient tree literature requires not only using metadata to locate, manage, and classify overall resource attributes to facilitate retrieval, development, organization, and reuse [7], but also employing ontology technology to extract and describe ancient tree restoration entities, concepts, events, their attributes, and interrelationships [8]. Therefore, ontology-based semantic analysis and annotation of ancient tree information resources lay the foundation for solving the fragmentation problem of ancient tree scientific data. By analyzing the numerous types of concepts (Figure 1) and their complex interrelationships contained in ancient tree literature based on vertical sub-domain knowledge themes (ancient tree health diagnosis, ancient tree maintenance and restoration, ancient tree habitat monitoring, ancient tree history and culture, ancient tree policy research, and ancient tree talent cultivation), developing an ontology-based query and search engine that maps traditional and heterogeneous relational databases to the semantic Web layer can reveal ancient tree data from a semantic perspective. This transforms ancient tree resource description from superficial subject, keyword, abstract, and journal source information to semantic content organization, excavating fine-grained and multi-grained ancient tree knowledge. This is significant for improving traditional disciplinary knowledge service capabilities and localized resource storage organization levels, and for providing users with innovative value-added services such as browsing, retrieval, and intelligent Q&A. For example, Beijing TV's "Time Xiaoni," a virtual digital human based on ChatGPT's neural information retrieval technology, will be able to reason and analyze information resources obtained through neural retrieval to answer users' diverse questions [9].

Digital Technology Blockchain Technology [Figure 2: see original paper] Types and Technical Classification of Library Ancient Tree Digital Resources from a Metaverse Perspective

3.2 Improving Intellectual Property Services in Agricultural Libraries from a Metaverse Perspective

Ancient and famous trees often possess longevity genes, resistance genes, and other valuable genetic resources, making them precious germplasm materials for plant genetic improvement and breeding superior new plant varieties with significant biological research value. AI empowerment has opened the "Pandora's box" of library intelligent services, while blockchain technology serves as the technical foundation for copyright confirmation and reuse of ancient tree genetic resources, playing a crucial role in protecting ancient tree genetic and germplasm diversity and constructing a new pattern of intellectual property services for ancient tree disciplines in the metaverse. Zhang Xingwang [10] refers to the process of digitizing collection resources as "minting," which technically requires expressing and describing the digital resources derived from collection

resources with metadata before writing them into blockchain via third-party platforms. Therefore, as the rights holder of genetic resources, when a library uploads ancient tree genetic resources to a third-party trading platform, the platform can write the digital resources into blockchain in the form of metadata according to relevant standards and specifications for non-fungible tokens (NFTs). This intelligently generates a unique and trustworthy digital rights certificate for ancient tree genetic resources, which serves as the sole identifier marking the authenticity, scarcity, and uniqueness of ancient tree genetic resources. The certificate clearly records creator information, creation time, ownership details, version information, etc., thereby solving issues of identity authentication, traceability, rights confirmation, and intellectual property protection for ancient tree genetic resources. This ensures that each ancient tree genetic resource in the library is unique and cannot be copied or tampered with, providing intellectual property protection for the preservation, identification, rejuvenation, improvement, and breeding of superior new plant varieties from ancient tree genetic resources.

3.3 Improving Personalized, Precise, and Intelligent Services for Ancient Tree Disciplines in Agricultural Libraries

An ancient tree is not only a natural and social history book, a precious historical artifact, a cultural landscape, and a gene bank of excellent provenance, but also a medium and bridge between library resources and the metaverse. The core of personalized, precise, and intelligent services for ancient tree disciplines in agricultural libraries lies in leveraging information technologies such as virtual reality, blockchain, digital twins, and artificial intelligence to break through spatial, temporal, linguistic, and platform barriers for the various types of tacit knowledge and information contained in physical library documents. This transforms traditional knowledge dissemination models and forms decentralized and diversified knowledge organization patterns [11], providing diverse, personalized, and intelligent emotional experiences and services for different types of users to meet their needs for knowledge innovation, knowledge exchange, emotional resonance, and cultural identity, ultimately achieving freedom and transcendence of the human spiritual world.

There remains a considerable gap between current practices and explorations of ancient tree discipline information services in agricultural libraries and the vision of intelligent knowledge services under metaverse technology. Therefore, as a vision, the metaverse still has a long way to go before real implementation. However, we can anticipate that in a metaverse environment, AI-empowered libraries will have higher-level technical platforms for literature resource construction, information services, and intellectual property protection for ancient tree disciplines, bridging the gap between the physical and spiritual worlds and removing barriers between future real and virtual worlds, thereby driving the intelligent development of agricultural libraries.

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