Digital Technology Empowering Archaeological Research Post-print

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Abstract

In the new era, language resource construction must embrace new starting points, new requirements, new momentum, and new achievements. In light of the current challenges facing language resource construction, this paper proposes the following recommendations.

Full Text

4 Recommendations for Language Resource Construction

In the new era, language resource construction must embrace new starting points, new requirements, new momentum, and new achievements. In light of the current challenges facing language resource construction, this paper proposes the following recommendations.

First, integrate resources and promote convergent development. Building upon the experience gained from modern Chinese and written text language resource construction, we should systematically address deficiencies in other language resources. Simultaneously, we must comprehensively advance the digital construction and integrated aggregation of ancient language resources, dialects, and minority languages, establishing a unified application platform to facilitate collaborative research across different language resources and leverage the synergistic effects of resource integration.

Second, foster collaborative innovation and technology empowerment. We should actively promote the application of emerging technologies such as big data and artificial intelligence in language resource construction. Through technological means, we can deeply excavate the linguistic patterns, cultural connotations, and social changes embedded within language resources, while conducting multi-dimensional segmentation, annotation, and intelligent analysis to enhance the overall quality and practical value of these resources. Additionally, we recommend moderately reducing preliminary achievement requirements for highly innovative interdisciplinary project applications, encouraging researchers from different fields to participate boldly and cultivating a favorable atmosphere for interdisciplinary collaboration to drive innovative development in language resource construction.

Third, improve mechanisms and ensure sustained investment. To guarantee the effectiveness and sustainability of language resource construction, we should adopt differentiated investment strategies. For language resources that are foundational or culturally significant but have limited commercial value, we recommend incorporating them into national major science and technology infrastructure construction plans, with authoritative national institutions taking the lead to ensure construction quality and long-term stable development. For other types of language resources, we should explore diversified and sustainable investment mechanisms, encourage social capital participation, and continuously enrich the diversity and scale of language resources.

Finally, optimize evaluation systems and strengthen talent foundations. On one hand, we should enhance the cultivation of interdisciplinary professionals, emphasizing the organic integration of theory and practice, and promote collaborative talent development among universities, research institutions, cultural heritage institutions, and enterprises. On the other hand, we must establish scientific and rational talent evaluation mechanisms that break away from the "five only-isms" (sole emphasis on papers, titles, professional ranks, academic credentials, and awards) and create more diverse and comprehensive evaluation standards that account for both individual academic achievements and contributions within team collaborations, thereby stimulating the innovative vitality of the talent pool.

Language resource construction constitutes an important component of national cultural development strategy. Against the backdrop of the new era, we should fully recognize the cultural value of language resources, promote language resource construction in a coordinated manner, adhere to the development philosophy that balances preservation and inheritance with development and utilization, continuously enhance the capacity of language resources to serve national cultural development strategies, and provide solid support for the inheritance and development of excellent traditional Chinese culture and the construction of a culturally strong nation.

Digital Technology Empowers Archaeological Research

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The rapid development of the digital technology wave has long permeated every aspect of social life. In archaeological work, digital technology runs through the entire process of spatial information acquisition, archiving, analysis, research, display, and inheritance, continuously expanding and refining the domains of modern archaeological research.

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1 Spatial Information Acquisition and Archiving

During archaeological surveys and excavations, the distribution of features and artifacts, as well as stratigraphic divisions, constitute important spatial information that forms the foundational material for archaeological research. Technologies such as electronic total station surveying and Real-Time Kinematic (RTK) satellite measurement can precisely obtain three-dimensional coordinates of various feature points, enabling the production of high-precision distribution maps of archaeological features and stratigraphic profiles.

Satellite remote sensing and aerial remote sensing can rapidly acquire high-resolution imagery containing rich ground surface information. By analyzing pattern characteristics of vegetation, water bodies, soil, and rocks within these images, we can potentially identify the distribution of archaeological features on the ground surface or in shallow strata. Early remote sensing imagery documented many ground elements that have since changed, allowing extraction of location and shape information for numerous important archaeological features that have disappeared. Modern high-resolution satellite image stereo pairs and low-altitude imagery captured by unmanned aerial vehicles can directly generate high-resolution digital orthophoto maps and digital elevation models, clearly revealing the micro-topography of archaeological sites and facilitating the interpretation of feature structures and distribution patterns.

Three-dimensional reconstruction technology can comprehensively capture spatial information from archaeological excavation sites, unearthed artifacts, and archaeological sites, enabling the creation of digital 3D models ranging from centimeter-sized stone tools to large archaeological sites several kilometers in length, with automatic generation of realistic textures. This technology provides important deliverables for archaeological research, cultural heritage preservation, museum virtual display, and data archiving, including digital orthophoto maps, digital surface models, and digital 3D models from different planes, elevations, and sections, significantly improving the speed and accuracy of site and feature mapping and artifact illustration. As various cultural heritage resources continue to suffer severe damage from natural and anthropogenic factors, many artifacts and features will no longer exist after several centuries. The multi-view imagery and 3D model data archived today will undoubtedly become important source material for future research, playing an irreplaceable role under the support of more advanced digital technologies. After three-dimensional reconstruction of large quantities of pottery sherds excavated from archaeological sites, we can potentially achieve simulated restoration in computers, presenting complete artifact characteristics for use in artifact illustration, display, archiving, and typological research.

2 Spatial Information Analysis and Research

Spatial information obtained from archaeological surveys and excavations can be used to establish databases and graphic/image libraries containing multiple layers of archaeological spatial and attribute information using Geographic Information System (GIS) software. This approach loads graphics, images, and other data with different projections and scales into a unified coordinate system, achieving the goal of "one map for field archaeology" with functions for displaying and querying archaeological spatial information, mutual access between text and graphics, editing and modification, overlay and output of graphics and images, and access and display of multiple data layers. GIS also possesses multiple spatial analysis capabilities, with functions such as distance analysis, line-of-sight and viewshed analysis, predictive modeling, inundation modeling, and spatial operations all finding excellent application in archaeological research, enabling calculations of watershed area, reservoir capacity, precipitation carrying capacity, and other data to explore the interactive relationships between ancient peoples and their surrounding natural environments and landscapes. In regional archaeological research, we can place three-dimensional spatial information of settlement sites within their surrounding environments for holistic study, analyzing the distribution and evolution patterns of ancient settlements, exploring the dependency and transformation relationships between ancient peoples and natural environments, and revealing and reconstructing the formation processes of settlement sites.

Based on in-depth interpretation of large quantities of spatial information, numerous prehistoric water management facilities have been discovered in the periphery of the Liangzhu ancient city and around the Jianghan Plain, revealing the success of water management by ancient peoples approximately 5,000 years ago and promoting the birth and development of prehistoric civilization.

3 Spatial Information Display and Inheritance

Comprehensively acquired three-dimensional spatial information from archaeological sites can be displayed through multiple methods. Settlements and regional environments can be demonstrated and simulated in 3D GIS software, enabling researchers and audiences to observe the distribution characteristics of settlement sites and their relationships with environmental factors such as terrain and water systems. Ancient structures and other features that have disappeared can also be reconstructed on modern ground surface 3D models to completely display the spatial landscapes during the periods when ancient buildings existed.

Three-dimensional data from grottoes and mural tombs can be converted into virtual reality display materials or produced through equal-scale 3D printing, enabling authentic display and dissemination of various types of information contained in cultural heritage at different locations and allowing audiences to experience an immersive feeling while inheriting the profound and extensive Chinese civilization. Virtual reality displays can reduce the number of people observing cultural heritage on-site, thereby mitigating damage to artifacts from water vapor and carbon dioxide produced by audience respiration.

In digital displays, museums can enable interactive operation of 3D models of movable artifacts, excavation sites, and settlement sites through monitors, virtual reality scenes, and even audiences' mobile phones, allowing interaction with display objects and providing functions for observing and manipulating spatial data from outside to inside or from whole to part. This enables audiences to observe digital models from different angles and at different resolutions, learning and comprehending the essence of cultural heritage. Researchers can increase perspectives for exploring questions, improve data utilization rates, and expand the space for archaeological research through analysis and simulation of 3D model data.

4 Development Trends of Digital Archaeology

With the deep application of technologies such as high-resolution satellite remote sensing, low-altitude UAV photography, and 3D site reconstruction, the acquisition of spatial information for various types of cultural heritage is becoming increasingly rich. Combined with compositional and attribute information of cultural heritage and supported by information technologies such as data mining, pattern recognition, machine learning, and artificial intelligence, the integration, processing, analysis, and interpretation capabilities of multiple data layers will be substantially enhanced, presenting data analysis results to researchers and audiences in flexible and diverse ways and solving unsolved mysteries in ancient civilization research.

The continuous development of spatial information acquisition and analysis technologies will drive the continuous improvement of digital archaeology and even traditional archaeological theories. Various types of spatial information from field archaeology sites recorded in digital form facilitate computer analysis and processing, and breakthroughs should first be achieved in pattern recognition, machine learning, and artificial intelligence, significantly increasing the degree of intelligence in archaeological research.

Innovative Development of Talent Evaluation Systems Empowered by Digital Intelligence

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The talent evaluation system constitutes an important component of the talent development institutional framework, providing critical support for the recruitment, cultivation, management, and utilization of scientific and technological talent. Current talent evaluation systems still face challenges including rigid value orientation, coarse talent classification, lack of depth in indicators, and vague evaluation standards.

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