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# Emerging landscapes of “alternative-academic” careers in library and information science: Evolutionary patterns and prospects in the Chinese context

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This study investigated the emerging landscape of alternative-academic careers in the field of library and information science in China using text mining techniques on a dataset of 7832 job postings from 334 institutions between 2016 and 2023. The findings revealed that alternative-academic positions are widely distributed across academic, cultural, governmental, and commercial institutions, with a growing presence in interdisciplinary and applied research domains. The results highlight the emergence of four distinct functional types: resource construction, academic services, intelligence research, and social functions. Alternative-academic roles have evolved towards greater professionalization, specialization, and collaboration, reflecting the shifting demands of the digital information landscape.

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## Introduction

Alternative-academic (Alt-Ac) careers have emerged as a significant phenomenon in the field of library and information science (LIS), reflecting the shifting landscape of knowledge production and dissemination. Alt-Ac refers to career paths that require or benefit from doctoral training but extend beyond the traditional tenure-track professoriate (Nowvskie, 2010; Rogers, 2013). These roles often involve the application of scholarly expertise in non-academic settings, such as libraries, archives, museums, government agencies, and private enterprises.

Several factors contribute to the rise of Alt-Ac in LIS. First, the paradigm shift from Mode 1 (traditional, discipline-oriented) to Mode 2 (emerging, problem-oriented) knowledge production has reshaped talent cultivation and career ecology in LIS (Gibbons et al., 1994). Second, the rapid advancement of digital technologies has created new opportunities and challenges for LIS professionals, requiring them to combine domain knowledge with technical expertise. Third, the evolving scope of LIS, enriched by interdisciplinary areas, underpins the critical role of Alt-Ac careers in connecting academic theories with societal applications.

China presents a unique and dynamic context for examining the development of Alt-Ac careers in LIS. The number of LIS doctoral programs in China has nearly doubled from 10 in 2016 to 19 in 2023 (Tian et al., 2023), indicating rapid growth in doctoral education. Moreover, in 2022, the Academic Degree Committee of the State Council upgraded “Library and Information Science” to “Information Resource Management,” incorporating 11 interdisciplinary secondary disciplines (Xinhuanet, 2022). This disciplinary restructuring signifies a shift towards a more comprehensive and data-driven approach to LIS education and research. It is imperative to comprehend the manner in which Alt-Ac careers are emerging and influencing the professional landscape as the LIS field in China continues to develop and expand.

Despite the growing scholarly attention on Alt-Ac careers, current research primarily focuses on the individual-level factors influencing the pursuit of Alt-Ac paths, such as motivations, experiences, and competencies (Chambers et al., 2019; Sanders, 2014). While these studies provide valuable insights, they lack a holistic understanding of the Alt-Ac phenomenon situated within specific knowledge production contexts and ecological relationships. Therefore, this study employed a novel approach using text mining techniques to analyze a large-scale dataset of Alt-Ac job postings in China’s LIS field from 2016 to 2023. By combining machine learning with manual coding, we uncovered the landscape, characteristics, and evolutionary trends of Alt-Ac positions across different institutional contexts.

We aimed to answer the following questions:

1. What types of Alt-Ac positions exist in China’s LIS field, and how are they distributed across institutions?
2. What evolutionary trends have Alt-Ac positions exhibited, and how do their role connotations and competency requirements differ?
3. How does the rise of Alt-Ac positions impact the academic labor market and reshape the knowledge production paradigm in LIS?

## Literature review

### (1) The Rise and Evolution of Alt-Ac Careers

The term “Alt-Ac” was coined by Bethany Nowvskie and Jason Rhody in 2010 to describe humanities and social science PhDs working in non-traditional academic

institutions (Nowvskie, 2010). Rogers (2013) expanded the definition to encompass careers that navigate between academia and industry, emphasizing practical knowledge application, social service, and cross-boundary collaboration. Subsequent studies have examined the motivations, experiences, and competency requirements of Alt-Ac professionals (Chambers et al., 2019; Sanders, 2014). Kelly et al. (2023) confirmed the growth and diversification of Alt-Ac careers. However, debates persist regarding the precise definition of Alt-Ac, with some scholars limiting it to non-tenure track positions within universities (Brechelmacher et al., 2015; Oxley, 2019), while others advocate for a broader understanding (Rogers, 2020).

The emergence of Alt-Ac is linked to structural changes in the academic ecosystem, including the rise of Mode 2 knowledge production (Gibbons et al., 1994), the expansion of doctoral education, and the increasing demand for versatile, doctoral-level talent (Larson et al., 2014). Universities have begun to provide Alt-Ac career support for graduate students (Liu, 2014), positioning Alt-Ac as an important force in the evolving doctoral labor market. Sekuler et al. (2013) emphasized the importance of cultivating transferable skills and exploring non-traditional career options for doctoral students across various disciplines. The UNC University Libraries (n.d.) provided a comprehensive guide to Alt-Ac careers, highlighting the diverse roles and opportunities available to PhDs outside academia.

Recent studies have further expanded the scope and practical implications of Alt-Ac research in different fields. Jackson (2023) provided a practical guide for quantitative social scientists seeking non-academic careers, focusing on leveraging skills in data analysis, consulting, and policy-making. Kent-Johnson (2024) examined the Alt-Ac professionalization opportunities for humanities PhD students, revealing strategies for developing transferable skills, building professional networks, and adapting to role transitions. Kansa and Kansa (2015) reflected on their own Alt-Ac journeys in the field of archaeology, discussing their experiences in public engagement, digital humanities, and open access. These studies not only shed light on the evolving landscape of Alt-Ac careers across various disciplines but also offer valuable insights for doctoral students and graduates navigating the complex job market.

### (2) Challenges and Opportunities for LIS Doctoral Education in China

In recent years, China has witnessed significant growth and transformation in LIS doctoral education. As of December 2023, there were 19 LIS doctoral-granting institutions in China, with an average of 103 graduates per year (Tian et al., 2023). The disciplinary structure of these programs has evolved, with an increasing emphasis on the first-level discipline of “Library and Information Science” and the emergence of new subdisciplines such as digital humanities and data science. The expansion of LIS doctoral education in China reflects the growing recognition of the strategic importance of information and knowledge management in the digital age. Highly qualified people who can use sophisticated technology and data-driven methodologies to assist scientific research, guide policy-making, and propel industry upgrading are desperately needed as China works toward its aim of becoming an innovative economy. By producing a new generation of academics and practitioners with great knowledge of information organization, retrieval, and analysis, LIS doctoral programs are positioned to meet this demand.

**Table 1 Institutional distribution of Alt-Ac positions.**

Institution Type	Secondary Department	Number
Higher Education Institutions (63.2%)	Libraries	171
	Archives	18
	Museums	3
	Journal Editorial Offices	8
	Administrative Departments (Research Management, Development Planning, etc.)	11
Research Institutions and Think Tanks (11.7%)	Research Departments	26
	Administrative Departments	10
	Journal Editorial Departments	3
Government & Public Sector (8%)	Public Institutions	14
	CPC Party Schools	11
	Civil Service	2
Cultural Institutions (6.6%)	Public Libraries	16
	Museums	3
	Archives	2
	Art Galleries	1
State-Owned Enterprises (4.8%)	Industry Intelligence Analysis Departments	8
	Publishing Enterprises	3
	Libraries	3
	Archives	2
Military and Police Institutions (4.2%)	Libraries	4
	Archives	2
	Administrative Departments	2
	Others Unspecified	6
Healthcare Institutions (1.5%)	Public Hospitals	2
	Medical Research Institutes	3

However, the rapid growth of LIS doctoral education in China also presents challenges. The COVID-19 pandemic and the subsequent economic downturn have created uncertainties in the academic labor market, with many universities and research institutes facing budget constraints and hiring freezes (Zheng, 2020). The competition for academic positions has been further exacerbated by the Ministry of Education’s policy to increase doctoral enrollment. Tian et al. (2023) noted that the significant increase in temporary faculty positions and academic librarian roles in university libraries in recent years is a response to these challenges and the evolving needs of the field, leading to concerns about the employability and career prospects of LIS doctoral graduates.

In the Chinese context, the rapid development of digital technologies, the expansion of LIS doctoral education, and the desire of libraries to establish MLIS programs have created new demands for specialized expertise and advanced research skills, leading to a growing recognition of the value of doctoral-level training in LIS and the emergence of Alt-Ac positions that leverage the unique skill sets of LIS PhDs.

Despite the growing scholarly interest in Alt-Ac careers, the current literature has several limitations. First, most studies have focused on describing the general characteristics and development trends of Alt-Ac careers, lacking in-depth analyses of the ecosystems, mechanisms, and impacts of Alt-Ac from a holistic perspective. Second, there is a scarcity of comparative research examining the variations of Alt-Ac careers across different types of institutions and sectors. Third, the knowledge of the particular expressions and dynamics of Alt-Ac in various environments is hampered by the paucity of empirical studies of Alt-Ac careers in certain disciplinary and geographical environments. By means of a detailed analysis of the Alt-Ac phenomena within the framework of LIS doctoral education in China, this paper fills in several research gaps.

**Research methods**

This study primarily employed quantitative analysis methods, using text mining techniques to automatically extract and statistically analyze large-scale recruitment text data combined with manual coding to cluster entities, revealing the overall ecological landscape, structural characteristics, and evolutionary trends of Alt-Ac careers in China’s LIS field.

**Data collection**

The data for this study was collected from the “LIS Jobs” WeChat official account, a platform developed and operated by the authors since 2015. This platform utilizes semantic web crawlers to continuously gather job postings related to the LIS field from over 1750 websites, including university websites, research institutions, government departments, and other relevant channels. Because all public sector employers in China are required to openly advertise job vacancies, the “LIS Jobs” platform provides comprehensive coverage of LIS-related positions in the public domain. The data quality and representativeness of this platform have been recognized by the LIS research community in China, and it has been used as a reliable data source in several studies (Tian & Zhang, 2021; Zhi et al., 2023; Zhou & Lin, 2021).

Therefore, we selected job advertisements between 2016 and 2023, focusing on positions that specifically required a doctoral degree. We obtained a total of 7832 valid job postings, spanning 334 unique employers, after cleaning and preprocessing the data. The eight-year time frame allows for a longitudinal analysis of the evolution and trends in Alt-Ac careers within the Chinese LIS field.

**Data analysis**

To examine the diverse landscape of Alt-Ac careers comprehensively, we adopted a multidimensional approach. The data analysis process consisted of the following steps:

1. Manual coding of institutions: We systematically coded 334 employers based on their institutional types, such as universities, cultural institutions, military and police organizations, government agencies, and other relevant categories.
2. Named entity recognition (NER): We applied the bidirectional encoder representations from transformers (BERT)-bidirectional long short-term memory (biLSTM)-conditional random field (CRF) model, a state-of-the-art deep learning architecture for NER, to automatically extract key entities from the job description texts, including specific departments, job titles, required disciplines and specializations, knowledge and skill requirements, and other relevant attributes.

The BERT-BiLSTM-CRF model used in this study combines the strengths of three key components:

1. BERT: A pre-trained language model that provides contextualized word embeddings, capturing rich semantic information from large-scale unlabeled text data.
2. BiLSTM: A recurrent neural network variant that can effectively capture long-range dependencies and contextual information in sequential data, such as text.
3. CRF: A probabilistic graphical model that considers the correlations between adjacent output labels, ensuring the coherence and validity of the predicted named entity sequences.

By integrating these components, the BERT-BiLSTM-CRF model can deeply understand the semantics of job description texts and accurately identify key entities, even in the presence of

complex linguistic phenomena and domain-specific terminology. Our experiments demonstrated that this model achieved an accuracy of 86%, a recall of 90.8%, and an F1 score of 88.33%, indicating its robustness and effectiveness for our research purposes.

3. Iterative clustering of similar entities: To ensure the validity and reliability of the extracted entities, a team of three LIS doctoral students conducted a systematic manual review and coding of the model outputs. The team employed a multi-round iterative coding approach, discussing and resolving discrepancies until reaching a consensus, particularly for job titles and disciplinary specializations.

The resulting structured dataset after the NER and clustering process had the following fields: {ID, Institution Type, Province, Institution, Department, Job Title, Job Description, Required Discipline, Education Requirement, and Other Entities}.

## Results and findings

**Institutional distribution of Alt-Ac positions.** Through a systematic analysis of 7832 job postings from 334 institutions, this study revealed the uneven distribution of Alt-Ac positions across institutional types (as shown in Table 1) and explored how specific organizational contexts shape the emergence and evolution of Alt-Ac roles.

**Higher education institutions: academic service and innovation-driven roles.** Higher education institutions have emerged as the primary hub for Alt-Ac positions in China's LIS field, with 211 out of 334 positions (63.2%) offered by universities and their affiliated institutions. Among these, university libraries stand out as the core host for Alt-Ac roles, providing 171 positions. Two key factors contribute to this prominence: university libraries' growing recognition of the need to enhance their academic capabilities and subject-specific information services, and the growing demand for highly educated faculty members to support the establishment and expansion of MLIS programs. Libraries are not the only institutions in the higher education sector offering Alt-Ac positions. Other university-affiliated institutions, such as archives, museums, and journal editorial offices, have also witnessed a growing presence of Alt-Ac roles. Additionally, a notable trend in recent years has been the marked increase in Alt-Ac opportunities within university administrative departments, particularly in the areas of research management and development planning.

The strategic emphasis on knowledge creation and dissemination, coupled with the intellectual resources and academic culture of universities, has shaped Alt-Ac positions in higher education institutions to prioritize academic service and research innovation. These roles closely align with the core missions of universities, focusing on supporting cutting-edge research, facilitating scholarly communication, and driving pedagogical innovation.

**Research institutions and think tanks: knowledge brokering and policy engagement roles.** Research institutions and think tanks have emerged as another key domain for Alt-Ac growth, closely following higher education institutions. The data reveals that 39 such institutions (11.7%) have advertised Alt-Ac positions, including prestigious national-level research organizations such as the Chinese Academy of Sciences and the Chinese Academy of Social Sciences, as well as influential think tanks like the National Information Center. Within these institutions, specialized departments dedicated to applied research have been at the forefront of driving the demand for doctoral-level talents with

LIS backgrounds. Meanwhile, research institutions' administrative departments have begun to offer research management and knowledge management positions specifically targeting LIS PhDs.

The strategic focus of research institutions and think tanks on bridging research and practice, combined with their intellectual resources and policy-oriented culture, has given rise to Alt-Ac positions that involve knowledge brokering and policy engagement. These roles often involve synthesizing complex information, producing actionable insights, and influencing decision-making processes.

**Government and the public sector: civic engagement and public service roles.** The government and public sectors analyzed in this study exhibit a complex landscape, with 27 institutions (8%) expressing demand for Alt-Ac positions. These institutions extend beyond civil servants at various levels of government, including directly affiliated public institutions and CPC party schools. Among these, public institutions have taken the lead in providing Alt-Ac opportunities. Representative examples include the Academic Integrity Department of the National Natural Science Foundation of China, the Book and Information Center of the Ministry of Education, and the Patent Information Service Department of the Jiangsu Intellectual Property Office. Additionally, CPC party schools have emerged as important employers of Alt-Ac talents.

The public service mandates and civic engagement goals of government and public sector institutions have shaped Alt-Ac roles that prioritize information accessibility, public outreach, and community empowerment. The organizational context of these institutions, characterized by a strong emphasis on accountability, transparency, and responsiveness to diverse societal needs, has fostered the emergence of Alt-Ac positions that leverage the information management and communication skills of LIS professionals to support effective governance and public engagement.

**Cultural institutions: cultural heritage preservation and community engagement roles.** Cultural institutions have demonstrated a more prominent role in absorbing Alt-Ac talents compared to government departments, with 22 libraries, archives, museums, and art galleries (LAMs) (6.6%) providing Alt-Ac positions specifically targeted at LIS PhDs. Among these institutions, public libraries have emerged as the driving force, with a significant number of institutions, such as the National Library of China, Shanghai Library, and Tianjin Library, establishing positions in areas like ancient book restoration and special collection resource construction. Museums have offered positions in collection curation and cultural relic data research, while archives primarily recruit LIS PhDs to engage in archival material organization and research.

The strategic focus of cultural institutions on safeguarding cultural assets, promoting lifelong learning, and fostering cultural participation, combined with their unique collections and public-facing nature, has shaped Alt-Ac roles that center around cultural heritage preservation and community engagement. These positions blend technical expertise with curatorial, interpretive, and outreach skills.

**State-owned enterprises: competitive intelligence and innovation management roles.** While the public sector's talent selection mechanisms partially contribute to the supply of Alt-Ac positions in government departments and cultural institutions, enterprises' interest in Alt-Ac talents directly reflects market demand orientation. This study identified 16 state-owned enterprises (4.8%)

that offer Alt-Ac positions specifically seeking LIS PhDs. Large corporations such as China Electronics Technology Group Corporation and China National Chemical Information Center have established positions in areas like industry intelligence analysis and patent analysis to enhance intelligence support capabilities for enterprise innovation decision-making and patent portfolio development.

The strategic imperatives of competitiveness and innovation, coupled with the market-driven culture and commercial resources of state-owned enterprises, have shaped Alt-Ac roles that emphasize competitive intelligence, intellectual property management, and the application of knowledge assets to drive business value.

**Military and police institutions: information assurance and intelligence analysis roles.** The talent demands of the military and police systems, represented by military and police academies, have also begun to emerge, with 14 institutions (4.2%) releasing Alt-Ac positions targeting LIS PhDs. Libraries, archives, and administrative departments primarily house these positions, which include subject librarians, engineers, researchers, and intelligence analysts.

The strategic priorities of national security and public safety, combined with the sensitive nature of the information handled and the hierarchical culture of military and police institutions, have shaped Alt-Ac roles that require a high degree of discretion, analytical rigor, and adherence to strict security protocols.

**Healthcare institutions: medical knowledge organization and evidence-based decision support roles.** Although the number of Alt-Ac positions provided by healthcare institutions is relatively limited, their unique disciplinary focus merits attention. The survey identified a total of five healthcare institutions (1.5%) that offered positions for LIS PhDs, primarily distributed across public hospitals and medical research institutes. These institutions prioritize Alt-Ac roles in areas like medical knowledge organization, evidence-based decision support, and disciplinary development planning. As precision medicine advances and medical knowledge experiences explosive growth, the analysis, organization, and application of vast amounts of medical literature and data have become essential requirements for the development of modern medicine.

These variations in Alt-Ac roles across institutional contexts underscore the importance of considering the dynamic interplay between organizational factors and individual agency in shaping the career trajectories of LIS professionals. As the knowledge landscape continues to evolve, LIS education and professional development programs must cultivate the skills and competencies needed to navigate these diverse institutional contexts and adapt to the changing demands of Alt-Ac roles.

**Functional typology of Alt-Ac positions.** To further reveal the differentiation of Alt-Ac positions in various research directions and fields of expertise within LIS, this study employed methods such as named entity recognition to extract keywords and conduct topic modeling on all job description texts from 2016 to 2023. We identified high-frequency words that reflected the characteristics of Alt-Ac positions, clustered semantically similar entities, and ultimately summarized them into nine types of Alt-Ac positions (Table 2).

**The rise of digital humanities and digital scholarship: spurring new Alt-Ac positions.** The rise of digital humanities and digital scholarship has catalyzed the creation of new Alt-Ac positions. Roles focused on ancient book and special collections

management, which are primarily concentrated in universities and public libraries, involve the analysis, verification, and organization of valuable and historical literary documents, requiring PhD holders to possess advanced philological skills and research capabilities. In contrast, digital humanities positions, distributed across both universities and research institutions, place a greater emphasis on constructing digital infrastructure within humanities disciplines and applying semantic technologies to humanities research. Furthermore, traditional positions such as collection curation and document development are transforming, increasingly prioritizing the digital preservation and intelligent display of collection resources. The rapid integration of resource protection and digital research methods is driving a pressing demand for versatile talents.

**Research data management: burgeoning with Alt-Ac positions.** Research data management, a critical pillar of digital scholarship, is witnessing a surge in Alt-Ac positions. Data literacy education and data curation emerge as the primary roles, with a strong presence in university libraries and research institutes. Data literacy education aims to enhance the data management, analysis, and visualization capabilities of faculty and students, while public libraries have begun to leverage data literacy training to serve the general public. Data curation focuses on developing data management plans and standardizing the entire data lifecycle. Traditional academic institutions are assuming a pivotal role in advancing open science by establishing dedicated data management positions. Moreover, emerging positions such as data ethics, data policy, and data security are gaining prominence across various sectors, reflecting the growing need to ensure the responsible use of research data and safeguard sensitive information. LIS PhDs' strong foundation in information organization theory and metadata cataloging skills positions them as uniquely competitive in data management.

**Subject services and research support: upgrading and transforming with data-driven intelligent services.** The advent of data-driven intelligent services is propelling a transformative shift in traditional subject services and research support positions, marked by a transition from resource assurance to knowledge services and from passive response to proactive embedding. Information literacy education emerges as the focal point of subject-based services, aiming to enhance the literature retrieval and academic writing skills of faculty and students by integrating information literacy into professional teaching. Subject librarians prioritize comprehensive assistance throughout the research process by capitalizing on their extensive subject knowledge and information analysis abilities. Additionally, traditional practices such as science and technology novelty search, academic evaluation, and subject intelligence analysis are harnessing data storytelling and intelligence to guide decision-making. LIS PhDs who possess a mastery of subject knowledge and adeptness in data analysis, capable of uncovering disciplinary trends through the examination of a vast literature, are emerging as a transformative force, disrupting conventional models of subject services.

**Archival management and compilation: seizing new opportunities in the digital era.** In the digital era, traditional archival management and compilation positions are embracing new opportunities. Archival compilation and university history research, primarily concentrated in university archives, involve the organization, cataloging, and analysis of archival documents. The innovative integration of cutting-edge technologies, exemplified by archival big data analysis and archival informatization, leverages data mining and artificial intelligence to explore the

**Table 2 Distribution of Alt-Ac positions (Top 5).**

Category	High-Frequency Positions and Word Counts	Total Proportion
Collection Development and Digital Humanities	Ancient Book and Special Collections Research (61), Digital Humanities (40), Document Development (34), Ancient Book Restoration (33), Collection Curation (22)	10.30%
Research Data Management	Data Literacy (52), Data Curation (50), Data Ethics (28), Data Policy (13), Data Security (10)	8.30%
Subject Services and Research Support	Information Literacy Education (85), Subject Librarians (73), Science and Technology Novelty Search (70), Academic Evaluation (63), Subject Intelligence (43)	18.10%
Archival Management and Compilation	Archival Compilation (57), Archival Big Data (35), Project Archival Management (26), Archival Informationization (25), University History Research (25)	9.10%
Information Systems and Technical Services	Semantic Technologies (35), Engineers (34), Knowledge Service Systems (21), Systems Maintenance (17), Smart Library (15)	6.60%
Scholarly Communication and Publishing	Journal Editing (55), Institutional Repository (25), Open Publishing (13), Science Communication (12), Open-Access Transformation Agreements (9)	6.20%
Academic and Industry Research	Academic Research (96), Industry Research (65), Policy Research (42), Researchers (38), Data Research (35)	15%
Administrative Management	Research Management (72), Development Planning (36), General Management (15), E-Governance (9)	7.20%
Intelligence and Patent Analysis	Intellectual Property (91), Intelligence Analysis (84), Knowledge Management (66), Industrial Intelligence (65), Data Mining (46)	19.10%

application value of archival resources and drive intelligent transformation. The exploration of electronic medical record management in healthcare institutions utilizes generative AI to enhance medical record retrieval while employing blockchain technology to protect patient privacy. Furthermore, project archival management in specialized industries is emerging as a new direction for Alt-Ac careers. LIS PhDs, who are versatile talents with a deep understanding of both archives and technology, are at the forefront of leading the intelligent development of archives.

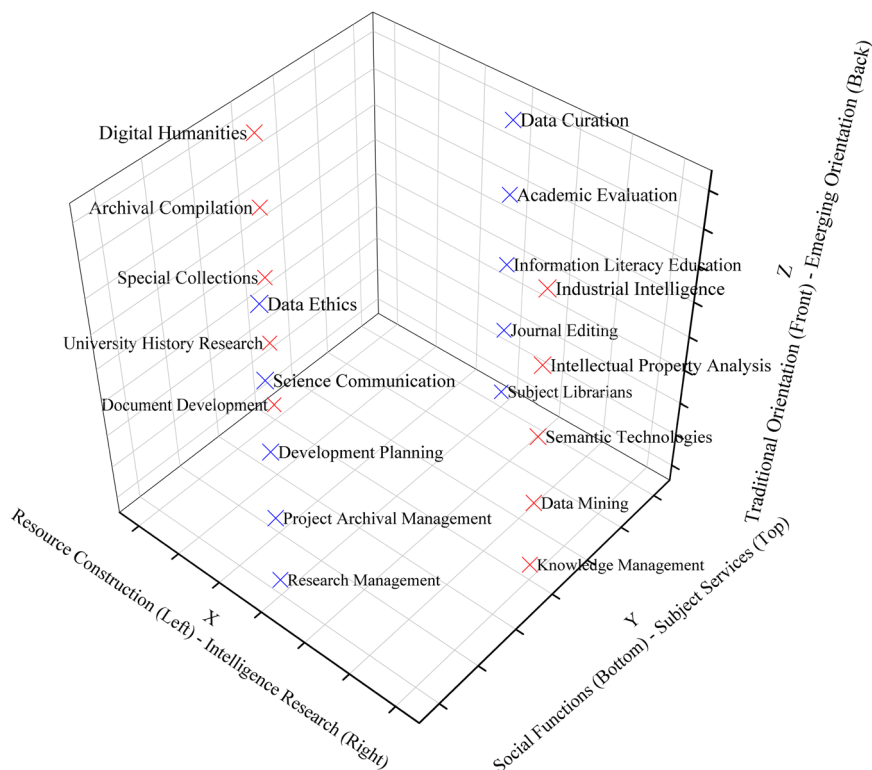
**Information systems and technical services: shifting from experience-driven to intelligence-driven.** The profound integration of information technology and LIS knowledge services has given rise to emerging technology services, such as semantic technologies, system integration, and smart libraries. These services represent a transformative shift, transitioning from experience-driven to intelligence-driven services and from support and assurance to leading innovation. Semantic technologies, predominantly established in research institutions and university libraries, enhance knowledge organization and retrieval through ontology construction and knowledge graphs. The development of smart libraries, particularly those explored by public libraries, encompasses various aspects such as print-electronic integration, unattended operation, and mobile services. Furthermore, knowledge service system development and library system maintenance are complex projects that require expertise in requirements analysis, functional design, platform development, and maintenance. These roles demand a high level of proficiency in software engineering and user experience design. “Engineer” positions, primarily found in military and police institutions, are responsible for the development, integration, and optimization of information systems, playing a crucial role in security and system integration.

**Scholarly communication and publishing: shifting from “Niche” to “Mass”.** Emerging trends such as open access and citizen science have triggered profound changes in scholarly communication and publishing. Journal editors are undergoing a role transformation from mere “gatekeepers” to “curators” and “marketers,” with expanded responsibilities in content production and new media communication. As semantic publishing and data publishing evolve, editors must acquire technical skills in

knowledge graph construction and data mining. Institutional repository construction, primarily situated in university libraries, involves the collection, preservation, and utilization of academic achievements, leveraging technologies such as knowledge organization, semantic linking, and user profiling. Open publishing and Open access transformation agreements are key focuses for facilitating the transition of academic publishing from a subscription-based model to an open-access paradigm. Science communication dedicates itself to using new media technologies for targeted communication with the public and industry. Scholarly communication and publishing is undergoing a shift from “niche” to “mass,” from “one-way” to “bi-directional interaction,” and from emphasizing “form” to prioritizing “user experience,” presenting new challenges for practitioners.

**Academic and industry research: leading the development of the LIS discipline.** Academic and industry research not only constitutes an essential aspect of Alt-Ac but also serves as a key driving force for leading the development of the LIS discipline. Universities, cultural institutions, and enterprises widely distribute academic research, the core activity of this field, giving LIS PhDs an ideal platform to leverage their strengths in theoretical and methodological innovation. Industry research, with its emphasis on real-world applications and business scenarios, explores the innovative implementation of new technologies, concepts, and paradigms in various industry settings. Policy research supports the strategic decision-making of institutions, encompassing areas such as open-data policies, intellectual property policies, population policies, and digital economy strategies. To reflect the growing importance of LIS professionals’ “think tank” function, the National Library of China established a dedicated legislative decision-making research department. Data research, primarily relying on government data resources, focuses on data governance, sharing, openness, and in-depth application. Individuals in “researcher” positions in military and police institutions are primarily engaged in intelligence research activities, such as information analysis, public opinion monitoring, and knowledge base construction.

**Intelligence and patent analysis: becoming a strategic emerging force for serving innovation-driven development.** Intelligence functions, represented by intelligence analysis and intellectual property analysis, are emerging as a strategic force for supporting



**Fig. 1** Functional types of Alt-Ac.

innovation-driven development. The demand for intellectual property services is rapidly increasing across universities, research institutions, and industries. Relevant positions require practitioners to be well-versed in intelligence analysis tools and possess a solid understanding of intellectual property laws. LIS PhDs with “patent agent” qualifications will have a distinct competitive advantage. The essence of intelligence analysis positions varies slightly across different institutions, ranging from providing intelligence support for enterprise innovation decision-making to uncovering research hotspots and frontiers. Knowledge management positions, primarily established in research institutes, focus on tracking the development trends of key technologies in specific fields.

**Administrative management: becoming increasingly professional and specialized.** The professionalization and specialization trend of administrative management positions is becoming prominent, accompanied by a rising preference for doctoral-level talents. Individuals in research management positions, primarily concentrated in research institutions, undertake responsibilities such as the full-process operation of research projects, performance evaluation, and integrity supervision. Besides, development planning positions contribute to institutional reform, disciplinary planning, and talent team building in various sectors. Administrative management has evolved from mere logistical support to a professional governance function, becoming a key focus for enhancing institutional performance and optimizing resource allocation. In addition, an increasing number of government and public sector organizations now favor LIS PhDs due to their management expertise and interdisciplinary professional background.

Based on the above analysis and the systematic examination of the institutional distribution and position characteristics of Alt-Ac, we further refined its functional types in the LIS knowledge

service ecosystem, as illustrated in the three-dimensional coordinate system (Fig. 1).

The proposed three-dimensional coordinate system captures the diverse roles and contributions of Alt-Ac professionals along three key dimensions: “resource construction vs. intelligence research” (X-axis), “subject services vs. social functions” (Y-axis), and “traditional orientation vs. emerging orientation” (Z-axis). This multidimensional framework provides a holistic view of the Alt-Ac landscape, revealing the dynamic interplay and evolutionary trajectories of different functional types across various institutional contexts.

The X-axis represents the spectrum from resource construction to intelligence research. Positions on the left side of the axis, such as special collections, archival compilation, and document development, focus on the foundational work of collecting, organizing, and preserving knowledge resources. These roles are primarily concentrated in university libraries, archives, and cultural institutions, as evidenced by the institutional distribution analysis in Section “Institutional Distribution of Alt-Ac Positions”. In contrast, positions on the right side, such as intellectual property analysis, industrial intelligence, and data mining, emphasize the synthesis and analysis of information to generate actionable insights and strategic recommendations. These roles are more prevalent in research institutes, government agencies, and enterprises, reflecting the demand for knowledge-driven decision-making in these sectors.

The Y-axis differentiates positions based on their primary focus, from subject services to social functions. Positions in the upper part of the axis, exemplified by subject librarians, information literacy education, and academic evaluation, prioritize the delivery of specialized support and expertise to the academic community. The core functions of university libraries deeply embed these roles, which significantly contribute to the advancement of research and education. Positions in the lower part, such as science communication, development planning, and

research management, focus on translating knowledge into societal impact and engaging with diverse stakeholders beyond academia. Different institutional types more evenly distribute these roles, indicating the growing importance of knowledge mobilization and social responsibility in the LIS field.

The Z-axis introduces a temporal dimension, distinguishing between traditional and emerging orientations. Positions closer to the front of the axis, such as document development, subject librarians, and knowledge management represent the established and conventional roles in the LIS field. These roles have long been the backbone of academic libraries and continue to play a crucial role in supporting research and learning. Positions towards the back, such as digital humanities, data curation, and semantic technologies, symbolize the emerging and transformative roles driven by technological advancements and evolving societal needs. These roles are increasingly prevalent in research institutions, government agencies, and innovative enterprises, as demonstrated by the position characteristics analysis in Section “Higher Education Institutions: Academic Service and Innovation-Driven Roles”.

The functional types represented in this coordinate system often exhibit overlapping and interconnected characteristics, not limited to distinct quadrants. For example, digital humanities positions—located in the upper-left-back region—combine elements of resource construction, subject services, and emerging orientation. These roles leverage cutting-edge technologies to enhance the discovery, analysis, and interpretation of cultural heritage resources, bridging the gap between traditional scholarship and digital innovation. Similarly, data curation positions—situated in the upper-right-back space—integrate aspects of intelligence research, subject services, and emerging orientation. Individuals in these roles apply data management and analytics techniques to support data-intensive research and knowledge discovery across various disciplines.

The three-dimensional framework also sheds light on the evolutionary dynamics of Alt-Ac positions in response to the changing institutional landscape and knowledge production paradigms. As universities, libraries, and cultural institutions embrace digital transformation and open science initiatives, there is a growing demand for Alt-Ac professionals who can navigate the intersection of traditional expertise and emerging technologies. Positions such as digital humanities, data literacy, and semantic technologies are becoming increasingly prominent, driving innovation and redefining the boundaries of the LIS field.

Moreover, the rise of Alt-Ac positions in non-academic sectors, such as government agencies, enterprises, and non-profit organizations, highlights the expanding scope and societal impact of LIS expertise. Positions such as industrial intelligence, open government data, and project archival management demonstrate the value of LIS professionals in leveraging knowledge assets to support evidence-based decision-making, policy formulation, and social innovation. This trend underscores the need for LIS education and professional development programs to cultivate a broader range of competencies and foster collaborative partnerships beyond academia.

**Dynamic evolution of the Alt-Ac structure.** The rapid advancement of the digital revolution has catalyzed transformative changes in the methods of knowledge production, dissemination, and utilization. The pervasive application of modern information technologies, such as big data and artificial intelligence, is reshaping the processes and ecology of academic research, publishing, communication, and knowledge services. A comprehensive examination of the characteristics and

institutional affiliations of Alt-Ac positions reveals the following evolutionary trends over time:

1. Declining Proportion of Traditional Alt-Ac Positions and Rapid Growth of Emerging Positions

The percentage of conventional Alt-Ac positions—such as subject librarians and scientific and technical novelty search—has been rapidly declining annually in recent years. Conversely, positions in collection development, digital humanities, and academic research have experienced exponential growth. Comparative data analysis from 2016 and 2023 revealed that the proportion of subject service positions among Alt-Ac roles decreased from 35.3% to 16.7%, while the proportion of collection development and digital humanities positions increased from less than 1% to 10.1%. Similarly, academic and industry research positions grew from 3% to 14.5%. This shift profoundly reflects the rapid extension of LIS knowledge services from traditional areas, such as resource assurance and subject services, to emerging fields like knowledge innovation, driven by the new circumstances of digitization and intellectualization.

2. Significant Increase in Research Support Positions and Integration of Academic Services into the Entire Research Process

As research paradigms shift towards data-intensive and open collaborative modes, the demand for research process management and performance evaluation continues to rise across various institutions. According to our longitudinal analysis of job postings, research-related Alt-Ac positions, such as data literacy, academic evaluation, research management, and development planning, have shown notable increases in recent years. These specific positions, which were not present in Alt-Ac careers in 2016, accounted for 2.8%, 3.3%, 3.8%, and 2%, respectively, in 2023. By actively embedding itself in the full lifecycle management of research and deeply participating in critical aspects such as academic resource construction, academic evaluation, and scholarly communication, Alt-Ac plays more than a passive supporting role. Instead, it is actively integrating into various stages of the innovation chain with an open and collaborative perspective, thereby transforming knowledge production methods.

3. Surge in Think Tank Research Positions and Expansion from Academia to Industry and Government Policy-Making

With the deep implementation of innovation-driven development strategies and the acceleration of the modernization of the national governance system, the demand for positions in intellectual property, industrial technology intelligence, and policy research continues to rise. From 2016 to 2023, these positions have seen their proportions leap from less than 0.5% to 4.9%, 3.5%, and 2.2%, respectively, showcasing substantial growth. Intellectual property and industrial technology intelligence positions directly connect with the frontiers of innovation, becoming crucial links for industry-university-research collaborative integration. Policy research positions provide intellectual support for macro-decision-making and social governance modernization. These trends demonstrate that Alt-Ac is becoming a key bridge for breaking down departmental barriers and promoting deep integration of government, industry, academia, and research through knowledge services.

4. Cross-Boundary Positions in Interdisciplinary Fields Accelerate the Fusion of Knowledge Services and Technological Innovation

The rise of emerging fields such as digital scholarship and open science has placed new requirements on the integrated development of LIS knowledge services and cutting-edge technologies. Interdisciplinary and cross-domain positions, such as semantic technology, science communication, archival big data, and OA transformation agreements, have emerged. These roles require practitioners to be proficient in professional knowledge while skillfully applying modern information technologies by innovatively grafting professional advantages onto emerging business scenarios. These position types increased from less than 1% cumulatively in 2016 to 4.8% in 2023, highlighting the accelerating trend of integration between LIS knowledge services and cutting-edge technologies.

This study's findings shed light on the evolving characteristics and mechanisms of knowledge production in the LIS domain, reflecting a fundamental shift in the knowledge production paradigm characterized by the increasing convergence of data, technology, and societal impact considerations. The evolutionary trends identified in this study demonstrate the transformative impact of the digital revolution on the LIS knowledge service ecosystem. Alt-Ac professionals, with their versatile skill sets and boundary-spanning roles, are critical agents in driving these transformations. They harness the power of data-driven approaches, open and collaborative research paradigms, interdisciplinary knowledge integration, technology-enabled innovation, and societal impact-oriented application to redefine the scope and nature of LIS knowledge production. In addition, they contribute to the development of a more dynamic, responsive, and impactful LIS discipline by actively participating in the full lifecycle of research, from resource construction to knowledge dissemination and application.

## Discussion

This study, situated in the Chinese context, revealed a diverse and evolving landscape of Alt-Ac positions in the field of LIS. Furthermore, it uncovered a wide spectrum of Alt-Ac roles across nine functional categories, unevenly distributed among various institutional contexts, with higher education institutions, research institutes, and government agencies serving as primary hubs. The longitudinal analysis identifies notable evolutionary trends, including the declining proportion of traditional Alt-Ac positions, the rapid growth of emerging positions, the significant increase in research support positions being integrated into the entire research lifecycle, the surge in think tank research positions, and the emergence of cross-boundary positions in interdisciplinary fields.

The establishment of the first LIS doctoral program at the University of Chicago in 1928 marked the beginning of the professionalization and academicization of librarianship (University of Chicago Graduate Library School, [n.d.](#)). Over the past century, LIS doctoral education has expanded to include many subfields and multidisciplinary domains to represent the information landscape's complexity and diversity. As Kelly et al. (2023) pointed out, alt-ac provides diverse career options for people with advanced degrees, which is particularly true for LIS PhDs. LIS, as an interdisciplinary field, encompasses the humanities and social sciences, as well as science, technology, engineering, and mathematics (STEM) aspects. This unique positioning allows LIS doctoral graduates to pursue Alt-Ac careers that leverage their diverse skill sets and knowledge.

The rise of Alt-Ac positions as a "third space" between academia and industry has profound implications for the academic labor market and knowledge production paradigm in the LIS field. Alt-Ac professionals, serving as connectors and translators,

infuse research with an application-oriented perspective while providing theoretical nourishment for industry practice. This hybrid talent structure challenges the traditional dichotomy between academic and non-academic careers, calling for a more fluid, competency-based approach to talent cultivation and mobility (Larson et al., 2014). The expansion of Alt-Ac opportunities is gradually shifting the center of gravity in the academic labor market, demanding a re-examination of conventional success metrics and career pathways.

To harness the transformative potential of Alt-Ac and better align LIS doctoral education with the evolving demands of the job market, a multidimensional framework for supply-side reform is proposed:

1. **Innovating Talent Cultivation Models:** LIS doctoral programs should embrace a more adaptable and interdisciplinary approach to talent development. This involves integrating project-based learning, industry collaborations, and entrepreneurial experiences into the curriculum to foster versatile skill sets and practical problem-solving capabilities.
2. **Enhancing Transferable Skills Training:** In addition to domain-specific expertise, LIS doctoral programs should prioritize the cultivation of transferable skills such as communication, teamwork, project management, and digital literacy. Incorporating workshops, seminars, and mentorship opportunities can help students develop these essential competencies for success in diverse Alt-Ac roles.
3. **Strengthening Industry-Academia Partnerships:** Fostering strong collaborations between LIS programs and industry partners is crucial for bridging the gap between doctoral education and Alt-Ac career demands. Joint research projects, internships, and co-designed courses can provide students with valuable exposure to real-world challenges and professional networks.
4. **Cultivating an Alt-Ac-Friendly Ecosystem:** Creating a supportive environment for Alt-Ac careers requires a concerted effort from multiple stakeholders. LIS programs should work closely with university leadership, funding agencies, and professional associations to advocate for policies and resources that recognize and value the contributions of Alt-Ac professionals.

Moreover, Alt-Ac professionals, with their distinct "embedded" viewpoints and multidisciplinary thinking, are driving a paradigm shift in LIS knowledge generation towards greater openness, collaboration, and societal impact. This transformation necessitates a critical re-examination of existing disciplinary evaluation systems, moving beyond the narrow focus on paper-based output to embrace a more holistic, impact-oriented approach (Konkiel, 2016). The LIS community must construct a new paradigm of open and dynamic academic evaluation that aligns incentive structures with the evolving nature of knowledge creation and dissemination in the digital age.

The LIS community can reaffirm its relevance and leadership in the knowledge society by proactively engaging with the Alt-Ac phenomenon, enabling it to effectively navigate the challenges and opportunities presented by the digital revolution. However, this study has limitations that must be acknowledged. The reliance on job advertisement data from primarily public institutions may have led to an underrepresentation of Alt-Ac positions in the private sector, particularly in innovative small and medium-sized enterprises. Future research could overcome this limitation by expanding data collection to encompass more diverse organizational contexts. Additionally, complementing the current approach with qualitative investigations into the actual employment experiences and trajectories of Alt-Ac professionals could

provide a more in-depth and comprehensive understanding of the Alt-Ac ecosystem. As Alt-Ac continues to evolve, ongoing scholarly inquiry and evidence-based decision-making will be crucial for understanding and shaping its transformative impact on the future of LIS education, research, and practice.

### Data availability

The datasets generated and/or analyzed during this study are not publicly available due to the datasets comprising secondary data collected over several years by multiple research assistants, and are thus subject to specific data-sharing agreements. However, the corresponding author is willing to share anonymized versions of the data with interested researchers upon reasonable request. Please contact the corresponding author for data access.

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### Author Contributions

TY: Conceptualization, Methodology, Data collection, Formal analysis, Investigation, Writing—original draft, Visualization. KHC: Conceptualization, Methodology, Resources, Writing—review & editing, Supervision, Project administration.

### Competing interests

The authors declare no competing interests.

### Ethical approval

This study did not involve human participants, their data, or biological material. It was based on publicly available job advertisement data. Therefore, ethical approval was not required.

### Informed consent

This study did not involve human participants. The analysis was based on publicly available job advertisement data. Therefore, informed consent was not applicable.

### Additional information

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