The Canadian Journal of Information and Library Science
La Revue canadienne des sciences de l'information et de bibliothéconomie

Mapping information research in Canada
Cartographier la recherche en science de l'information au Canada

Philippe Mongeon, Catherine Gracey, Poppy Riddle, Madelaine Hare, Marc-André Simard et Jean-Sébastien Sauvé

Volume 46, numéro 2, 2023

URI : https://id.erudit.org/iderudit/1108307ar
DOI : https://doi.org/10.5206/cjils-rcsib.v46i2.15568

Aller au sommaire du numéro

Éditeur(s)

Canadian Association for Information Science - Association canadienne des sciences de l'information

ISSN

1195-096X (imprimé)
1920-7239 (numérique)

Découvrir la revue

Citer cet article

Mongeon, P., Gracey, C., Riddle, P., Hare, M., Simard, M.-A. & Sauvé, J.-S. (2023). Mapping information research in Canada. *The Canadian Journal of Information and Library Science / La Revue canadienne des sciences de l'information et de bibliothéconomie*, *46*(2), 1–27. https://doi.org/10.5206/cjils-rcsib.v46i2.15568

Résumé de l'article

Cet article examine le paysage canadien de la recherche en sciences de l'information à travers le prisme des huit unités universitaires offrant des programmes d'études accrédités par l'ALA. Nous avons réalisé un réseau basé sur les citations en utilisant les articles scientifiques publiés par les membres du corps professoral et les doctorants de chaque unité universitaire pour identifier et caractériser des grappes de recherche distinctes dans le domaine. Ensuite, nous avons déterminé comment les publications et les chercheurs de chaque unité sont répartis dans les grappes de recherche pour décrire leur domaine de spécialisation. Nos résultats soulignent comment la nature inter-, multi- et transdisciplinaire du paysage canadien de la recherche en sciences de l'information forme une riche mosaïque de travaux dans le domaine de l'information.

Mapping information research in Canada

Cartographier la recherche en science de l'information au Canada

Philippe Mongeon
Dalhousie University & Université du Québec à Montréal

Catherine Gracey
Dalhousie University

Poppy Riddle
Dalhousie University

Madelaine Hare
Dalhousie University

Marc-André Simard
Université de Montréal

Jean-Sébastien Sauvé
Université de Montréal

Abstract: This study examines the Canadian information research landscape through the lens of the eight academic units hosting ALA-accredited programs. We created a citation-based network utilizing the scholarly articles published by the faculty members and PhD students at each academic unit to identify and characterize distinct research clusters within the field. Then we determined how the publications and researchers from each unit are distributed across the clusters to describe their area of specialization. Our findings emphasize how the inter-, multi-, and transdisciplinary nature of the Canadian information research landscape forms a rich mosaic of information scholarship.

Keywords: bibliometrics, information studies, library studies, research clusters

Résumé : Cet article examine le paysage canadien de la recherche en sciences de l'information à travers le prisme des huit unités universitaires offrant des programmes d'études accrédités par l'ALA. Nous avons réalisé un réseau basé sur les citations en utilisant les articles scientifiques publiés par les membres du corps professoral et les doctorants de chaque unité universitaire pour identifier et caractériser des grappes de recherche distinctes dans le domaine.

La Revue canadienne des sciences de l'information et de bibliothéconomie, Vol. 46 (2023), No. 2
https://doi.org/10.5206/cjilsrcsib.v46i2.15568

Ensuite, nous avons déterminé comment les publications et les chercheurs de chaque unité sont répartis dans les grappes de recherche pour décrire leur domaine de spécialisation. Nos résultats soulignent comment la nature inter-, multi- et transdisciplinaire du paysage canadien de la recherche en sciences de l'information forme une riche mosaïque de travaux dans le domaine de l'information.

Mots clés : bibliométrie, sciences de l'information, bibliothéconomie, pôles de recherche, grappes de recherche

Introduction

Because information is inherent to every research discipline, Bates (1999) referred to Information Science as a meta-field. Indeed, Information Science is hallmarked by its inter-, multi-, and transdisciplinarity. As the various disciplines that comprise the evolving Library and Information Science (LIS) landscape bring their disciplinary assumptions, practices, and worldviews, theoretical distinctions between the characteristics of the different degrees of disciplinary synthesis have become foundational discussions in Information Science (Madsen 2013). A theoretical distinction between these characteristics has been presented by Madsen (2013), who conceptualized a continuum of integration from multi- to inter- to transdisciplinarity, which describes the movement towards the greatest degree of synthesis of disciplines (Madsen 2013). Zhang and Benjamin (2007) also discussed the importance of a theoretically based distinction of interdisciplinarity and its implications for developing a conceptual framework for the Information field. They argued that the fundamental components of a framework must be seen as embedded in disciplines, along with their theories, concepts, approaches, and assumptions. The attempt to situate Library and Information Science along a continuum of disciplinary synthesis may be futile or even unneeded. Scholars in LIS draw from disciplines disparately in their work, and if theoretical frameworks require components to be embedded in disciplines, as Zhang and Benjamin (2007) propose, disproportionality may skew how the field of Information is defined from scholar to scholar.

Empirical investigations of LIS have highlighted its multidisciplinary nature (Aharony 2012; Chua and Yang 2008; Onyancha 2018; Paul-Hus, Mongeon, and Shu 2016), as well as the gradual shift of the field's focus from libraries to a more diverse range of topics such as information technologies, knowledge management, and bibliometrics (Chua and Yang 2008; Figuerola, Marco, and Pinto 2017; Larivière, Sugimoto, and Cronin 2012; Ma and Lund 2020; Onyancha 2018). These considerations present challenges for characterizing the field as a whole; past studies have questioned whether the field of Information Science risks disintegration through being pulled by centrifugal forces, as well as if the field has a weak sense of identity as a result of its "epistemic promiscuity" (Aparac-Jelušić et al. 2013). This dilution may also have ramifications for individual works produced under the banner of LIS. For instance, it has been shown that highly interdisciplinary works tend to have a lower scientific impact as the research may be too dispersed amongst disciplines to find its niche (Larivière and Gingras 2010). Arafat et al. (2014) questioned whether the recurring debate on LIS'

disciplinary status and frontiers implies that its fundamental nature remains unclear and recurring conversations about the disciplinary identity of LIS may prevent the field from progressing in meaningful ways. By straying from conversations around disciplinary status and instead surveying the Canadian LIS landscape by looking at the superpositions of higher education institutions' research foci, a nuanced understanding of the field emerges affording a different way of looking at how the heterogenous landscape evolves around and within disciplines.

Many of the previous quantitative studies that have attempted to map the LIS research landscape suffer from the same limitation: despite acknowledging the multidisciplinary nature of LIS, they tend to ignore the differences in publication practices that characterize the disciplines and specialties composing the field and the potential biases that may result from these differences (Archambault and Larivière 2010). For instance, they often use journal-based classifications to delineate the field, which can lead to major problems: the inclusion of multidisciplinary journals such as *PLOS One*, *Science* or *Nature* may lead to the inclusion of non-LIS articles, while the exclusion of these same journals may lead to the exclusion of core LIS articles published in multidisciplinary or even non-LIS journals. Furthermore, the general lack of normalization methods used in these studies tends to drown the research contribution of some LIS specialties with lower or other types (i.e., monographs) of research outputs such as archival research in favour of more productive and more cited ones such as bibliometrics and altmetrics. In this way, though journal-level classifications are necessary for different use cases, they are not as precise as other classification methods (Rivest, Vignola-Gagné, and Archambault 2021).

Our study provides a snapshot of the research landscape across the network of eight LIS units in Canada until 2022. By looking at the topical foci of LIS institutions and their researchers across Canada, we can avoid the limitations of journal-based classifications and are better able to identify work overlap and integration, potentially liberating the field from a focus on disciplinary borders and their limitations and homogenous research output distribution, and subsequently breaking the silos of LIS.

Research objectives

This study aims to delve into the composition of the Canadian LIS research landscape and to highlight the specific role played by each unit within it by mapping them using a hybrid method of co-citation and direct citation. More specifically, this paper addresses the following research questions: RQ1) What research areas are identified within the Canadian LIS landscape? RQ2) How is research output distributed across research areas overall and for each LIS unit in Canada? RQ3) What does topical distribution reveal about the disciplinary boundaries of LIS? Are topic clusters relatively siloed, or is there substantial integration?

Literature review

This section reviews the past literature that has attempted to identify and describe LIS scholarship. The first two subsections focus on the methodological choices and strategies that were adopted in past work to: 1) identify a set of publications that are representative of the field as a whole; and 2) identify topics and categories of LIS research and assign these topics and categories to the publications. The third subsection of our literature review summarizes the findings of these past studies and what they have told us about LIS scholarship and its evolution based on these common attributes, both generally and in Canada specifically.

Data sources and the identification of LIS publications

Database approach

A large body of literature has highlighted the scattering of LIS research across journals and databases. Meho and Spurgin (2005) noted that many specialized databases must be combined with multidisciplinary databases and monographic databases such as WorldCat to represent the research produced by LIS departments accurately. In a later study comparing Web of Science (WoS), Scopus, and Google Scholar (GS) to measure the citation counts of LIS scholars, Meho and Yang (2007) found that the best results were achieved by combining the databases and that GS was the most comprehensive source of citation data.

Figuerola, Marco, and Pinto (2017) utilized the Library and Information Science Abstracts (LISA) database to analyze the titles and abstracts of LIS papers. LISA contains work that is focused on library science as well as information science and is updated monthly. It is broad and includes work from 45 countries in 20 languages. However, Figuerola, Marco, and Pinto focused on peer-reviewed works submitted in English, primarily comprised of journal articles and conference proceedings.

Journal-based approaches

Journals are commonly used as a unit of analysis to describe research within the LIS field (Larivière, Sugimoto, and Cronin 2012). When compiling a list of journals, researchers utilize different methods and sources to develop a comprehensive picture of the LIS research landscape. Purposive selection is often a major component, as used by Tuomaala, Järvelin, and Vakkari (2014) in developing a list of "core" LIS journals. Their criteria included wide distribution, international contributors and editors, and previous categorization as a core journal by other researchers, which resulted in a dataset of 42 journals published over a 40-year timeline. This method was used again by Järvelin and Vakkari (2021) who selected journals based on the definition of LIS as "the provision of access to desired information" (69) for a total of 30+ journals.

Another resource for compiling LIS journals is the Journal Citation Report (JCR). Ma and Lund (2020) selected the highest-ranked journals in the 2019 Journal Citation Report's rankings that were also contained in the dataset used by Tuomaala, Järvelin, and Vakkari (2020) for 31 LIS journals. Armann-Keown and Patterson's (2020) selection of 97 journals was based on previous research, including Jarvelin and Vakkari's (1990)

work, as well as the Information and Library Science category of the JCR. Noa Aharony (2012) selected 10 journals based on their impact factor according to the *JCR 2008*. Nisonger and Davis's (2005) list of journals was based on a list of 31 journals compiled by Jesse H. Shera (1976) and then expanded to 71. Their article studied the perceptions of prestige for various LIS journals by deans of ALA-accredited LIS programs and directors of ARL libraries. They utilized surveys, asking the deans and directors to rate the importance of being published in each of the 71 journals for tenure or promotion at their home institution on a 5-point scale, one being low. The respondents were additionally asked what the five most important journals were to publish in for promotion or tenure and they could also include journals not on the list provided. Cronin and Meho (2008) adapted Nisonger and Davis's list of journals during their selection of journals. They also made additions to databases, including Ulrich's Periodicals, Library Literature and Information Science and WorldCat for a total list of 275 LIS journals. Similarly, Larivière, Sugimoto, and Cronin (2012) used the "Information Science & Library Science" field and subfield in the U.S. National Science Foundation (NSF) journal classification to identify a total of 160 LIS journals.

Researcher-based and institution-based approaches

Another data source is the individuals or institutions involved in LIS research, which may be less restrictive than examining LIS-specific journals. This approach allows for the work of LIS researchers done outside of the traditional boundaries of the field to be included in the scope of LIS research, considering the collaborative and interdisciplinary patterns that emerge. Paul-Hus, Mongeon, and Shu (2016) characterized the current Canadian LIS research landscape as the research produced from 2010-2015 by faculty members at the eight institutions included in the Association for Library and Information Science Education's (ALISE) 2013 Directory of Library and Information Science Programs and Faculty.

Munroe-Lynds et al. (2021) used the websites of ALA-accredited LIS programs in Canada to compile a list of current faculty members and PhD students. They then collected their publications using Web of Science (WoS) and expanded the dataset using the departments listed in WoS to retrieve publications written by previous faculty and students. Shu and Mongeon (2016) examined the doctoral dissertations of LIS PhD graduates between 1960 and 2013 from 44 ALA-accredited institutions, as well as seven iSchools without ALA-accredited programs. This data was compiled from the MPACT database, ProQuest Dissertation and Thesis Database, and university websites. The same data collection was employed by Shu et al. (2016), with the addition of LIS PhD advisors' doctoral dissertations.

Topic classification of LIS publications

Manual classification

Attempts to classify research outputs of LIS by research topics or areas can be challenging since there is no universally accepted standardized list of LIS-specific research areas. Wolfram and Chu (1989) identified 46 research areas in LIS grouped into five major research areas by examining definitions of LIS, LIS journals, and LIS

curricula. Later, Wolfram (2012) added four additional major research areas, bringing the total number up to nine. Julien and Fena (2018) used these nine research areas in their content analysis of works published in the Canadian Journal of Information and Library Science over the last 31 years. In these works, the authors manually assigned publications to a research area based on the title, abstract or keywords, but no more details are provided on the classification process.

The Library and Information Science topic classification developed by Järvelin and Vakkari (1990) is commonly used to categorize journals or articles. More recently, authors have modified this classification system by adding new subclasses to represent developing areas of research to ensure they are not all lumped into the "other aspects of LIS" class which would skew the data (Järvelin and Vakkari 2021; Ma and Lund 2020; Tuomaala, Järvelin, and Vakkari 2014). This classification system provides a framework for researchers, but assigning publications to categories is done manually by the authors. Using the ISI subject classification scheme, Cronin and Meho (2008) categorized the sources that cited their identified 275 journals. When sources did not appear in the ISI database, they were categorized based on citation analysis, i.e., its categorization came from the discipline that most frequently cited the source.

Text-mining approaches

Text-mining approaches (such as topic modelling) have also been used to identify sets of topics or research areas in the LIS literature. Figuerola and colleagues (2017) used Latent Dirichlet Allocation (LDA) to identify topics from publications indexed in the Library and Information Science Abstracts (LISA) database and, based on several attempts and their judgement, settled on 19 topics, which they grouped into four broad themes (Processes, Technologies, Libraries, and Specific areas).

Bibliometric/network approaches

Hou, Yang, and Chen (2018) describe how citation analyses are one of the most used methods for characterizing the knowledge structure and dynamic evolution of a field. As such, many bibliometric studies have been conducted in the LIS field, which was originally the target of the academic tool of citation analysis (Ellegaard and Wallin 2015). Larivière, Sugimoto, and Cronin (2012) provided a bibliometric chronicling of the first hundred years of the LIS landscape: a lexical analysis was conducted by examining the frequency and use of keywords, the identification of the growth and decline of terms, rates of co-authorship, the number and growth of journals, the number and type of publications produced, and other bibliometric data. They also measured the proportional usage of these words within LIS literature compared to the greater research literature to quantify the interdependent interactions LIS might have with other disciplines. This approach differs from other attempts to delineate the LIS research landscape as it does not sort research data into categories but instead examines trends within the LIS research community and outside of it based on keywords. Paul-Hus, Mongeon, and Shu (2016) previously surveyed the Canadian LIS landscape using bibliometric methods and identified sub-communities based on the disciplines of collaborators and their countries of affiliation. Liu and Yang (2019) presented a picture

of popular research topics on seminal literature in the field to gain a sense of emerging trends, and Chang and Huang (2012) used direct citation analysis, bibliographic coupling, and co-authorship analysis to make observations about LIS researchers and their relationships to LIS-affiliated institutions. Yang et al. (2016) visualized the intellectual structure of the IS field and provided a comprehensive account of different bibliometric approaches undertaken over past decades in the same endeavour highlighting a myriad of strategies including using core IS journals for analysis and manually labelling identified specialties or computer-aided automatic labelling of co-citation networks.

Describing LIS in research

LIS research does not occur in a vacuum and is influenced by the developments occurring in related fields as well as technology shifts such as the rising popularity of the internet (Figuerola, Marco, and Pinto 2017; Onyancha 2018). During the 50 years between 1965 and 2015, there has been a shift from professional articles to research articles within the LIS field (Järvelin and Vakkari 2021; Larivière, Sugimoto, and Cronin 2012). This period also represents an exponential growth in LIS research, with both the number and proportion of LIS articles published in core journals rising dramatically (Larivière, Sugimoto, and Cronin 2012; Tuomaala, Järvelin, and Vakkari 2014). The higher output and shift toward academic research articles demonstrate LIS's maturation as a research discipline (Järvelin and Vakkari, 2021).

Järvelin and Vakkari (2021) found the four main research topics within LIS were scientific and professional communications, information services and retrieval, library and information services, and information seeking. Scientific and professional communications were the most researched subtopics, with 37.4% of publications falling into this category. However, the inclusion of *Scientometrics* contributed to the most articles, so its exclusion would change the most popular area to information services and retrieval. *Scientometrics* and the *Journal of the Association for Information Science and Technology (JASIST)* were large contributors to the field, publishing 2-4 times more than average LIS journals, which pushed scientific communication articles to the forefront (Ma and Lund 2020).

Figuerola, Marco, and Pinto (2017) classified processes, technologies, libraries, and specific areas as the main fields in LIS research. They noted that research specifically conducted on historical sources has skyrocketed since 2008, which they attribute to the rise of digital humanities. Works within the library research field have decreased significantly, comprising 70% of publications in LISA in 1979 to approximately 30% by 2014 (Figuerola, Marco, and Pinto 2017). That still represents a large share of research. Though libraries remain the second largest field within LIS research behind areas of specialization, this decrease represents their decline in relative importance in the LIS field.

The methodology utilized within the field is contingent on the topic being studied. Experiments are most common overall with their highest rates occurring within information systems/retrieval (Ma and Lund 2020). Questionnaires were the most utilized when studying information seeking/behaviour and library and information

services, while citation analysis was used the most within the scholarly communication topic.

As noted by Larivière, Sugimoto, and Cronin (2012), the interdisciplinarity of the field has been increasing steadily since the 1990s. LIS's import dependency has been decreasing while exports have been increasing with medical sciences topping the list. Additionally, when examining other fields that LIS authors (those who have published in an LIS journal) have published in within the same year, Larivière, Sugimoto, and Cronin found that LIS researchers were among the most transient compared to other fields, suggesting that LIS is not an insular research field in the same way it once was. Cronin and Meho (2008) also found that the "export" of ideas outside the field has increased with LIS research garnering a high number of citations from computer science, business and management, and health/medical science in particular. They also found that LIS researchers have been increasingly drawing on other disciplines, which is consistent with the hiring trends of the 2000s with more academics with non-Information Science backgrounds appointed (Cronin and Meho 2008; Shu et al. 2016). This interdisciplinarity is reflected in the dissertation topics of LIS PhD graduates, with multiple topics being examined 86.5% of the time by the 2010s, compared to 0.6% of the time in the 1960s (Shu et al. 2016). Library Science no longer ranks highest as a dissertation topic as it has been replaced by Information Science. Collaborative authorship has also become the norm in the field: Armann-Keown and Patterson (2020) note that this approach is ideal for content analysis since it improves the reliability of the content when more than one person performs data coding.

LIS research in Canada

The LIS research field is newer in Canada than in the United States, only emerging as a distinct area in the 1970s, potentially due to the lack of academic opportunities provided by Canadian institutions at the time (Wolfram and Chu 1989). Before this, the library and librarianship were the firm focus of academics and professions within the field. Collaboration was widely undertaken between researchers at Canadian institutions, specifically at the University of Western Ontario, University of Toronto, McGill University and Dalhousie University. In contrast, collaboration with researchers at international institutions was rare (Wolfram 2012).

The interdisciplinary nature of research conducted in Canadian LIS academic institutions has become increasingly prominent but varies by unit. For example, the discipline of Computer Science sees more integration and collaboration with academic LIS units at the University of Toronto and Dalhousie University than at other institutions. The University of Western Ontario, the University of Ottawa, and the University of Alberta focus more on the Health Sciences (Paul-Hus, Mongeon, and Shu 2016). Potential explanations for these differences could include faculty cross-appointments, the organizational structure of the LIS academic unit, and the composition and characteristics of researchers who work within and in collaboration with the unit. LIS institutions in the United States possess distinct blended or merged programs and the interdisciplinarity shift in the Canadian field appears to be evolving in this direction (Adkins and Budd 2006).

Limitations in the literature

As noted by Nisonger and Davis (2005), utilizing journals as a unit to measure publications in the LIS field can be ineffective, as it excludes articles published in journals that are not strictly LIS-focused. Due to the interdisciplinary nature of the field, examining only specifically LIS publications cannot hope to encompass all the research in the field.

Journals like *JASIST* and *Scientometrics* have much higher publication outputs than other LIS journals and tend to skew towards bibliometric methods, which have resulted in some analyses removing them for purposes of comparison (Järvelin and Vakkari 2021; Ma and Lund 2020). Ellegaard and Wallin (2015) raise the question of whether the steadily increasing number of publications that use bibliometric methods is driven by a need to evaluate scientific production or whether this growth is facilitated by exponential publication growth. Their study found that bibliometric studies produced outside of the LIS community have seen an almost linear increase in impact over the years, meaning that bibliometrics is being recognized as a valuable tool for professionals in all scientific communities and not just as an academic tool for bibliometricians. Bibliometrics offers a useful way of evaluating research and productivity, appearing more frequently in the many fields and sub-fields that comprise the diverse LIS landscape.

Data and methods

Delineating the Canadian LIS field

Contrary to previous studies that used entire databases or journal lists to identify LIS publications, our approach is centred around the individuals affiliated with the eight Canadian academic units offering ALA-accredited programs (American Library Association 2008). We collected a list of current faculty members, postdoctoral fellows, and PhD. students from the websites of these eight units on November 4th, 2022. We searched each person on Google Scholar (scholar.google.com) and in ORCID (orcid.org) and retrieved their profile IDs when available. Our final list contained 360 individuals, 177 of whom we were able to find on Google Scholar and 174 for whom we were able to find an ORCID.

One important implication of our choice to define the field using the individuals affiliated with the academic units offering ALA-accredited programs is that these units vary in size and structure. In many cases, such as the School of Information Management (SIM) or the École de bibliothéconomie et des sciences de l'information (EBSI), the unit is almost entirely comprised of faculty members teaching in the ALA-accredited program. On the other hand, the Faculty of Information at the University of Toronto and the Faculty of Information and Media Studies at Western are much larger units and are expectedly the home of many researchers who may associate with the field of information science/studies broadly defined and not necessarily with the more "traditional" library programs that their units offer. This method, in our view, allows us to draw a portrait of the information research landscape that is neither too restrictive (which would be the case if we considered only researchers in the traditional LIS areas)

nor too broad (which would be the case if we considered all researchers in information-related fields regardless of their affiliations). Instead, our approach enables us to more fully capture the spectrum of the field's inter-, multi-, and transdisciplinarity.

Indeed, the specificities of academic units, their structures, and their programs offer notable differences. ALA-accredited programs sit within academic units in Canadian institutions that vary from Schools to Faculties. The University of Toronto and the University of Western Ontario possess distinct faculties dedicated to Information Science which house their LIS programs. In contrast, other institutions' ALA-accredited programs sit within Schools within other faculties. Most of these Schools exist within the Faculty of Arts, except for Dalhousie University, where the School of Information Management belongs to the Faculty of Management and the University of Alberta, where the School of Library and Information Studies belongs to the Faculty of Education. While some programs offered across institutions can be undertaken as combined/dual degrees, all ALA-accredited programs are firmly at the Master's level. In Table 1, we present the eight units included in the study and the programs that they offer to give the reader a sense of the breadth of topics and, correspondingly, the breadth of expertise and disciplinary backgrounds that we can expect to be represented among the researchers for whom these units are the primary affiliation.

University	Academic Unit	Housed programs
Dalhousie University	School of Information Management	Master of Information; Master of Information Management; Combined degree programs (JD, MPA, MREM); Bachelor of Management (Managing Data and Information major)
McGill University	School of Information Studies	Master of Information Studies; Information Studies PhD; Graduate Certificates (Digital Archives Management/Information Architecture/Information & Knowledge Management/LIS)
University of Alberta	School of Library and Information Studies	Master of Library and Information Studies; Combined degree programs (MA/MLIS in Digital Humanities, MBA/MLIS)
University of British Columbia	School of Information	Master of Library and Information Studies; Master of Archival Studies; Dual degree programs (MLIS/MAS); MA in Children's Literature; PhD program
Université de Montréal	École de bibliothéconomie et sciences de l'information (EBSI)	Maîtrise en sciences de l'information (M.S.I.), Certificat en archivistique; Certificat en gestion de l'information numérique; Doctorat en sciences de l'information
University of Ottawa	School of Information Studies	Diploma in Information Studies; Master of Information Studies
University of Toronto	Faculty of Information (iSchool)	Bachelor of Information; Master of Information; Master of Museum Studies; Combined Degree Program (MI/MMSt); PhD in Information; Diploma of Advanced Study in Information Studies

University of Western Ontario	Faculty of Information and Media Studies	MA Media Studies; Master of Health Information Science; Master of Library and Information Science; Master of Media in Journalism and Communication; PhD Health Information Science; PhD Library and Information Science; PhD Media Studies; Undergraduate programs (Creative Arts and Production/Media, Information & Technoculture/Media & the Public Interest); Certificate & Diploma in Digital Communications

Table 1. ALA-accredited and other programs within LIS academic units in Canada

Our publication's data source is the OpenAlex database (Priem, Piwowar, and Orr 2022) which is the most comprehensive citation index available, is all open data, and where authors are represented by a unique identifier (author ID) associated with their works. We first retrieved all OpenAlex authors whose names matched with one of the 360 researchers on our list. When no matches were found, we manually searched OpenAlex (explore.openalex.org) to find alternate names for the search. Overall, we found 7,479 authors in OpenAlex whose names matched 305 of our 360 researchers. It should be noted here that in OpenAlex, a single person tends to be split into multiple OpenAlex author IDs, so one researcher on our list is likely to be represented by multiple authors in OpenAlex. We then used the OpenAlex Application Programming Interface (API) to retrieve the 28,480 distinct works associated with the 7,479 OpenAlex author IDs.

To remove false positives, we applied several steps. First, we identified all publications where the institution matched the authors' affiliation. We also retrieved the list of raw affiliations (which sometimes included the department) to identify those likely to be LIS departments or libraries (not limited to Canada). We identified all publications with one of these affiliations. Then we used the Google Scholar API with the scholar R package to collect all the publications from the researchers' profiles and flagged the matching OpenAlex works. We also flagged authors and works that are associated with ORCIDs present from our researchers list. A total of 17,914 publications matched one of these criteria. After manually removing 13,064 false positives, we were left with a final dataset of 4,858 distinct publications authored by 264 distinct researchers. The dataset is summarized in Table 2.

Affiliation	**Researchers on Website**	**Google Scholar profile**	**ORCID**	**Researchers on OpenAlex**	**Number of publications**
Dalhousie University	13	8	9	13	150
McGill University	36	19	20	27	732
University of Alberta	20	7	13	14	259
University of British Columbia	40	20	26	31	491

University of Ottawa	12	13	20	8	258
University of Toronto	123	5	7	96	2,022
Université de Montréal	45	75	41	27	570
University of Western Ontario	71	30	38	48	806
Totals	**360**	**177**	**174**	**264**	**4,858***

Table 2. Dataset of researchers and publications

* The total number of publications is smaller than the sum of the rows because of co-authorship between academic units.

Data processing

Clustering

We mapped the Canadian LIS research landscape using a hybrid method of direct citation and co-citation. We explored seven different options of networks, including direct citation (DC), co-citation (CC), bibliographic coupling (BC), as well as hybrid approaches using co-citation and direct citation (CC-DC), bibliographic coupling and direct citation (BC-DC), bibliographic coupling and co-citation (BC-CC), and bibliographic coupling, co-citation, and direct citation (BC-CC-DC). Community detection using the Louvain algorithm (Blondel et al. 2008) with the resolution parameter set at 1.0 (Lambiotte, Delvenne, and Barahona 2014) was calculated in R before exporting edges and node files for each method. We then manually checked clusters by random article selection from each cluster. Terms from each cluster were used to manually derive a label for each cluster in conjunction with our comprehension from reading randomly selected papers.

Networks were visualized using Gephi (Bastian, Heymann, and Jacomy 2009) for each of the exported node and edge files produced from each method. Force Atlas 2 (Jacomy et al. 2014) was used for mapping the resulting networks with colours assigned by cluster. Parameters were adjusted until recognizable categories could be identified using a scaling of 25, gravity of 75, and approximate repulsion deactivated. We found the most recognizable communities were obtained with the hybrid method of co-citation and direct-citation (CC-DC), which captures emerging areas in contrast with networks that included BC. Including the BC network produced core communities that were too large and did not contribute to understanding LIS within the context of our research questions. We then exported the network map from Gephi and manually applied "bubbles" and labels from Table 2 using InkScape (https://inkscape.org). Since 1,317 publications were not linked to any cluster in the DC-CC network, we assigned them to the cluster with which they shared the most references. We were thus able to assign all but 331 publications to a cluster. The 331 papers were removed from the analysis, reducing our final number of publications to 4,527.

Specialization scores

For each academic unit and cluster, we calculated the specialization score at the publication level and the author level. To calculate the publication level specialization score, we divided the share of an institution's total research output that is within a cluster by the share of the output of all units that are within this cluster. The denominator thus represents the share of publications that would be *expected* if all units contributed the same share of their total output to the cluster.

One issue with the publication-level specialization score is that the scores can be significantly influenced by the outputs of a few prolific scholars within a unit. The author-level specialization score is an attempt to mitigate this. We took individual researchers and calculated the relative frequency distribution of their research output across the research areas. This way, every researcher has an equal weight. Then, for each university, we calculated the relative frequency distribution of researchers across research areas so that every unit has the same weight. The average share of researchers in a research area thus provides a denominator to calculate the specialization index for each unit-research area combination. A score below or above 1 respectively indicates a lower or higher than average number of researchers working in a specific area.

Results

In this section, we first describe the network of Canadian LIS scholarship and the different publication clusters detected within that network by the Louvain community detection algorithm. We then look at the distribution of publications from each cluster across the eight Canadian units. We then show how the publications of each of the Canadian LIS units are distributed across these clusters as a proxy for the unit's respective available expertise.

The general Canadian LIS landscape

Figure 1 shows the identified clusters using our hybrid method of research output from Canadian LIS units. At the core and highly connected to surrounding clusters are Information Behaviour, Information Retrieval, Archives and Preservation, Social Media, and Culture, Society, and Communication. Each cluster has overlaps and is well connected with its neighbours with some, such as Culture, Society, and Communication, spread across a very wide area. Peripheral smaller research areas extend beyond the core, some with distinct strong connections to multiple areas, such as Privacy extending to Information Behavior and Cybersecurity, or Library Evaluation's connections to the core groups of Archives, Information Systems, and Information Visualization. Other peripheral groups have singular connections, such as Computational Linguistics, Energy Consumption Models, or Information and Policy.

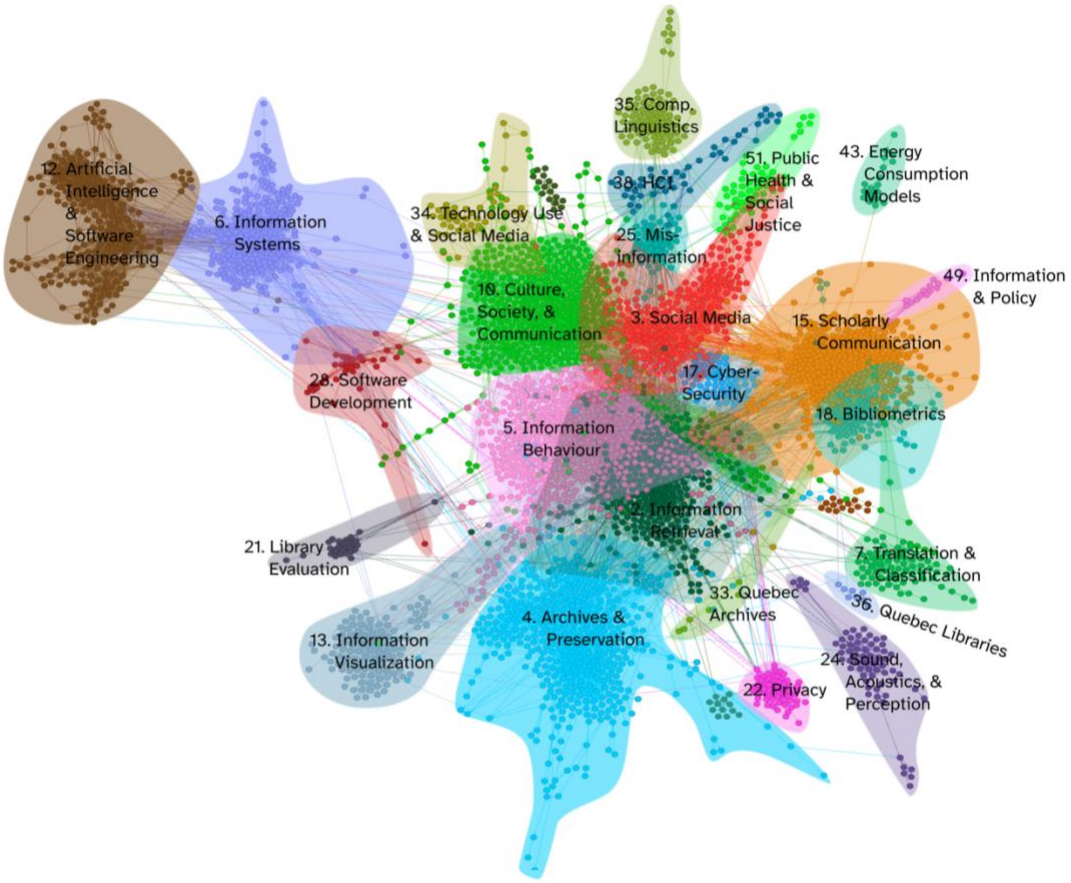

Figure 1. Map of the research output of scholars affiliated with the eight Canadian academic units offering ALA-accredited programs.

The number of papers in each cluster and the main keywords are presented in Table 3. Labels are based on an interpretation of the top words and an assessment of article-level content from a random selection of papers in the cluster. Size represents the number of works found in each cluster. Top words were derived from Term Frequency – Inverse Document Frequency (TF-IDF) weighted term frequency for each cluster.

Label	Size	Top words
Information Behaviour	684	information; library; knowledge; study; student; LIS; practice; organization; research; science; community; social; health; management; experience; public; program; read; immigrant; km; paper; professional; Canadian; tag; finding; archive
Culture, Society, & Communication	604	medium; worker; digital; policy; technology; labor; social; public; communication; cultural; labour; AI; design; platform; privacy; music; system; political; television; economy; datum; information; form; right
Archives & Preservation	526	record; archival; preservation; digital; archive; blockchain; authenticity; information; electronic; library; curation; genre;

		document; datum; research; archivist; management; model; framework; system; archaeological; repository; trust
Scholarly Communications	504	citation; journal; scientific; OA; science; scholarly; publication; author; publish; article; social; research; cite; paper; impact; de; indicator; altmetrics; bibliometric; tweet; authorship; researcher; fund; discipline; Mendeley; medium; Twitter; academic; country; collaboration
Information Retrieval	435	search; information; retrieval; interface; web; user; library; portal; student; design; thesaurus; digital; task; serendipity; child; system; multilingual; knowledge; text; query; model; browse; research; UGC
Information Systems	274	model; requirement; business; software; goal; system; design; strategic; enterprise; security; actor; framework; approach; goal-oriented; coopetition; process; analysis; engineer; trade-off; alternative; organizational; agent; propose; organization; service; knowledge; stakeholder; analyze; reason; support
Social Media	221	social; medium; network; Twitter; online; adult; privacy; digital; NPOS; communication; post; community; information; internet; tie; Facebook; inequality; study; knowledge; user; engagement; learn; personal; finding; datum; technology; organization; people; analysis; policy
Artificial Intelligence and Software Engineering	221	model; software; check; product; property; modelchecking; merge; multivalued; logic; system; uncertainty; vacuity; line; partial; safety; transformation; specification; verification; operator; approach; abstraction; requirement; correctness; refinement; technique; checker; reason; set; assurance; variant
Information Visualization	125	visualization; visual; cognitive; analytics; interaction; health; design; tool; interactive; debate; datum; mathematical; online; information; activity; support; vaccine; system; framework; public; user; game; task; website; ViNCent; medication; interface; gameplay; VA; representation
Bibliometrics	100	citation; author; co-citation; count; science; analysis; field; ACA; journal; article; research; scientific; bibliometric; publish; LIS; publication; cite; intext; medical; education; study; information; library; all-author; result; method; structure; scholarly; specialty; cell
Computational Linguistics	99	Arabic; dialect; model; language; task; BERT; subtask; pretrained; transformer; sentiment; detection; Aranet; bidirectional; dataset; datum; identification; accuracy; learn; deep; MSA; train; share; medium; SSA; translation; social; machine; subjectivity; multitask; text
Translation & Classification	92	translation; translator; corpus; terminology; language; corpus-based; student; program; CERTT; tool; resource; train; French; terminologist; machine; specialize; speed; term; LIS; de; bilingual; technology; LSP; teach; linguistic; translate; academic; postedited; termbases; approach
Sound, Acoustics, & Perception	88	sound; soundscape; auditory; soundscapes; noise; urban; reproduction; experiment; localization; acoustic; velocity; aircraft; environment; stimulus; questionnaire; laboratory; spatial; park; water; perceptual; perception; recalibration; musikiosk; vibration; evaluation; Montréal; threshold; motion; effect; hz

Cybersecurity	81	malware; authorship; cluster; assembly; attribution; clone; email; cyber; text; datum; propose; limbo; code; anonymous; criminal; document; suspect; software; approach; model; investigation; mine; method; author; feature; write; information; cybercrime; attribute; topic
Privacy	80	datum; privacy; anonymization; publish; mashup; privacy preserving; differential; trajectory; RFID; private; utility; mine; reallife; preserve; information; sensitive; algorithm; release; propose; anonymizing; provider; differentially; record; model; secure; guarantee; kanonymity; person-specific; mPrivacy; cluster
Public health & Social justice	78	Covid; violence; health; pandemic; suicidal; SEC; victimization; China; twitter; family; bully; infodemic; officer; public; Chinese; IPV; victim; domestic; abuse; mental; child; rape; tweet; woman; social; study; topic; self-rated; Weibo; suicide
Software Development	73	app; developer; sustainability; software; engineer; ad; review; discount; update; service; intertemporal; decision; system; release; study; library; user; requirement; debt; smell; store; respond; choice; mobile; Google; temporal; design; note; emergency; research
Human Computer Interaction	65	dementia; HCI; click; error; aphasia; slip; mouse; design; menu; adult; pen-based; device; people; pen; steady; social; curriculum; interaction; impairment; participant; target; AAC; touchscreen; program; motor; user; difficulty; support; education; input
Misinformation	61	news; deception; deceptive; detection; certainty; fake; rumor; satirical; truthful; information; story; veracity; IQ; detect; clickbait; cue; satire; automate; manipulation; online; disinformation; truth; model; credibility; LIS; variety; trust; level; intentionally; computer-mediated
Technology Use & Social Media	53	crime; Bangladesh; privacy; social; online; medium; technology; harassment; app; bipolar; violent; HCI; south; digital; policy; disorder; design; parent; study; sexual; multiuser; non-use; Hofstede's; child; chi; statistic; ethnic; rumor; participant; user
Buildings & Energy Consumption	23	occupant; energy; build; consumption; building; tensor; datum; phenotype; prediction; model; factorization; data-driven; mine; EHR; end-use; method; correspondence; behavior; propose; occupancy; fairness; accuracy; predictive; preprocess; methodology; residential; performance; nonnegative; learn; clinically
Information & Policy	19	marine; environmental; information; Bridger; coastal; organization; fishery; grey; policy; Maine; scientific; publication; gulf; influence; intergovernmental; government; Nova; Scotia; interdisciplinary; communicator; management; stakeholder; sector; network; Gulfwatch; ocean; audience; literature; public; science
Québec Libraries	10	Québec; politique; LOI; bibliothèques; library; bibliothèque; lecture; années; publiques; réalisations; national; gouvernement; francophonie; country
Québec Archives	7	revue; Québec; documentation; évolution; archivistique; fouille; scientifique; bibliothèques; contenu; textes; bibliothéconomie; archive; archivistes; association; professionnels

Library Evaluation	4	libQUAL; library; ARL; liQUALtm; protocol; service; score; quality; index; item; lite; paraprofessional; LES; survey; de; user; norm; assessment; measurement; datum; force; des; measure; membership; collection; participant; perception; investment; chronicle; result

Table 3. Description of the publication clusters.

Distribution of LIS units' research output

The areas of specialization for the eight units are shown in Table 4 (raw publications numbers) and Table 5 (specialization index). We can see that the larger units tend to cover a broader range of research but still specialize in different areas. Smaller units tend not to cover all the research areas and thus tend to have higher specialization scores in the areas where they are active. Some clusters appear for all or most of these institutions, like Information Behaviour and Information Retrieval, while some clusters are unique to a single institution, like Québec Libraries and Québec Archives at Université de Montréal.

These tables can be used to determine the research foci of each institution based on their specialization indexes. Dalhousie focuses on Information and Policy, as well as Scholarly Communications and Cyber Security. McGill's research specializes in Sound, Acoustics and Perception, and Privacy and Cyber Security. The University of Alberta produces research in Bibliometrics, Information Retrieval, and Social Media. The University of British Columbia has a high research output in Computational Linguistics and Archives and Preservation. As previously mentioned, Université de Montréal has a high research concentration in topics pertinent to Québec specifically, as well as Library Evaluation. The University of Ottawa focuses on both Translation and Classification and Library Evaluation. The University of Toronto is the least specialized, with some research output in nearly every category, but their highest scores are in Information Systems, Artificial Intelligence and Software Engineering, and Software Development. Western focuses on Information Visualization and Misinformation. It should be noted that the total in Table 4 is in many cases lower than the sum for the row because of collaboration between institutions.

Cluster	**Dal**	**McGill**	**UofA**	**UBC**	**UdeM**	**uOttawa**	**UofT**	**Western**	**Total**
Information Behaviour	33	106	56	51	64	3	248	136	684
Culture, Society, & Communication	1	6	9	15	2	14	342	219	604
Archives & Preservation	2	58	10	114	52	27	264	15	526
Information Retrieval	24	141	76	71	47	9	78	62	504
Scholarly Communications	34	9	10	7	267	91	40	30	435
Information Systems	0	3	0	0	3	0	268	0	274
Artificial Intelligence and Software Engineering	2	1	0	0	0	3	214	1	221
Social Media	7	10	20	18	3	3	74	89	221
Information Visualization	0	1	0	14	2	1	11	96	125
Computational Linguistics	0	3	0	88	0	0	8	1	100
Bibliometrics	4	3	47	0	13	13	12	9	99

Cybersecurity	5	48	1	5	0	1	32	0	92
Translation & Classification	1	0	1	1	3	78	4	1	88
Software Development	1	3	2	2	0	1	72	0	81
Sound, Acoustics, & Perception	1	74	0	1	1	0	3	0	80
Privacy	0	69	0	2	0	0	7	0	78
Technology Use & Social Media	1	9	2	5	1	0	55	1	73
Public Health & Social Justice	1	0	0	3	5	0	56	0	65
Human Computer Interaction	1	37	0	1	0	2	15	5	61
Misinformation	0	3	0	5	2	1	2	40	53
Buildings & Energy Consumption	0	20	1	0	0	0	2	0	23
Information & Policy	16	1	0	1	0	0	0	2	19
Québec Libraries	0	0	0	0	10	0	0	0	10
Québec Archives	0	1	0	0	6	0	0	0	7
Library Evaluation	0	0	1	0	1	1	1	0	4
Total	134	606	236	404	482	248	1,808	707	4,527

Table 4. Distribution of works across clusters and institution.

Cluster	**Dal**	**McGill**	**UofA**	**UBC**	**UdeM**	**uOttawa**	**UofT**	**Western**
Information Behaviour	1.63	1.16	1.57	0.84	0.88	0.08	0.91	1.27
Culture, Society, & Communication	0.06	0.07	0.29	0.28	0.03	0.42	1.42	2.32
Archives & Preservation	0.13	0.82	0.36	2.43	0.93	0.94	1.26	0.18
Information Retrieval	1.61	2.09	2.89	1.58	0.88	0.33	0.39	0.79
Scholarly Communications	2.64	0.15	0.44	0.18	5.76	3.82	0.23	0.44
Information Systems	0.00	0.08	0.00	0.00	0.10	0.00	2.45	0.00
Artificial Intelligence and Software Engineering	0.31	0.03	0.00	0.00	0.00	0.25	2.42	0.03
Social Media	1.07	0.34	1.74	0.91	0.13	0.25	0.84	2.58
Information Visualization	0.00	0.06	0.00	1.26	0.15	0.15	0.22	4.92
Computational Linguistics	0.00	0.22	0.00	9.86	0.00	0.00	0.20	0.06
Bibliometrics	1.36	0.23	9.11	0.00	1.23	2.40	0.30	0.58
Cybersecurity	1.84	3.90	0.21	0.61	0.00	0.20	0.87	0.00
Translation & Classification	0.38	0.00	0.22	0.13	0.32	16.18	0.11	0.07
Software Development	0.42	0.28	0.47	0.28	0.00	0.23	2.23	0.00
Sound, Acoustics, & Perception	0.42	6.91	0.00	0.14	0.12	0.00	0.09	0.00
Privacy	0.00	6.61	0.00	0.29	0.00	0.00	0.22	0.00
Technology Use & Social Media	0.46	0.92	0.53	0.77	0.13	0.00	1.89	0.09
Public Health & Social Justice	0.52	0.00	0.00	0.52	0.72	0.00	2.16	0.00
Human Computer Interaction	0.55	4.53	0.00	0.18	0.00	0.60	0.62	0.52
Misinformation	0.00	0.42	0.00	1.06	0.35	0.34	0.09	4.83
Buildings & Energy Consumption	0.00	6.50	0.83	0.00	0.00	0.00	0.22	0.00
Information & Policy	28.45	0.39	0.00	0.59	0.00	0.00	0.00	0.67
Québec Libraries	0.00	0.00	0.00	0.00	9.39	0.00	0.00	0.00
Quebec Archives	0.00	1.07	0.00	0.00	8.05	0.00	0.00	0.00
Library Evaluation	0.00	0.00	4.80	0.00	2.35	4.56	0.63	0.00

Table 5. Specialization index based on the number of publications for each cluster and institution.

Distribution of researchers within LIS units

We now examine the research landscape through the number of full-time researchers in terms of raw count (Table 6) and specialization index (Table 7). This approach reduces the weight of highly prolific researchers since all researchers have the same weight (1) and can contribute to several clusters. For example, a researcher who published half of their work in Information Behaviour and the other half in Information Retrieval will count for .5 researchers (full portfolio equivalent) in both categories. We find similar results to those observed with the publication scores, where some clusters are particular to specific institutions – like Québec Libraries – and that other clusters have a number of people at each institution working within them, like Information Behaviour and Scholarly Communications.

Cluster	**Dal**	**McGill**	**UofA**	**UBC**	**UdeM**	**uOttawa**	**UofT**	**Western**	**Total**
Information Behaviour	3.92	4.60	5.09	6.13	8.48	0.68	16.12	16.14	61.16
Culture, Society, & Communication	0.06	1.13	0.94	1.44	0.12	1.11	27.12	14.13	46.05
Archives & Preservation	0.40	3.73	0.79	6.14	5.09	0.94	14.07	2.10	33.26
Information Retrieval	3.28	5.92	3.27	4.37	4.69	0.24	6.85	4.03	32.65
Scholarly Communications	1.24	1.68	0.78	1.38	4.32	1.75	4.58	1.43	17.16
Information Systems	0.00	0.74	0.00	0.00	0.22	0.00	2.84	0.00	3.80
Artificial Intelligence and Software Engineering	0.33	0.02	0.00	0.00	0.00	0.14	2.11	0.20	2.80
Social Media	0.80	0.44	1.83	3.28	0.44	0.17	5.93	1.94	14.83
Information Visualization	0.00	0.01	0.00	1.02	0.18	0.08	1.54	1.04	3.87
Computational Linguistics	0.00	0.02	0.00	2.77	0.00	0.00	1.85	0.01	4.65
Bibliometrics	0.10	0.03	0.91	0.00	0.05	0.73	0.42	0.65	2.89
Cybersecurity	0.50	0.35	0.03	1.35	0.00	0.05	1.27	0.00	3.55
Translation & Classification	0.03	0.00	0.50	0.25	0.51	0.95	0.30	0.04	2.58
Software Development	0.17	0.21	0.08	0.04	0.00	0.08	2.63	0.00	3.21
Sound, Acoustics, & Perception	0.08	3.19	0.00	0.09	0.07	0.00	0.07	0.00	3.50
Privacy	0.00	0.52	0.00	0.06	0.00	0.00	0.45	0.00	1.03
Technology Use & Social Media	0.08	0.14	0.42	0.76	0.09	0.00	3.92	0.73	6.14
Public Health & Social Justice	1.00	0.00	0.00	0.27	0.26	0.00	3.11	0.00	4.64
Human Computer Interaction	0.33	2.84	0.00	0.17	0.00	1.05	1.56	0.66	6.61
Misinformation	0.00	0.03	0.00	0.16	0.18	0.03	0.03	2.91	3.34
Buildings & Energy Consumption	0.00	0.13	0.01	0.00	0.00	0.00	0.18	0.00	0.32
Information & Policy	0.67	0.02	0.00	0.33	0.00	0.00	0.00	0.99	2.01
Québec Libraries	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.81
Québec Archives	0.00	0.25	0.00	0.00	1.45	0.00	0.00	0.00	1.70
Library Evaluation	0.00	0.00	0.33	0.00	0.05	0.03	0.05	0.00	0.46
Total	13	26	15	30	27	8	97	47	263

Table 6. The total number of researchers (full portfolio equivalent) by cluster and institution.

Cluster	Dal	McGill	UofA	UBC	UdeM	uOttawa	UofT	Western
Information Behaviour	1.30	0.76	1.46	0.88	1.35	0.36	0.71	1.48
Culture, Society, & Communication	0.03	0.25	0.36	0.27	0.02	0.79	1.60	1.72
Archives & Preservation	0.24	1.13	0.42	1.62	1.49	0.93	1.15	0.35
Information Retrieval	2.03	1.83	1.75	1.17	1.40	0.24	0.57	0.69
Scholarly Communications	1.47	0.99	0.80	0.70	2.45	3.36	0.72	0.47
Information Systems	0.00	1.97	0.00	0.00	0.58	0.00	2.02	0.00
Artificial Intelligence and Software Engineering	2.40	0.08	0.00	0.00	0.00	1.60	2.04	0.40
Social Media	1.09	0.30	2.17	1.94	0.29	0.37	1.08	0.73
Information Visualization	0.00	0.02	0.00	2.32	0.44	0.66	1.08	1.51
Computational Linguistics	0.00	0.04	0.00	5.23	0.00	0.00	1.08	0.01
Bibliometrics	0.72	0.11	5.54	0.00	0.17	8.26	0.39	1.26
Cybersecurity	2.86	0.99	0.13	3.34	0.00	0.42	0.97	0.00
Translation & Classification	0.20	0.00	3.40	0.85	1.92	12.11	0.32	0.09
Software Development	1.05	0.67	0.46	0.10	0.00	0.79	2.22	0.00
Sound, Acoustics, & Perception	0.48	9.22	0.00	0.23	0.19	0.00	0.05	0.00
Privacy	0.00	5.10	0.00	0.54	0.00	0.00	1.18	0.00
Technology Use & Social Media	0.27	0.23	1.21	1.08	0.14	0.00	1.73	0.66
Public health & Social justice	4.35	0.00	0.00	0.51	0.55	0.00	1.82	0.00
Human Computer Interaction	1.02	4.34	0.00	0.22	0.00	5.20	0.64	0.56
Misinformation	0.00	0.10	0.00	0.42	0.53	0.28	0.02	4.87
Buildings & Energy Consumption	0.00	4.12	0.68	0.00	0.00	0.00	1.50	0.00
Information & Policy	6.68	0.12	0.00	1.45	0.00	0.00	0.00	2.76
Québec Libraries	0.00	0.00	0.00	0.00	9.74	0.00	0.00	0.00
Québec Archives	0.00	1.48	0.00	0.00	8.31	0.00	0.00	0.00
Library Evaluation	0.00	0.00	12.58	0.00	1.05	2.02	0.31	0.00

Table 7. Specialization index based on the number of researchers (full portfolio equivalent) for each cluster and institution.

Discussion

LIS research in Canada appears to be both a melting pot and a mosaic of areas and disciplines of research. The unifying areas of research that each school contributes to seem to be those traditionally associated with the disciplinary boundaries of LIS, like Information Behaviour and Retrieval and Archives. These commonalities are represented near the centre of the map of the research landscape (see Figure 1), highlighting how these areas are highly connected within the field. However, there are also research areas unique to particular institutions or researchers or that are not yet widely adopted. Specialized research output in areas like Computational Linguistics, Buildings and Energy Consumption, and Québec Libraries/Archives highlights how the bounds of LIS research can vary by institution. These silos demonstrate the difficulty in

defining the boundaries of the field and the issue with older definitions that do not encapsulate the newer research areas that stray outside the traditional boundaries. Our desire to capture the emerging areas is reflected in our choice of the CC-DC network instead of a BC-based network, as both CC and DC will continue to change over time as new publications cite older publications, evolving the field's boundaries.

The range of research specializations between institutions contributes to the interdisciplinarity of the LIS field in Canada, which is critical to consider when answering RQ2 regarding the composition of research at each institution in Canada. Institutional makeup and individual actors can be powerful in determining what "specializations" are at each university. In considering the effect of institutional makeup on specialization, the University of Toronto, for example, is the least specialized out of all academic units included in this analysis. While size does not imply diversification, it presumably facilitates it, so having the largest number of researchers (123) and publications (2,022) may allow their spread across clusters. Conversely, smaller units tend not to engage in all research areas resulting in higher specialization scores. At Dalhousie, the School of Information is located within the Faculty of Management, which could contribute to its focus on the intersection of Information and Policy. In contrast, at Western, the Master of Library and Information Science (MLIS) program is offered within the Faculty of Information and Media Studies, which is reflected in the research interest in Information Visualization, Misinformation, and Social Media.

Also of note are specific researchers or groups who contribute to work in other disciplines or are cross-appointed to their respective Information Faculties. Lynne Bowker at the University of Ottawa is a professor in both Information Studies and Translation and Interpretation, and this is a potential explanation for the heavy emphasis on Translation and Classification at the University of Ottawa. This example emphasizes one important implication of using individual researchers and their research to characterize research units: it allows us to capture the diversity of topics and disciplines that are part of the units more fully than approaches based on LIS journals or other classifications. By associating research with individuals and only indirectly with units, we can also emphasize the dynamic nature of a constantly moving network as individual researchers join, leave, or transfer units. This also means that highly prolific researchers can heavily skew the topical structure of a unit, especially for smaller units. We considered this essential factor in our analysis by distributing both papers and authors across clusters.

Our data supports the notion that interdisciplinarity is an important characteristic of the Canadian LIS landscape and corroborates the findings of much of the previous research on the topics (Aharony 2012; Chua and Yang 2008; Larivière, Sugimoto, and Cronin 2012; Onyancha 2018; Paul-Hus, Mongeon, and Shu 2016). It additionally supports the notion that the scope of LIS research has begun to include newer subject areas outside the confines of traditional understandings of the field (Figuerola, Marco, and Pinto 2017; Ma and Lund 2020; Onyancha 2018). Our dataset might also prove helpful for units that want to understand the terminological boundaries of their contributions, as González-Valiente et al. (2021) showed in their co-occurrence analysis within the LIS landscape. While there are some highly specialized areas, other areas

such as Information Behaviour, Culture, Society, and Communication, and Information Retrieval overlap topically and widely. Information Retrieval especially so with green nodes spread wide into other sections. Culture, Society, and Communication also has a very wide breadth of topics that includes economics, politics, sociology, feminism, humanities, and more. While it overlaps with a few LIS fields, its overlaps with other fields outside of LIS are substantial.

Limitations

As a data source for our map, OpenAlex includes a wider range of document types and journals not found in Web of Science or Scopus, which are highly curated. While efforts were made to refine our data, this likely means that clusters are less restricted and may overlap more than if using another database. It was also our agenda to take a bottom-up approach with our labels, using article-level terms to provide evidence for an appropriate term or combination of terms that reflect the whole. This is much more of an interpretation, which is less accurate at the individual level within large clusters such as Culture, Society and Communication than for smaller clusters, such as Information Visualization. As such, our choice of labels is subjective and reflects our interpretation which, in some cases, is quite different than would have been applied if we had used a journal-level classification and lost some of the nuances of the topics that Canadian researchers are working on.

Where there are seemingly semantic similarities, using the position on the map provides some clues as to their differing content. For example, Technology Use and Social Media (cluster 34) is different than Social Media (cluster number 3), with cluster 34 containing articles about human factors of using technology and how social media is impacting people's lives. This is reflected in its overlap with Culture, Society, and Media (cluster 10). Whereas cluster 3 overlapped Cybersecurity, Information Behaviour, Misinformation, Public Health and Social Justice, and Scholarly Communication, which provides some insight into the topical alignment as separate from issues of use or impact. We recognize that these labels are highly reductive and are intended to reflect the whole but may do injustice at more granular levels.

We also recognize the limitation of mapping and that maps we produce on Gephi may be slightly different when reproduced with more effect at the micro than macro level. The length of time that the algorithm runs, its settings, and the number of passes will produce slightly different results, but the macro-structure should remain the same. However, like Anscombe's quartet, there are different ways to produce valid maps and we are open to criticism for choosing one graphing algorithm over another to answer our research questions.

Further research

While this map is static, it may be of benefit to see how the research frontier as made evident by the CC-DC links has changed over time; changes that possibly reflect researcher movement from one institution to another, policy change, or resource allocation among other explanations. This may provide evidence for the effectiveness of those strategic decisions.

Labelling could also be improved in future work to include the scholar's research area so that labels for clusters centred around one unit or person might be more accurate from their perspective rather than from our interpretation. It is not our desire to apply a predetermined vocabulary to the emerging frontiers and the research defined by the scholars in their words may be more accurate. This is especially challenging for articles that have many collaborators across disciplines.

Conclusion

This study has surveyed the Canadian Information Studies landscape, focusing on the research output and specialization of LIS research at eight institutions. It has described publication clusters, their distributions across institutions, and their specialization indexes. Prior bibliometric studies that have mapped, characterized, and captured the intellectual network of the evolving Library and Information Science field have shown the field to be increasingly interdisciplinary. Our study illustrates the superposition of Canadian LIS institutions; topic clusters are situated in the research landscape based on the specializations of institutions, actors within those institutions, faculty structures, and emerging areas in Library and Information Science. Providing a heterogenous analysis of the LIS field allows us to avoid the limitations accompanying journal-based classification approaches. It demonstrates that Library and Information Science need not be siloed in disciplinary classifications; we can study how it evolves in and around disciplines and the structure of the academic units that house ALA-accredited programs. Aparac-Jelušić et al. (2013) have commented on whether the field of LIS risks disintegration or dilution as opposing forces impose too much diversity to allow publications to find their niche; our study finds, however, that the topical diversity and the ever-changing nature of topical clusters make up a mosaic that characterizes the landscape. This perhaps seems scattered at first, but there is meaning in how it integrates to produce knowledge. Appreciating this heterogeneity rather than attempting to neatly silo LIS allows us to better understand the field and thereby allows it to progress in meaningful ways.

Acknowledgements

The authors would like to thank Cora-Lynn Munroe-Lynds, Vinson Li, and Emily McClean for their help with data collection, as well as the reviewers for their constructive feedback.

About the authors

Philippe Mongeon is an associate professor at the Department of Information Science of Dalhousie University's Faculty of Management, director of the Quantitative Science Studies lab, and an associate member of the Centre interuniversitaire de recherche sur la science et la technologie.

Catherine Gracey is a student in the Master of Information program at Dalhousie University.

Poppy Riddle is a student in the interdisciplinary PhD program at Dalhousie University.

Madelaine Hare is a Digital Transformation and Innovation PhD student and Instructor at the University of Ottawa.

Marc-André Simard is a PhD student at the École de bibliothéconomie et des sciences de l'information at the Université de Montréal.

Jean-Sébastien Sauvé is an assistant professor at the École de bibliothéconomie et des sciences de l'information at the Université de Montréal.

References

Adkins, Denice, and John Budd. 2006. "Scholarly Productivity of U.S. LIS Faculty." *Library & Information Science Research* 28 (3): 374–89. https://doi.org/10.1016/j.lisr.2006.03.021.

Aharony, Noa. 2012. "Library and Information Science Research Areas: A Content Analysis of Articles from the Top 10 Journals 2007–8." *Journal of Librarianship and Information Science* 44 (1): 27–35. https://doi.org/10.1177/0961000611424819.

American Library Association. 2008. "Searchable Database of ALA-Accredited Programs." Education & Careers. Last modified June 10, 2008. https://www.ala.org/educationcareers/accreditedprograms/directory/search.

Aparac-Jelušić, Tatjana, Fidelia Ibekwe-SanJuan, Isto Huvila, Lai Ma, Virginia Ortiz-Repiso Jimenez, and Julian Warner. 2013. "Crossing the Boundaries in Information Science: Perspectives on Interdisciplinarity." *Proceedings of the American Society for Information Science and Technology* 50 (1): 1–3. https://doi.org/10.1002/meet.14505001009.

Arafat, Sachi, Michael Buckland, Melanie Feinberg, Fidelia Ibekwe-SanJuan, Ryan Shaw, and Julian Warner. 2014. "Pluri, Multi-, Trans- Meta- and Interdisciplinary Nature of LIS. Does It Really Matter?" *Proceedings of the American Society for Information Science and Technology* 51 (1): 1–5. https://doi.org/10.1002/meet.2014.14505101010.

Archambault, Éric, and Vincent Larivière. 2010. "The Limits of Bibliometrics for the Analysis of the Social Sciences and Humanities Literature." In *World Social Science Report 2009/2010*, edited by UNESCO, 251–54. Paris: UNESCO Publishing et International Social Science Council.

Armann-Keown, Vera, and Liane Patterson. 2020. "Content Analysis in Library and Information Research: An Analysis of Trends." *Library & Information Science Research* 42 (4): 101048. https://doi.org/10.1016/j.lisr.2020.101048.

Bastian, Mathieu, Sebastien Heymann, and Mathieu Jacomy. 2009. "Gephi: An Open

Source Software for Exploring and Manipulating Networks." *Proceedings of the International AAAI Conference on Web and Social Media* 3 (1): 361–62. https://doi.org/10.1609/icwsm.v3i1.13937.

Bates, Marcia J. 1999. "The Invisible Substrate of Information Science." *Journal of the American Society for Information Science* 50 (12): 1043–50.

Blondel, Vincent, Jean-Loup Guillaume, Renaud Lambiotte, and Etienne Lefebvre. 2008. "Fast Unfolding of Communities in Large Networks." *Journal of Statistical Mechanics: Theory and Experiment* 2008 (10): P10008. https://doi.org/10.1088/1742-5468/2008/10/P10008.

Chang, Yu-Wei, and Mu-Hsuan Huang. 2012. "A Study of the Evolution of Interdisciplinarity in Library and Information Science: Using Three Bibliometric Methods." *Journal of the American Society for Information Science and Technology* 63 (1): 22–33. https://doi.org/10.1002/asi.21649.

Chua, Alton Y. K., Christopher C. Yang. 2008. "The Shift towards Multi-Disciplinarity in Information Science". *Journal of the American Society for Information Science and Technology* 59 (13): 2156-70. https://doi.org/10.1002/asi.20929.

Cronin, Blaise, and Lokman I. Meho. 2008. "The Shifting Balance of Intellectual Trade in Information Studies." *Journal of the American Society for Information Science and Technology* 59 (4): 551–64. https://doi.org/10.1002/asi.20764.

Ellegaard, Ole, and Johan A. Wallin. 2015. "The Bibliometric Analysis of Scholarly Production: How Great Is the Impact?" *Scientometrics* 105 (3): 1809–31. https://doi.org/10.1007/s11192-015-1645-z.

Figuerola, Carlos G., Francisco Javier García Marco, and María Pinto. 2017. "Mapping the Evolution of Library and Information Science (1978–2014) Using Topic Modeling on LISA." *Scientometrics* 112 (3): 1507–35. https://doi.org/10.1007/s11192-017-2432-9.

González-Valiente, Carlos Luis, Rodrigo Costas, Ed Noyons, Jela Steinerová, and Jaroslav Šušol. 2021. "Terminological (Di) Similarities between Information Management and Knowledge Management: A Term Co-Occurrence Analysis." *Mobile Networks and Applications* 26 (1): 336–46. https://doi.org/10.1007/s11036-020-01643-y.

Hou, Jianhua, Xiucai Yang, and Chaomei Chen. 2018. "Emerging Trends and New Developments in Information Science: A Document Co-Citation Analysis (2009–2016)." *Scientometrics* 115 (2): 869–92. https://doi.org/10.1007/s11192-018-2695-9.

Jacomy, Mathieu, Tommaso Venturini, Sebastien Heymann, and Mathieu Bastian. 2014. "ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software." Edited by Mark R. Muldoon. *PLoS ONE* 9 (6): e98679. https://doi.org/10.1371/journal.pone.0098679.

Järvelin, Kalervo, and Pertti Vakkari. 1990. "Content Analysis of Research Articles in Library and Information Science." *Library and Information Science Research* 12 (4): 395–421. https://eric.ed.gov/?id=EJ431585.

Järvelin, Kalervo, and Pertti Vakkari. 2021. "LIS Research across 50 Years: Content Analysis of Journal Articles." *Journal of Documentation* 78 (7): 65–88. https://doi.org/10.1108/JD-03-2021-0062.

Julien, Heidi, and Christine Fena. 2018. "Thirty-One Years of the Canadian Journal of Information and Library Science: A Content Analysis / Trente et Un Ans de La Revue Canadienne Des Sciences de l'information et de Bibliothéconomie : Une Analyse de Contenu." *Canadian Journal of Information and Library Science* 42 (1): 1–17. https://muse-jhu-edu/article/717385.

Lambiotte, Renaud, Jean-Charles Delvenne, and Mauricio Barahona. 2014. "Random Walks, Markov Processes and the Multiscale Modular Organization of Complex Networks". *IEEE Transactions on Network Science and Engineering* 1 (2): 76-90. https://doi.org/10.1109/TNSE.2015.2391998.

Larivière, Vincent, and Yves Gingras. 2010. "On the Relationship between Interdisciplinarity and Scientific Impact." *Journal of the American Society for Information Science and Technology* 61 (1): 126–31. https://doi.org/10.1002/asi.21226.

Larivière, Vincent, Cassidy R. Sugimoto, and Blaise Cronin. 2012. "A Bibliometric Chronicling of Library and Information Science's First Hundred Years." *Journal of the American Society for Information Science and Technology* 63 (5): 997–1016. https://doi.org/10.1002/asi.22645.

Liu, Guoying, and Le Yang. 2019. "Popular Research Topics in the Recent Journal Publications of Library and Information Science." *The Journal of Academic Librarianship* 45 (3): 278–87. https://doi.org/10.1016/j.acalib.2019.04.001.

Ma, Jinxuan, and Brady Lund. 2020. "The Evolution of LIS Research Topics and Methods from 2006 to 2018: A Content Analysis." *Proceedings of the Association for Information Science and Technology* 57 (1). https://doi.org/10.1002/pra2.241.

Madsen, Dorte. 2013. "Interdisciplinarity in the Information Field." *Proceedings of the American Society for Information Science and Technology* 49 (1): 1–7. https://doi.org/10.1002/meet.14504901016.

Meho, Lokman I., and Kristina M. Spurgin. 2005. "Ranking the Research Productivity of Library and Information Science Faculty and Schools: An Evaluation of Data Sources and Research Methods." *Journal of the American Society for Information Science and Technology* 56 (12): 1314–31. https://doi.org/10.1002/asi.20227.

Meho, Lokman I., and Kiduk Yang. 2007. "Impact of Data Sources on Citation Counts and Rankings of LIS Faculty: Web of Science versus Scopus and Google Scholar." *Journal of the American Society for Information Science and Technology* 58 (13): 2105–25. https://doi.org/10.1002/asi.20677.

Munroe-Lynds, Cora-Lynn, Marc-André Simard, Vinson Li, Emily McClean, and Philippe Mongeon. 2021. "Mapping the Canadian Library and Information Science Research Landscape". *Proceedings of the Annual Conference of CAIS / Actes du congrès annuel de l'ACSI*. https://doi.org/10.29173/cais1221.

Nisonger, Thomas E., and Charles H. Davis. 2005. "The Perception of Library and Information Science Journals by LIS Education Deans and ARL Library Directors: A Replication of the Kohl–Davis Study." *College & Research Libraries* 66 (4): 341–77. https://doi.org/10.5860/crl.66.4.341.

Onyancha, Omwoyo Bosire. 2018. "Forty-Five Years of LIS Research Evolution, 1971–

2015: An Informetrics Study of the Author-Supplied Keywords." *Publishing Research Quarterly* 34 (3): 456–70. https://doi.org/10.1007/s12109-018-9590-3.
Paul-Hus, Adèle, Philippe Mongeon, and Fei Shu. 2016. "Portraying the Landscape of Canadian Library and Information Science Research." *Canadian Journal of Information and Library Science* 40 (4): 332–46. https://muse.jhu.edu/article/649274/pdf/649274/pd.
Priem, Jason, Heather Piwowar, and Richard Orr. 2022. "OpenAlex: A Fully-Open Index of Scholarly Works, Authors, Venues, Institutions, and Concepts." arXiv. https://doi.org/10.48550/arXiv.2205.01833.
Rivest, Maxime, Etienne Vignola-Gagné, and Éric Archambault. 2021. "Article-Level Classification of Scientific Publications: A Comparison of Deep Learning, Direct Citation and Bibliographic Coupling." *PLoS ONE* 16 (5): e0251493. https://doi.org/10.1371/journal.pone.0251493.
Shera, Jesse Hauk. 1976. *Introduction to Library Science: Basic Elements of Library Service. Library Science Text Series*. Littleton, Colorado: Libraries Unlimited.
Shu, Fei, Vincent Larivière, Philippe Mongeon, Charles-Antoine Julien, and Andrew Piper. 2016. "On the Evolution of Library and Information Science Doctoral Dissertation Topics in North America (1960–2013)." *Journal of Education for Library and Information Science* 57 (2): 131-42. https://doi.org/10.3138/jelis.57.2.131.
Shu, Fei, and Phillippe Mongeon. 2016. "The Evolution of iSchool Movement (1988-2013): A Bibliometric View." *Education for Information* 32 (4): 359–73. https://doi.org/10.3233/EFI-160982.
Tuomaala, Otto, Kalervo Järvelin, and Pertti Vakkari. 2014. "Evolution of Library and Information Science, 1965–2005: Content Analysis of Journal Articles." *Journal of the Association for Information Science and Technology* 65 (7): 1446–62. https://doi.org/10.1002/asi.23034.
Wolfram, Dietmar. 2012. "An Analysis of Canadian Contributions to the Information Science Research Literature: 1989–2008/Une Analyse Des Contributions Canadiennes à La Littérature de Recherche En Sciences de l'information : 1989–2008." *Canadian Journal of Information and Library Science* 36 (1-2): 52–66. https://doi.org/10.1353/ils.2012.0005.
Wolfram, Dietmar, and Clara M. Chu. 1989. "Information Science: The Canadian Context." *Scientia Canadensis: Canadian Journal of the History of Science, Technology and Medicine / Scientia Canadensis : Revue Canadienne d'Histoire Des Sciences, Des Techniques et de La Médecine* 13 (2): 110–22. https://doi.org/10.7202/800289ar.
Yang, Siluo, Ruizhen Han, Dietmar Wolfram, and Yuehua Zhao. 2016. "Visualizing the Intellectual Structure of Information Science (2006–2015): Introducing Author Keyword Coupling Analysis." *Journal of Informetrics* 10 (1): 132–50. https://doi.org/10.1016/j.joi.2015.12.003.
Zhang, Ping, and Robert I. Benjamin. 2007. "Understanding Information Related Fields: A Conceptual Framework." *Journal of the American Society for Information Science and Technology* 58 (13): 1934-47. http://onlinelibrary.wiley.com/doi/10.1002/asi.20660/full.