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Directions in Digital Scholarship: Support for Digital, Data-Intensive, and Computational Research in Academic Libraries

A Coalition for Networked Information Initiative 2023

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Table of Contents

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Report

Executive Summary

This report of a 2023 Coalition for Networked Information (CNI) initiative takes a broad look at library engagement with digital scholarship (DS) and examines connections with data-intensive and computational research over roughly the past five years and into the future. There is no set formula for a DS program, while there might be good models and good practices. The kinds of programs offered, the balance of research vs. instructional services, and the key constituencies served are dependent on institutional factors such as the goals represented in the university's strategic plan or the support of a particular college.

To understand trends in DS programs, including attention to the impact of the pandemic, especially with reference to the importance of physical spaces and in-person programming, evidence was gathered from several sources, including online interviews with 12 library and DS leaders, profiles of 47 libraries' DS programs, and conversations during two online forums representing a total of 24 institutions. Findings from these sources are analyzed and synthesized in this report.

DS programs include a wide range of activities with a core of consultation and instruction, with supporting facilities, serving faculty and students, usually of most or all disciplines of the institution. DS programs have an institutional flavor, with some programs emphasizing research, some instruction, and with changes over time often in response to new priorities at the presidential or provostial level. When working with faculty, DS staff often note that research and instruction activities are intertwined.

Many libraries have increased emphasis on data-related activities and some are developing new or renovated facilities. Diversity, equity, and inclusion (DEI) principles are becoming a mainstream part of libraries' DS programs.

Factors that aid in building a strong, sustainable program include:
- Aligning the program with university priorities and strategic initiatives
- Gaining support from faculty who partner with and use services of the DS program
- Providing strong library administrative support, including making DS an integral part of the library's offerings and reshaping staff positions to include or focus on work that is integral to DS
- Communicating what the DS program offers to internal staff and a variety of constituencies and potential supporters
- Developing strong campus partnerships

Factors that hinder the development of DS programs include:

4

- Staffing problems: lack of expertise, vacant positions, difficulty attracting qualified staff
- Difficulty scaling programs to meet burgeoning demand
- Lack of policies guiding the degree of involvement in projects, consultations, and instruction and commitment to curation
- Weak participation by library staff in other units
- Communication and legibility of the DS program

Some important areas for further study include developing:
- Clear notions of success for DS programs
- Common data collection practices for DS activities
- Policies and guidelines for projects and instruction
- Models of organizational roles and reporting relationships
- Models for campus partnerships
- Improved modes of internal and external communication for DS programs

In many institutions, computational, data-intensive research will take a growing share of DS programs and requires particular types of skills in the library and partnerships across the institution. This report provides many options for those developing or reconfiguring DS programs to examine in their own institutional contexts as they think through goals, alignment with their institutional priorities, staff capacity, and ways to develop a sustainable program. Many professionals involved in DS work and some library administrators believe that the kinds of programs offered by a DS unit are, in fact, core library services and should be considered mainstream, ongoing aspects of academic library work today.

Introduction

This CNI initiative examines programs in academic libraries that support digital scholarship (DS), data-intensive, and computational research activities. This encompasses an evolving set of partnerships, services, instructional programs, events, and other activities and includes working with faculty and students in such technologies as GIS, data visualization, text mining, AR/VR, programming environments, 3-D printing, artificial intelligence (AI) or machine learning, and many more. There is great variety among academic libraries as to how such programs are constituted and organized, what technologies are supported, and the depth of services provided. However, while some programs were started primarily to work with digital humanities (DH), increasingly libraries that have such programs serve most or all disciplines represented at their institution and consider faculty, graduate students, undergraduates, and university staff among their constituents. Often in tandem with the development of DS programs, libraries instituted a set of consultative services associated with data management, particularly in response to funder mandates and driven by compliance issues. While library staff who focused on advising researchers on data management, curation, and other types of research data practices were often in a separate unit from DS staff, their efforts are increasingly intertwined and complementary. This is due, in part, because more aspects of DS practice and methodologies involve structuring, analyzing, and representing large sets of data.

While most DS programs increased their online consultation and instructional activities during the pandemic, representatives of those programs continue to believe that physical facilities related to DS, data-intensive, and computational research are important.

It is essential to note that while some academic administrators and librarians question why libraries are involved in DS, most academic libraries have provided both content and services for a wide array of information formats for many decades. Libraries have longstanding collections of music, films, maps, manuscripts, and datasets, in analog and digital form, that require specialized equipment to access the content and a variety of tools to query and analyze it. The sources of data involved in DS projects derive from texts, photographs, videos, maps, data streams from scientific instruments, etc., all important types of content in the scholarly enterprise. In the digital environment, the use of tools to collect, analyze, and produce new content is inextricably intertwined with the content itself, and this presents challenges for both users and the information professionals who work with them. DS programs are a mechanism to consolidate a set of activities that bring together content, tools, services, and facilities to support and advance new types of scholarly work. This results in deeper interactions with both technologies and users in the analysis and creation of content than was typical of library services of the past.

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Background

CNI has had an interest in DS centers from at least 2011 and back to the 1990s if one includes CNI's interest in DH. In 2014, CNI held its first workshop on DS centers, focusing on libraries or other units offering specialized tools, physical facilities, consultations, research partnerships, workshops, and other activities related to the use of high-end technologies to enable scholars to ask new types of research questions and to assist them in representing the outputs of their scholarship in new modes. After the 2014 workshop, CNI held a series of in-person workshops that used the term "digital scholarship planning" rather than "digital scholarship centers," to assist libraries in the early planning stages of program development. The change in wording also signals the emphasis on institutions prioritizing programming rather than physical space. During the early phase of the pandemic, CNI hosted a wide-ranging webinar series on DS; videos and other resources are available at https://www.cni.org/events/cni-workshops/digital-scholarship-planning-2020-webinar-series. Over the years, CNI's membership meetings have included many sessions on DS topics.

At the institutional level, DS programs and centers often developed serendipitously, through relationships between a faculty-led project team and interested librarians and library staff. Programs grow as word of mouth often leads from collaboration with a single research project to partnerships with multiple projects. Work with researchers on DS projects often incorporates elements of working with students and integration of the project's outputs or processes into the faculty members' courses. Currently, many DS programs struggle to keep up with the demand for the many types of activities in which they are engaged.

Digital scholarship, data-intensive research, and computational research are terms used in this current CNI initiative, shorthanded together as DS in this report, although they may not be clear to librarians and the constituencies they serve. Many people in the DS field dislike the term "DS" but continue to use it, largely because a good alternative is not in common use. The term likely started to be used because libraries wanted to convey that their programs served more than DH, since many developed from a core DH program, expanding into the social sciences and in some cases the sciences and professional fields. This came about, in part, because technologies such as GIS and data visualization are used in almost every discipline; therefore, the expertise in the library serving those needs can be discipline-neutral. Some DS programs have developed over decades while others are quite new.

In the current environment, programs are adding expertise, especially in the areas of support for data-intensive and computational research; however, the services developed for those activities may be in separate units from DS.

While some DS and many DH centers developed outside of academic libraries, CNI's interest over the years has focused on those that have a strong tie to libraries, administratively and often in a physical presence. However, there is

great variation in the nature of those programs, starting with whether they have been constituted as a "program" with a director and staff or whether they are a group of services distributed over a number of library (and other campus) units. Naming is also an area of variation, with many libraries using the terminology "digital scholarship" to describe their initiatives while others use terms such as "faculty commons" or "scholars lab." In more recent years, "research data" has become a component of the names of some library programs. Many libraries have some dedicated spaces for their DS programs, but not all. The types of facilities and technologies available vary, with some facilities designated solely or mainly for use by those involved in DS activities and others, such as a library classroom, that may be used for a variety of purposes.

CNI DS Initiative in 2023

Through this report and associated content, CNI is interested in providing materials that review and illuminate the landscape of academic library support for DS, data-intensive research, and computational research over a period of time and into the future. We want to understand the trajectory of programs and what has influenced those trajectories. This initiative explores many characteristics of programs including whether some were developed in the context of the university's broad priorities, such as those represented in a strategic plan, what groups are included in their constituencies, and what affects their sustainability. In addition, the initiative attempts to understand trends in DS programs including attention to the impact of the pandemic, especially regarding the importance of physical spaces and in-person programming.

A particular area of interest is how DS programs relate to other technology-intensive or digitally focused initiatives within the library, e.g. digital publishing or virtual reality activities, and how DS programs incorporate or connect to research data support services, both within the library and with other campus units such as research computing or central IT.

The components of the initiative included online interviews with 12 library and DS leaders (Appendix B), collection of information on libraries' DS programs, two online forums, and some dissemination activities including this report, a session at the Spring 2023 CNI Membership Meeting, and two follow-on webinars. Details on the process are described in Appendix A.

Analysis of DS Programs

To develop this report, sources included a brief literature review, interviews with 12 library and DS leaders, analysis of DS profiles collected from 47 institutions, and responses by 24 participants in two online forums, which included some responses to polls. This report attempts to analyze and synthesize the information collected and provide perspectives on trends. However, there is a great deal of variation among DS programs, and no one, or small number, of configurations emerged as a model for other institutions. For example, DS programs ran the gamut of whether or not they included such units as

8

publishing, makerspaces, media production, scholarly communication, and GIS. It was not clear what factors led libraries to include some things in the DS program, and this question was not directly addressed in the forums. Likely, historical evolution, campus politics, administrative preferences, disciplinary needs, and personalities influenced the evolution of the organization.

This report provides multiple options for those developing or reconfiguring DS programs to examine in their institutional contexts as they think through goals, alignment with their institutional priorities, staff capacity, and ways to develop a sustainable program.

Digital Scholarship, Data-intensive, and Computational Research Programs

Data-intensive and computational research activities have taken a more prominent role on many campuses in recent years. In some cases, universities have developed new data science initiatives, integrated data-intensive competencies in many curricular areas, and hired new faculty cohorts with those specialties. Academic libraries have been responsive to those trends. Most of the libraries examined in this initiative offer a wide array of programmatic initiatives related to DS, research data, and computational research. Some libraries organize those activities under one administrative umbrella, e.g. an associate university librarian (AUL), while others have units in those arenas reporting up different channels. In some cases, another unit on campus is the primary entity offering services in an area, such as computational research, while in other cases, support is offered in a partnership of the library, IT, the research office, or other units.

During the forums, participants discussed whether their libraries have a coordinated program for support of DS, data-intensive, and computational research. If offered by the library, most often services for computational research are in a unit separate from DS. Several participants noted that they see increased connections among these areas. For example, some DS projects are described as examining collections as data, and visualization projects, often part of a DS program, are data-intensive. If projects in DS and computational research are using programming environments such as R or Python, does it make sense to have that expertise in two different parts of the organization? A small number of libraries have reorganized or are in the process of reorganizing so that units working in all of these areas are under one administrative umbrella. A number of participants mentioned that the library website often does not assist their user community in easily determining who to approach for particular needs related to these services. All of the participants noted the need for good mechanisms for handing off user queries to the appropriate unit. Some libraries have developed a concierge service in partnership with the research office and IT to facilitate connections between potential users and appropriate expertise. In some cases, that includes referring individuals to units on other parts of the campus, such as research computing. Some noted that while researchers need to work with IT on projects involving very large datasets, they often prefer to have consultations with someone in the library first since the library staff is more receptive to talking through the project lifecycle and specific issues whereas interactions with IT are more transactional.

9

In a small number of the institutions represented at the forums, participants described emerging, provost-level supported initiatives to build a coordinated set of research data support with partnership between the library, research office, and IT.

In the forums, there was discussion of the use of terms such as "support" and "service" as distinct from characterizing activities as "partnerships" or "collaborations," either with the constituencies involved or with other campus units. This report acknowledges but does not focus on such distinctions, although they are touched on in the section below on consultation programs. Professional activities, such as offering workshops, can be seen as a service without directly involving a partnership, for example.

Relationship of DS Programs to Institutional Priorities

During the forums, we asked whether an institution's DS program had a close connection to institutional priorities, whether at its inception or at present, and there was much variability in responses. Some of the long-standing programs described serendipitous origins where a faculty member or team approached a receptive librarian to partner on a DS project, which led to other projects, often through word of mouth. Some participants who described their institution as STEM-oriented had developed their DS programs most closely in concert with institutional priorities, often in response to emphases on data-informed research priorities. In a few examples, presidential-level focus on interdisciplinarity was instrumental in the library developing a DS program since it is seen as a neutral party on campus. In fact, many participants noted institutional emphases on multidisciplinary thinking and innovation as a way that a library could leverage its position to build a DS program since it is seen as a discipline-neutral space, a kind of connective tissue, and a trusted third party among disciplines. Some also noted the translational role that libraries play between and among disciplines. Other participants noted specific administrative emphases, usually at the presidential or provostial level, to develop more initiatives to support research generally or in a specific area such as public humanities or to develop digital literacy skills for students. A number of representatives mentioned conducting some needs assessments at some point in the development of their program.

Another way that some programs can be responsive to institutional priorities is through their advisory boards. While we did not ask specifically about this topic, several forum participants mentioned their advisory boards in relation to setting directions and priorities, particularly at the outset of their programs.

Constituencies Served and Changes over Time

Unsurprisingly, the profile data demonstrated that almost all examined DS programs serve faculty, graduate students, and undergraduate students, and most serve postdocs (some may not serve postdocs because their institution does not have individuals with that designation). Around half also serve community members and a smaller number serve individuals external to the university and local community (these could be partners in projects, for example). Few serve

10

local high school students. One forum participant noted that we had not included the category of university staff among the constituencies served. She stated that almost 50% of their consultation work is devoted to campus staff from the research office, compliance staff, facilities department, and others. This is an area for further exploration and a potential lever to request more resources for DS in the library.

For many DS programs, graduate students are the largest constituency served, but many mentioned a significant increase in use by undergraduate students in recent years as they tackle more technology and data-intensive projects, either independently or as part of course assignments. One institution that began with a focus on humanities projects led by faculty has recently seen substantial growth in the use of its services by graduate students.

The DS programs of almost all of the profiled institutions serve the disciplinary areas of humanities and social sciences; slightly fewer also serve the arts, STEM, and professional fields such as health sciences, business, and law. A number of institutions with a strong STEM emphasis participated in the forums and described how that influenced the types of programs they developed, particularly related to data-intensive research. A number of their representatives stated that while their programs largely began as humanities-focused, they quickly attracted users from social sciences and later added capabilities specifically targeting sciences, medicine, and professional schools, such as business or law. Several participants mentioned strong user constituencies from music, art, design, and dance. Several other user groups or partners in DS programs mentioned included individuals from digital media, computer science, and disability studies. One individual noted that alumni had participated in several of their DS projects that featured events that had taken place at the institution.

Several participants noted that new faculty often approach DS staff shortly after they arrive at the university to explore what the program could offer them. Others noted that during the pandemic campus closures, some faculty began to work with DS staff to try new things in their research or instruction and have continued those relationships.

Balance and Type of Services for Research and Learning

DS programs offer a variety of consultation services, support or partnership on projects, and instruction activities. We asked about whether DS staff spent more time on activities related to research or learning and found that distinction was often not easily made. Participants in the forums noted that an interaction with a faculty member might start with a consultation about developing a digital project assignment for students in a course. Through that interaction, the faculty member often returned to discuss her or his research needs. In other cases, the faculty member might interact with a particular technology available through the DS program, such as AR but then return to request that the DS staff work with them in other areas. Also, the products of a faculty member's research might include using those resources in classes with students. DS professionals believe

that many elements of research and learning are intertwined. A representative from a liberal arts college noted that they specifically seek to support projects where research and curricular development intersect. In some cases, forum participants were clear that they chose to put more resources into either research or instruction, at times in response to funding from an internal source such as a college or the research office and at times in response to the president's strategic directions, but there was no overall pattern to those responses.

<u>Consultation Programs and Project Support</u>

Consultations are the bread and butter of most DS programs. However, the category of consultations can include anything from a one-time interaction to assist with a coding problem to a years-long partnership with departmental faculty and others working on a scholarly project. Consultations may be between a faculty member, student, or university staff and someone who works full-time in the DS unit or with subject liaisons, metadata specialists, special collections librarians, preservation librarians, IP consultants, and others.

In recent years, funder policies (government and non-government) related to data management and data accessibility in the US, Canada, and internationally, have had the most impact on the demand for consultations at many libraries. In some cases, this type of consultation was available on campus only through the library; in other cases, there are partnerships with the library, research office, and research computing (or others) to work with faculty on fulfilling their obligations for data management plans, etc. In addition to the funder requirements, more faculty and graduate students are seeking consultations on other data-oriented activities such as processing data and data migration.

Consultations: Amount and Mode (Poll Results)
- Most forum participants answered that they are doing **more online consultations with a <u>corresponding reduction</u> in those taking place in person** compared to prior to the pandemic.
- About a quarter of forum participants responded that they are doing **more online consultations now <u>and also more</u> in person** compared to prior to the pandemic.
- One participant reported that in-person consultations have mostly evaporated since the onset of the pandemic.

Several significant concerns about working with faculty projects emerged during discussions at the forums. Some individuals representing programs that have been in place for decades have learned lessons from the years they have been in operation. Participants described legacy projects, often bespoke humanities projects that their unit had partnered on in the early years of their program's existence, sometimes a decade or more ago. Usually, the DS staff that had originally worked on the project were no longer at the university. The participants had concerns that faculty expected the library to keep these projects alive, which would take considerable resources and was often not seen by the DS unit as a high priority. The library's commitment to the long-term viability of the

12

project had never been documented. Often faculty expected the library to provide this work as a "service" rather than working as a partner on the project. This created conflicts that were not easily resolved.

In addition to issues with these legacy projects, some faculty expect the DS unit to develop a website or a database with the faculty member's content as a core service. Here again, DS staff expressed concern that faculty did not approach them as partners to discuss the nature of the project, software used, etc., but wanted to hand it off to DS staff to implement according to their instructions.

In the discussion of these projects, a few institutional representatives indicated that they have or are working on developing tiers of service or guidelines as to when and how much they will commit to faculty-led projects. One institution requires individuals or teams to complete some foundational instructional experience to be eligible for a higher level of project support from DS staff. Some others noted that they no longer build websites for faculty but will train them or their students to do that work.

It is important to realize that many DS programs are still heavily involved in large research projects with faculty; in some cases, a DS staff member may be a co-PI on the project. In addition, a number of DS programs have their own significant research agendas, whether developing digital projects, often related to the university or local area, or developing new digital tools for the DS community. One forum participant stated that working on developing tools makes staff members more effective in working with their constituencies.

One topic mentioned but not expressly addressed in the forums was the ongoing concern about recognition for digital projects in promotion and tenure decisions, which can affect which faculty want to get involved in this type of work.

Instructional Programs
Instruction related to DS programs takes many forms and involves a significant amount of staff time. The most common are stand-alone workshops and course-integrated class sessions. For stand-alone workshops, topics can include specific types of software and coding tools; processing, formatting, and curating data; website development and hosting; open access publishing; and more. Often these workshops are offered to graduate and undergraduate students, faculty, and staff. Some may use or incorporate online materials developed by other institutions, and workshops may be offered in person, synchronously online, or asynchronously. Many DS programs are offering more workshops online than they did before the pandemic and are attracting large participant groups. One institution reported that they had over 450 individuals representing close to 90 different departments or units taking part in their asynchronous, Carpentries-based programming workshops during one academic quarter. Using online workshops may still entail real staff time to develop and administer programs, grade assignments, if applicable, and hold office hours for student questions.

One participant stated that expectations that the library provides the technical training of all students in a particular program have been unsustainable. They switched their model to doing some intensive summer training for faculty so that the faculty could do more themselves with their students.

One question that was discussed only briefly was whether workshops needed to include discipline-specific examples and context to be effective with participants; in what instances can a generic workshop on a specific coding tool, for example, Python or R, be accepted by participants from many disciplines?

One institution described teaching sessions through a graduate school initiative whereby students are required to take a certain number of offerings; the library offers sessions on DS topics and ethical issues related to information. Several specialized initiatives involved various types of partnerships. In one institution, all instructional activities for graduate students are in partnership with campus IT. Another institution reported that its ability to offer a wider range of online programs had increased because it collaborates on those offerings with other area institutions. Another program reported that it partners with the teaching and learning center on workshops focused on accessibility, privacy, and other ethical issues.

Several institutions reported that they were moving away from one-time workshops to a series of workshops scaffolding on the content of the previous one, to assist attendees in building stronger skillsets. They also hope to build learning communities where peer-to-peer learning can flourish.

Another type of workshop series offered by several institutions is a summer institute for faculty, focusing either on developing skills with particular software types or on partnering with DS staff to develop assignments for digital projects in their courses. Often these series are in person, and one institution reported that they had to suspend their summer program at the onset of the pandemic and had not yet restarted it.

Instruction: Amount and Mode (Poll Results)
To compare the number and mode of instruction sessions currently to prior to the pandemic, the responses showed:
- Slightly under half of forum participants are doing both **more online <u>and</u> more in-person instruction** now compared to prior to the pandemic.
- Slightly under half of forum participants are doing **more online <u>and less</u> in-person instruction** now compared to prior to the pandemic.
- A couple of individuals responded that they had seen **no change**.

Course-related instruction usually involves partnering with a faculty member on developing a relevant digital assignment and then meeting with students for one or more class sessions. Some DS programs actively involve subject liaisons or other librarians to collaborate or directly teach those course-related class sessions.

A small number of participants noted that there was a drop in the inclusion of digital projects as course assignments during the pandemic, and faculty burnout seemed to be a factor in the slow resumption of those assignments.

A limited but significant number of institutions reported that DS staff are teaching in institutional data science programs, DH programs, or similar programs. Others reported that they are administering and offering certificate programs in those topic areas.

Diversity, Equity, and Inclusion (DEI) Initiatives
Participants in the forum commented that their programs were making efforts to address DEI in a variety of ways. A number of them provided links to specific initiatives in which their DS program and the library were engaged, often with other partners in the institution or local area. Many higher education institutions include DEI principles in their strategic directions, and libraries have found their involvement in DEI initiatives to be a fruitful way to contribute to and align their projects with their university's work in this area.

Responding to a poll, participants provided information on the types of actions they are taking related to DEI. Almost all are initiating more partnerships with faculty and students working on projects that highlight diverse groups and content, and a similar number are doing more exhibits that highlight diversity. Almost as many are doing more liaison with and outreach to campus groups of diverse populations. Over half are hosting more events highlighting diversity, and slightly more than half are putting more effort into hiring staff that reflects their student population.

One participant noted that as they revise the mission statement of their program, they are integrating DEI principles into the core of what they do and why. Several reported that DEI principles are now integrated into their project proposal process. One participant commented that she was interested in leveraging emerging technologies to support accessibility.

Links to Selected DEI Initiatives in Forum Participant Institutions
- https://www.lib.umich.edu/research-and-scholarship/awards-and-grants/anti-racist-digital-research-initiative
- https://crrj.org/
- https://exhibits.library.dartmouth.edu/s/HistoricalAccountability/
- https://digblk.psu.edu/
- https://library.georgetown.edu/collection/we-are-georgetown-celebrating-our-black-history
- https://blacklib1969.swarthmore.edu/
- https://diyhistory.lib.uiowa.edu/collections/show/20
- https://www.lib.ncsu.edu/projects/virtual-martin-luther-king-jr-project-vmlk

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Staffing

The profiles of 47 institutions yielded information about the types of staff employed by DS programs. All DS programs employed librarians, archivists, and/or library staff. Most employed graduate students, undergraduate students, and information technologists (including programmers). Less than half of the respondents employed multimedia professionals, data scientists/data analysts, postdocs, instructional technologists, and faculty from academic departments. Institutions were not asked about the number of staff employed.

During the forums, many participants commented on the involvement or lack of involvement in DS programs from library staff in other units, such as subject liaisons, metadata specialists, special collections staff, and scholarly communications librarians. Some DS programs successfully work with individuals from other library units, finding enthusiastic participants in consulting and instruction activities. Others mentioned that there is a lack of interest from other staff or concern that supervisors would not reward or approve of time spent working in the DS unit. There is a sense that encouragement by deans and associate deans in libraries results in more support for staff of all types to be involved in DS programs.

Most programs reported no increase in staff over the past few years and a number reported vacant or frozen positions. Some had been successful in adding new staff through funding of research data positions that were made as a joint budget request from the library and the office of research. In some institutions, internal funds from a college or provost's office to support fellowship work (faculty and/or graduate level) as part of a DS program resulted in additional individuals assisting with DS programs. Many institutions find that employing graduate students and undergraduate students who have the technical skills needed to work on projects and deliver workshops is a useful strategy in coping with gaps in the skills of existing staff or increased demand for a particular type of work.

One administrator noted that it's not easy to have both a structure with certain types of expertise and the ability to quickly shift focus in response to changes in technology or changes in faculty research needs demand. It can also be a challenge to cross-train staff so they can meet current needs, which may expand in a particular area, or to fill in a vacated position where someone was previously the primary staff person with particular expertise.

Staff turnover, lack of specific skills, difficulty replacing staff due to local competition offering higher salaries, and burnout due to ever-increasing demands were all issues cited in discussions related to program sustainability.

Physical Facilities

From the profile data, four of the ten types of physical facility spaces were available in the libraries of most respondents: training/classroom spaces, consultation spaces, facilities for collaborative projects, and computer/data labs. Whether these facilities were part of a physically separate DS facility or not was

16

not specified. Slightly less than half of the libraries represented had makerspaces or VR/AR facilities. Many had media production spaces but this is one type of facility that may not be administratively part of the DS program. The profiles indicated that non-library campus units had a much higher representation of computer/data labs, makerspaces, and VR/AR facilities than libraries.

During the forums, participants were asked via poll about the relative importance of physical facilities at present as compared to five years ago (pre-pandemic). Most respondents chose responses that demonstrate they believe that physical facilities are important for their programs at about the same level of importance as five years ago. Only a few chose the response that physical facilities are now less important. Several participants described the physical spaces of DS programs as connectors between and among disciplines; they can be welcoming spaces where partners in interdisciplinary projects meet.

Some participants described thinking through what kinds of technologies are best to offer in their physical facilities. Some noted that they are not looking for the most advanced or cutting-edge technologies but rather those that can be used more easily by a broad range of faculty and students.

In pre-pandemic CNI workshops on DS, many participants commented on the informal community development and peer-to-peer learning opportunities afforded by physical facilities for DS programs. There was much less mention of that aspect of facilities during the forums this year, perhaps because those relationships are being rebuilt as people return to campus.

In the section below on what DS programs would like to offer next, a number of items related to physical facilities are mentioned. Several forum participants are currently remodeling spaces or creating new spaces for DS program activities.

<u>Partnerships</u>
Partnerships with other campus units are important for many DS programs. Funder directives regarding access to and curation of research data have, in particular, spurred the development of partnerships among the library, research office, and IT. Overall, partnerships mentioned most frequently were with research computing, central IT, IT departments of specific colleges, and the research office. In addition, some participants mentioned strong or emerging partnerships with campus DEI offices, publishing offices (although sometimes this was within the DS program), and university museums or galleries. One participant expressed interest in creating a campus ecosystem of storage and preservation to replace the silos that currently exist.

A small number of participating institutions are developing formal partnerships that result in programs or centers administered jointly by the library and one or more partners, usually research computing, the research office, or IT. Often this involves joint funding and/or supplemental university funding. This is a significant development, but some expressed concerns that if university priorities change or overall funding is cut, ongoing support could be in jeopardy.

17

Grant Funds and Institutional Subsidies

Participants were not asked about their budget or overall sources of funding in the profile questionnaire or during the forum, except for several polls about whether their programs received grant funds. The assumption was that grant funds were supplemental to the program's budget, which is usually the case with programs administered by the library. Grant funds might come from external funding sources, such as the National Institutes of Health, the National Science Foundation, the National Endowment for the Humanities, and the Mellon Foundation. Many DS programs initially grew out of externally funded grant projects, in which the library often served as a partner or had some specified roles in a faculty-led project.

External Grant Funds (Poll Results)
- More than half of forum participants are currently receiving external grant funds where a faculty member is the PI
- More than half of forum participants receive external grant funds where library staff is a PI or Co-PI
- Almost half of the forum participants currently receive more external grant funds than five years ago
- Around a fifth now receive less from external funds than five years ago
- Very few reported receiving no external grant funds

During the forums, a number of participants commented on receiving start-up funds or subsidies for particular types of programs or facilities from internal institutional sources such as a college, provost's office, office of research, or a center for teaching and learning. Some library DS programs receive presidential and provostial funding for institutional digital collections initiatives related to historic aspects of the institution, including reckoning with equity and inclusion issues.

Institutional Subsidies (Poll Results)
- More than half of forum participants currently receive funds from institutional (non-library) sources
- Most receiving institutional funding are now receiving more as compared to five years ago

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Note that we did not ask about funding from library or university development (fundraising) initiatives, which have been used successfully by several programs to fully or partially fund facilities, equipment, and/or initiatives.

We also did not explicitly ask about cases in which a DS program provided grants to faculty or graduate students, which could be for intensive training to develop a project for a course, support for a research project, or fellowship stipends, but many mentioned such programs in various discussions. Funds for these types of initiatives come from the library budget, another institutional source such as a college, or joint library funding with another unit.

18

<u>**Sustainability**</u>

In discussions about sustainability, staffing concerns are often at the fore. While DS programs revolve around technologies to some extent, having enough and the right kind of staff expertise for consultations, instruction, and other activities is essential to the ongoing health of those programs. When asked via poll during the forums about enablers and barriers to sustainability, many items related to staffing were at the top of the list. Concerns about staffing included not having enough staff to meet the rising needs of users, not having the types of expertise needed, vacant positions, and difficulty in recruiting qualified staff in the marketplace. Participants noted that engagement from staff in multiple other library units was an enabler of sustainability. As described in the section of this report on consultations and projects, participants believe that the lack of formal agreements around projects is a barrier to sustainability.

There was a clear consensus among participants that having strong faculty participation in DS activities was the most important enabler of sustainability for DS programs. Participants believe that when faculty have positive experiences in their interactions with the DS program, they will relate those experiences, express their support to colleagues and administrators, and assist them in securing resources. An increasing number of faculty who engage in DS practices in their research and instruction will hopefully lead to the DS program becoming core infrastructure in the library and the university. Additionally, participants believe that strong support from the library administration leads to sustainability. Promoting the work of DS to institutional constituencies and assisting them in understanding why the library is engaging in those activities, conveying to library staff the importance of this work in today's research environment, and encouraging many library staff to take on roles in the DS program can also bolster sustainability.

Additional barriers to sustainability include navigating changes in institutional priorities that could result in more or less funding, letting go of activities that now have lower priority than in the past, and sunsetting projects. Lack of recognition of DS work in promotion and tenure decisions was also noted as a barrier. On the positive side, one participant described how their program was building community through a salon series where researchers from across campus share their work and get feedback from their peers.

What Would DS Programs Like to Offer Next?

At the suggestion of one of the interviewees, we included a question in the institutional profile about what the people administering the DS program would like to do next. Many of the 47 institutions completing an institutional profile answered this optional question, with some indicating that items they listed were in the early stages of implementation while others are plans or ideas for the future.

Since programs at different institutions are at varying stages of development, a number of institutions described their next steps, such as digital exhibits, creation of a makerspace, or digital literacy support, that are already in place in other libraries. However, a small number of themes were evident, including the creation of spaces and services for VR/AR, visualization, and AI and more attention to a variety of functions related to data and computational research. Also notable were themes related to the reorganization of library services and staff, new policy development, and attention to partnerships.

Surprisingly, given limited resources, many of the profiles included several new areas for development or expressed interest in expanding certain programmatic initiatives. A snapshot of categorized responses is provided below (numbers in parentheses indicate multiple responses).

What's Next for Your Program?	
Emerging technologies	• AI, VR/AR (spaces, services, creation) (8) • 3-D modeling and printing
Data, computational, and infrastructure services	• Data science, data curation, data management, data and text mining, work to produce digitized collections as data ready (9) • More computational research services and infrastructure (2) • Expand offerings for data visualization and data science • Collections as data initiatives • Deepen partnerships and support for research data services • Offer useful traditional and non-traditional scholarly infrastructure • Webscraping
Publishing and publication-related services	• Expand digital publishing (2) • Expand infrastructure for open research publishing • OER publishing services • Self-publishing services for digital publications • Support for scholarly identity and research impact • Evidence synthesis • Bibliometrics, scientometrics
Instruction and community related	• Digital literacies course for core curriculum • Digital literacy support • Quantum computing literacy • Build an internal learning community for those using digital methods in

	• research and teaching • Integration of DS methods and approaches into undergraduate curriculum • Develop undergraduate program for data humanities with campus partners • Intensive DS research institute for faculty and graduate students • DS course • DH certificate program • Instructional programs on data science and AI for non-technical individuals • Regularly offer student data bootcamp • Focus media lab on inclusion • Sustainable community building • Create informal DS/AI community
Additional or expanded services	• Project management services (2) • Events, e.g. project showcase, research sprint (2) • Oral history creation, exhibit, preservation • Digital exhibits • Service where graduate students and postdocs apply to get extended consultation services from variety of DS experts • Services to support the use of a new DH infrastructure on campus • Consultations on metadata standards • Self-service digitization capability • Podcasting capabilities • Application development support • Scholarly communication and intellectual property services • Science/scholarship communication services
Administration or policy-related	• Formalizing library services for grant-funded projects • Grants and fellowships to students and faculty • Fellowship programs • Hire DS/AI librarian • Better connection with the office of research • Provide a more unified and holistic approach (within the library and the institution) for DS support • Participate more in cross-campus initiatives related to DS support • Develop integrated IRB process with campus partners to support

	• researchers working with highly confidential data • Specialize in community-based critical DS • Comprehensive service catalog • Integrate an array of DS and computational services into a new organizational structure • Assure appropriate roles are in place to meet current and emerging needs • Integrate multiple library services into coherent configurations • Re-launch DS center • Integrating environmental and climate change impact principles into DS programs • Accessibility
Curation	• Expand digital preservation • Curation of DS outputs in the institutional repository • Web archiving as a service
Physical spaces	• Data Visualization lab/studio (2) • Integrate DS services with library spaces • Multi-purpose "black box" space to be used for visualization, gaming, etc. • Makerspace/workshop space • Institutional partnership core facility for DH • Upgrade physical facilities with visualization wall, specialized workstations • Data visualization/AR center, upgraded digitization and media centers • Podcasting facility • Simplifying technology when replacing, to encourage wider use

Topics for Further Exploration

While the profiles and forums captured many elements of the landscape, a number of relevant topics were not explored due to time constraints or other factors. These are described below.

What Organizational Structures are Developing for DS Programs?

Many libraries noted that they have recently reorganized or are examining the organizational structure of their range of programs related to DS, data-intensive, and computational research. Organizationally aligning units such as DH, scholarly communication, research data, GIS, digital infrastructure, digital

collections, and others is a challenge and a puzzle. As noted earlier in the report, the origins of activities in these various areas were motivated by different factors, such as faculty interest in experimenting with new types of scholarship vs. responding to funder mandates. There is no clear assessment or advice on which organizational structures are working and could be models for other institutions. Some of the issues that need examination include:

- What factors should be taken into account when planning the organizational structure to support DS needs?
- Why are certain types of activities grouped together and others offered in different units, whether within or outside of the library?
- What are the overlaps, for example, between some scholarly communication and publishing activities and DS; what are overlaps between research data programs and DS?
- What is the synergy between a library's overall instruction program and the instruction offered on DS topics?

Some of the interest in understanding aspects of organizational structure have to do with the availability of qualified staff. If a staff member is an expert in data visualization, can that individual be called upon to provide consultations and workshops outside of the department to which they are assigned? For example, if they are in a research data group and the DS unit is separate, how easily can the expertise of a staff member be called on to participate in activities of another unit? Another reason for interest in organizational structure is the need to become more understandable for the user community: Where do they go for assistance of various types? How can a researcher with a variety of needs best be served?

In addition, as more research and learning incorporates digital and data components and involves the production of a range of outputs, can support for what might now be pigeon-holed as DS work be distributed more broadly among library staff, becoming a mainstream component of the work of subject liaisons, instruction librarians, special collections staff, and others?

What Constitutes Success and What Reporting Structures Exist?

How will libraries evaluate the success of programs in DS, data-intensive, and computational research support? Who will set the parameters for what constitutes success? Activities in these areas are bound to change over time if they are to be responsive to research and instructional needs and changes in technology. There are no clear guidelines regarding what success looks like for DS programs and what factors assist or hinder a program's sustainability. While we did not explicitly ask about reporting frameworks for DS programs or about metrics for what constitutes success, our familiarity with the field leads us to believe that this is an area of opacity. Generally, the success of library programs can be viewed as analyses of whether goals and implementation strategies set forth in strategic plans or similar documents have been met and/or how a program compares to the work in other, comparable institutions. In a broader context, success can also be viewed in the framework of institutional goals and priorities. If the library's goals and those of the university are out of synch, a DS

23

program may meet its goals but not have clear institutional support, which may impact its sustainability.

How can these programs use data to build support for increased resources, especially staffing? How are DS activities integrated into the assessments of the overall library program? How are they represented and valued? These are some of the pressing questions in the area of assessment. When DS staff engage in consultations with users, how are they counted? Are they recorded in categories as to the degree of difficulty or time spent? Are they included with reference or consultation figures for other units of the library? How are engagements or partnerships with large, ongoing projects measured or represented in the library's annual reporting? These types of measures would be useful for benchmarking activities if there were consensus among libraries about how to represent DS work. Is a large number of major projects considered a marker of success? Are testimonials from faculty partnering with DS staff in research and instruction systematically collected to provide qualitative data for library administrators seeking additional support for DS programs? All of these questions relate to the issue of how the value of the DS program is conceived and represented, both within the library and to external audiences.

What Kinds of Policies are Needed for Programs?
During the forums, animated discussions took place about parameters for requests from faculty, graduate students, and others. For example, under what conditions will the library work with a faculty member or team on an extended DS project: will the library receive a portion of the project's grant funds, will library staff who work on the project receive appropriate recognition in presentations and publications, how will project outputs be published or represented online, and how will the project outputs be curated? As described earlier in this report's consultation and project support section, how to sunset projects or manage expectations of curation of complex digital projects was a concern of many forum participants. Participants also discussed questions about under what circumstances the library offers instructional sessions and workshops. For example, will the library be expected to offer ever-increasing numbers of workshops on technologies of particular interest at a point in time, such as GIS and VR, without additional resources from the institution? While some institutions have policies in place regarding some of these circumstances or are putting them in place, most do not have them at present. It would be valuable to have some model policies and agreements available for the DS community.

How Can DS Programs Improve Communications?
How to communicate better what libraries offer in this arena is another topic that was only touched on during the forums; some described this as a need for better legibility for the work they do. Communication with constituencies outside of the library, including academic administration, colleges, departments, and individual faculty, is a necessary element for gaining an understanding of how libraries can be partners in research and instruction. Good communication about the needs for DS services and facilities can build donor support. In addition,

24

library leaders need to work with DS staff to communicate the centrality and value of DS programs to the academic enterprise; they should assist library staff in understanding that these are mainstream elements of the library program, not peripherals or add-ons.

What are the Challenges in Digital Curation and Preservation?
Consultation on preservation and providing curation and preservation services is a challenging area that was not explored explicitly. What agreements should be in place regarding the preservation of large-scale projects and very large data sets? Where will the resources and expertise for those activities come from?

Sessions at future CNI events will likely explore many of these topics.

Key Takeaways and Conclusion

This CNI initiative intends to provide an overview of the DS landscape in 2023, including the recent past, current situation, and trends into the future. While a number of evidence sources were used to develop this report, it does not represent a thorough review of all university library DS programs in existence but rather a subset of programs in CNI institutions. The intention is for the findings to assist institutions in developing new DS programs, considering how existing programs might be reconfigured, and shaping perspectives about changes for the future.

The trends identified in this report, along with the institutional profiles and presentations from six participating institutions in the two follow-on webinars, provide good examples of how libraries are developing and reimagining their DS programs. It is important, though, to keep in mind that the kinds of programs offered, the balance of research vs. instructional services, and the key constituencies served are dependent on institutional factors. Completing a periodic environmental scan, which includes other university units and overall trends, and regularly conducting needs assessments of constituencies are important in developing a program that can build institutional support.

In the programs represented in this initiative, the degree of intentional relationship to institutional priorities varies. Some of this is demonstrated through hiring staff with particular expertise, changing the nature of some positions, and developing facilities that can support technology-intensive work and collaborative projects. Those focusing on computational services often cite working with other campus units such as the research office or campus IT. In noting developing specific ties to the institutional strategic plan, one forum participant commented that since both the president and provost of the university were changing, the institutional goals might well change, too, creating new challenges.

The two external factors that seem to have the most impact on DS programs and the library in general are 1) recent funders' policies, in the US, Canada, and internationally, related to data and Open Access and 2) the pandemic. The

25

funders' policies have spurred institutional responses that have fostered partnerships among the library, office of research, and IT on many campuses, with an infusion of institutional funding in some cases. These changes may lead to a broader reassessment of how DS and other services, such as compliance-driven research support services, might be consolidated or how they should relate to and mutually enhance each other. The pandemic led libraries to ramp up their offerings of synchronous and asynchronous consultation and instructional programs, with dramatic increases in user participation in some cases. As the pandemic recedes, many programs report a return to in-person activities in DS facilities while online programs continue at a high level. Physical facilities continue to be an important aspect of DS programs, for their specialized technologies and for their ability to promote interdisciplinary work and build communities among users.

In many institutions, computational, data-intensive research will take a growing share of DS programs and requires particular skill sets in the library and partnerships across the institution. Some of the programs represented in the forums have recently been reorganized or anticipate some reorganization within the library to provide more coordination among a wide variety of units that have involvement in DS. Many library leaders are still unsure how best to configure their organization to scale up DS partnerships and services. Often these reorganizations are considering how to best meet the growing needs along the spectrum of DS, data-intensive, and computational research. Many of the participants believe there is more convergence in research approaches among a variety of fields and efficiently and effectively meeting those needs with limited staff is a challenge. There are opportunities for libraries to serve many more researchers with a broader set of services but at the same time, this possibility stretches resources and provides challenges for scaling up services. How to communicate what the library offers in this broad arena also requires attention, both to the potential user community and to the university's administration.

Many heads of DS programs feel the stress of too many requests by constituents and some have or are working on policies that will yield a set of tiered services and/or guidelines for when and under what conditions the library will partner on a project or in instructional activities. Even with those guidelines in place, ongoing issues of staff turnover and inadequately trained staff will continue to result in difficulties in what the library can offer.

While many of the DS programs represented in the forum have existed well over five years, it is still unclear whether they are considered by library administration, other librarians, or academic administrators as "core" services of the library or whether they are seen as an add-on or something peripheral. This has implications for funding, staffing, and overall sustainability. A few noted that everyone in the library does digital work and needs to see how they are connected to DS; administrators can play a strong role in that. Important ways of communicating the centrality of DS programs in libraries include emphasizing the library's role as a neutral party and connector; promoting interdisciplinarity; highlighting the library's role in working with faculty and students from all

26

disciplines; integrating consultation and instruction into the suite of technologies offered; and describing the library's long tradition of providing access to and services related to information of many types—multimedia, maps, musical scores, data—as a core mission of the library.

Appendix A
CNI DS Initiative Details

Components of the 2023 Initiative
Work on this current CNI DS initiative began early in 2023 with a series of 12 online interviews with library deans, associate deans, and heads of DS and/or research data programs. While the purpose of these interviews was to get feedback on the scope of the initiative, draft institutional profile template, and proposed questions to be asked of participants in a set of forums, the conversations were often more wide-ranging and shed light on many of the complex issues associated with DS.

At the end of January 2023, CNI issued a call for participation in two forums, to be held online. In order to apply to attend a forum, potential participants were asked to complete a template providing a profile of their DS program. Forty-seven profiles were received, and 12 participants were selected for each of the two, two-and-a-half-hour forums, which were held via Zoom on March 9 and 20, 2023.

Outputs of this initiative include the profiles of institutions represented at the forums, this report on key findings, a session at the CNI Spring 2023 Membership Meeting in April 2023, and two follow-on webinars.

Developing the Institutional Profile and Forum Questions
One of the products of this initiative is the collection of institutional profiles of 24 DS programs from CNI member institutions. We wanted to ensure that the information we collected would be useful to the CNI membership and that the components of the profile would be easily understandable. During the 12 interviews, we received useful comments, including the suggestion of an additional question: what would you like to offer next, which elicited some interesting information and additional data elements related to the infrastructure/enterprise services and instruction sections of the profile.

During the interviews, we also requested feedback on a draft set of questions that would be asked of the participants in the forums; these questions would comprise the core of the forum agenda and were meant to yield responses that would provide a useful overview of the landscape of DS in selected CNI institutions. Again, this information would be collected and summarized here in this report, in order to inform the larger CNI and academic library community. We received helpful comments on the question wording and reinforcement that responses to this set of questions would yield useful observations for the CNI community.

Applicants for Forums
Individuals from 47 academic libraries in the US and Canada applied to attend one of the forums and as part of the application process, completed a profile of their institution's DS program. Profiles of the 24 institutions whose

representatives attended the forums are available at
https://www.cni.org/events/cni-workshops/directions-in-digital-scholarship-support-for-digital-data-intensive-and-computational-research-in-academic-libraries/digital-scholarship-participant-profiles. The information collected includes:

- Name of institution and program
- Mission statement or similar description
- What the program offers (by the library, by the library + partners, and by other units in the institution):
    - Consultation services
    - Education and training
    - Facilities
    - Infrastructure/enterprise services
- What the program would like to offer next
- Types of staff employed
- Constituencies served
- Disciplines served
- Pointers to additional information

It was difficult to choose only 24 representatives from the applicant pool of 47 since most had well-developed programs with many components. The criteria used to select participants included the desire to have individuals at different levels of the organization (dean, associate dean, head of DS program); public and private institutions; US and Canadian institutions; large research universities, medium-sized universities, and liberal arts colleges; institutions in a variety of geographic regions; and diversity of individuals. Twelve individuals were selected to participate in each of the two forums.

Forums
Forums were held via Zoom on March 9 and March 20, 2023, for two and a half hours each; a different group of institutions were represented in each forum, for a total of 24 institutions. The forums were a mix of discussion on a set of questions, distributed in advance to participants, comments in the online chat, and responses to a set of questions in polls.

The discussion questions were:

1. How has your program been shaped in regards to institutional mission/priorities, needs assessments, availability of resources?

2. How has the constituency of your program changed regarding participation by faculty, graduate students, undergrads, or use by different disciplines over the past 5 years?

3. What is the balance of your program's initiatives in working on research-focused projects/services as compared to instruction-focused projects/services and has that changed over the past 5 years?

29

4. What factors impact the sustainability of your program?

5. This forum groups digital scholarship, data-intensive research, and computational research together. Does this reflect how these approaches are viewed in your library?

6. What partnerships have you developed with other units in your university, e.g. IT, office of research, or external partnerships that are important to your program? [Note: time did not permit inclusion of this question during the forums, but many participants addressed partnerships in responses to other questions.]

7. What do you wish you had had a chance to say during the forum, or what topic should have been covered but wasn't?

Poll questions included:
- impact of the pandemic on in-person vs. online consultation and instruction
- external and institutional grant funds
- impact of diversity, equity, and inclusion principles on your program
- key enablers of success for your program
- key obstacles to success for your program
- physical facilities - importance and current status

Appendix B
Interviewees and Institutions Represented in the Forums

List of Interviewees
*Dan Cohen, Vice Provost for Information Collaboration and Dean, University Library, Northeastern University
Lisa German, University Librarian and Dean of Libraries, University of Minnesota
Harriett Green, Associate University Librarian for Digital Scholarship and Technology Services, Washington University in St. Louis
*Harriette Hemmasi, Dean of the Library, Georgetown University
Peter Leonard, Assistant University Librarian for Research Data Services, Stanford University
Adriene Lim, Dean of Libraries, University of Maryland at College Park
Thea Lindquist, Professor and Executive Director, Center for Research Data and Digital Scholarship, University of Colorado Boulder
Liz Milewicz, Co-Director, ScholarWorks Center and Head, Digital Scholarship & Publishing, Duke University
*Greg Raschke, Senior Vice Provost and Director of Libraries, North Carolina State University
Barbara Rockenbach, Stephen F. Gates '68 University Librarian, Yale University

*Emily Sherwood, Director, Digital Scholarship & Studio X, University of Rochester
Keith Webster, Dean of University Libraries, Director of Emerging & Integrative Media Initiatives, Carnegie Mellon University
* Also provided comments on an earlier version of this report

List of institutions represented in the forums
Brown University
Connecticut College
Dartmouth
Duke University
Georgetown University
McMaster University
North Carolina State University
Northeastern University
Pennsylvania State University
Stony Brook University
Swarthmore College
Temple University
University of California, Irvine
University of Chicago
University of Colorado Boulder
University of Houston
University of Idaho
University of Iowa
University of Michigan
University of Oregon
University of Pennsylvania
University of Rochester
Yale University
York University