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Intellectual Diversity and the Faculty Composition of iSchools[1]

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ABSTRACT

We provide evidence and discuss findings regarding intellectual distribution and faculty composition of academic units involved in the iSchool community. To better understand the intellectual heritage and major influences shaping the development of the individual and collective identities in iSchools, we develop a classification of the intellectual domains of iSchool faculty education. We use this to develop a descriptive analysis of the community's intellectual composition. The discussion focuses on characterizing intellectual diversity in the iSchools. We conclude with a short discussion of the potential implications of these trends relative to the future development of the iSchool community.

INTRODUCTION

Through this paper we describe and discuss the intellectual underpinnings and institutional characteristics of the faculties of the academic units in the iCaucus. We do so for two reasons. First, the academic units who collectively choose to identify themselves as iSchools represent a form of innovation in the multidisciplinary and interdisciplinary pursuit of teaching and research on information-related topics and phenomena. These types of units are seen by many as critical to the future of the academy ("Facilitating Interdisciplinary Research," 2005). The analysis uses the educational background of iSchool faculty as a means for understanding the intellectual composition of the unit, using the doctoral degree earned as a proxy for individuals' intellectual perspectives.

Second, as members of an iSchool and participants in the iSchool movement, we are intellectually pragmatic: what trends can we detect and report regarding the disciplinary structures and hiring patterns of the faculties that make up the various iSchools? Moreover, what do these structures and patterns mean for the intellectual geography of iSchools? Responses to these questions are likely of interest to others in iSchools, to some other members of intellectual communities that are found in iSchools, and to various agencies and institutions who interact with iSchools or might be considering creating an iSchool. Scholars in the sociology of science may be interested in the nature of iSchools as academic innovations, much as is posited in "Facilitating Interdisciplinary Research," (2005).

As seen from their collective web presence, www.ischools.org, iSchools present themselves as a thriving, heterogeneous, and inter- or multidisciplinary scholarly community who focus on the convergence of information, computing, and their roles in human and social experience. It also seems that iSchools demonstrate a meaningfully different academic focus from intellectual “near neighbors” in the academy such as computer science, information systems, science and technology studies, education and communication, and others (e.g., Constable & Richardson, 2009; Wiggins, 2009; Grudin, 2011a).

To advance our position, the paper continues with a discussion of the motivation for the research and a summary of prior empirical studies of the iSchools. We then present the results of our current analysis of the types and distributions of doctoral degrees held by faculty members at iSchools. To do this we develop a classification of iSchool faculty members’ academic disciplinary training and education, depict academic disciplines by iSchool, and discuss several patterns of variation across iSchool faculty. We conclude by discussing implications for the community and issues for future attention.

MOTIVATION

There is a steadily growing stream of research regarding interdisciplinary scholarship and the emergence of new academic entities (e.g., Sugimoto, 2011; Abbot, 2001). These issues are perennial topic of interest in the sociology of science (e.g., Small, 1999). The nature and implications of interdisciplinary research, relative to projects, doctoral training, and the creation of new academic units draw scholarly attention from a range of intellectual communities (e.g. Klein, 1990; Golde, 1999; Karlqvist, 1999). And, there has been specific interest in interdisciplinary connections among library, information, communications and other faculty for at least 20 years (e.g., Horn and Lee, 1989; White, 1999).

What are iSchools?

The iSchools are members of the iCaucus, the official organizational entity enfolding this network. Membership in the iCaucus was initially by invitation, with the founding group of schools contributing fairly substantial membership fees in the first few years of the iCaucus. In late 2008, the iCaucus started accepting new member schools. By 2011, membership involved a relatively low annual fee and a brief application (subject to approval by current members) to confirm the membership criteria:

> "The iSchools take it as given that expertise in all forms of information is required for progress in science, business, education, and culture. This expertise must include understanding of the uses and users of information, the nature of information itself, as well as information technologies and their applications... Criteria for being recognized as an iSchool are not rigid, but schools are expected to have substantial sponsored research activity (an average of $1 million in research expenditures per year over three years), engagement in the training of future researchers (usually through an active, research-oriented doctoral program), and a commitment to progress in the information field." (http://www.ischools.org/site/join/)

Faculty members at iSchools engage in a broad range of research and the academic programs at iSchools have courses that draw on findings, models, theories, techniques, and problems from intellectual communities such as (applied) computer science, communication, the humanities, the social sciences, engineering, design, education, information science, policy, and library science, among other disciplines. Thematically, iSchool research activities and academic programs typically focus on some combination of people, information, and computing, across a wide variety of organizational and social contexts.

Historical Roots of iSchools

The emergence of iSchools appears to be a result of two larger-scale trends. First, there is the growth of computing: an increasing presence and reliance on digital information and related information and communication technologies (ICT) which transcend any single area of study (such as computer science). Second, changes in library-oriented professional preparation programs which began in the 1980's when several long-standing programs closed or ceased to maintain their accreditation. Hildreth and Koenig (2002) documented the prevalent survival strategies for these schools: mergers with a larger partner or expansion into ICT-related fields (e.g., Aspray, 1999; Buckland, 2005; Grudin, 2011b; Rayward, 1985). Several of the original iSchools were represented by Hildreth and Koenig (2002) as mergers or realignments of pre-existing library programs. Two founding iSchools reflect successful academic mergers: Rutgers incorporated its library program with communications and journalism and UCLA's information studies program partnered with education. Other library programs were organizationally realigned or aggressively expanded their studies related to ICT; these include Berkeley, Syracuse, and Michigan.

Reflecting the expanding interest in computing and digital information, current iSchools at Penn State, Washington, and Indiana (Informatics) were recently formed in order to bring together scholars from several disciplines interested in ICT-related phenomena, and to expand the host university's presence in this intellectual and educational space. Still others, like Irvine, Georgia Tech, and Carnegie Mellon, expand on the scope of an existing academic program. More generally, as discussed below, it seems the intellectual background of an academic unit is influenced by the structures, histories, and current interests of the university in which each iSchool is embedded.

Community Identity

The iCaucus was chartered in 2005 and theefirst annual iConference, was that year. A workshop organized independently of the iSchools movement, held in 2004 at Indiana University's College of Informatics, may be considered a forerunner of the iConferences. And, the iConference now serves in part as a venue for reflection by the members on the efforts of the whole (Harmon, 2006; Tyworth & Sawyer, 2006). Issues with formation of a community identity for (or of) iSchools continues to inspire conference papers at the iConference (Annabi, Fisher, & Mai, 2005; Leazer, 2005).

iSchool identity remains a challenge.This means iSchools must constantly articulate their value and vision to attract faculty. Likewise, iSchool graduates must articulate the identity and value of their interdisciplinary studies to secure employment, as they cannot rely on tradition to frame their identity. Further challenges identified at the 2005 iConference pertained to the development of the scholarly community from the perspectives of publication, funding, and interdisciplinary research efforts (Tyworth & Sawyer, 2006). These concerns are echoed in the writings of other recently established intellectual communities such as African-American studies and Information Systems, where concerns over institutional legitimacy frame the development of the communities' identity (Small, 1999; Lyytinen & King, 2004).

Interdisciplinarity

The iSchools can be considered multidisciplinary environments ast they are home to academics from multiple disciplinary backgrounds. This type of environment can foster the pursuit of interdisciplinarity through the integration of multiple domains of study (Beghtol, 1995; Klein, 1990; Karlqvist, 1999; Morillo et al., 2003; Avison & Ein-Dor, 2007). More broadly, interdisciplinary research is seen as both challenging existing university structures and increasingly imperative to addressing many intellectual, social and practical problems (Klein, 1990; "Facilitating Interdisciplinary Research", 2005). Developing a better understanding of the factors that allow for or support interdisciplinary academic endeavors to survive and thrive is in the interest of both the iSchools and the broader scientific community as a means of insight into cultivating interdisciplinary research.

Doing strong interdisciplinary research requires scholars to recognize both the importance of academic disciplines and the effort it requires to stand among or between them. Academic disciplines are enduring social institutions that provide both normative and regulated structures which shape and guide participants (Abbott, 2001; Kuhn, 1970). Academic disciplines are powerful social institutions that frame one's education and training in fundamental and systematic ways (Becher, 1989; Knorr-Cetina, 1999; Turner, 2000). Still, academic disciplines are malleable – they evolve – and individuals retain the ability to not adhere to the discipline's norms and rules (though often at some personal cost).

Our interest here is not to review the forms, evolutions, roles and structures of academic disciplines. Our focus is to the iSchool phenomenon. Thus, we defer detailed discussions of the literature on interdisciplinarity to others (e.g., Ackoff (1960); Piaget (1973); Klein (1990); Qin, Lancaster & Allen (1997), Weingart & Stehr (2000); and Lattuca (2001)). We note only that disciplines matter because they create and legitimate boundaries among scholars and scientists. The differentiating force of these boundaries are reflected in the kinds of questions being asked by scholars; the ways in which scholars seek and represent evidence, claims and insights; and the nature of what is knowledge.

Doing interdisciplinary research requires understanding the variations in disciplinary standards regarding these issues: it means remaining connected to disciplines. This connection is the means by which knowledge is shared across disciplinary borders. The attribute of doing interdisciplinary research that is the focus of this study is bringing together scholars from different intellectual traditions, with the degree earned by individual scholars used as a proxy measure of these differences. Faculties with a range of degrees among the members are typically seen as being more multidisciplinary. This, in turn, fosters the possibility of doing interdisciplinary work by integrating knowledge from different disciplines.

STUDYING ACADEMIC UNITS

The intellectual composition of an academic unit has traditionally been studied by examining academic hiring patterns and this is also recurring topic of research in the sociology of science. These studies typically focus on the role of intellectual pedigree and academic prestige, a form of social capital derived from networks of social exchange and association (e.g., Burris 2004). Collectively, these studies make it clear that in longstanding academic disciplines, changes to the social structure are slow and directed towards prestige stratification, or hierarchical distribution of power and wealth according to institutional prestige (e.g., Bair, 2003; Burris, 2004; Baldi, 2005).

Particular fields have also (with varying degrees of self-consciousness) focused on hiring patterns and reflective analysis regarding intellectual geographies, prestige and stratification. These studies show that when hiring is based on criteria such as prestige instead of merit-based criteria, such as scholarly productivity, there may be potentially detrimental effects to the field in the form of greater stratification – with no clear scientific benefit (Bedeian & Feild, 1980; Hunt & Blair, 1987). These studies of academic hiring indicate a PhD program's prestige is more relevant to post-PhD job placement prestige than is one's scholarly productivity at the time of graduation. And, while scholarly productivity has little influence on hiring, hiring has a strong effect on scholarly productivity (Long, 1978; Long & McGinnis, 1981).

One legacy of disciplinary structures is known as "academic inbreeding." For example, for faculty hiring in finance, the majority of new hires in the top ten programs were graduates of those same top ten programs, (Bair, 2003). In sociology, much like political science and history, departmental prestige was the effect of a department's position within PhD-hiring networks (Burris, 2004). The prestige of the PhD-granting sociology department was found to be the strongest determinant of the prestige of initial job placements (Baldi, 1995). In management, there is evidence of extensive cross-hiring among the top graduate programs and a preference among hiring departments to choose graduates from departments with similar prestige rankings as their own (Bedeian & Feild, 1980). This pattern is also seen in the field of biochemistry (Long, Allison, & McGinnis, 1979), where pre-employment productivity was found to confer no significant advantage in job placement. More recent work confirms the continued correlation between academic departments' rank and centrality in academic hiring networks, identifying the competitive advantage of top institutions as a potential cause for the stagnancy of academic program rankings (Hevenstone, 2008).

While these studies lay the groundwork for what we report here, they suggest why, in mature academic disciplines, change can be slow to permeate existing institutional structures. By contrast, the iSchools are an emergent, loosely coupled, and multidisciplinary academic community. As yet, there is little history of, much less scholarly research on, the iSchool community. And, recent work demonstrates how errors in sampling for such a small academic community can lead to misrepresentations of the member institutions, particularly for uncertified data (Chen, 2008). As a venue for community development among members of the iSchools Caucus, the iConferences have generated a few self-reflective studies from the community. Most of these pieces are either conceptual or anecdotal (Annabi et al., 2005; Dillon & Rice-Lively, 2006; King, 2006; Leazer, 2005). Some represent histories in the making (Bruce, Richardson, & Eisenberg, 2006; Thomas, von Dran, & Sawyer, 2006). Little of the discourse in these papers focusing on the iSchools as a phenomenon is based on empirical data.

One such empirical work is Wiggins' (2007) study of hiring patterns in the iSchools. This research compared the structural characteristics of faculty hiring in iSchools to Computer Science departments. A central finding from that study is expanded on here and in more detail below: the disciplinary diversity of the iSchool community was evident in 674 faculty PhD degrees distributed across 172 areas of study.

CURRENT WORK

The work reported here extends Wiggins' (2007) analysis of iSchools' hiring by focusing on variations in disciplinary training for faculties in the iSchool community. In this section, we describe the research methods, including data collection, classification, and measurement of interdisciplinarity.

Methods

We categorized and analyzed the doctoral degrees of the faculty at iSchools, using the degree as a proxy for the holder's research training and intellectual community. The population for this study is the full-time doctoral degree-holding faculty of units who were participating in the iSchools Caucus as of January 2009. Analyzing a specific community necessarily requires purposeful sampling in order to gather data regarding the phenomenon of interest. Thus, this selection excludes those schools which may be self-identified as information schools in name or mission, but which have not joined the iCaucus.

Data collection

Data were collected from the faculty listings on 21 iSchools web sites as of January 2009. January was chosen for data collection so that each iSchool had time to update their websites with faculty changes for the academic year. The sampling unit is the iSchool as named in its affiliation listing on the iCaucus web site, as the focus of the study is on the institution as represented by the individuals that comprise it. Not all iSchools have departments, while others do; therefore, we relied on the explicit affiliations and chose not to sample at the sub-unit level. This decision has consequences for the analysis and reporting of findings. For example, UCLA would appear very differently if only the Information Studies faculty were sampled, as would also be the case for Irvine, Georgia Tech, and Rutgers were only one department included in the sample.

Faculty roles are variously defined at different schools. For example, roles such as "lecturer" or "associate in information studies" are not necessarily representative of the long-term intellectual investment in academic expertise that our analysis targets. In addition, *professor emeriti* are more representative of the prior identity states of a school than its current state. For these reasons, only current full-time professorial faculty members were included in the sample. These faculty members were identified by standard academic titles of professor, associate professor, assistant professor, associate dean and dean. To the extent possible, clinical professors, assistant deans, visiting professors and research professors were not counted.

For the analyses presented below, we needed to know the degree name and department or school granting the current iSchool faculty member's terminal degree[1].. Most of this data could be found on the iSchools' websites. The rest were drawn from the Proquest UMI Dissertation Abstracts database, faculty web pages, and faculty vitae. Complete data were retrieved for 766 of 769 faculty members at the 21 iSchools as of January 2009.

Classification

The areas of faculty training were coded into nine broad disciplinary categories as shown in Table 1. Any categorization is a coarse and partial view of the wide variability in faculty training and interests, even an imperfect coding scheme can provide insight. For this reason, we articulate here our classification effort by first noting that these categories are based on logical groupings of related fields of study, modified from the Classification of Instructional Programs (CIP) (Morgan & Hunt, 2002). Building from the CIP, we combined similar degree areas into broader codes. For example, "Computing" encompasses Computer Science, Electrical Engineering and Mathematics. This grouping is premised on the understanding that Electrical Engineering and (applied) Mathematics are precursors of research in Computer Science. Many of the iSchool faculty with these degrees were trained in various aspects of "Computing," broadly conceived.

The distinction between "information" and "library" studies is less clear. Building from informal guidance of colleagues, we considered "Communication, Information and Library Studies" to be an "Information" degree due to the ambiguity stemming from the diversity of fields in the degree name. All other instances where

[1] These data were not entirely consistent in granularity (e.g., any or all of degree name, department or school might be available) but the potential error introduced by this was reduced through abstraction in the process of classification.

"library" occurred in the PhD degree name were coded as Library degrees. While scholars of different backgrounds may receive degrees with the same name, it is impossible to distinguish in which category a given faculty member's educational experience may better fit based on the degree names alone.

INSERT TABLE 1 HERE

Table 1: Classification of disciplinary areas for the 2009 iCaucus.

The "Social & Behavioral" category includes psychology, sociology and other social sciences. Economics is grouped with law, business and management in the "Management & Policy" category because the methods and applications of economics research in many iSchools are (arguably) more congruent with policy and strategy than those of the behavioral and social sciences. The "Science & Engineering" category includes physical and life sciences; statistics and engineering (excluding electrical) are less common, but also included here. The "Humanities" category is dominated by historians, several of which specialize in science and technology studies, as well as scholars of literature, who are most common at iSchools with long-standing library programs.

Measuring Interdisciplinarity

Our operating premise is that each iSchool follows its own particular strategy to build a strong faculty. Some iSchools are highly specialized, while others are highly interdisciplinary. There is an extensive literature in scientometrics applying bibliometric and social network analysis techniques to measure interdisciplinarity, including betweenness centrality, Shannon entropy, Gini coefficient, and Rao-Sterling measures (Leydesdorff & Rafols, 2011). The data in this study are poorly suited for network measures such as betweenness centrality, nor are they ratio variables that can be modeled with Lorenz curves for the Gini coefficient. For the categorical data we collected, the Shannon information entropy measure is a more appropriate choice (Shannon, 1948). Information entropy provides a means to represent the diversity in areas of subject specialization by applying the calculation $-f\log(f)$, where f is the percentage of the faculty in a given area of expertise, summing these values for each discipline represented in a school. The information entropy measure provides a single index value that summarizes both the number of disciplines represented and the distribution of faculty between them, indicating distributional redundancy. The sample is also small enough that size effects are not a substantial concern, and the data show that larger schools are less interdisciplinary, contrary to what might be expected.

When the information entropy calculation is applied to the percentage of faculty with degrees in each disciplinary area and normalized to a *z*-score, the result is a “interdisciplinarity score.” The score is higher for the most interdisciplinary schools and lower for schools with a very strong disciplinary focus (as reflected in the subject areas studied by their faculty). A school with equal proportions of faculty in each of five areas therefore has a higher entropy value than a school with 80% of faculty in one area and 5% of faculty in each of four areas. For the values shown in the findings, the original information entropy values were inverted so that high value scores correspond with high interdisciplinarity and low scores with low disciplinary diversity. Likewise, using *z*-scores provides a way to report relative value range.

Limitations of this approach

This work is limited by its use of secondary data sources. Our premise is the iSchools’ web sites are windows into the institution: some of these windows remain more opaque than others. This can lead to the situation where an apparently large change in faculty composition may represent better information rather than substantial change. Another issue related to data quality is the representation of faculty on a web site. For example, a relatively large change at Penn State between 2007 and 2009 reflects a change in the school’s choices of faculty relationships to list on their web site, as courtesy appointments are now more clearly distinguished from full-time faculty.

The faculty PhD degree subject area is used here as a proxy for intellectual interests and domain expertise. Current faculty research, however, may be substantially different from doctoral training with respect to the focus and intellectual audience for the work. This noted, the domain of faculty training represents a set of long-term intellectual resources that are not diminished by the evolution of individual research careers. Self-selected labels for current faculty research areas are so diverse and inconsistent between institutions as to be even more problematic as a basis for comparison.

Taking the individual iSchools as the unit of analysis is also challenging, as their boundaries are variously defined across different institutional environments. Some iSchools have distinct units, while others do not. The iSchools vary in size and degrees they offer, and are found in both public and private institutions.

Additional limitations of these data are related to the dynamic nature of the community. Since the data were gathered in January 2009, several new iSchools have become members of the iCaucus. Many of these are institutions outside of North America, primarily in Western Europe and Asia, further diversifying the community as a whole. Therefore, the data in this study represent a snapshot of the iSchools community at an early stage of development, just following the acceptance of the first new members since the founding of the iCaucus.

FINDINGS

We report our four sets of findings, beginning with the aggregate disciplinary composition of the iSchools at the level of the community. We then examine the general trends of faculty changes between 2007 and 2009. Next, we define four sub-groups of the iSchools community based on a qualitative clustering the iSchools according to their disciplinary makeup (as noted above). We conclude by examining faculty interdisciplinary diversity at the level of individual iSchools.

iSchool Community Composition

In Table 1 we summarize the disciplinary makeup of the iSchools faculty in 2009. Doing this makes clear that, at the aggregate "community" level, the largest number of faculty share a computing background. The total number of computing-trained faculty is equivalent to the sum of the number of faculty trained in information sciences, library, and social & behavioral sciences.

INSERT TABLE 2 HERE

Table 2: iSchools' intellectual demographics in 2009.

These data, shown by individual schools in Table 2, make clear there are large variations in the compositions of the faculty across these schools. For example, the dominance of computing in the overall picture can be attributed to large numbers of computer science faculty from Georgia Tech and Irvine, two of the largest units in the iCaucus. Likewise, the strong representation of communication is largely due to the presence of Rutgers. Similarly, UCLA is responsible for the prominence of education. Computing aside, there is a fairly even distribution of scholars in five additional areas for iSchools: management & policy, information, library, science & engineering, and social & behavioral studies. Given their representation across many of the iSchool faculties, we consider these six areas "core" intellectual aspects of iSchools.

As seen in Table 3, removing those iCaucus schools that have formal computer science departments provides a different insight into this community. When we remove the iSchools that have two-thirds or more of their faculty from Computing (Irvine, Georgia Tech, and Singapore), computer science remains the largest group of faculty, butby only a few percentage points. When we remove the iSchools that have over half of their faculty from Computing (Irvine, Georgia Tech, Singapore, and Indiana Informatics) we find that Information, Library, and Social Sciences dominate, with Computing tied for fourth place with Management & Policy. We also see less representation from Science & Engineering, while all other fields remain stable or increase in proportion, yielding a slightly more even distribution across the fields.

INSERT TABLE 3 HERE

Table 3: Community composition without Computing outliers.

Changes in Faculty Composition

The differences between the 2007 and 2009 data provide an opportunity to make some preliminary observations about changes in faculty size and composition. The inclusion of two new iSchools increased the total by 66 faculty members, while 30 more faculty additions were made by the 19 founding members of the iCaucus, raising the 2007 total of 673 academics to 769 in 2009. The losses and additions at each iSchool, shown in Figure 1, seem to represent the normal changes of an active intellectual space.

Beyond growth, we see three systematic patterns of change across these two years: (1) increased numbers of faculty with degrees in information, (2) decreased numbers of faculty with degrees in library, and (3) increased numbers of faculty with degrees in computing. Relative to 2007, the iSchools had 11 more faculty in information and 15 fewer library faculty represented among the initial 19 iSchools' faculties in 2009. As we have noted, the number of faculty with Computing degrees is growing, but mostly through the addition of schools with large numbers of computing faculty on staff.

INSERT FIGURE 1 HERE

Figure 1: Change in number of faculty from 2007 – 2009. Asterisk indicates dean change.

Clustering iSchools by Similarity

Examining the iSchools by the proportion of faculty from each discipline allows us to qualitatively cluster the schools based on similarities. The process of inductively clustering the schools was based on emergent heuristics that reflect the most dominant combinations of disciplinary areas. That is, we consider disciplinary areas where 10% or more of the school's faculty members are included, using 10% as a practical threshold for comparative purposes. This conservative approach reduced the spectrum of interdisciplinarity, but it provides a means to focus on the most obvious similarities across schools.

Clustering the schools was achieved by iteratively grouping them according to similarities in the disciplines represented in the faculty and the relative percentages of faculty in each discipline. For example, one group of schools has the distinguishing feature of faculties with at least 80% computing degrees, which was markedly different from all other schools. The relatively small number of iSchools allowed us to group them into four clusters based on similarities in patterns of faculty degrees, as shown in Table 4. We call these four the *Computational Science* cluster, the *Sociotechnical* cluster, the *Library and Information* cluster, and the *Niche* cluster. We further divide schools in the Library and Information cluster into a *Library* sub-cluster and an *Information* sub-cluster based on the proportion of the schools' faculty from these specific subject areas.

INSERT TABLE 4 HERE

Table 4: Inductively generated clustering heuristics.

From our similarity-based clustering, we identify some initial patterns. iSchools in the Computational Science cluster seem deeply invested in Computing and Science & Engineering: 80% of the faculty in these schools earned their doctorate in one of these two areas. Those iSchools in the Sociotechnical cluster combine computing with at least three fundamentally social areas of study and, together, these areas make up at least 70% of their faculty. The iSchools in the Library and Information cluster have from 50% - 77% of their faculty trained in Information, Library, or Humanities. In most cases, these iSchools' faculties do not seem to be dominated by these core areas to the extent that is observed in the Computational Science cluster or the Sociotechnical cluster. Niche iSchools seem to showcase both a diversity of backgrounds and perhaps hint at a variety of future paths. We now describe each cluster individually;

The Computational Science cluster members, shown in Figure 2[2], each have from 60% to 80% of their faculty from a Computing background. Science & Engineering is the sole additional area of study with more than 10% of the faculty. Together, these two areas of study comprise from 80% to 93% of the faculty at each of the institutions in this cluster. Notably, however, the analysis in the findings above demonstrated that this entire cluster is eliminated when we omit iSchools with over 50% of their faculty from Computing. This shows both the strength of within-group similarity for these members and the degree to which they may be considered different in comparison with the other clusters.

INSERT FIGURE 2 HERE

Figure 2: Computational science cluster composition.

In the Sociotechnical cluster, shown in Figure 3, are schools with a significant investment in computing. Faculty from Computing comprise from 24% to 40% of the faculty. In addition, these schools' faculties represent at least three additional disciplinary areas that reflect upon social phenomena, mostly in the categories for Social & Behavioral studies, Management & Policy, Library, and Information. For these schools, no more than 34% of the faculty members are from the combined Library and Information areas. All but one of the Sociotechnical cluster schools operates an ALA-accredited Master's program (Berkeley ceased offering an MLS in 1994).

INSERT FIGURE 3 HERE

Figure 3: Sociotechnical cluster composition.

[2] Each of the Figures 2-5 includes a panel for each discipline represented at greater than 10%, listing the schools in the cluster along the vertical axes and showing the proportion of faculty in each field across the horizontal axes.

The iSchools in the Library and Information cluster (see Figure 4) display more variation among one another than the schools in the prior two clusters. Each of the schools in this cluster offers an ALA-accredited Master's degree. Computing is only represented at half of these schools, where it comprises no more than 16% of the faculty. The combination of Library and Information faculty, however, ranges from 39% to 76% of the total number of faculty for each school. While a handful of other disciplinary areas appear along with the primary areas of Library and Information, representation from the Humanities is more common in this cluster than others. This is likely attributable to the presence of faculty whose studies in literature are more closely related to librarianship. When Humanities scholars were added to the Information and Library areas, these areas accounted for 50% to 76% of the faculty in these schools.

Schools in the Library and Information cluster have a consistent focus, but the degree to which the core areas of Library and Information dominate the school's intellectual makeup varies. We further divide this cluster into two smaller clusters, but not along the somewhat ambiguous divide between Library versus Information. Rather, the division is according to the overall percentage of the faculty in these two areas combined with Humanities, as some of the faculty members in these schools have backgrounds in literature (typically in combination with MLS degrees). The distinction made here is based on the empirical bimodal distribution of this summed value. Dividing the schools in this manner would yield a Library sub-cluster with North Carolina, Texas, and Illinois, all of which have more than 70% of their faculty in these three areas, with an average of 75%. The second group forms an Information sub-cluster containing Washington, Florida State, Indiana SLIS, Toronto, and Maryland, with an average of 56%. Despite the naming, faculty with degrees in the Library area are more common than those with Information backgrounds at both Washington and Florida State. The overall proportion of these three fields is lower than at schools in the Library sub-cluster, however, and the overall diversity of faculty at schools in the Information sub-cluster is higher.

INSERT FIGURE 4 HERE

Figure 4: Library and Information cluster composition.

Finally, the Niche cluster (see Figure 5) contains all the iSchools that do not fit into the Computational Science, Sociotechnical, or Library and Information clusters. These schools are not dominated by either Computing or Library faculty. In Niche iSchools, between 16% and 19% of the faculty members came from Social & Behavioral Studies. Three of the five schools with the highest representation of Management & Policy scholars fall into this group, as do the schools with the single highest proportions of faculty in Communication (Rutgers), Education (UCLA), and Science & Engineering (Penn State). Half of these schools offer an ALA-accredited Master's degree, although all have less than 10% representation in the Library area. At Syracuse and Rutgers, more faculty members have an Information degree, and the combined percentage of faculty from Library and Information at these schools is substantial, at 31% and 23%, respectively. UCLA's iSchool has a predominant Education influence. Singapore represents an interesting Niche case, as it is the only school in this cluster with more 10% of the faculty in Computing. This means that Singapore is similar to Georgia Tech and Irvine, but was not placed in the Computational Science cluster because Singapore's additional focus is primarily in Management & Policy (specifically, Information Systems) instead of Science & Engineering. Singapore is the only Niche cluster school that is affected if we omit iSchools with greater than 50% of the faculty in Computing.

INSERT FIGURE 5 HERE

Figure 5: Niche cluster composition.

It appears that each of the Niche cluster schools play a unique role in their local institution's intellectual community. Each provides intellectual specializations in areas that are not strongly represented in other schools, or combine their strongest areas with a unique set of secondary fields. A simple explanation for these schools' distinctive intellectual profiles is one of local logics; we suspect that the hiring decisions at these schools were made largely independently of isomorphic influences from other iSchools, but reflect strong institutional influences from their local university environment.

Interdisciplinary diversity

As noted previously, the information entropy measure provides a means for evaluating and comparing the diversity of faculty training represented in each iSchool viz. other iSchools, shown in Table 5. Recall that the information entropy measure does not discriminate by category, so two schools with the same distribution—for example, 80% of faculty in one discipline and 5% of faculty in each of four other disciplines—will receive the same score, regardless of which five core areas are represented in each school. While schools with faculty representing a larger number of areas of study will typically appear to have greater interdisciplinarity, the sensitivity of the measure to distribution can be seen in Table 5, as five of the iSchools each have faculty from nine areas of study, but are not all listed among the most diverse: UCLA's position reflects a rather extreme distribution inequality due to the large number of Education faculty. Rutgers is similarly positioned lower in the relative scale due to the predominance of Communications faculty. In this respect, the information entropy measure is very effective for identifying schools where the majority of faculty come from one or two areas of study.

There is significant variation among iSchools relative to the diversity of faculty expertise. Some iSchools have chosen to pursue a rich but narrower focus, such as the University of North Carolina, whose faculty backgrounds are most strongly centered on library and information studies. In contrast, schools such as the University of Michigan have a broadly interdisciplinary faculty with representatives from a range of intellectual communities.

INSERT TABLE 5 HERE

Table 5: Interdisciplinarity, measured with information entropy scores.

The entropy measure calculated on the faculty areas of study seems to support this interpretation. Florida State and Drexel stand out with the highest scores, indicating the most even distribution of faculty across the full range of disciplinary areas in their schools, while Georgia Tech and Irvine cluster together with the lowest scores, indicating the greatest concentration within disciplinary areas represented.

The largest schools in terms of the faculty size are among the least interdisciplinary based on the information entropy measure. This is likely an effect of the local evolutionary trajectory of these schools, most of which are rooted in a traditional disciplinary focus. At the other end of the scale, the mid-sized and more diverse iSchools represent a group that is aggressively expanding into IT-related areas. Some are doing so by broadening from a long-standing academic base in library science, such as Michigan and Drexel. Others, like Penn State and Indiana Informatics, were founded as iSchools.

It appears the clustering from the previous section is meaningfully (but not perfectly) aligned with the entropy measure. However, because it is sensitive only to distributions and not categories, entropy cannot fully validate the classification generated by the clustering process. From the Library and Information cluster, schools in the Information sub-cluster all show higher interdisciplinarity than schools from the Library sub-cluster. Likewise, Computing cluster schools are among the least diverse, while schools in the Sociotechnical and Information clusters are among the most diverse. Niche cluster schools are distributed along the entropy scale.

Dividing the iSchools using the middle range of z-scores (at zero), one-third of the schools fall below, which we call "Focused" and two-thirds lie above, and which we label "Diversified." The Focused schools include all of the largest institutions and those with the fewest areas of study represented on the faculty. No Sociotechnical or Information cluster members are in this grouping; several represent the traditional disciplinary departmental structure of more established fields. The Diversified schools, on the other hand, include no Computing cluster members, and all have faculty from at least six areas of study. Among these schools, Rutgers and Indiana SLIS are notable for their positioning relative to the number of disciplines represented. As discussed, Rutgers has a lower placement due to the large number of Communications faculty, but also has the largest number of faculty among the Diversified schools. This indicates that Rutger's faculty is fairly evenly distributed among the school's other seven disciplines. Similarly, Indiana SLIS has a smaller faculty size and fewer disciplines represented, but their faculty is more evenly distributed among disciplines than either Illinois or Berkeley.

If we remove the schools that are heavily dominated by Computing faculty (Irvine, Georgia Tech, Singapore and Indiana Informatics) the order of the schools is unchanged, but the zero point for the z-scores is shifted, falling between Maryland and Toronto instead of Berkeley and UCLA. The change in zero point is greater than the number of schools omitted, indicating that these are indeed substantially different than the rest of the iCaucus schools. Using the same logic as before for categorizing Focused and Diversified iSchools, half of the schools are Focused and half are Diversified, creating a more even distribution. Calculating an entropy score for the community as a whole verifies this observation, with an increase in community-level interdisciplinarity of 13%.

Finally, the presence of an undergraduate degree programs is fairly consistent with high or low measures of interdisicplinarity. iSchools with moderate levels of interdisciplinarity are typically those without undergraduate programs. All the Computing cluster schools have undergraduate programs, as do nearly all of the Sociotechnical cluster schools. Library and Information cluster schools are much less likely to have an undergraduate program. In general, this seems congruent with the traditional library school format, where an accredited graduate degree is required for professional employment in most library settings.

DISCUSSION

The individual iSchools' histories and development trajectories demonstrate diversity *vis-a-vis* the school's intellectual heritage and their faculty. This diversity showcases the breadth and richness of these interdisciplinary environments. Here we discuss these roots, reflect on the trajectories, and speculate on the future development of the iSchools community.

Intellectual Heritage

Building from these findings it seems the processes of organizational emergence are one source of the community's intellectual breadth. For iSchools who have faced, or are facing, mergers or institutional partnerships, the prior identities of their consorts remain at least partially intact. This type of outcome is likely the result of institutional and disciplinary cultures, strategies, physical location, accreditations, political and economic factors, reflecting the suitability of an institutional arrangements perspective. For this reason, we would expect to see the intellectual heritage and local institutional arrangements, rather than some collective iSchool identity, to be the strongest forces shaping iSchools that have recently experienced substantial structural changes. Examples of these re-arranging institutional structures are reflected at Rutgers, UCLA and more recently at Florida State.

Similarly, examining the iSchools based upon the areas of greatest concentration in faculty training suggests there is evidence of the influence of "local logics" on their development. That is, the form and shape of an iSchool has more to do with responding to the local institutional environment than it has to do with any defining characteristic or shared intellectual identity across iSchools. One such example is Syracuse, where the strategic decision of a former Dean to establish degree programs in Information Management and Information Policy has yielded a faculty with one-third of its members from a Management or Policy background, with greater sub-disciplinary diversity within these categories than elsewhere. This local logics argument also helps to explain the wide variations between iCaucus members, seen in such iSchools as Toronto, where the Humanities make up a larger proportion of faculty than elsewhere, and Penn State, which has invested in Science and Engineering.

Intellectual Agenda

This intellectual diversity among iSchools is undoubtedly a result of many factors playing out over time. The current faculty compositions are the accumulation of these events as manifest in hiring decisions that represent a dynamic combination of organizational history, current identity, and future ambitions, to which we now turn our attention. Implications for the future of the iSchools suggested by this descriptive analysis seem tied to each unit's fortunes viz. the local institution. This noted, collectively we observe the iSchools continued hiring faculty during economic recession. These schools had strong enrollments when declining enrollments is a matter of increasing concern in the adjacent fields of Computer Science and Information Systems (Chabrow, 2004; Lenox & Woratschek, 2005; Lomerson & Pollacia, 2006; Avison & Ein-Dor, 2007). And, according to the annual Taulbee Survey of the Computing Research Association for 2007-2008, responding iSchools also had more diverse student enrollment, with more balanced racial and gender composition, than did computer science and computer engineering programs (Zweben, 2008).

We speculate that one direction for future growth of the iSchools will be through mergers, particularly with departments of communications and mass media, which are also experiencing substantial growth in research and education. One example of this is the recent merger between the College of Information and the Department of Communications at Florida State. At the same time as the change expands Florida State's range of scholarship and interdisciplinary collaboration potential, the merger will also displace the school as one of the most interdisciplinary, due to the redistribution of overall expertise resulting from the infusion of a relatively large number of faculty with backgrounds in communications and speech disorders.

Another potential direction for growth in the iCaucus may be through partnership, merger, or simple expansion into the field of (Management) Information Systems. Their research goals and scholarly interests are generally compatible with the work of iSchools (Ellis, Allen, & Wilson, 1999), and several iSchools already include faculty from this research community.

One third directionl for growth, and substantiated by the new members added to the iCaucus in early 2011, is that when an iSchool faculty member becomes a dean at a non-iSchool it may subsequently join the iCaucus (such as at the University of British Columbia).

We further note the official name change at Rutgers from the School of Communication, Information and Library Studies to the School of Communication and Information in 2009 reflects a subtle shift in identity, moving away from the explicit inclusion of library studies to the implicit inclusion of these intellectual traditions under the more flexible, though ambiguous, label of information. As noted previously, one observation from the accumulated data is the percentage of faculty with degrees in the Library area is diminishing while the percentage of faculty with degree in Information is increasing, generally in the same proportion. This trend may have more to do with the dynamic nature of the environment in which the iSchools operate than any change in intellectual focus; the names of degree programs are changing, and new junior faculty hires are more likely to have earned diplomas labeled with “information” instead of “library” than they were even five years ago. Despite the changing labels, the focus of these scholars’ research may still be on issues central to librarianship. Further, the growing interest in digital humanities and digital curation reflect broad computerization movements that draw heavily on, and also propel, library scholarship.

We have examined the effects of omitting iSchools that are predominately staffed with Computing faculty. The four iSchools affected are the three members of the Computing cluster and one from the Niche cluster; all members of the Computing cluster include an entire computer science department, due to initial institutional configurations or administrative decisions rather than an abiding interest in information. This raises a further issue related to iCaucus membership, as a very small number of faculty and a Dean can make the decision to join the iCaucus without consensus from, or even knowledge of, the rest of the school. It is entirely possible that the majority of faculty at some of the departmentalized iSchools do not realize that they are members of the iSchool community, particularly those in the Computing cluster. This increases the potential that membership signifies little more than institutional positioning, or perhaps an attempt at top-down organizing of a field despite appearances to the contrary. Although no iSchools have as yet withdrawn and there has been 50% growth in the first six years of the iCaucus, over time it would be only natural to see some schools allowing their membership to lapse.

Finally, we choose to opine on the future of the newly-minted PhDs graduating from the iSchools. While we are not aware of any reported findings regarding placement trends for graduates of iSchools, Olson & Grudin, (2009)noted that these graduatees are faring well in the academic job market, although not all are choosing to pursue employment in academia. It is not clear whether this success is due to a surfeit or deficit of options for graduates; the academic job market in the late 2000's has not provided as many opportunities as would ordinarily be expected under better economic conditions. At the same time, the applied and interdisciplinary nature of most iSchool PhDs' training means that a broader array of options may be available to them.

The data we present makes clear that each iSchool is sufficiently distinct at this juncture that hiring the graduates of other iSchools is unlikely to yield a net decrease in actual intellectual diversity. It also seems that given enough time, particularistic hiring practices which unduly favor graduates from within the community would lead to greater convergence not only in the faculty's degree names, but also in the actual content of their interdisciplinary heritage, leading toward institutionalization and disciplinarity. Like so many other fields, the iSchools are likely to produce more PhD graduates than academic jobs, and the diversity of graduate placement seems a fair indicator of potential future trends. Some PhD graduates end up in policy, administration, or private sector research settings, while some remain in academia.

Although the idea of homogenization of the iSchools may provoke mixed reactions within the community, we note that these early hiring trends suggest that this is an unlikely outcome for the near future. It seems more likely that the iSchools will continue to focus faculty recruitment on attracting the most suitable candidates for their needs based on the institutional structures of their local environment and the particular interests of their unit. This implies that hiring along disciplinary lines may continue to support programmatic needs such as professional accreditation, potentially combined with selection of candidates from other iSchools who bring unique blends of expertise that complement the existing faculty research portfolio. Conversely, the ongoing expansion of the iCaucus also suggests that demand for iSchool PhD graduates will likely increase, with less concern over traditional disciplinary boundaries. Although many of the faculty with Information degrees came from schools outside of the iCaucus, the increase in the number of Information degrees in the iSchool faculty from 2007 to 2009 suggests that there is already demand for iSchool PhDs within the community as well.

Future Work

This study's primary contribution is an empirical description of the diverse intellectual space of the iSchools. In doing so we document one aspect of intellectual diversity; many other sources of evidence should be integrated into future investigation. In addition, as the iSchools are a new phenomenon, much work remains to document and better understand the emergence of intellectual community identity in interdisciplinary institutions. Regarding the value of longitudinal insight, it seems useful to continue assessing the community composition to support analyses of change over time. Combining these quantitatively-focused analyses with qualitative and explicitly historical accounts of the iSchools' emergence (e.g., Olson & Grudin, 2009) could provide a more complete picture of the community's development, as would incorporating data on job placement for PhD graduates from iSchools. As new iSchools have continued joining the iCaucus since the data were collected for this study (a total of 31 iSchools at the time of writing), such growth brings new elements to examine as the community becomes increasingly international, extending both its intellectual and cultural diversity.

CONCLUSION

The iSchools serve as a naturally occurring experiment of the creation of interdisciplinary academic units. While the iSchools currently represent a relatively small and growing intellectual population, some patterns are emerging with respect to interdisciplinary community development. Computing clearly plays a large role in the community as a whole, but diversity is important as well and the iSchools include many vibrant areas of intellectual activity. The richness and diversity of these broad disciplinary domains make an important contribution to the community and scholarship. The variations we observe between different iSchools' intellectual composition seem to be related to local logics that, over time, have guided hiring to meet individual schools' needs. From this, we infer that these local arrangements are more important to hiring decisions than is any sense of shared community identity. We also note that this local logics perspective is consistent with the findings of prior research on the emergence of interdisciplinary academic endeavors (e.g., Gioia & Thomas, 1996; Small, 1999)

The data and findings reported here reflect only a brief history of community development. The outlook at this time suggests that the iSchools will likely find valuable sources of fresh perspectives by pursuing new intellectual areas for growth, while continuing to cherish the important contributions of the traditional domains upon which they are building their successes.

Notes:

1. Portions of this paper were first presented at the 2010 iConference. We thank the members of the audience, and our anonymous reviewers, as their comments and questions have helped us extend the analysis and discussion presented. However, the current material is solely our responsibility.

Tables & Figures

Table 1: Classification of disciplinary areas for the 2009 iCaucus.

Area	N (%)	Component Areas
Computing	233 (30%)	Computer Science, Electrical Engineering, Mathematics
Information	88 (11%)	Information Science, Information Studies, Information Transfer, Communication Information and Library Studies
Library	79 (10%)	Library Science, Information and Library Science, Library and Information Science
Social & Behavioral	78 (10%)	Psychology, Sociology, Social Sciences
Management & Policy	70 (9%)	Business, Management, Policy, Economics
Science & Engineering	69 (9%)	Life Sciences, Physical Sciences, Statistics, Engineering (not electrical)
Education	58 (8%)	Education
Humanities	54 (7%)	History, Philosophy, Literature, Multi & Interdisciplinary Studies
Communication	40 (5%)	Communication

Table 2: iSchools' intellectual demographics in 2009.

Area of study	Total N	Overall %	Berkeley	Carnegie Mellon	Drexel	Florida State	Georgia Tech	Indiana Info	Indiana SLIS	Pittsburgh	Penn State	Rutgers	Singapore	Syracuse	Irvine	UCLA	U Illinois	U Maryland	U Michigan	U North Carolina	U Texas Austin	U Toronto	Washington
Computing	*233*	30%	39%	10%	27%	8%	79%	59%	9%	28%	16%	4%	70%	3%	75%	2%	7%	11%	24%	12%	9%	16%	16%
Information	*88*	11%			19%	12%	1%	3%	17%	24%	11%	19%		22%	2%	2%	27%	39%	11%	28%	18%	28%	23%
Library	*79*	10%	11%		12%	27%		2%	22%	10%		4%		9%		8%	30%	11%	11%	48%	36%	16%	29%
Social & Behavioral	*78*	10%	22%	17%	12%	8%	1%	5%	22%	10%	16%	17%		16%	6%	19%	13%	11%	16%		5%		7%
Management & Policy	*70*	9%	17%	61%	8%	12%					21%		20%	34%		2%		6%	21%		5%		10%
Science & Engineering	*69*	9%	6%	2%	8%	8%	12%	21%		21%	24%	6%	10%	3%	18%	2%			3%	8%		4%	7%
Education	*58*	8%		2%	4%	8%	4%	2%	13%	3%	5%	4%		6%		51%		11%	3%	4%		4%	3%
Humanities	*54*	7%	6%	7%	8%	12%	4%	7%	17%	3%	3%	4%				10%	20%	11%	11%		18%	24%	3%
Communication	*40*	5%			4%	23%		2%			5%	41%		6%		6%	3%		3%		9%	8%	3%
Total	*769*	*100%*	*18*	*41*	*26*	*26*	*84*	*61*	*23*	*29*	*38*	*48*	*29*	*32*	*67*	*67*	*30*	*18*	*38*	*25*	*22*	*25*	*31*

Table 3: Community composition without Computing outliers.

Area of Study	Full Community, N=769	Under 66% Computing, N=598	Under 50% Computing, N=537
Computing	233 (30%)	103 (17%)	67 (12%)
Information	88 (11%)	86 (14%)	84 (16%)
Library	79 (10%)	79 (13%)	78 (15%)
Social & Behavioral	78 (10%)	73 (12%)	70 (13%)
Management & Policy	70 (9%)	66 (11%)	66 (12%)
Science & Engineering	69 (9%)	45 (8%)	32 (6%)
Education	58 (8%)	55 (9%)	54 (10%)
Humanities	54 (7%)	51 (9%)	47 (9%)
Communication	40 (5%)	40 (7%)	39 (7%)

Table 4: Inductively generated clustering heuristics.

Cluster	**Heuristic**
Computational	60% to 80% Computing with Science & Engineering as only additional area over 10%
Library & Information	More than 50% Library, Information, and Humanities together
	Library: Library + Information + Humanities > 70%
	Information: 70% > Library + Information + Humanities > 50%
Sociotechnical	24% to 40% Computing with 3+ additional social science areas (Social & Behavioral, Management & Policy, Library, Information) but no more than 34% from combined Library and Information areas
Niche	Dominant areas are not strongly represented elsewhere, or combines strongest areas (e.g., Computing) with unique set of secondary fields

Table 5: Interdisciplinarity, measured with information entropy scores.

School	**Entropy (*z*-score)**	**Number of faculty**	**Number of areas of study**	**Undergraduate Program**	**Cluster**
FSU	1.23	27	9	Y	Information
Drexel	1.13	26	9	Y	Sociotechnical
U Michigan	1.00	32	9	Y*	Sociotechnical
Washington	0.86	38	9	Y	Information
Penn State	0.84	39	8	Y	Niche
Syracuse	0.54	32	8	Y	Niche
Indiana SLIS	0.48	23	6	N	Information
Maryland	0.47	21	7	N	Information

Toronto	0.47	27	7	N	Information
Pittsburgh	0.42	31	7	Y	Sociotechnical
Texas-Austin	0.36	22	7	N	Library
Rutgers	0.30	48	8	Y	Niche
Illinois	0.10	30	6	N	Library
Berkeley	0.01	22	6	N	Sociotechnical
UCLA	-0.12	67	9	N	Niche
North Carolina	-0.67	26	5	Y	Library
Indiana Info	-0.70	63	8	Y	Computing
Carnegie Mellon	-0.90	46	6	N	Niche
Singapore	-1.91	20	3	Y	Niche
Georgia Tech	-1.95	85	6	Y	Computing
Irvine	-2.02	67	4	Y	Computing

*Michigan's undergraduate program is not wholly managed by the iSchool, and is operated as a partnership with another large college on campus.

FIGURES and TABLES

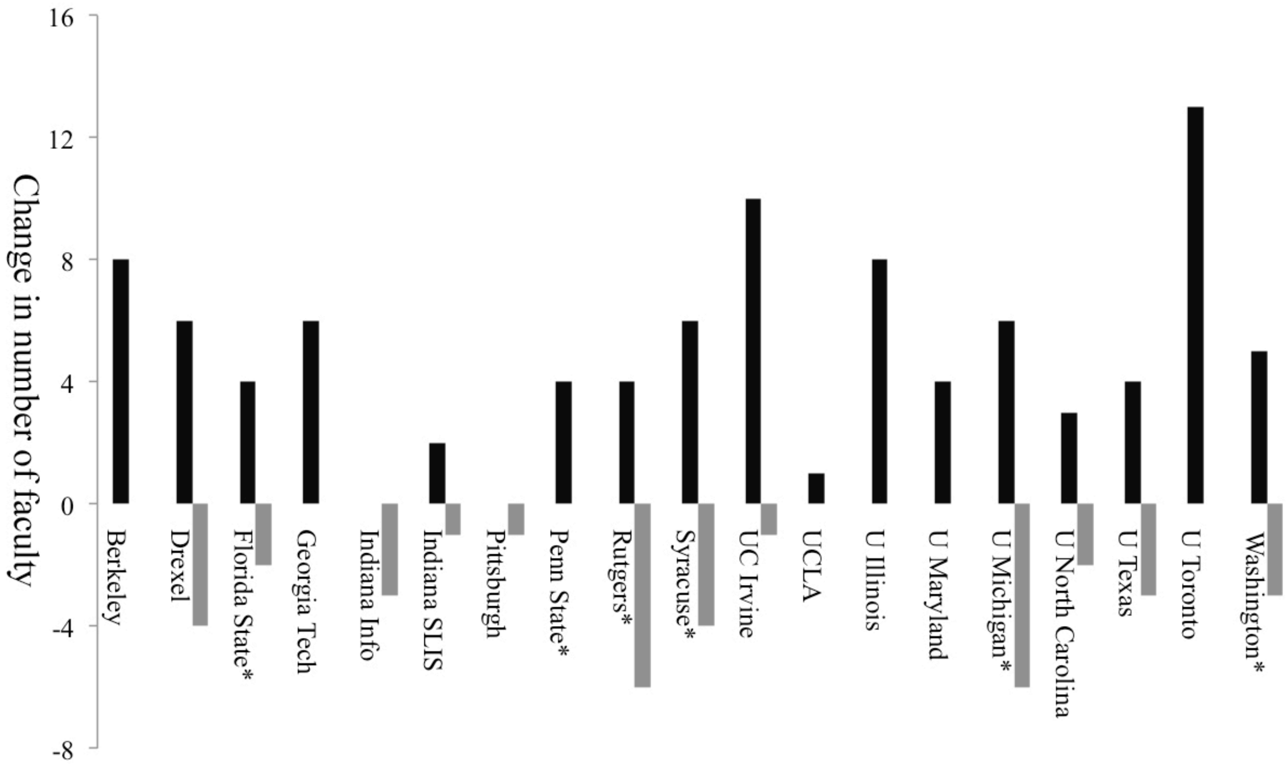

Figure 1: Change in number of faculty from 2007 – 2009. Asterisk indicates dean change.

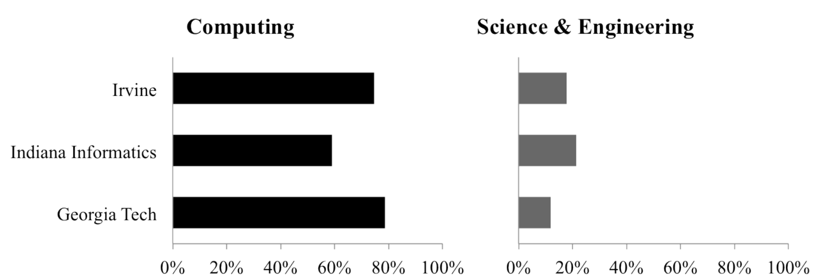

Figure 2: Computational science cluster composition.

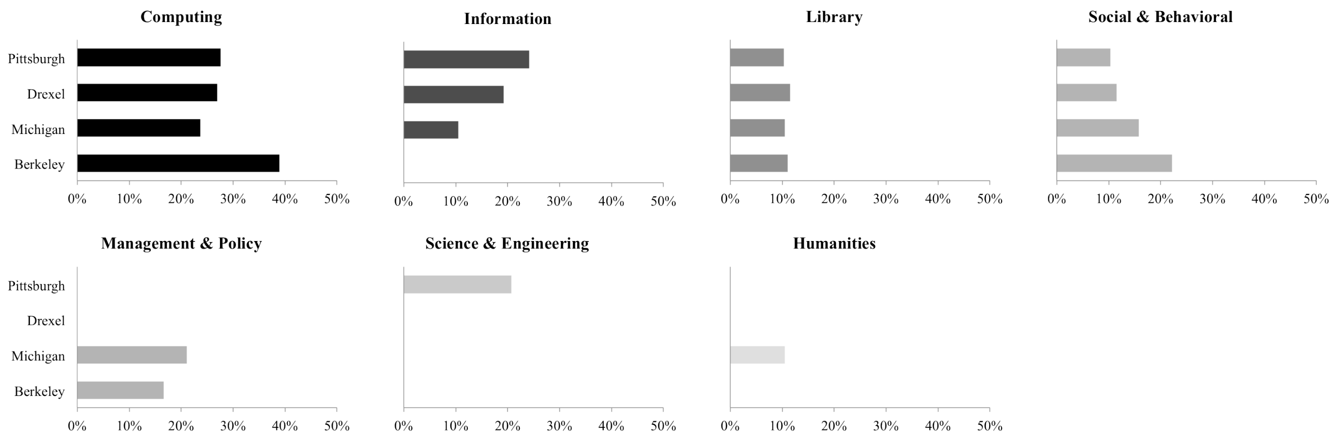

Figure 3: Sociotechnical cluster composition.

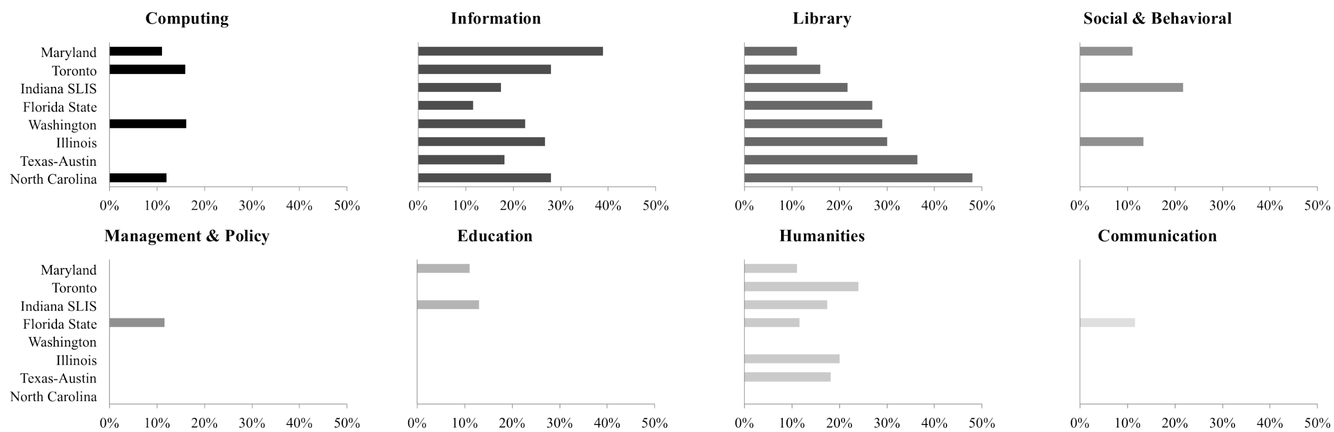

Figure 4: Library and Information cluster composition.

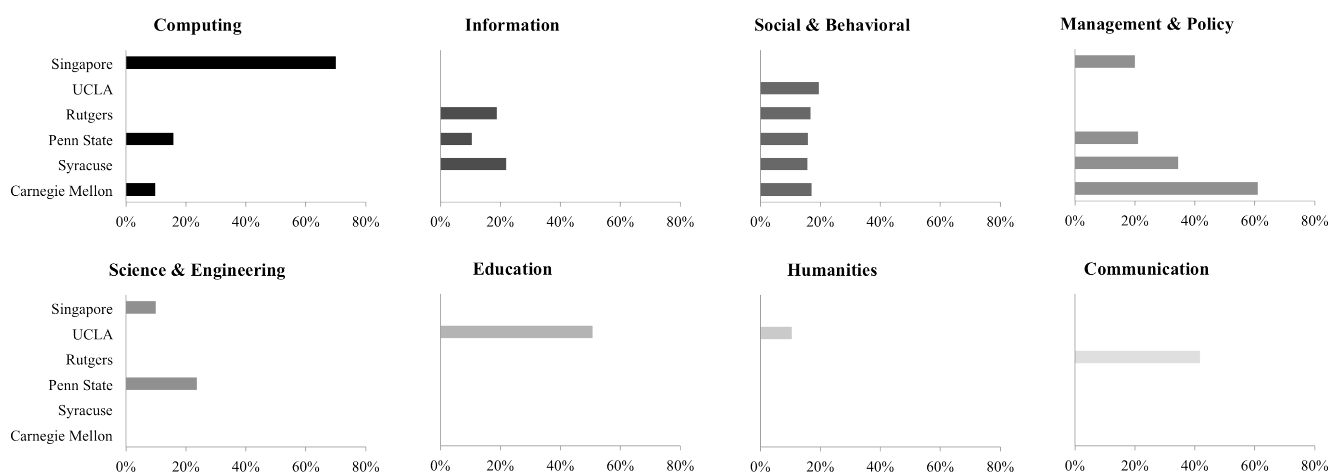

Figure 5: Niche cluster composition.

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