Title
Knowledge infrastructures in past, present, and future tense

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Knowledge Infrastructures in Past, Present, and Future Tense

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Our 2012 workshop, *Knowledge Infrastructures: Intellectual Frameworks and Research Challenges*, identified three themes (Edwards et al., 2013):

1. How are knowledge infrastructures changing?
2. How do knowledge infrastructures reinforce or redistribute authority, influence, and power?
3. How can we best study, know, and imagine today's (and tomorrow's) knowledge infrastructures?

Our 2020 workshop, about half of whose participants attended the event eight years earlier, takes those three themes as points of departure, asking what we have learned in the interim, and what research directions are most (and least) promising to pursue at this juncture.

Among the outcomes of the 2012 workshop was creating the UCLA Center for Knowledge Infrastructures. Having founded and directed that Center, the 2020 workshop is an opportunity to reflect on the three questions identified by the current collaboration.

1. What are the most urgent research questions to address about KI? Why?

The phrase *knowledge infrastructures* has gained some currency in scholarly, government, business, and other literatures since the 2013 workshop report, but never acquired the popularity of related terms such as *platform* and *big data*. To the extent that Google Scholar metrics are considered valid or reliable, a notable datapoint is that the report itself has garnered about 200 citations in six years.

One question to address is what are knowledge infrastructures? How do they differ from platforms, cyberinfrastructure, global information infrastructure, and other technology metaphors for infrastructure? This general question encompasses a number of specific questions to address in the 2020 workshop, such as:

a. What are the benefits of KI approaches to solving or framing problems? How do these approaches differ from other social or socio-technical approaches?
b. What research methods are most appropriate for asking KI questions?
c. Where does KI fit in academic curricula? Information science? Data science? Sociology? Science and technology studies? Computer science? Systems theory?
d. Is KI a concept useful at the undergraduate level? Is it best reserved for post-graduate level inquiry?

2. Identify and describe a knowledge infrastructure whose survival is under threat.

In theory, all knowledge infrastructures are under threat, because infrastructures are inherently fragile (Borgman, Darch, Sands, & Golshan, 2016). Two KIs whose survival is of urgent concern are those of research universities and those of data-driven research domains. These examples are useful to explore the sub-questions posed to participants:

a. What led to these threats? Over what time frame?
b. What actions or changes in circumstances might lead to its survival?
c. What will be gained or lost, by whom, if this KI fails to survive

a) Knowledge Infrastructures of Research Universities

Universities in the US, Europe, and elsewhere are outsourcing large parts of their knowledge infrastructures. Outsourced components include email (gmail especially), computing storage (from Dropbox to AWS), academic personnel processes, recruiting, student admissions, data repositories, institutional analytics, and much more. Rather than governing and exploiting the vast array of "grey data" that universities produce to their own advantage, many institutions are dispersing control to external agencies (Borgman, 2018). Publishers and other data companies are gladly filling these gaps (Posada & Chen, 2018). Universities also are outsourcing service jobs, ranging from janitors to hospital technicians (Roosevelt, 2019). As research, teaching, and practice in universities depends upon digital resources, this is an opportune time to invest in knowledge infrastructures that enhance scholarly communication. Outsourcing functions that are core to an institution's mission puts those missions at risk, however. RQ: What are the origins, political economy, and consequences of university outsourcing on knowledge infrastructures, on scholarly communication, on academic freedom, and on privacy?

b) Knowledge Infrastructures of Data-Driven Research Domains

Despite the political pressures and institutional requirements for university researchers to share and to retain their data, investments in knowledge infrastructures to sustain access to those data resources are relatively few. Scientific data are heterogenous in type, volume, funding sources, instrumentation, standards, and other factors, making them difficult to sustain (Borgman, 2015). "Big science," such as genomics, climate science, and astrophysics have longer histories of data management than most of the social sciences and humanities. However, even these investments are under threat. Funding agencies are beginning to focus on common data management architectures, with the recognition that they cannot make indefinite commitments to sustaining access to the growing body of biomedical and other scientific data (Office of Data Science Strategy, 2019). Areas hard-hit by funding cuts, such as climate science, face reductions in new research and in their ability to sustain long-term access to critical data resources. In astrophysics, data investments are uneven, with larger and longer-term commitments to space-based than ground-based missions (Borgman et al., 2016). These threats emerged over a period of decades as data became digital, as open science became the norm, as the volume and variety of data have scaled upwards, and as funding, scientific practice, and institutional commitments have failed to keep pace. RQ: Given the intractability of data sustainability challenges in the sciences, how can we parse the problem into units that can be studied with current social science methods?

3. How do KI spread information? Misinformation? Alone and in combination with other infrastructures?

How knowledge infrastructures spread information and misinformation varies by context. In the case of KI for scholarly communication, as discussed above, robust infrastructures can enhance the distribution of information through trusted networks. Scholars rely on peer review, publishers, libraries, institutional repositories, data repositories, academic personnel systems, and other features of their KI to disseminate and evaluate information. When components of these systems break down, such as the rise of "fake journals," "fake peer reviews," and outsourcing personnel processes in ways that may comprise academic freedom or privacy, the KIs are less trusted.

A rising concern for the governance of knowledge infrastructures is the use of these systems by bad actors for unforeseen purposes. KI are "under siege" in areas such as climate science, where climate change deniers are exploiting public data systems to spread doubt, for example (Edwards, 2019). Law enforcement agencies are beginning to use DNA samples to predict phenotypic characteristics, a practice that is scientifically suspect, with broad implications for privacy and justice (Donovan, Pasquetto, & Pierre, 2018; Molteni, 2019; Pasquetto, 2018, 2019; Wee & Mozur, 2019). RQ: How can we design and govern knowledge infrastructures in ways that address their pro-social and anti-social consequences?

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