Reading databases: slow information interactions beyond the retrieval paradigm

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Abstract

Purpose – In this conceptual essay, the purpose of this paper is to argue that the structure of databases and other information systems provides valuable information beyond their content. The author contends that reading databases – as a separate, distinct activity from retrieving and reading the documents that databases contain – is an under-studied form of human-information interaction. Because the act of reading databases encourages awareness, reflection, and control over information systems, the author aligns the author's proposal with "slow" principles, as exemplified by the slow food movement.

Design/methodology/approach – This paper presents an extended argument to demonstrate the value of reading a database. Reading a database involves understanding the relationship between database structure and database content as an interpretation of the world. For example, when a supermarket puts vermicelli in the pasta section but rice vermicelli in the Asian section, the supermarket suggests that rice vermicelli is more "Asian" than "noodle." To construct the author's argument, the author uses examples that range from everyday, mundane activities with information systems (such as using maps and automated navigation systems) to scientific and technical work (systematic reviews of medical evidence).

Findings – The slow, interpretively focused information interactions of reading databases complement the "fast information" approach of outcome-oriented retrieval. To facilitate database reading activities, research should develop tools that focus user attention on the application of database structure to database contents. Another way of saying this is that research should exploit the interactive possibilities of metadata, either human-created or algorithmically generated.

Originality/value – This paper argues that information studies research focuses too heavily on seeking and retrieval. Seeking and retrieval are just two of the many interactions that constitute our everyday activities with information. Reading databases is an area particularly ripe with design possibilities.

Keywords Information studies, Metadata, Information organization, User experience, Human-information interaction, Slow technology

Paper type Conceptual paper

Introduction

In this conceptual essay, I propose that reading a database – not reading the content of a database, but reading the database itself – is a productive form of human-information interaction. The value from this act of reading databases is separate from that of retrieval: I do not need to extract anything from a database to read the database itself. Reading a database involves understanding how the database integrates and relates the objects that it contains, rather than reading the objects themselves.

Here is an example from everyday life to illustrate what I mean. At my local supermarket in Carrboro, North Carolina, USA, most of the noodles are on an aisle labeled "pasta," which also includes a large array of jarred tomato sauce. But some noodles are located separately, on an "international" aisle, grouped with foods from Asia. For my local supermarket, the shape similarity and functional similarity of thin rice sticks (rice "vermicelli") and angel hair pasta (also "vermicelli") is not salient. From the supermarket's perspective, I probably should not put tomato sauce on my rice noodles, nor should I put angel hair in my Thai pad kee mao. This, in turn, tells me something about the culture of the community where I live.

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"Pasta," especially with tomato sauce, may have Italian origins, but it is been assimilated into the local context and become ubiquitous; pasta is noodles, according to my supermarket. In contrast, rice vermicelli is more Thai than noodle. If I invite my neighbors over for pasta, but give them pad kee mao, they might be surprised, at least according to what my supermarket tells me.

Although my understanding of the supermarket's interpretation of noodles comes from interacting with information at the market, this understanding is not connected to a successful outcome, in terms of efficient retrieval of any particular noodle. Reading the supermarket and finding the items on my shopping list might involve similar processes, such as wandering the aisles, but they are different forms of human-information interaction. In fact, if the supermarket had a service that delivered everything on my grocery list to my house, I might get the rice vermicelli, but I would lose the conceptual orientation provided by the supermarket's information structure.

I propose the notion of reading databases as a mode of slow information, inspired by the slow food movement, the most widely known application of slow principles. Slow food advocates believe that processes associated with making food are worthwhile: growing it, preserving it, cooking it, sharing it, and learning about it. In the slow food perspective, there is more of value to interacting with food, in other words, than efficient delivery of nutrition. Many slow food enthusiasts also believe that already prepared or "fast" food has the potential for harm, and that understanding of food preparation processes can mitigate that harm through awareness. A slow food approach might enable a consumer to ask about the provenance, composition, and preparation of a fast food hamburger, and so to understand the implications of eating it. In this way, slow food encourages the transparency of food systems.

Similarly, surfacing the forms of value enabled through reading databases emphasizes that interacting with information systems extends beyond retrieval. Many of the everyday information systems that we encounter – such as supermarkets, maps, and shoe-shopping websites, to use some examples from this essay – are more than mere repositories, and we do more with these systems that just retrieve items from them. Why do people read maps for places they have never been and do not plan to visit? It is because the map itself is more than a repository of routes; it is a mechanism for synthesizing, structuring, and interpreting information. Importantly, using maps for more than navigation is not unusual. In fact, it is so common and typical that it seems strange to insist that we do more with maps than search them to extract their facts. Of course we interact with maps in diverse ways! So why does information studies research continues to focus predominantly on using search engines for task-oriented information seeking and retrieval? We do more with information systems that search them, and there are many more kinds of information systems than search engines, systems that we use everyday: from supermarkets, maps, and shoe-shopping websites to photo albums, Facebook, and Twitter.

By arguing for the value of reading databases, I argue that information studies, as a discipline, focuses too much on search and retrieval. I propose that research should look beyond the retrieval paradigm to identify, characterize, and facilitate interpretive modes of information experience. In advocating for a perspective that de-emphasizes "fast," outcome-oriented, retrieval interactions, my argument contributes to recent work that has demonstrated the applicability of slow thinking to information interactions. Slow search has been proposed as a means of acknowledging and facilitating the range of search activities that prioritize quality, diversity, and even openness of results over speed (Teevan, *et al.*, 2013; Dörk *et al.*, 2013). Poirier and Robinson's (2014) concept of information balance is derived from considering the impact of slow principles for information behavior. Interaction designers Hallnäs and Redström (2001) propose slow technology as a design approach that encourages reflection on digital artifacts through use. Similarly, this proposal for reading

databases focuses less on the temporal component of "slow" approaches and more on slow principles of awareness, reflection, and control. (Some studies associated with "slow" search, in contrast, are more interested in understanding how users perceive tradeoffs in speed vs quality. Burton and Collins-Thompson (2016), for example, quantify the amount of time information seekers are willing to wait for better search results. In the conceptualization of slow information that I am using here, such research is actually in the realm of "fast" interactions, in that it adopts a typical outcome-oriented retrieval paradigm.)

The rest of this paper presents an extended argument to demonstrate the value of reading databases. These slow, interpretively focused information interactions are seen as complementing the "fast information" approach of outcome-oriented retrieval.

My argument takes the form of a conceptual essay, not an empirical study. My goal is not to establish that the activity of reading databases improves retrieval, facilitates task performance, or increases user knowledge in a measurable way. Instead, I use the idea of reading databases as an example to illustrate a broader perspective on human-information interaction, one in which the value of information systems transcends the retrieval paradigm. In taking this approach, I follow a long tradition within information studies of making such conceptual arguments. As a recent example, Bawden and Robinson (2016a, b) propose that human-information interaction should include understanding as a design goal distinct from information provision. Other examples include Julian Warner's (2009) labor-theoretic perspective on information retrieval and Birger Hjørland's (2015) reappraisal of Boolean searching based on Warner's arguments. (Later in this essay, I explain how my argument for reading databases complements Warner, Hjørland, and Bawden and Robinson.) In using a variety of everyday examples as evidence for my assertions, I adopt an approach similar to that of Marcia Bates's (1990) proposal that search systems should enable more direct user control. (I also explain, later in this essay, how my argument for reading databases envisions a broader understanding of human-information interaction than that contemplated by Bates.)

The paper is structured as follows. First, I use Patrick Wilson's (1968) classic book, *Two Kinds of Power*, to explore underlying assumptions of outcome-oriented, fast information retrieval interactions. I follow this discussion by reviewing human-information interaction research that emphasizes the search process, including exploratory search and searching as learning. My position on reading databases extends this research to systems and situations that transcend the retrieval paradigm altogether. I also emphasize how reading a database can convey valuable information even if no documents are retrieved or used. In the subsequent section, I demonstrate the value of database reading through examples from everyday life: automated navigation systems and maps. Next, I describe how a focus on reading databases aligns with Julian Warner's labor-theoretic critique of outcome-oriented retrieval, using the example of systematic reviews in evidence-based medicine to demonstrate this. I conclude the essay by suggesting new research and design possibilities in human-information interaction oriented around database reading.

Examining the tradition of outcome-oriented retrieval: the ideal of exploitative control

Almost 60 years ago, Patrick Wilson put forth the notion of exploitative control as the ideal power over information (Wilson, writing in 1968, calls it power over the "bibliographic universe"). Although exploitative control does not actually exist, Wilson introduces the concept as a means of clarifying our goals for interacting with information systems. Wilson defines exploitative control as the ability to receive the best textual means to one's ends, or the just that information that best serves one's purpose.

If I am fixing a broken faucet or trying to understand the decline and fall of the Roman Empire, with exploitative control I magically receive the information that best facilitates my

accomplishment of those ends, given my own particular situation: that I am not a handy person and do not know anything about faucets, for example. A crucial element of exploitative control is that the seeker might not be able to describe the information that best suits his or her purpose: I might think that I want videos that show fixing a faucet, when actually detailed diagrams might be better for me, or may be a fictional account of Rome is a better expression of its decline for the purposes of my general interest than a historical text would be. As should be apparent from these examples, exploitative control necessarily involves subjective appraisal; it delivers the best information for a particular person in a specific situation.

Wilson contrasts exploitative control with descriptive control, which is the ability to retrieve all the documents that match a set of arbitrary and objective search criteria; the criteria are objective in that they describe the documents themselves and not the documents in relation to the information seeker. The example of getting a haircut works well to differentiate these two kinds of power. With descriptive control, I could ask my hairstylist very specifically for a particular kind of cut, but ultimately that style might make me look terrible. The stylist has done exactly what I asked, but what I asked was actually not the "best means to my ends," even though I may have been convinced, before the haircut, that my request would produce a ravishing coiffure. With exploitative control I just say "Make me beautiful!" and magically it is so, even if I cannot explain what works so well about the magic haircut or what caused my hairstylist to cut it that way, as opposed to some other way.

Wilson argues that perfect exploitative control, if it existed, would be a sufficient power over information. If one had exploitative control, one would not need descriptive control, and one would not need to interact with information systems in anyway whatsoever. In Wilson's depiction of human-information interaction, if you will get a beautiful, perfect haircut every time, then why would you care about also being able to systematically describe that haircut? It is unnecessary. If you have perfect exploitative control, there is no reason to know how an information system works, how it makes its judgments of appraisal, or any of the mechanisms by which information is provided to you.

"In the bibliographical world," says Wilson, "one may be a witless king, powerful because of the knowledge and skills of one's subjects" (Wilson, 1968, p. 39). Mastery of the information system, and control in terms of being able to manipulate it, is superfluous. In Wilson's conception, the purpose of interacting with information systems is in what one extracts from them. The interaction experience is a means to achieve that end. Accordingly, minimal user effort in retrieval actions is a benefit.

The persistence of the ideal of exploitative control

Wilson's articulation of exploitative control involves a number of underlying assumptions that, I contend, persist in our understanding of human-information interactions. One assumption is that an information need is a problem that needs to be solved to accomplish a task. A related assumption is that information seeking constitutes a set of strategies to locate and retrieve information that resolves the need. Accordingly, we turn to information systems when information needs hinder our progress toward some external motivating task. A final assumption suggests that successful interactions with information systems culminate with the retrieval of information necessary to proceed with that task. This set of basic assumptions provides the foundation for classic models of information seeking (Belkin *et al.*, 1982; Kuhlthau, 1991; Wilson, 1999). Such assumptions also inform the influential task-based orientation articulated by Byström and Järvelin (1995).

Under this set of assumptions, interactions with information systems are seen as worthwhile primarily for their outcomes: search results, typically in the form of documents. Accordingly, research in human-information interaction focuses on improving retrieval processes to more efficiently and effectively achieve these outcomes. As Kelly

explains: "IIR evaluation [interactive information retrieval] asks the question 'Can people use the system to retrieve documents?'" (Kelly, 2009, p. 2). Interactive information retrieval is typically assessed using measures that demonstrate functional improvements in retrieval, either in performance (e.g. the precision and recall of results) or process (e.g. the time taken to complete a search task or the number of queries used to complete the task) or usability (e.g. satisfaction with search results or ease of use) (Kelly and Sugimoto, 2013). Simply put, human-information interaction research attempts to make retrieval easier, faster, and better.

If IIR research achieved its ultimate aims, then information retrieval would work in the magical way that Patrick Wilson describes: an information seeker would retrieve perfect results in no time without expending any cognitive effort. In this vision of the future, users would never require expertise in manipulating information systems, and, indeed, should not really need to know anything about how information systems might work to produce those magic results. Snap your fingers, get information: end of story.

I argue that the form of user experience achieved through Wilson's ideal notion of exploitative control, where user needs are magically granted and extensive manipulation of a system is unnecessary, has become the de facto standard for information retrieval interactions. Even if perfect exploitative control remains elusive, it forms a powerful and pervasive vision for how an information system should function. The work of the system should be maximized, and the work of the user minimized, and the user should not need to understand how the system operates in order to use it effectively.

Perspectives on information seeking and retrieval that emphasize process

The ideal of exploitative control, as articulated by Patrick Wilson, finds little utility in the search process. If you magically have the information that you require, then there is nothing to be gained from the activity of searching. But a significant strand of work within information seeking and retrieval does emphasize the process of information seeking. For example, the Kuhlthau's (1991) model of information seeking, which I mentioned in the previous section as adhering to Patrick Wilson's foundational assumptions, emphasizes process. Is this a contradiction?

It is not. The primary assumption of exploitative control is that the ultimate power over the information universe is "the best textual means to one's ends." We might restate this assumption to say that the ultimate purpose in interacting with information systems is satisfying information needs. Most approaches to human-information interaction that emphasize the search process do not contradict this assumption. Instead, they emphasize the search process because search engines are imperfect. In other words, the human process of searching is necessary to get closer to Patrick Wilson's ideal of exploitative control – to obtain the best textual means to one's ends – simply because search engines are not good enough. Researchers that emphasize human search processes tend not to perceive the ideal of exploitative control as insufficient. These researchers contend that, given the current state of the art in search engines, user control is a necessary component of satisfying information needs.

The supermarket example from the introduction to this paper helps to clarify this distinction. Within the set of assumptions that inform the ideal of exploitative control, knowing that the rice vermicelli is in the Asian section while the other vermicelli is in the pasta section is useful if it helps me to accomplish a shopping task: to find what's already on my grocery list, or to help me generate or refine my list. If the process of looking for vermicelli helps me to determine what to get and my eventual retrieval of those items, then the process is valuable. But the idea of reading databases is broader than retrieval. It posits that understanding how the supermarket interprets vermicelli is valuable information even if it does not contribute to my shopping task at all. To return to the language of Patrick Wilson, reading databases is a different kind of power over information.

If the information produced through reading databases is valuable, it means that the ideal of exploitative control is insufficient, and that the assumptions that accompany this ideal might be reexamined.

The work of Marcia Bates on the complementary roles of person and search system also helps to illustrate my argument here. Writing in 1990, Bates contends that information systems should focus more on user support, and less on automation. Bates's proposal, nonetheless, maintains the assumptions that find their ideal conclusion in the notion of exploitative control: that interacting with information systems involves a primary purpose, that of fulfilling the "best textual means to one's ends." Bates advocates for user control and participation in the search process because she observes that, given the existing capabilities of search engines, appropriate search strategies are not achieved with automation. Thus, systems should better support the success that users are already able to achieve via their own suites of stratagems, tactics, and moves. In 2011, Moraveji and colleagues draw directly from Bates to demonstrate that providing tips to help users align their own search tactics with Google's current capabilities and features does, indeed, facilitate task performance, in terms of completion times and user assessment of success. However, like Bates, Moraveji and colleagues also maintain the assumptions that undergird the ideal of exploitative control. For Moraveji and colleagues, understanding search engine capabilities is valuable for users because it makes search better, not because understanding search capabilities facilitates a different sort of power over information. If search engines were perfect, there would be no reason for the tips, in the paradigm reflected in Moraveji and colleagues' work.

Searching as learning and exploratory search

Other research within human-information interaction takes a more expansive view of searching, discussing it as a form of learning. In providing a comprehensive review of this area, Rieh *et al.* (2016) describe two primary research directions. One area, which Rieh and colleagues call "searching to learn," aligns closely with earlier work on information seeking, such as that of Kuhlthau and Bates, as discussed in the previous section. In research associated with searching to learn, outcomes tend to be associated with task performance, like that of Moraveji *et al.* (2011). In a conceptual essay that synthesizes literature on searching as learning, Vakkari (2016) associates search outcomes with learning: that is, when searches are successful, learning occurs. Vakkari describes potential measures of search performance associated with learning, such as having users write a text based on search results. Learning, here, is another mechanism for describing successful task completion.

Rieh *et al.* (2016) distinguish exploratory search from searching to learn, noting that providing results is not the goal of exploratory search. Instead, exploratory search is oriented toward helping users to "navigate, understand and better interpret the meaning of retrieved information" (Rieh *et al.*, 2016, p. 22). Exploratory search, then, does stretch the retrieval paradigm beyond the provision of results. How is database reading different from exploratory search?

In exploratory search, learning is enabled through the documents that are retrieved, not from interpreting how documents are structured by the system that contains them. For example, Eickhoff *et al.* (2014) associate learning in a web search engine with page visits. Learning arises from reading the pages, not the position of the pages within the search engine's results. Accordingly, exploratory search tools enable users to discover potentially useful materials in information systems when information needs are nebulous, tasks are complex, and user expertise is limited, making it difficult for users to formulate effective queries. For example, Capra *et al.* (2007) and Capra and Marchionini's (2008) Relationship Browser employs a faceted structure to help users navigate complex materials about government labor statistics. Capra *et al*'s (2015) search guide offers information seekers the opportunity to view another user's search trails for similar tasks. To evaluate these systems, the researchers used standard interactive information retrieval measures focused on task

completion, such as the time taken to complete the assigned search task, and the accuracy, confidence, and mental effort associated with task results. Exploratory search maintains a strong focus on retrieval as the means through which learning and investigation occur. Search tasks are completed by finding documents that address information needs. In contrast, database reading focuses on how a database works to interpretively frame its contents. Retrieval is not a focus, because learning arises from reading the database itself, not from reading the documents that the database contains.

In the following section, I will further illustrate what I mean by reading a database and not retrieving its documents. To do so, I compare automated navigation systems and maps, two common, everyday information systems.

Assessing the sufficiency of exploitative control: the case of automated navigation systems and maps

In order to consider limitations of outcome-oriented retrieval, I want first to interrogate the ideal that motivates it. Is Wilson's notion of exploitative control, or obtaining the best textual means to one's ends, indeed a sufficient power over the information universe?

To think about the potential limits of exploitative control, let us consider the relationship between automated navigation systems and maps. Automated navigation systems, such as those available through GPS devices, web browsers, and smartphones, are an excellent approximation of exploitative control: they are getting quite good at providing dynamic, customized directions that take both local factors (such as traffic or construction) and personal preferences (such as avoiding highways) into account when suggesting a route. Just like Wilson's conception of perfect exploitative control, Google Maps may very well select a better route than your own expertise enables you to do. For the purpose of developing this argument, let us assume, although in reality this technology is not yet perfect, that we do have perfect navigation technology. It never fails, it is exquisitely adapted to your preferences, and it is always available (your phone battery never dies, and you always have a data connection!). With perfect automated navigation, is there any reason to use maps? Put another way, do we use maps for purposes besides getting from one point to another?

Of course we do. It is not at all difficult to think of an array of uses for maps that do not involve point-to-point navigation. For example, one might read a map in a general way as a form of orientation to a new place. Travelers may find that looking at a map not only helps us find our way and not get lost, but also helps us get a sense of a new city and its neighborhoods and how those relate to each other. The process of reading and rereading the map is a way of organizing the facts we might have read in our guidebooks and reinterpreting them in the light of our own experience. The map is a form of tool for understanding a place, and the process of reading the map is a way of integrating this knowledge into one's own interpretation of the city.

Moreover, reading different kinds of maps can help us to understand a city in different ways, even as we might become familiar with some of its basic characteristics. In fact, not just tourists, but residents or natives of a place might extend or complement their knowledge with public transportation maps, maps of inexpensive restaurants, or historical maps, for just a few examples. Such maps also become a way for people – individuals, groups, and institutions – to communicate particular perspectives for others and initiate conversation about municipal features that perhaps should be more widely known, or that should be improved, or that are unequally distributed amongst the population, amongst a variety of potential viewpoints. A bicycle advocacy group, the city transportation department, and a motivated individual enthusiast may all create and disseminate different maps of bicycle routes through a city, for example, highlighting different perspectives on potentially the same information. (The advocacy group might make the routes appear sparse, to generate support for more funding of bicycle trails; the city transportation

department might emphasize how the routes connect to other public transport options, making the overall network seem comprehensive; and the individual enthusiast might highlight the potential sights and destinations accessible through the trail system.)

It is also possible to create new, innovative forms of interpretive infrastructure – what appears on a map and how it appears – that extend the very idea of a map and what it is for. For example, a 2015 conceptual exhibit on the theme of Africa, at the Louisiana Museum of Modern Art (2015) outside of Copenhagen, began with a series of maps. Some of the maps displayed commonly used interpretive infrastructure, such as national boundaries, natural resources, and industries. Other maps distorted typical representational techniques and categories to invite debate about images and stereotypes of Africa. One of these maps marked the most popular sport of the 2014 Winter Olympics per African country, as determined via social media, inviting dialogue on both the Eurocentrism of institutionalized winter sports (it is absurd to think of Winter Olympics popularity in Africa, where snow and ice are rare) and their sociocultural status (figure skating, e.g., is popular in formerly white-dominated South Africa and its neighbors, but not elsewhere). Another map displayed the vast majority of the continent in one color, with the label "No Ebola," with a tiny multicolored splotch indicating the three, small, Ebola-stricken West African nations of Guinea, Liberia, and Sierra Leone. This map provokes dialogue about our understanding of the Ebola epidemic of 2014 and its relation to the rest of Africa, and about the nature of information dissemination via modern media.

Another such innovative use of maps is the "judgmental" city map popularized through social media (a collection of these is available at http://judgmentalmaps.com/). The basic premise of the judgmental map is to describe the districts in a metropolitan area (such as Los Angeles or Dallas) with the local stereotypes of its residents. These local stereotypes often involve blunt characterizations of an area's residents based on class, race, economic status, and other factors. A judgmental map, for example, might label a neighborhood as "rich white people," "gay couples with strollers," or "snotty hipsters."

Many of these judgmental maps describe serious conflicts (in a joking way) involving issues of race, class, sexual orientation, and political differences in their communities. For example, a judgmental map of Austin, Texas, traces escalating effects of gentrification in a rapidly growing city, as longstanding demographic groups shift and are displaced (Bui, 2012). As shown in Figure 1, the south and east edges of the Austin map are marked by labels for poverty and people of color (such as "Asia," "Blacks resisting gentrification," "N. Mexico," and "S. Mexico"). Austin's reputation as a haven for "weirdos" and "hippies" is shown to be false in today's city, as only "fake," "rich" and "old" hippies appear on the map, while "actual weirdos" are relegated to the city's outskirts.

In this brief discussion, I have identified four uses for maps that are not focused on point-to-point navigation:

- Orientation: obtaining an interpretive framework for understanding a conceptual space (using a map to understand a new city);
- Synthesis: generating or refining one's own interpretation of a conceptual space against an existing system's framework (internally integrating the city map's interpretation with other information sources, including direct personal experience);
- Conversation: creating and disseminating new interpretive frameworks, via creating new systems with different interpretive infrastructure (like public transportation maps or restaurant maps); and
- Interpretive innovation: creating new kinds of interpretive frameworks, or new kinds of interpretive infrastructure (like the Africa maps or the judgmental city maps).

Clearly, this is not a comprehensive list; nor are these uses meant to preclude others. (In fact, many of these uses will entail others: maps that demonstrate interpretive innovations

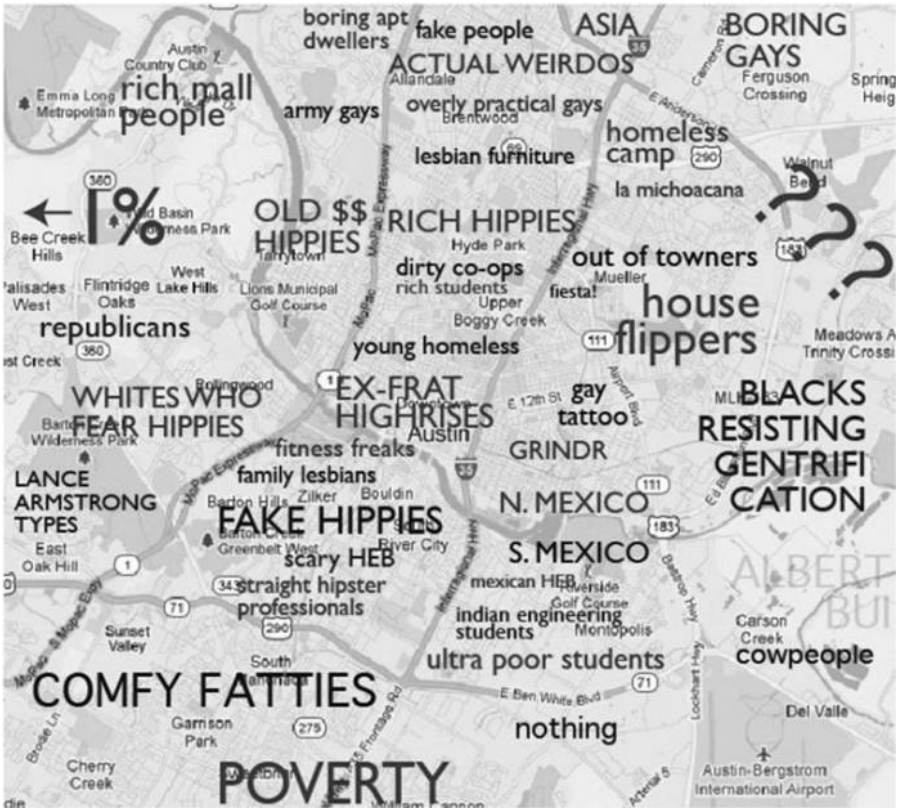

Figure 1.
Example of a map that uses innovative interpretive infrastructure to provoke dialogue: Albert Bui's judgmental Austin map, version 1

should also promote conversation; synthesis can only occur after orientation, and so on.) However, this sketch is sufficient to suggest that we might envision many productive and useful interpretive interactions with cartographic information systems, in addition to point-to-point navigation. Reading maps has other forms of value.

Accordingly, if a map is more than a container of routes to extract – if we interact with maps for more purposes than navigation from one place to another – then is not any information system more than a container of resources to extract? Do not we also employ and benefit from similar interpretive interactions when we are working with digital libraries, databases and other kinds of information systems? I suggest that the same four uses of maps – orientation, synthesis, conversation, and interpretive innovation – also apply to information systems in general, and that there is value to reading databases, as there is value to reading maps. (In a subsequent section, I illustrate this by showing how orientation and synthesis activities with journal databases contribute to systematic reviews of medical evidence.)

If maps, to some degree, enable such interpretive interactions, automated navigation systems do not. Why? To use a map – to read it – one needs to attain some level of mastery in how maps generally work, and one needs to engage attentively to the particular interpretive infrastructure of any specific map.

To read any map, one must be able to identify landmarks (intersections, points of interest) and connections between these entities (streets), as well as expressions of

degree (scale) and scope (boundaries). One must blend these structural representations with the conceptual space illustrated by the map (streets of Budapest, nations of Asia, primary agricultural outputs of South America). Because using a map requires engagement with its interpretive infrastructure, even if it is just to find a route from one's hotel in downtown San Francisco to the Green Apple bookstore in the "outlying" Richmond district, the map has to make that structure available for inspection and manipulation. And so one might interrogate the map's perspective, even as one uses it: why is the street with the Green Apple bookstore outside the edge of the tourist map, when the city clearly extends far beyond that point? The map itself, to some degree, facilitates such interpretive exchange.

Automated navigation systems, however, neither require nor enable this sort of engagement with their structure; typically, they endeavor to protect users from the details of their operation, elevating users to the status of Wilson's "witless kings," who have their wishes automatically granted, without insight into the work performed. Google navigation, for example, typically provides three route options, one of which is the "fastest." Sometimes the system informs you why a route is the fastest, for example, if it avoids current traffic. But often no explanation is provided. Moreover, it can be hard to discern why the other two routes have been chosen out of all the potential options available. One's ability to assess and select between results, to compare them and understand how they are related in the system, is not well facilitated. You are encouraged, if not compelled, to accept the navigation system's judgment.

Of course, if the recommended route really is "the best means to your ends," then, in Patrick Wilson's outcome-based paradigm of retrieval, this lack of transparency into the route selection process, and accompanying lack of control over the information system, is meaningless for the purpose of getting to your destination. In fact, you should prefer having the selection process done for you – you should rejoice in being a witless king! – because all you care about is arriving on time. Similarly, because most information retrieval paradigms assume that the purpose for using an information system involves the resources you obtain from it, and not the process of interacting with the system, databases in general are designed to protect users from the details of how they work, instead of facilitating user understanding of their intricacies.

In her 1990 proposal that search engines should support, rather than automate, the information-seeking behavior of users, Marcia Bates refers often to user control. In most cases, when Bates invokes the language of control, she indicates that user control is necessary to satisfy information needs in the ways that users want and expect. When making these sorts of statements, Bates is not contradicting the ideal of exploitative control. She is observing that because current search systems could not achieve exploitative control via automation, user input was necessary to remediate technical deficiencies. Occasionally, however, Bates refers to a different kind of user control, one that is not necessary to achieve user goals. She uses examples of driving a car with a manual transmission or taking pictures using a camera with manual focus, even when the automatic versions of these features work perfectly, and the outcomes are otherwise unaffected. Although Bates does not distinguish between these two forms of user control, they are clearly different. In the search situations that Bates describes, user control is necessary to achieve a better outcome. But in the cases of driving and photography, the outcome is not affected. Why then is user control in the latter two cases valuable?

Bates does not addresses this question explicitly in the 1990 article. But I suggest that control in situations like manual transmissions and manual focus is valuable primarily for its effect on user experience. Using a manual transmission makes for a different experience of driving, and for a different understanding of the driving process. It is for such

experiential reasons that I, personally, knead bread dough by hand, even though using a stand mixer is both easier and produces a more consistent outcome. Kneading the dough by hand does not result in better bread (if anything, it makes the bread more likely to fail!). But I do it anyway. It gives me a visceral sense of the transformations occurring in the dough's gluten structure: I feel it under my fingertips. Kneading, and the form of control it provides, affects the experience of baking and – importantly – my understanding of the outcome, in terms of how the bread comes to be. This experiential form of value aligns with slow principles, which also emphasize the value of knowing how things are made and where they come from.

While it does not seem unduly strange to see value in human control of experiences like driving and bread baking, it is more unusual to find value in human control of information interactions when the outcome does not necessarily change. Bates does not mention this form of experientially driven control in the context of search: there is no comparison made between, for example, the experience of "feeling the road" when driving a manual transmission car and the experience of using a manual card catalog. For information interactions, Bates's focus remains on the outcome.

Birger Hjørland, however, does find value in the experience of using search engines, similar to the value of driving a manual-shift car or the value of kneading bread dough by hand. Hjørland (2015) suggests that the experience of using Boolean operators facilitates an understanding of how search engines work, and that there is value in the manual search experience – even if an automated search engine appears to produce acceptable results. Hjørland's argument builds on Julian Warner's (2009) labor-theoretic perspective on information retrieval. The next section summarizes Warner and Hjørland's work and integrates it into the overall argument.

Imperfect exploitative control and lack of system transparency

In *Human Information Retrieval*, Julian Warner (2009) provides a systematic model of the various forms of labor required to select useful resources from information systems. Much like Patrick Wilson, Warner emphasizes that the retrieval of relevant, helpful information from a broader collection requires selection power, or the ability to discriminate between documents and appraise them for their relative value to one's goals. Warner asserts that some of the labor required to achieve selection power can be taken over by automated techniques, but that other kinds of selection labor, those that require semantic comparisons, are more difficult to accomplish by automation.

The result, in the case of web search engines such as Google, is that a lot of selection labor remains the responsibility of the information seeker. For many retrieval interactions, this reliance on the searcher's labor is not noticed, or is perceived as trivial, because the need is simple and concrete, and few sources are required. As long as it is practically instantaneous to recognize the correct source for today's movie times, or whatever one's typical web search might involve, we do not recognize the mental work associated with selection. But for information needs that encompass more abstract, ambiguous, or complex conceptual spaces – which are not uncommon – the searcher must perform a good deal of invisible mental labor to understand what the results mean and discriminate between items. This situation is problematic because web search engines, to an even greater degree than automated navigation systems, do not facilitate this labor. Google does not provide transparency into how its relevance algorithms establish relationships between documents in a set of results, and so does not assist users when selection labor is required to interpret and characterize results sets. Instead of rejoicing in her power, the witless king finds herself an unrecognized servant for the information system, forced to grapple with a mystifyingly opaque, often tremendously large list of items. In these cases, Warner suggests, Google's "magic" relies on the willingness of searchers to perform this

labor without realizing that they have been required to contribute such extensive intellectual resources. On the one hand, Warner's analysis implies that when a retrieval system performs less than perfectly, the outcome-oriented interaction paradigm of retrieval can be insufficient. User insight into and mastery of information system processes can remediate deficiencies in automation. But Warner's analysis also implies that, even when a search engine works well, in terms of requiring little semantic labor, there is value in transparency, in understanding how the system works – similar to the value of kneading bread dough by hand. There is an experiential form of value in knowing how search results come to be as they are.

Birger Hjørland (2015) adopts Warner's perspective in a paper that promotes Boolean searching as a form of human-information interaction. Because Boolean searching is transparent to the information seeker, users can more easily attain mastery over a system and manipulate it to achieve their ends. When I search with Google it can be difficult or even impossible to know why a certain item is included in a list of results and why that item is in a certain place in the results list. But with Boolean searching I can understand the relationship between query, results set, and indexing vocabulary with greater control and confidence. This is similar to how I get a better sense of how a car works when I manually shift its gears, or how I get a better sense of how the texture of bread is achieved when I feel the dough change as the gluten develops through kneading. Another way of understanding Hjørland's position is that Boolean searching enables databases to be more easily read, in addition to searched. In other words, Boolean searching enables multiple forms of human-information interaction, and not just outcome-oriented retrieval.

My argument for reading databases extends proposals such as those of Warner and Hjørland to maintain that even if retrieval systems could achieve perfect exploitative control, the interpretive reading of databases provides additional forms of value. In the following section, I use the example of systematic reviews of medical evidence to demonstrate how interpretive database reading integrates with and complements Warner's and Hjørland's critiques. Subsequently, I discuss how information interactions for reading databases complement design ideas proposed for exploratory search.

Boolean searches and systematic reviews of medical evidence: multiple uses for interpretive database interactions

Hjørland notes that systematic reviews, such as those performed in the context of evidence-based medicine, are an area where the ability to understand how information systems structure information, and to use that knowledge to construct carefully tuned search protocols, is important to establish a reasonable balance between precision and recall in results sets. In a systematic review, all search results are scrutinized to see how they match established criteria for inclusion in the review. Precision is necessary to avoid prohibitive amounts of selection labor. Research teams do not have the resources to evaluate the millions of results they might get from a simple query with Google Scholar. Mastery over the pertinent databases – understanding how they work, in terms of their contents and underlying indexing vocabularies – is necessary to develop queries that can achieve acceptable retrieval results. Hjørland's endorsement of Boolean searching for this situation is similar to the arguments put forth by Marcia Bates (1990) that I discussed earlier in this paper: user control over search is necessary because search engines do not automatically produce results as user needs require. My own argument is broader. I propose that the activity of database reading provides value beyond that of finding and selecting a set of useful results. Here, I use the context of systematic reviews to provide an example of that value.

I have personal expertise in constructing queries for systematic reviews: I worked as a search expert for a knowledge translation group that produced systematic reviews in the area of rehabilitation medicine, and I co-authored an article that makes process recommendations for

producing systematic reviews in this subject domain (citation removed for blind review). In my experience, the ability to manipulate databases and so understand their interpretation of the conceptual space – to read them – has additional benefits to the systematic review process, in alignment with the orientation and synthesis purposes for reading maps.

The researchers in rehabilitation medicine that my knowledge translation team worked with had subject expertise, but they did not have information systems expertise. They were not familiar with the underlying structures of the medical databases that they used (such as indexing vocabularies, operations for constructing queries, and automatic query expansions for keyword searches). These researchers did not know how to determine, in the medical databases, how documents were related and for what reasons. Moreover, the areas of research concern were vague and ill-defined, with an unclear conceptual extent and inconsistent terminology. At the beginning of a project, therefore, the principal investigators for a particular review often did not have a firm sense of their motivating research questions and, accordingly, the scope and extent of the review.

When I started working for the knowledge translation team, I had no subject expertise in rehabilitation medicine and little experience with the medical databases they used (such as PubMed, PsycInfo, and CINAHL, which focuses on nursing literature). However, I did understand how such databases worked in general: the role of indexing vocabularies, the basics of query formation, and how to analyze results sets to determine salient relationships between documents, concepts, and indexing terms. Accordingly, the understanding of the conceptual space that I could obtain from reading the databases – in the form of orientation and synthesis – contributed to the way that the researchers ultimately framed their studies.

As an example, researchers for one systematic review proposed a topic of "returning to work after burn injury." Although this topic appeared concrete, it was unclear what sorts of activities might be involved in preparing for and returning to work. The small set of results achieved through basic queries for "return to work after burn" made it seem as if the resource databases understood this conceptual space in a variety of ways that were not congruent with the researchers' perspectives. I began a process of both formulating exploratory queries and of interpreting characteristics of the results sets against potential keywords and controlled indexing terms for a variety of databases in this area. By looking at the set of terms assigned to a particular document, for example, I could identify strongly and weakly related concepts to "returning to work after burn," and by examining the application of those concepts to other documents, I could also isolate concepts that might not be expressed explicitly in the controlled indexing vocabulary but that seemed to be encompassed within or related to established terms.

As a result of this process of reading the pertinent databases, additional concepts of "community integration" and "community participation" emerged as connected to the concept of returning to work. These were controlled vocabulary terms in some databases (CINAHL) but not in others (PubMed). In PubMed these concepts appeared in abstracts and co-occurred with associated controlled terms of "Burns/rehabilitation" and "Social participation/psychology" but were not contiguous with the intersection of these more general concepts. The ideas of community integration and participation, in PubMed, were silent components of related controlled vocabulary terms. However, by reading PubMed to understand the potential scope and extent of general indexing terms such as "Burns/rehabilitation," and by synthesizing my understanding from other databases (such as CINAHL), where the community integration and participation concepts were explicitly formulated, I could reveal these conceptual components as potential concepts of interest in their own right. It is, perhaps, not insignificant that such community-oriented concepts were expressed explicitly in the nursing database CINAHL but not in PubMed, which favors research oriented around clinical trials, not qualitative understanding of experience.

To summarize my intervention in the systematic review process, I could use the interpretive frameworks that I saw in the medical databases (orientation) to help the medical researchers refine their own interpretation of clinical phenomena (synthesis). These interactions were not retrieval-oriented, and neither were they focused on developing queries: they were focused on understanding the domain as interpreted by the information systems and on using that understanding to help the medical researchers frame their research focus. The value of these reading interactions did not arise from reading the documents, but from understanding how these documents were structured and interpreted by the databases that contained them. Importantly, the goal of reading the database was not to learn more about returning to work after burn injury. The researchers were already subject experts; they did not need to learn about the subject area. Instead, I read the databases to understand how the subject of returning to work after burn injury was interpreted and articulated in different information systems: how CINAHL understands the domain, as opposed to how PubMed understands it. This is what the researchers did not know: how other interpretations of the subject area (as instantiated by the databases themselves) were related to their own understanding of the subject. Accordingly, through this act of reading the databases themselves, I was able to facilitate the research process.

When I was working with the knowledge translation team, I was initially surprised that my colleagues had such little understanding of how databases worked – how they structured information – and how to read databases as another source of insight. These were, after all, researchers. And the tools I was using for orientation and synthesis were not secret or new: I was merely going back and forth between documents, indexing terms, and queries to identify and characterize relationships. I did not have special knowledge or training. I am not even a librarian! I had never taken a single class in reference, searching, or information services. All I did was to "look under the hood" to see how the engine worked; that is what enabled me to read it. My knowledge translation colleagues, on the other hand, were not even aware that "looking under the hood" was possible. Accordingly, envisioning new sorts of tools for reading databases – tools for users to examine how databases structure and produce information – is, I believe, a promising direction for information studies research. The next section provides some preliminary thoughts toward this goal.

Information interactions for reading databases: an application of slow information

The primacy of outcome-oriented retrieval interactions – fast information – in search interfaces is one reason that reading databases is a more difficult proposition than it needs to be. To return to the example of automated navigation systems, tools for effective reading of these systems (e.g. to determine why routes are selected and arranged in a particular way) are scarce. For reading cartographic information systems, we turn to maps, which require some understanding of their structure in order to use them at all. To read a map for any purpose, including that of point-to-point navigation, we need to know something about how maps work in general, as well as how any particular map makes use of those conventions.

The interaction designers Hallnäs and Redström suggest that surfacing the relationship between form and function is a focus of slow technology. To design artifacts that encourage reflection on their construction (a slow principle), it is necessary to "amplify their presence" in order to "make them into something more than just a silent tool for fast access to something else" (Hallnäs and Redström, 2001, p. 209). This amplification must be part of the experience of the artifact, not external to it. It is not sufficient, according to Hallnäs and Redström, to "put up a sign saying PLEASE REFLECT ON X." When we engage with the structure of maps in order to use them, we "learn and realize function," becoming able

to read maps and also becoming aware of that knowledge and how we are employing it to achieve particular goals. For Hallnäs and Redström, an effective slow technology extends this experience. They use the example of a slow mirror: an object that only gradually turns into a mirror and then gradually deletes the mirrored image. It functions as a mirror, but this "mirror" appears in a form that to some extent hides the basic functionality of a mirror (Hallnäs and Redström, 2001, p. 209):

> Through elongating the anticipated temporal extent of the everyday, taken-for-granted activity of glancing at a mirror, the slow mirror accentuates the experience of looking. As it simultaneously fulfills and subverts user expectations, the slow mirror encourages the viewer to consider the relationship between form and function (for the mirror, the relationship between seeing oneself and the effort of attention required to see).

Following Hallnäs and Redström's perspective on slow technology, we might develop tools for database reading that enable interpretation of database structure and that simultaneously focus attention on the act of interpretation itself: both the database's interpretation of its contents and the user's interpretation of the database.

To begin thinking about how to approach the design of "slow" tools to facilitate database reading, it is worthwhile to revisit the differences between exploratory search and database reading in the context of existing interaction mechanisms. Faceted browsing is a good example for this. Faceted browsing systems that enable the display of document sets based on selective application of metadata values are a common feature of exploratory search tools (White and Roth, 2009). In the context of exploratory search, faceted browsing enables users to examine a range of documents without needing to develop a query. By adding or removing facets from the results, users can identify a set of potentially useful documents without having the knowledge to construct a complex, precise search query. Although users may come to a new understanding of the database and its documents based on interacting with the facet values, the outcome of this exploratory process is still focused on retrieval of documents. If no useful documents are identified, then the exploratory search has not been successful.

In the context of database reading, however, the goal is to understand what the dimensions mean in the context of that particular database; retrieval is ancillary. Understanding how the database works is valuable, even if no likely set of documents is identified – as when, as mentioned in this paper's introduction, understanding my local supermarket's perspective on rice vermicelli has value beyond any retrieval of particular noodle products.

As a concrete illustration, consider an everyday application of faceted browsing: shoe shopping. From an exploratory search perspective, faceted browsing enables me to identify a set of potential shoe purchases even if I am not really sure what I am looking for, and even if I do not really understand the potential variation in women's shoe options (a wide array of diversity, indeed). From a database reading perspective, faceted browsing could help me understand how a particular vendor constructs shoes as information resources, whether an eventual purchase is facilitated or not.

Let us say I am using the faceted browsing interface for Zappos, a popular shoe retailer (see Figure 2). A wide array of facet dimensions are available for me to filter their wares, including Size, Color, Styles, Occasion, Accents, Materials, and Theme, to name a selection. I start by looking at the Styles facet, and find a category labeled Euro. With visions of avant-garde Paris and Berlin in my head, I click it. But instead of edgy modern designs, I see a set of what appear to me as conventional, stolid shoes, blocky and not chic at all. From the perspective of exploratory search, I eliminate the idea of Euro from my search and move on to another style. Euro is not relevant to finding a pair of shoes. But from the perspective of database reading, this is where my investigation begins. Euro certainly does not mean what I thought. What does Euro mean in the Zappos database? How is the Zappos information system implementing the concept of Euro?

Figure 2.
Some of the facets available for shoe browsing on Zappos.com. "Euro" is in the styles facet

Here is how I might attempt to read the Zappos database to answer this question. First, I notice that within the set of Euro shoes, certain values for other facets predominate. For example, Euro shoes tend to have heel between one and two inches in height, to cost between $100 and 200, to be for casual occasions, and are often sandals (although this does not appear so from the first page of the set). Euro shoes with all these values might therefore be considered central members of the Euro set. Upon viewing this group, however, it is still

difficult for me to understand what gives it a Euro character, in addition to these shared values. To investigate this further, I examine the set of moderately priced casual sandals with low heels that are not also described as Euro. What distinguishes the Euro set from this one? The non-Euro group includes exemplars with bright colors, that have rhinestones or other ornaments, that have thin straps (including flip flops), and that are athletic shoes – and I realize that few of the Euro group have these characteristics. The Euro set, then, is distinguished by members that are dark, plain, and sturdy: they are multifunctional, in that they are appropriate for walking (no high heels, no thin straps), but not meant for sports.

Based on this reading, what did Euro mean in the context of the Zappos database, at the time when I was reading it? I suggest that, in the Zappos system, Euro serves primarily as a functional designation based on formal elements, rather than an aesthetic designation, as we might initially expect from its name. This emphasis on function over aesthetics in the construction of Euro is consistent with other values in the Styles facet. Styles facet values tend to focus on aspects of form such as heel shape (wedge, platform), and the shape and position of straps and other fasteners (Mary Jane, T-strap, thong), and not on aesthetic factors. As implemented within the Zappos information system, however, Euro also involves some aesthetic properties (such as being dark and plain) in addition to the more predominant functional properties (low heels, thicker straps, not athletic). Euro, as implemented by Zappos, is quite a complex assemblage of characteristics. It is also conceptually coherent: the facet value Euro groups sensible shoes that are appropriate for someone who walks a lot in the course of a day – perhaps someone who takes public transport and lives in a city (as opposed to someone who walks only for fitness, and might select sneakers). This is the argument that the Zappos information system is making here: that a Euro shoe is not chic but practical, in both its features and its stylistic elements. When I am able to understand the components of the Euro assemblage and how it structures a set of resources in the Zappo's system, I understand the world a little bit differently – about shoes, about Zappos, about style, about commodification – even if I do not buy anything. This process is the same as understanding a city by reading its maps, even without using the map to navigate to a particular location. It is also the same as when I helped the rehabilitation medicine physicians understand the array of concepts they actually meant when they used the words "return to work after burn injury" in shaping their systematic review.

Notably, the meaning of Euro as conveyed via the Zappos information system has little to do with whatever meaning might attach to the label "Euro" itself. Remember, based on the name, I initially had a very different idea of what Euro might be. To understand the meaning of Euro in the context of Zappos, I needed to investigate how the label Euro was applied to the resources in the system, and the relationships between the Euro label and other facets. For the purposes of reading, a database is more than its schema and associated vocabularies: a database is the relationship between entities as plotted via assigned metadata values. (Similarly, a map is more than a list of streets and other features, it is the relationship between features as plotted in space.) To read a database, you cannot just understand its schema: you need to understand how the schema has been applied to resources.

Faceted browsing is a fine tool for exploratory search. But its support for database reading is rudimentary. In order to dissect the meaning of Euro in the Zappos system, I had to use my knowledge of metadata schemas and controlled vocabularies to compare the resource sets associated with different combinations of facet values. (This process was quite similar to the work I did for systematic reviews of medical evidence.)

This is where I see research potential. What kinds of "slow" database reading tools can we imagine for faceted browsing systems like Zappos that "amplify the presence" of metadata infrastructure, both enabling the system to be more easily read and drawing attention to the system's interpretive role? Through my reading activity, I learned that

Euro, in Zappo's, implies dark, plain, and sturdy, because many of the shoes described by Euro have those characteristics. "Dark," "plain," and "sturdy" are unacknowledged components of the meaning of Euro. It is these hidden components of meaning that database reading brings to the surface.

Slow reading tools might surface such unacknowledged characteristics within resource sets. For example, a slow reading tool might arrange the shoes in the Euro set to identify degrees of Euro identity, revealing that some shoes are more Euro than others. Such a tool might also enable discovery of the characteristics that contribute to an individual shoe's membership in the Euro set, revealing the components that constitute Euro identity – or those components that diminish Euro identity. Figure 3 shows a rough mockup that illustrates this idea. In the figure, the selected shoe is Less Euro because it is too expensive and its heel height is too high; but its color and shape make it a peripheral member of the Euro set.

In addition to tools that facilitate reading, human-information interaction research might begin, as well, to consider both the design and application of metadata infrastructure itself as a matter of concern. The designers of exploratory search systems have tended to view such metadata as just another data source, something to be plugged into a faceted browsing system, visualization, or other interface. The application – and aggregation – of metadata to resources is a significant determinant of database interpretation and, accordingly, of user experience, whether this metadata is created by human acts of description or by algorithmic means. The meaning of "Euro" in Zappos does not change whether or not that label was applied by people or by computers; the restriction of metadata to quantitative elements like size and price does not change the interpretive function of the database either, only the character of the perspective that is instantiated.

Conclusion

The benefits of fast information, as exemplified by simple web search, are undeniable. The amazing availability of information to ever-increasing groups of people is enabled, partly, through the perceived speed and simplicity of fast information. Similar benefits are also attributable to the availability of processed food. Slow food advocates do not

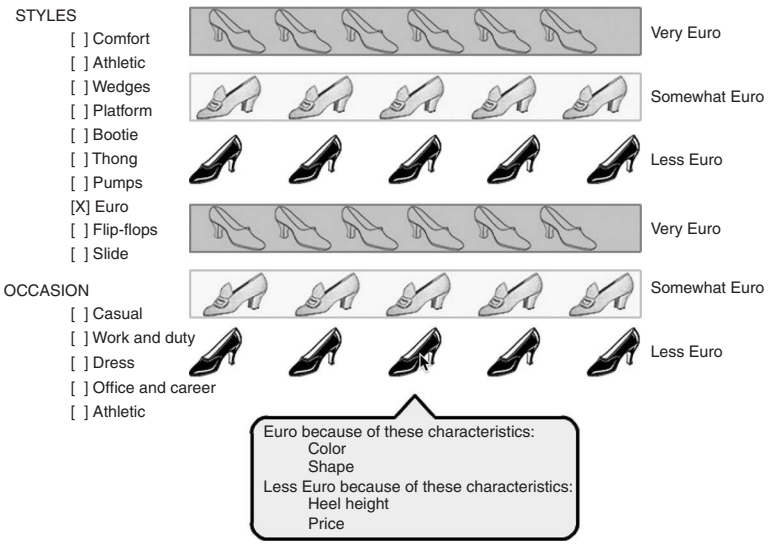

Figure 3.
Sketch of a slow reading tool to "amplify the presence" of metadata infrastructure and draw attention to the information system's interpretive role

necessarily object to all such processing – commodities such as flour, peanut butter, and canned tomatoes are extensively processed, even if we tend to think of these as "raw ingredients" and not ready-to-eat meals. But as the scale of processing increases, it is less easy for the average consumer to identify the transformations that food items have undergone. It is not difficult to envision, with some degree of accuracy, the processes by which spinach becomes frozen spinach; it is more difficult to understand what happens to chicken to make it into frozen nuggets. In search of profits, food producers may perform many unseen manipulations, such as feeding chickens growth hormones and antibiotics, or using animal parts that would be rejected by consumers in raw form. Because such processing can result in eventual harm – such as obesity, diabetes, and poor nutrition – slow food advocates contend that it is worthwhile for everyone to have a better sense of where their food comes from and how it is made.

As with fast food, the ease with which fast information can be accessed, and our increasingly reliance on it, can lead information seekers to make less-well-informed decisions than they may realize. Moreover, not realizing the scale of transformations required to produce ranked search results, "clean" data sets, or "data-driven" decisions can leave information seekers vulnerable to misinformation and manipulation. As Geoffrey Bowker (2014) observes, "just because we have big (or very big, or massive) data does not mean that our databases are not theoretically structured in ways that enable certain perspectives and disable others." Through the systems where information is made available, theory and data are, in Bowker's words, "irreducibly embodied." Database reading enables people to disentangle theory from data, and to understand how "information" results from theory-data integration. It provides another kind of control over the information universe – one distinct from, but complementary to, the satisfaction of information needs through retrieval.

In making this suggestion, this paper aligns with Bawden and Robinson's (2016a, b) proposals to develop understanding as a design goal for information systems. Database reading is one concrete interactive mechanism to facilitate a certain kind of understanding. We can – and we should – imagine other sorts of information interaction to enable yet more forms of understanding. What other ways of interacting with information systems do we already perform in our everyday lives that we might envision and support in digital environments? What completely novel information interactions might we contemplate with new information structures and capabilities? It is time for information studies research to move beyond seeking and retrieval and into the realm of the unknown.

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