Interacting with Digital Information

Kamran Sedig
Western University, Canada

Paul Parsons
Western University, Canada

INTRODUCTION

Every day, people from all kinds of professions and disciplines need to use information to make decisions, plan courses of action, discover patterns, solve problems, analyze situations, make sense of phenomena, learn new concepts, make forecasts about future trends, and so on. These are all activities that involve human cognition; in other words, they are cognitive activities. People whose professions involve the frequent or continual performance of cognitive activities include scientists, health-care specialists, medical researchers, librarians, journalists, learners, engineers, stock brokers, archeologists, educators, social scientists, and others—i.e., the so-called knowledge workers. As the amount and complexity of information is on the rise, computer tools are increasingly being used to support knowledge workers in their everyday cognitive activities.

The component of these tools that allows knowledge workers to think and reason with information is their digital information interface, where information is displayed in a digital form such that it can be accessed and manipulated. Historically, we have been used to non-digital information that is displayed with static media. With the advent and proliferation of modern computers, however, we now have novel ways in which we can engage with information. Interaction with digital, electronic, computational tools can bring information to life and enable a human-information discourse. In order to perform cognitive activities effectively, we need to know the different forms in which information can be represented and displayed, as well as how we can interact with this information.

Cognitive activities may take place in many different domains, including, among others, finance, medicine, insurance, healthcare, business, education, journalism, science, and engineering. The types of interactive computational tools that enable interaction with information to support cognitive activities have been referred to in various literature as decision support systems, educational and cognitive technologies, and digital library, problem solving, forecasting, analysis, planning, knowledge discovery, and sense making tools. This article is concerned with all such tools, in any domain, that enable, support, and enhance interaction with digital information for the purpose of carrying out cognitive activities.

DOI: 10.4018/978-1-4666-5888-2.ch370

BACKGROUND

This section will briefly examine some background concepts. This includes a brief discussion of the concept of information and the differences between digital and non-digital information, as well as an examination of the role that interaction with information plays in human cognition.

Information: Digital vs. Non-Digital

Information does not have any widely agreed upon meaning. Researchers have suggested that information can be defined, in its most basic sense, as the pattern of organization of matter and energy (Bates, 2005; Stonier, 1990). Books, light and sound waves, diagrams, and galaxies all contain information. Information, then, is everywhere—as Fidel (2012) suggests, "we interact with information during every waking moment..." (p. 1). This general definition of information is inclusive and can serve as a foundation for more specialized definitions. Moreover, all other basic views of information, such as information as an artifact or as a communication process, can be related to this basic definition (Marchionini, 2010).

Information can be categorized into digital and non-digital. What is meant in this article by digital information is digital, electronic, information that is stored, operated upon, and represented by interactive computational tools. This digital information, like all information, consists of patterns of organization of matter and energy—magnetic patterns on a hard disk platter, for example. Non-digital information, then, refers to patterns of organization of matter and energy that are not electronic, digital, and computational. Multiple characteristics of digital information distinguish it from non-digital information, two of which are important to note here. First, such information must be represented by a computational tool to make it potentially meaningful to a human observer. Some implications of this are examined in the sections below. Second, digital information transcends limitations that non-digital information has and, in doing so, can enhance the performance of cognitive activities.

Sedig and Parsons (2012) describe how non-digital information has three main limitations with respect to the performance of cognitive activities: perceptual limitations, cognitive limitations, and action limitations. Perceptual limitations arise from the fact that it is not possible to perceptually access all of information that exists within a physical object or space. For example, although a rock contains information, only the surface information is easily perceivable, and perceptual access to deeper, internal information is limited. Cognitive limitations arise from the lack of representational aids with which cognitive processes may be supported. A book, for example, cannot take on information processing abilities and become an active partner in cognitive activities. The third limitation is in regards to the action possibilities that non-digital information affords. For instance, given a paper-based (i.e., non-digital) map, it is not possible to act upon it to request more information, to filter portions of it, or to generate motion within it. With digital information, however, these three limitations can potentially be removed, resulting in increased potential for tools to support cognitive activities.

Interaction and Cognition

In the early days of cognitive science research, the dominant view of the mind was that of an information processing apparatus operating inside the head. This view was deeply influenced by the workings of electronic computers that were growing in influence at the time. Consequently, the mind was likened to an information-processing computer—cognition could be understood as a flow of information from the external environment, through sensory receptors, into the brain for processing and storage, which could then lead to information outputs. Although this view is still generally accepted, in recent years it has been greatly expanded to recognize the primary role that our bodies, our external environment, and our interactions with the external environment play in cognition. It is now largely agreed that cognition is influenced in very fundamental ways by one's environment—whether physical, social, cultural, or otherwise. Philosophers such as Andy Clark (2008) have argued that through interactions our minds are extended beyond the confines of our brain and body into the external world. Through such mental extension, a coupling is formed between one's brain and nervous system and objects that are external to the body. Such a coupling results in an integrated cognitive system, where there is a dynamic interplay between internal (i.e., the brain and mental representations) and external components of the system.

The implications of this new view of cognition are far reaching, and certainly influence our understanding of the role that interaction with information plays in shaping our cognitive processes and activities. Studies have suggested that actions we perform on objects in the external environment can be fundamental components of our thinking and reasoning processes (e.g., see Kirsh & Maglio, 1994). Some of the actions we perform are used to transform the state of the environment in order to facilitate mental information-processing needs. For example, while solving a problem, we may rearrange or juxtapose objects to facilitate mental tasks such as comparison, identification, and ranking of information items. Such actions shoulder some of the information processing load that would otherwise be taken on solely by the brain, and are, therefore, pivotal in the performance of cognitive activities. As discussed above, digital information is not subject to the same limitations as non-digital information. In light of this understanding of the role that interaction plays in cognitive activities, the ways in which we interact with digital information to support cognitive activities have to be examined. As digital information is not directly accessible to users, it is through digital information interfaces that we access, work with, and think with the underlying information.