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Investigating Evaluative Stopping Rules in Information Requirements Determination

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Abstract

Information requirements determination (IRD) is often considered the most important phase of IS development. Research directed at the cognitive challenges of IRD has presented a variety of narrative and diagrammatic tools for eliciting information and representing requirements. However, none of these addresses the cognitive processes used by systems analysts when assessing the sufficiency of the information acquired during IRD. This research identifies the stopping rules employed by analysts to decide when to stop gathering requirements for system development. Experimental findings show that the cognitive limitations of analysts result in flawed application and evaluation of stopping rules, producing premature termination of the IRD process. Further, the results show that the use of a strategic prompting tool reduces the risk of premature stopping by the analyst.

Introduction

The development of an information system (IS) is a complex problem-solving task made difficult by the involvement of numerous stakeholders and by dynamic organizational environments in which data and modeling needs may change rapidly. The ultimate success of an IS hinges on a clear and complete understanding of the problem to be solved and a thorough definition of the users' needs and expectations; this understanding is accomplished through a process known as information requirements determination (IRD). Given the necessity of complete and accurate requirements for the development of successful information systems, it is not unexpected that IRD is frequently and convincingly presented as the most critical phase of IS development (Byrd, Cossick, and Zmud, 1992; Davis, 1982; Vessey and Conger, 1993; Watson and Frolick, 1993).

The majority of research on requirements determination has focused primarily on the structure and use of the specific methods or tools that analysts use to gather information requirements. However, it has been widely accepted that systems analysts face various cognitive challenges and problems when performing requirements determination. As a result, researchers are beginning to look at the cognitive aspects of requirements determination, both in terms of the cognitive appropriateness of the various tools and techniques (Larsen and Naumann, 1992; Lohse, 1995) and in the analyst and user communication processes and relationships (Bostrom, 1989; Valusek and Fryback, 1987). The current research focuses on understanding the cognitive processes employed by systems analysts when determining the sufficiency of the information gathered during requirements determination.

Stopping Rules in Requirements Determination

In problem-solving and decision-making situations, individuals gather information until they feel the problem can be properly structured or a decision can be made. During these information acquisition processes, individuals invoke some evaluative heuristic or test, called a stopping rule, to make an assessment of the sufficiency of the information obtained. If the information is deemed satisfactory, the person terminates the information gathering process. There is evidence in the information systems development literature for the use of stopping rules in system design and testing (Byrne, 1977; Goel & Pirolli, 1989; Hinrichs, 1992; Yang and Chao, 1995), but there is no similar research in the domain of information requirements determination.

Stopping rules in general have been explored in a variety of contexts. Past research has postulated stopping rules based on the economic value of information, the marginal value of acquired information, the expected value of information, and the expected loss from terminating the information acquisition (Busemeyer and Rapoport 1988; Kogut, 1990; McClave and Benson, 1994; Spetzler and Staël von Holstein, 1975). However, considering the limited information processing capabilities of humans and the cognitive difficulty of computation, it is not surprising that there is significant evidence that people do not adhere to these normative stopping rules. Research has shown that individuals stop too soon (Perkins, Allen, and Hafner, 1983; Baron, Beattie,

and Hershey, 1988), fail to access relevant information (Fischhoff, 1977; Shafir and Tversky, 1992), fail to consider all appropriate alternatives (Farquhar and Pratkanis, 1993), and commit errors of omission when acquiring information (Fischhoff, Slovic, and Lichtenstein, 1978). A person's decision to stop acquiring additional information is dictated by external factors (e.g., time pressures, schedule deadlines, budget limitation) and internal factors (e.g., cognitive processes, fatigue).

In addition to the fact that normative stopping rules do not seem to describe people's actual behavior very well, such rules are silent about the cognitive processes involved in stopping behavior. In reaction to both of these facts, researchers have recently proposed process-based stopping rules used by decision makers (Nickles, Curley, and Benson, 1995). Two judgment-based rules have been hypothesized: a magnitude threshold rule and a difference threshold rule. The *magnitude threshold* rule assumes that the degree of belief concerning the sufficiency of evidence must reach some predetermined level, or threshold, before the person will stop seeking information and reach a conclusion (Nickles, Curley, and Benson, 1995). When using the *difference threshold* stopping rule, the decision maker assesses the marginal value of the latest piece of information and stops the information acquisition process when the marginal difference is less than a predetermined threshold (Nickles, Curley, and Benson, 1995).

Two reasoning-based stopping rules have also been proposed: the mental list and representational stability rules. The *mental list* stopping rule involves the use of schemas (Schank and Abelson, 1977) possessed by the individual for the construction of mental lists. As information is acquired, arguments are made for or against using a piece of information to fulfill a requirement on the list. The information acquisition process ceases when the list is complete. The *representational stability* stopping rule involves continuous adaptation of the individual's internal representation of the problem situation. Arguments are developed that either support or discourage the use of the acquired information to modify the representation. When his mental model of the problem is no longer being developed, the decision maker ceases acquisition of additional information (Yates and Carlson, 1982).

To overcome the threat of premature stopping and hence underspecification of system requirements, the present research tested a strategic prompting tool. The prompts provided by this tool are intended to challenge the analyst to explore requirements beyond the limits imposed by his usual heuristic stopping rule. There is evidence that the use of context-independent prompts based on argument types (e.g., causation, generalization, and analogy) and argument strategies (e.g., building scenarios, elaborating with instances, and generating counterarguments) can be effective for eliciting information from individuals that they might not otherwise evoke (Browne, Curley, and Benson, 1997). It may also be true that prescriptive use of these types of prompts would cause the analyst to inquire in ways he might not have otherwise. Although argument types and strategies are features of everyday human reasoning, there often is not conscious effort on the part of individuals to use them (Kuhn, 1991). Hence, the introduction of specific argument and strategy prompts into the requirements determination process should mitigate the effects of premature stopping when the prompts are designed to overcome the limitations imposed by the analyst's stopping rule.

Methodology

The present study consisted of two parts. The first part was descriptive in nature and was intended to reveal the stopping rules used by systems analysts. Subjects were asked to perform an information requirements determination task concerning a proposed on-line grocery shopping application. Subjects elicited requirements from a user of such a system (the "user" was the same person for all subjects, and provided pre-defined responses written on note cards). The number and type of requirements elicited from the user by the subjects were counted for later analysis. Further, a short questionnaire was completed by each subject that was designed to help determine which cognitive stopping rule he or she used to end the elicitation process. Additional evidence of stopping rule use was gathered by analyzing tape-recorded think-aloud protocols made by each subject while performing the task.

After eliciting requirements for the system, subjects were assigned to one of two groups for part two of the study. The first group was a control group instructed to reconsider the task using a syntactic prompting tool consisting of the who, what, why, where, when, and how questioning approach to eliciting requirements (Brody, 1982; Couger, 1996). Because of their general nature, such prompts served as a control group in the present context. The second group utilized a strategic prompting tool consisting of argument and strategy types (discussed above).

A completely randomized design was used for the second part of the experiment. The subjects were randomly assigned to the two experimental groups. The stopping rule used by each subject was determined post hoc and was a between-subjects variable that was measured but not manipulated. The effects of the method of prompting intervention were measured for the subjects within each stopping rule, as well as across all stopping rules. Therefore, the method of prompting was both a within-subjects and a between-subjects variable. The data again consisted primarily of the number and type of requirements elicited. An analysis of variance was used to analyze the data.

The subjects for this study consisted of practicing systems analysts. Only analysts with at least two years of experience in system development were eligible to participate in the study. Subjects were paid a fee for their participation.

Results

Analysis of the results will be completed by May 1998 and presented at the conference.

Discussion

Investigation of the use of stopping rules in the context of requirements determination contributes to the growing body of literature addressing cognitive concerns in systems development in general and requirements determination in particular. Identification of stopping rule use by systems analysts is of theoretical value to the study of requirements determination. This research shows that premature stopping due to stopping rule use can be mitigated, and will encourage additional research on strategies for overcoming premature stopping.

From a practical perspective, identification of the use of stopping rules in IRD could result in significant economic impact on system development efforts. As organizations make increasing investments in information systems, it is essential that organizational leaders be able to ensure that IS development efforts result in systems that are on time, within budget, and that satisfy user needs. A decision aid in the form of identifiable stopping rules, supplemented by specially designed prompts, has been shown to assist the analyst in determining at what point sufficient information has been obtained. This reduces the risk of underspecification and utilizes valuable development time and budget more effectively.

References

References cited are available upon request (mpitts1@umbc.edu; gbrowne@coba2.ttu.edu).