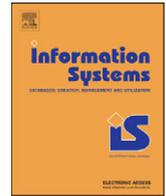




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FACETS: A cognitive business intelligence system [☆]

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ABSTRACT

A cognitive decision support system called FACETS was developed and evaluated based on the situation retrieval (SR) model. The aim of FACETS is to provide decision makers cognitive decision support in ill-structured decision situations. The design and development of FACETS includes novel concepts, models, algorithms and system architecture, such as ontology and experience representation, situation awareness parsing, data warehouse query construction and guided situation presentation. The experiments showed that FACETS is able to play a significant role in supporting ill-structured decision making through developing and enriching situation awareness.

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1. Introduction

Business intelligence (BI) is promising to turn ‘data’ into ‘knowledge’ and to help managers survive data tsunami and eventually succeed in decision making. A BI system is capable of providing executives with huge amounts of internal/external business data. However, more data does not equal to more valuable information [1]. Current BI systems can only partially support executives’ management processes [2]. Executives often feel lost when presented with a large body of data concerning decision making. A recent survey, by Economist Intelligence Unit [3], shows 73% of senior managers agreed that it is important to have less but more timely data to improve the quality and speed of decision making. This result corresponds to the research by Sutcliffe and Weber [4] about knowledge accuracy. Their research implies that

having a lot of facts about a decision situation is less important than having a clear and consistent overview picture.

Decision support systems (DSS) are envisioned as “executive mind-support systems” that are expected to support decision-making from human cognitive perspectives [5]. Nevertheless, BI systems are essentially data-driven decision support systems. OLAP-based ad hoc query and reporting are mainly pre-defined information representation. During a decision process, managers are provided with information in the form of reports, ad hoc analysis, or some so called knowledge, which is pulled out of a data warehouse according to pre-defined queries, such as SQL sentences and multidimensional expressions (MDX). The emphasis is manipulation of large volumes of business data, rather than supporting managers’ decision making from a cognitive perspective.

The focus of this study is to investigate how various cognitive models can be incorporated into traditional information systems. A prototype DSS system was designed, developed and evaluated based on the Situation Retrieval (SR) model.

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The remaining of this paper is organized as follows. After the introduction, the related works are reviewed in Section 2. Section 3 presents the system architecture of FACETS. The ontology design is described in Section 4. Section 5 introduces the mental model, experience and cue maps. Section 6 details the situation awareness parsing procedure. The process of query construction is described in Section 7. Section 8 shows the process of situation presentation. Section 9 details the experiments in which FACETS was evaluated. Conclusions are given in Section 10.

2. Related work

Managers' cognition plays an important role in business decision making, as has been noted by many researchers. In behavioral organization theory, managers' cognition acts as a filter between inter-organizational and intra-organizational environments, which helps managers to search for selective information concerning functions of the business and certain organizational actions [6]. Similarly, based on a survey of 12 Fortune 500 companies, Donaldson and Lorsch [7] concluded that senior executives simplify business reality by employing interrelated beliefs to filter irrelevant information. The simplified business environment helps executives to gain better understanding of their business during strategic decision making, as concluded by Porac and Thomas [8]. Mintzberg [9] categorized managers' work into ten different roles and connected them with managers' mental models. He found that managers spend most of their time communicating with other people and thinking, by which a series of mental models are built. Isenberg [10] observed that higher level decision making is mainly based on managers' intuition rather than 'choosing' the best one from a number of identified alternatives. Managers are skillful at using historical experience to envision future scenarios of the company, by which they predict potential threats and possible opportunities. In dynamic, ill-structured environments, managers have little time to conduct thorough rational reasoning. Ironically, managers tend to quickly assess a decision situation by comparing a current decision problem with their past decision scenarios [11].

Managers' cognitive abilities are nevertheless subject to many cognitive biases. A cognitive bias is a distortion pattern in human mind which leads to a perception, judgment, or reliability that deviates from the reality [12]. Cognitive biases might be useful in certain circumstances, but they are more likely to cause serious mistakes in decision making. For example, people tend to accept new information that confirms their preconceptions and to avoid conflicting ones. Russo and Schoemaker [13] described ten most common mistakes in decision making related to cognitive biases: plunging in, frame blindness, lack of frame control, overconfidence in your judgment, shortsighted shortcuts, shooting from the hip, group failure, fooling yourself about feedback, not keeping track and failure to audit your decision process. Most cognitive biases are hard to avoid and they are attributed to different psychological biases. For example, judgmental biases are caused by judgmental rules and heuristics employed by people to reduce difficult mental tasks to a

simpler one [14]. However, well-designed information systems are helpful for manager to overcome some negative cognitive biases [1,15].

Cognitive map, as the knowledge representation technique of human mental models, has received wide research attention in DSS community. A number of DSS have been developed to support manipulation of cognitive maps.

An early DSS called SPRINT (Strategic Plan and Resource INtegration), was developed by Carlson and Ram's [16]. SPRINT is an executive planning support system which can be used by managers to explicitly represent planning models which are of implicit nature in managers' minds. The visual representation of planning models is based on managers' mental models. The concept nodes and links between concepts can be created by managers according to their understanding, thoughts about the company. SPRINT also supports heuristic rules and goal-oriented communication between different managers. The cognitive aspects of SPRINT lie in that it supports visual representation and dynamic creation of managers' mental models regarding business plan formulation. Although managers' cognition is supported in terms of information systems in a limited degree, SPRINT represents one of the early research efforts toward cognitive decision support in DSS community.

A conceptual DSS Cognitive Lens Support System was described by Yadav and Khazanchi [15]. They proposed the concept cognitive lens as the description of mental models from information systems perspective: 'A cognitive lens converts filtered information into a set of constructs and their interrelationships of the real world'. The description of the cognitive lens support system revolves around the inquiry of cognitive lenses stored in a database. They proposed three categories of IS functions for inquiry of cognitive lenses: introspective, dialectic, and eclectic, which allow managers to examine their past experience for a specific decision problem, to compare their own experience with others, and to aggregate multiple pieces of experience. The major argument relying on the cognitive lens support system is that IS support provided to managers through 'cognitive orientations' will facilitate better understanding of ill-structured problems. Compared to previous research, the cognitive lens support system illustrates a more comprehensive analysis about the significance and IS techniques of supporting managers' thinking process for business decision making, although at a conceptual level lacking empirical validation.

Following the cognitive lens support system [15], Chen and Lee [5] developed a cognitive DSS for strategic decision making. Similarly, their system also includes three supporting modules: retrospective, introspective, and prospective. The first module provides the manager with tools to manage business cases, experience, other people's views, speculations, and even rumors. The second module is used to explore and represent the manager's own mental models. And the last module provides the user aids in forward thinking by creating and managing future business scenarios. An exploratory assessment was conducted to evaluate this system by interviewing real business executives from three different industrial

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