



## ACTIONABLE FILTERING THEMES IN EXECUTIVE INFORMATION SYSTEMS FOR MANAGING INFORMATION OVERLOAD

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### ABSTRACT

Executives are subjected to relentless onslaught of information. Many strategies have been suggested in the past to negotiate the torrents of information flows confronting executives. This paper recommends modifying the structure of information flows reaching the executives as an effective strategy to manage information overload. Such a strategy will enhance the actionability of the decisions taken by the executives who use information inflows as inputs to such decision making. Autonomous software agents can be used for the purpose of building more effective information inflow structures.

**Key Words:** *Information Overload, Autonomous Agents, Executive Information Systems*

### 1. INTRODUCTION

Executives are under siege from the information onslaught. The advances in information processing technology have immensely increased the creation, storage and flow of information (Brandel 2008). The world produced almost 800 MB of recorded information per person each year in 2003 (Lyman & Varian 2003). By 2009, the amount of digital information grew 62 per cent over 2008 to 800 billion gigabytes or 0.8 Zettabytes (IDC 2010). The cost of storage capacity is halving every 9 months (Bradley 2004). Database growth has been nothing short of spectacular, both in size and complexity of data and usage (London 2004). The largest reported Online Transaction Processing (OLTP) system in 2003 contained nearly 18.3 terabytes of data, almost double the size of 2001 leader and the 2003 data warehouse leader contained 29.2 terabytes of data, almost three times the 2001 leader (Aurbach 2003). In 2009, eBay corporation owned database containing 6.6 petabytes of user data. According to market research firm IDC, by 2011 the digital universe will be 10 times the size it was in 2006 (IDC 2010). Surveys of senior executives have found 97 percent to 100 percent of respondents agreeing that data is increasing and well over half saying data is doubling or tripling over the previous year (Terry 2004). The massive accumulation of information by organizations in turn increases the information that eventually

reaches the executives, who, due to their position, are recipients of substantial amount of solicited as well as unsolicited information (Katzer & Fletcher 1992).

### 2 WHY EXECUTIVES COLLECT SO MUCH INFORMATION

Some of the key reasons behind executives obtaining such overwhelming amount of information are:

- They collect information to convey a commitment to rationalism and competence.
- They receive large amounts of unsolicited information.
- They seek more information to validate information already acquired.
- They want to be able to demonstrate justification of decisions made by them.
- They gather information just in case it may prove useful.
- They prefer safety and get all possible information.
- They use information as currency to keep up with colleagues. (Butcher 1998).

### 3 INFORMATION OVERLOAD

Extensive exposure to information often causes information overload which can make the utilization of available information less than effective. Paradoxically, past some optimal point too much information can lead to decreased decision making performance but increased



feelings of satisfaction thus making decision quality an unintended victim of large information input (O'Reilly 1980). Massive availability of information has not allowed for superior decision making since almost three-quarters of U.S. executives and over half of their counterparts at European companies state that the lack of "right-time information" has cost their company money (Terry 2004). K-Mart Corporation could not escape bankruptcy even though it was in possession of a 12.6 terabyte data warehouse covering stocks, sales, customers and suppliers (London 2004). The challenge of putting available information to productive use by overwhelmed executives can be met by instituting changes in the way executives receive information so as to prevent information overload. This paper recommends modifying the structure of the information flows that reach the executives and application of software agents that can act on the information reservoirs and flows in accordance with the directives of the executives to filter and present right information to executives at the right time.

#### 4 SOFTWARE AGENTS

Employing software agents that constantly seek out information of high relevance for recommendation to executives and can adapt to their changing requirements in real time can make the information flows highly targeted to immediate executive needs and improve the quality of decision making. Software based agents have been employed with a fair degree of success to filter information flows for news reading, entertainment and internet browsing. Such agents are typically designed to fulfill a set of goals in a constantly changing dynamic environment. Adaptable autonomous agent, a special class of agents, is situated in the environment; it can sense the environment through its sensors and act upon the environment using its actuators (Maes 1997). Adaptable autonomous agents are recommended for applications in information filtering because of their reduced dependence on users in attaining their objectives.

Dominant information filtering paradigm influencing the design of agents has essentially focused on the demographic characteristics and past behavior of the information user and others similar to the user. The objective of information filtering is usually achieved by agents in three ways; demographic filtering, content based

filtering and collaborative filtering. In demographic filtering, agents utilize descriptions of people to learn the relationship between a single item and the type of people who use it. The user profiles are based on the stereotypical descriptions representing the attributes of the classes of users. Content based filtering uses previously experienced items as exemplar to recommend new items. The items are recommended based on their similarity to items the user has shown a preference for in the past. In collaborative filtering techniques, recommendations are made based on choices made by people similar to the user. Similarity criteria could be demographic or functional.

The focus on user attributes and past behavior ignores the fact that these factors may not always be an accurate predictor of future information requirements of executives for two reasons. First, executives usually deal with fairly atypical and unstructured problems which would make matching information items, selected on demographic and/or historical usage basis by the agent, to the needs of the problem a less effective exercise. Second, the paucity of time with which executives are faced will make evaluation of every new piece of agent recommended information unlikely as executives would prefer to utilize information they perceive familiar and thus more usable. This implies that the agent cannot rely on the usual feedback mechanism to refine its future information search to the extent it can do in say searching news items or movies. The impetus to utilize a piece of information by an executive is likely to be provided by its perceived usability without too much analysis.

Software agents targeted to executives' information filtering needs have been termed Executive Information Systems (EIS). A study of EIS involving British executives found that the executives satisfied with their EIS received more actionable information from them compared to executives dissatisfied with their EIS, but actionability aspect was not a key design feature of any reported EIS. The same study also found that major complaints regarding EIS included problems with the scope of information presented, i.e. either lots of detail was available or no detail was available. Often the reports were too detailed and not summarized in a user friendly manner, the drill down facility was not present to look at disaggregated information if they needed to and that EIS generally fed them too much unrequited



and unrelated information (Xu 2003). The EIS thus failed to evaluate the information in accordance with the needs of the executives. Unless an evaluation criteria appropriate to executives' needs is developed, the EIS cannot be a highly useful tool of the executives.

An information filtering system targeted for executives must take into account the fact that executives essentially require information that is readily conducive to decision making without requiring too much analysis or searching. The information fed to executives has to have a bias toward actionability and against extensive user analysis. Actionability may be described as the ability of an information to be put to productive use with minimal analysis by the executives. Most information handled by executives is within a short period ultimately used as input to the process of selecting actions to be undertaken by them in the pursuit of organizational goals. Thus, executives need information that can help them evaluate various options related to decisions and actions under consideration. This directly implies that the excess of information and paucity of time available to executives necessitates creation of summarization categories for information handled by the executives based on the types of actions they generally take. An effective summarizing scheme, with a built in drill down ability to provide access to underlying components of information, is needed to present executives with information categories that contain information from multiple sources grouped together to make it conducive to actionability.

## **5 FUNCTIONALITY AND COMPONENTS OF INFORMATION**

From the executives' actionability perspective, a meaningful classification of information into separate components, useful to the executives in that the components are broad enough to allocate a large subset of information to a summarization category, yet specific enough to retain the dominant essence of that subset, is to establish it in terms of the ultimate use of that information. Peterson laid out one such categorization scheme stating that executives are concerned with the following types of information: information to evaluate decisions, information to implement decisions, persuasive information, damaging information and information required to be submitted to the authorities (Peterson 1977). These categories of information may not be watertight and mutually

exclusive as boundaries of different components could overlap; neither would a given executive be concerned with all these categories of information, however, this classification scheme can be usefully applied to unstructured information to draw out a coherent information subset that is rich in the contextualized attributes an executive may use as inputs for high quality decision making and action selection.

Accordingly, information may be summarized into categories of decisive information, implementation information, persuasive information, damaging information, and required information. Each of these categories would contain information from multiple functions and departments within the organization, as also from sources external to the organization, compiled in a summarization scheme based on the similarity of eventual use. Decisive information is a type of information that directly influences decisions. Decisive information could have frequent instances of data with a bearing on operational parameters of processes under the scrutiny of the executive entrusted with formulating decisions. Implementation information would consist of routine and unsurprising but reassuring data indicating that the processes are lying within their control limits. Persuasive information would be a form of information in which data reduction has been undertaken from a biased point of view with the objective of producing a good public image or influencing a decision. This type of information could have originated either inside or even outside the organization from entities such as vendors or affiliates aiming to promote their cause at the expense of rivals. Damaging information would be information which would be detrimental to a decision maker or the organization if it were released or became generally known, being highly confidential in nature. Instances of such information could be legal contracts and confidential reports. Required information consists of constraint-fulfilling data which add to the costs of a firm, but are generated to satisfy the information needs of an external decision making body, such as a local, state and federal regulatory agencies (Peterson 1977). This categorization scheme is being presented as one example of several unique categorization schemes an organization may come up for the use of its executives.



## 6 AGENT DESIGN

Employing intended use of a body of information as the basis for creating a typology of information for information filtering avoids weakness of reliance on historical information or demographic attributes. It also reduces the possibility of stereotypical specialization by the agent and instead allows for its functional specialization. Eschewing direct accessing, searching and analyzing of information by the executives themselves, autonomous adaptable agents can implement a complementary style of interaction in creating information filters. Applying the metaphor of a personal assistant who is collaborating with the user in the same work environment, the executive and agent may engage in a cooperative process, initiating communication, monitoring events and performing tasks (Maes 1994). Agents employing usage based information classification scheme could contain sub-systems, each of which is trained to look only for information pieces that may fall under one of the categories. Taken together, these sub-systems shall create multiple information streams, each of which would be rich in attributes relevant to a particular action domain of the executive, such as decisive domain, implementation domain etc. Each sub-system of the agent entrusted with the obligation to monitor one component of the information will scan the data storage and seek out those pieces of information that fit the criteria for recommendation to the executive using Structured Query Language (SQL), Online Analytical Processing (OLAP) or Knowledge Discovery and Data Mining (KDD) tools. These multiple information streams may then be displayed on the user interface using hyperlinks to facilitate drill down lookup by the executive. A learning aspect can be built into each sub-system of the filtering agent for it to appraise its performance and take appropriate learning action.

The learning aspect of the agent would be associated with monitoring the information reservoirs and seeking information that can be recommended based on themes underlying each action domain rather than seek information entirely on the basis of the personal attributes of the executive or the keywords previously used by the executive. The agent would learn primarily by building and modifying themes, which are different combinations of semantically networked keywords that match the context of a given functional domain. The initial action domain

profile and themes can be supplied by the organization or built by the executive himself in advance and amended subsequently. Over time, the agent will learn to discriminate between themes that are used extensively by the executive, those not favored at all and those in between and rank or eliminate them accordingly. The agent may also recommend newly created themes based on previously successful themes or periodically request the executives to suggest new themes. Such a system will benefit greatly by the inclusion of new themes supplied by different sections of the organization as they will include the keywords representing dominant operational characteristics of that section. While the actual actions taken by the executives may not be predictable, their action domains are predictable being decided by their organizational responsibilities and therefore subject to cataloging. It is important to look at presence of themes consisting of semantically networked keywords and not at presence of individual instances of keywords themselves as the latter approach is likely to produce far too many results most of which will not be suitable to the requirements of the executives and lead to loss of confidence in the agent's ability to produce highly targeted information.

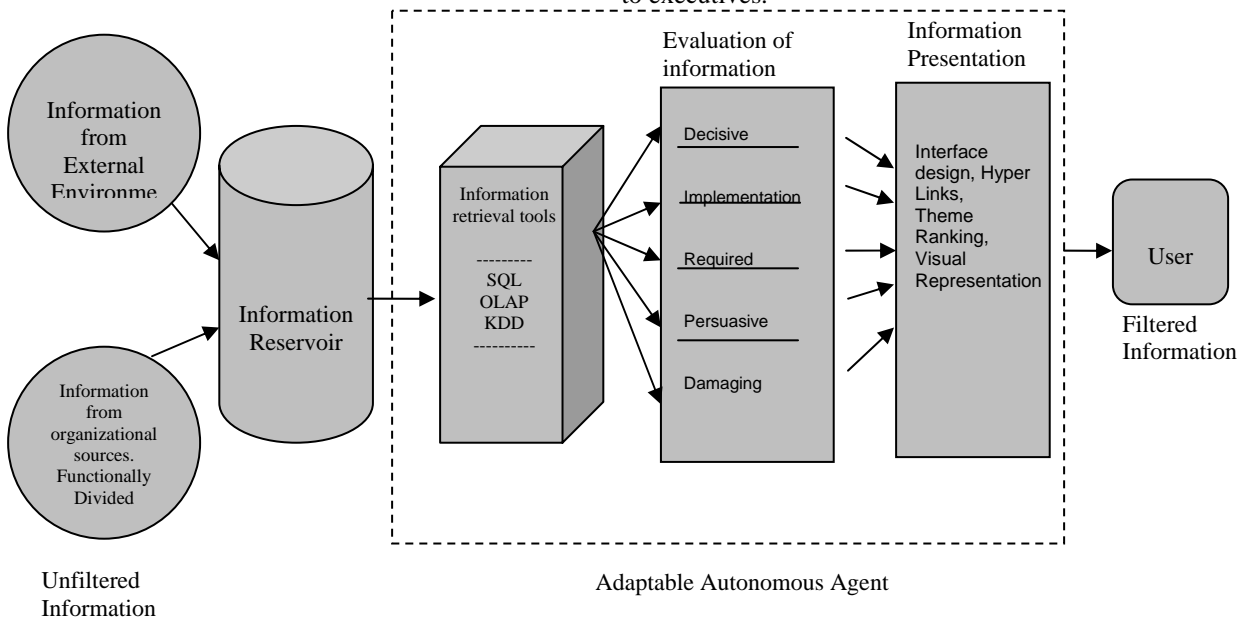
A fundamental requirement of such an information filtering system is that the agent needs access to structured information that is capable of being captured in a data store being constantly updated by information from the organizational and external environmental sources including the World Wide Web. The sub-systems of the agent would constantly evaluate the changing state of the data store for any new information that meets their criteria and include it in their information sub-set for possible recommendation to the user. The information filtering agent is specialized for the executive but the specialization is based on functionality and not demographic or historical usage patterns. It should be possible for multiple executives, entrusted with similar duties, to share the same filtering agent. Over time, producing results that induce confidence in the executives about the robustness and relevance of the agent's recommendation would be key to extensive acceptability of such systems.

The actions of adaptive autonomous filtering agent are bound within the limits of the specific requirements determined by the

executives and the agents are composed of self-contained modules that carry out small, independent functions, which when combined together create the full functionality of the agent. In their application as EIS, such agents would be dealing with tasks defined by the executives based on the scope of their responsibilities within

the organization and each sub-system of the agent will carry out a part of the overall required functionality that will contribute towards the attainment of overall objective of creating highly targeted information for high quality decision making and action choice.

intervention and thus provide efficient assistance to executives.



(Fig.1 Model of the proposed adaptable autonomous filtering agent)

**8 CONCLUSION**

Information overload can be managed by taking into account the factors defining the environment within which a user is situated. Since executives depend on actionable information for decision making, the agents assisting executives with information filtering can be designed to seek themes representing different action domains of the executives as this approach is likely to provide highly targeted information flows compared to keyword based approaches. Theme based filtering should be better able to match the contextual attributes of the issues executives need information about with the information that is provided to them by the agents. Adaptable autonomous agents are highly suitable for such filtering operations as they can reduce user



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