# An Intelligent Agent for Prioritizing E-Mail Messages

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*The proliferation of telecommunication networks, like Internet and Bitnet, has promoted electronic mail (e-mail) into a viable business communication tool with widespread use that traverses all levels of management. In some organizations, e-mail users are being overwhelmed with a barrage of useless messages or "electronic junk" mail. This interferes with a user's information processing capability and causes a negative effect on usefulness of this communication tool. This paper addresses the issue of time management by reducing information overload in e-mail. A knowledge-based agent, called AIMS, was developed to prioritize e-mail messages. AIMS is different from other systems in three ways: 1) it does not burden users with the task of creating or maintaining message prioritizing rules, 2) it uses a user's personal knowledge (or preferences) with organizational considerations for prioritizing messages, and 3) it was evaluated at an academic institution with a group of 46 e-mail users who found the prioritized list generated by AIMS highly accurate.*

The proliferation of computers and telecommunication networks has encouraged a rampant use of electronic mail (e-mail) in organizations. For example, Travelers Insurance Corp. has over 30,000 e-mail users worldwide. Similarly, several studies report that e-mail usage has spread to all levels of the organization, including top-management (Markus, 1988). The popularity of e-mail has soared because it provides the flexibility to communicate from any place, at any time, and to any person without worrying about their physical location and presence. In addition, the cost of sending messages via telecommunications networks, like Internet, is less than two cents a page, compared with $2 for a fax, and 29 cents for a letter. (de Llosa, 1993).

Although organizations welcome the increased use of this new communication medium, e-mail has its limitations. A meta analysis study on the usage of all electronic media (Rice & Shook, 1990) placed e-mail at the middle of the information richness/social presence scale because it transmits very few non-verbal cues. This characteristic makes e-mail attractive mainly for exchanging routine information (Crawford, 1982; Sumner, 1988), such as announcements and for-your-information type messages, that require quick and massive distribution. It also explains the increase in demand for message distribution lists (Mackay, 1990) which provide an easy mechanism for disseminating electronic junk (Denning, 1982).

In organizations where e-mail has matured extensively, users are being overwhelmed with a barrage of electronic junk mail (Malone et al., 1987a). This has resulted in stretching the human information processing capability (message screening skills) to a point where users experience message overload (Hiltz & Turoff, 1981). Users experiencing overload either filter or ignore their messages randomly (Miller, 1984) often missing useful information. Some organizations have even issued specific guidelines to restrict electronic junk mail (Redding, 1984).

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Consequently, the widespread use of e-mail has increased the work load of e-mail users. A recent case study (Mackay, 1990) on people using e-mail under the condition of information overload identifies three different work patterns utilized by users to manage their messages. First, there are "prioritizers" who are interested mainly in managing time by identifying and prioritizing important messages on certain criteria before reading. Second, there are "archivers" who are interested mainly in managing information by archiving the messages into folders to read at a later date. Finally, there are "requesters and performers" interested mainly in managing tasks by delegating the actions (such as remind me, for your information, please reply to) to their subordinates. Thus future e-mail systems should address the three issues time management, information management, and task management to help users in managing message overload (Mackay, 1990).

This paper addresses the issue of time management by providing a knowledge-based agent to prioritize messages using each user's personal preferences for several reasons. First, users from the Mackay, et al. 1990, rated time management as more important than managing information or task. Second, the scope of AIMS was limited to decision support using expert systems application.. A solution to information management problem is more appropriate for intelligent DBMS. While task management is a complex problem which can be addressed in the future. However, all three are important issues in managing information overload and should be integrated into a single system in the future.

There is some consensus among researchers developing systems for managing user's time (Malone, et al., 1987a; Boyle & Clark, 1985; Chang & Leung, 1987; Pollack, 1988). All of them have addressed the issue of time management by providing mechanisms to assist users in filtering or prioritizing e-mail messages through knowledge-based (or expert system) approaches. However, none of these systems have been adequately evaluated from a user's perspective, that is, does a user agree or disagree with the filtering decisions of the system? This research addresses this problem by comparing the prioritized message list generated by our system with the prioritized message list generated manually by a user.

The next section reviews relevant research on intelligent e-mail filtering systems addressing the issue of time management through prioritization of messages. The third section discusses the methodology employed for design, development, and evaluation of An Intelligent Mail System (AIMS). The final section concludes the paper with a discussion on implication of AIMS on time management and future research directions.

## Previous Research

The issue of time management in e-mail is still at an infancy stage, therefore only a few research systems have addressed this issue. Motiwalla and Aiken (1993) found 14 intelligent mail systems that have attempted to provide systems to assist users in a combination of time and information management tasks. Four of these systems have specifically addressed the issue of time management through intelligent systems to filter and prioritize messages which is also the focus of our system. Hence, this section reviews these systems in detail to identify some common trends which can be compared and contrasted with our system later.

The first system is an Intelligent Mail Filter (IMAIL) system (Boyle & Clark, 1985). This system provided an information filtering mechanism to prioritize messages. It created active and passive user profiles which were matched with the keywords[1] extracted from messages on a electronic bulletin board to compute a total score for each message which was used to prioritize messages. Each user profile consisted of keywords, relations between keywords, and numeric weights for each keyword. Active user profiles were created by explicitly asking each subject for the criteria they used for prioritizing and filtering messages, while passive profiles were created by implicit observation of user action on their messages. This system was built as a stand-alone prototype in the Prolog programming language. It was not linked to an e-mail system nor was it evaluated by the users. Nonetheless, this system provided some good ideas for message filtering. For example, the authors suggested that a future system should provide rules to show messages scoring above a certain threshold to the user or sort messages by the score and present all the messages in a sorted order to the user.

The second system was the Information Lens system (Malone, et al., 1987a). This system allowed a user to compose messages in semi-structured templates.[2] These templates were distributed on a network to receivers who specified rules to automatically filter and classify the templates according to their preferences. Although the Lens system provided several features for message filtering, our focus was only on how it helped users in prioritizing messages. In order to prioritize messages users were required to create rules, via template editors, which were used to classify a message as important. Messages classified as "important" were then moved to an "urgent" folder. Users overloaded with messages can read their important messages from this urgent folder. The evaluation of this system was done with a research group of five members for a year.

The third system was the Knowledge-based Message Management System (Chang & Leung, 1987) or KMMS which used a linguistic message filter and an expert system to automatically process mail messages. The linguistic filter used message frequency, length, relevance (determined from message and user profiles), and network traffic patterns to classify messages into one of three categories: J for junk messages, G for general processing mail, and I for messages requiring immediate action. This classification was used by an expert system consisting of personal rules to trigger actions, such as performing database retrievals, office and filing activities, or message filtering actions. Examples of message filtering actions are: "express_in" action which flagged incoming messages for a quick deposit in an express folder, and "express_out" action which flagged outgoing messages to be deposited in an express mail folder for quick delivery. Like the other systems, no results were reported on how successful the system was with its users.

Finally, the ISCREEN system (Pollack, 1988) used a message filtering approach similar to the Lens system but focused on increasing the accuracy of personal knowledge. This was done by the system performing consistency checks and conflict resolution actions on the rules generated by the user. The system also provided detailed and context-sensitive explanations ("Why" and "How") for its actions. The prioritization process worked similar to the Lens system but ISCREEN made certain the knowledge base was consistent and accurate and hence, according to the author, ISCREEN performance was better than Lens. The evaluation of ISCREEN was restricted to a field test with a small group of users in an office.

Some common trends emerge. First, all systems actively involved the user in providing guidelines (or knowledge) to prioritize messages. Second, because knowledge-based systems provide flexibility for a quick manipulation of the knowledge base (the user guidelines) and are easier to maintain, they were the design choice of all the systems. Finally, the focus of these systems was more on design and development and less on testing their performance (quality of decisions) with the e-mail users.

## A Knowledge-Based Approach to Prioritize Messages

AIMS also incorporates the knowledge-based approach, discussed above, and allows active user involvement in providing and maintaining a personal knowledge base to prioritize messages. The following is a summary of the unique features of our approach:

- an experienced body of e-mail users were asked to develop a knowledge base consisting of a taxonomy of message categories[3] arranged in a top-down hierarchy with general categories on the top and specific categories at the bottom. The taxonomy was developed using a group decision support system;
- the message categories were used by a knowledge acquisition module of AIMS to elicit a user's priority in the form of numeric weights between one and ten. However, the system provided a default weight of five (median) on all categories;
- the knowledge acquisition module was menu driven requiring minimal keyboard skills from the user;
- keywords were extracted from the header of a message and matched with the message categories to compute a composite score for each message;
- messages in the user's mailbox were sorted based on the composite score and presented in a directory listing format commonly used in most e-mail systems;
- AIMS software was developed with a conventional programming language (Pascal) on a VAX/VMS system and linked to the VAX Mail system;
- the AIMS interface was same as the VAX Mail interface. For example, the "DIR" command of AIMS displays a prioritized listing of messages from the mail directory. The same (DIR) command of VAX Mail displays a chronological listing of messages from the mail directory. This minimizes change (and confusion) from the e-mail user's perspective; and
- an exploratory research study with 45 e-mail users was conducted to evaluate the prioritized list generated by the system with the prioritized list generated manually by user.

The key benefits from our approach are: 1) users require minimum training on either updating their personal knowledge base (because users do not have to keep adding or changing rules), or using AIMS because its user interface is the same as VAX Mail, 2) users can freely interact with other non-AIMS e-mail users on the VAX, and 3) users can change priorities on various issues by simply changing the weights on the different attributes. These features have the potential of attracting casual users to AIMS. Furthermore, the users have full control in prioritizing their messages because AIMS is highly sensitive to the allocation of weights to the keywords.

On the other hand, a key limitation of our approach is that it requires periodic knowledge acquisition sessions for updating the taxonomy of message categories. However, periodic update of the knowledge base is a problem to all knowledge-based systems because they lack automated learning ability. This problem can be corrected with the incorporation of neural network systems, which have the ability to learn, in the future.

## AIMS

AIMS was developed at a MIS Department of an academic institution. The site was convenient for our exploratory study because it had over 100 VAX Mail users and easy access to windowing and interface tools on the VAX/VMS operating system. AIMS was developed using a knowledge-based (or expert systems) life-cycle approach which has three major phases (after problem identification), namely, knowledge acquisition, system prototyping, and system evaluation. These phases operate on an iterative basis until a satisfactory prototype model of the system emerges (Harmon & Sawyer, 1989). This section discusses the knowledge acquisition, system prototyping, and system evaluation phases of AIMS.

### Knowledge Acquisition Phase

AIMS requires two kinds of knowledge. The first kind was the development of message taxonomy consisting of

| Level-1 Message Category | Teaching | Research | Service | Overall |
|---|---|---|---|---|
| Level-2 Message Category (# of items) | 8 | 10 | 8 | 26 |
| Level-3 Message Category (# of items) | 35 | 59 | 55 | 149 |
| Group Size | 7 | 8 | 6 | 21 |

**Table 1: Results from the Three Knowledge Acquisition Sessions**

a hierarchical set of keywords to identify messages into various categories. The second kind was the priorities assigned to the message categories by the user. This is an ongoing process between the user and AIMS because a user's priorities can change with changes in her environment. This section discusses knowledge acquisition for the first kind of knowledge, while the next section will focus on the second kind of knowledge.

The development of a common message taxonomy, with general message categories at the top and specific message categories at the bottom, agreeable to all the e-mail users at the site was essential for the success of AIMS because it prioritizes messages received on the network from the users' communication partners. If all users do not use common nomenclature, AIMS will not be able to match the categories in the user's knowledge base with the keywords used in the message header.

At the top level, the message categories were classified into three areas based on the department structure, namely, messages related to research work, messages related to teaching work and messages related to service work in the department. Within each area, a representative sample consisting of experienced e-mail users (three years or more with the department) was selected and asked to develop a message taxonomy that would be appropriate for the majority of the users communicating messages through the prototype system.

The research group consisted of eight people (faculty and research assistants) covering all research projects within the department. The teaching group consisted of seven people (faculty and teaching assistants) who taught courses at both undergraduate and graduate levels. Finally, the service group consisted of six people (administrative assistants and department secretaries). A knowledge acquisition methodology recommended by Nunamaker, et al. (1988) was used to develop the taxonomy of message categories is described below.

The knowledge acquisition phase consisted of three sessions, lasting about an hour each, conducted with the GroupSystems (GroupSystems, 1989) tool-set in a conference room to determine the message categories for each area. Each session began with a session preparation phase, lasting about 10 minutes, which provided the objective of the session, outlined the tasks of the experts, and demonstrated the prototype system using an example knowledge base. A second phase, lasting about 20 minutes, involved idea generation on the different message categories with the Electronic BrainStorming tool and Issue Identification tool from GroupSystems. Users were also allowed to type additional text to describe the categories in detail and provide synonyms, if any. The message categories were submitted into a common pool and displayed on an overhead projector to a "public" screen. In the final phase, lasting about 30 minutes, the participants verbally interacted in order to classify the message categories into two levels. As a result of using GroupSystems, the three groups were able to come up with a large number of message categories in a relatively short period of three hours.

As shown in Table 1, the three sessions together produced 26 message categories at the second level and 149 message categories at the third level. For this study, we stopped at the third level to restrict the problem to a manageable size for our first prototype.

### Prototyping Phase

AIMS was accessible to the users like any other software in VAX/VMS operating environment, that is, it could be activated with the "RUN AIMS" command at the VAX prompt. It consists of two major components: the Knowledge Acquisition and Maintenance System (KAMS) and the Message Prioritizing System (MPS). As shown in Figure 1, the system prototyping of AIMS began with the development of KAMS. The purpose of KAMS was to provide an easy mechanism to elicit each e-mail user's priority (the second kind of knowledge mentioned in the previous section) on the message categories and represent this knowledge in the user's mailbox. The frame-based knowledge representation scheme (Minsky, 1977) was used to represent message categories in a top-down hierarchical manner with general categories at the top and more specific categories at the bottom. The representation was strictly declarative in nature, that is, the slots in our frames did not store procedural knowledge such as functions or procedures.

At the top level, there are three frames each representing a class of message categories for an area of the MIS Department, namely, RESEARCH, TEACHING, and SERVICE. The next lower level or Level-2 message categories were established as the subclass of the three parent frames, followed by Level-3 message categories as shown in Figure 2. For example, the class RESEARCH had a subclass of MEETINGS, ANNOUNCEMENTS, etc. (Level-2 message category) and the class MEETINGS in turn had subclass of

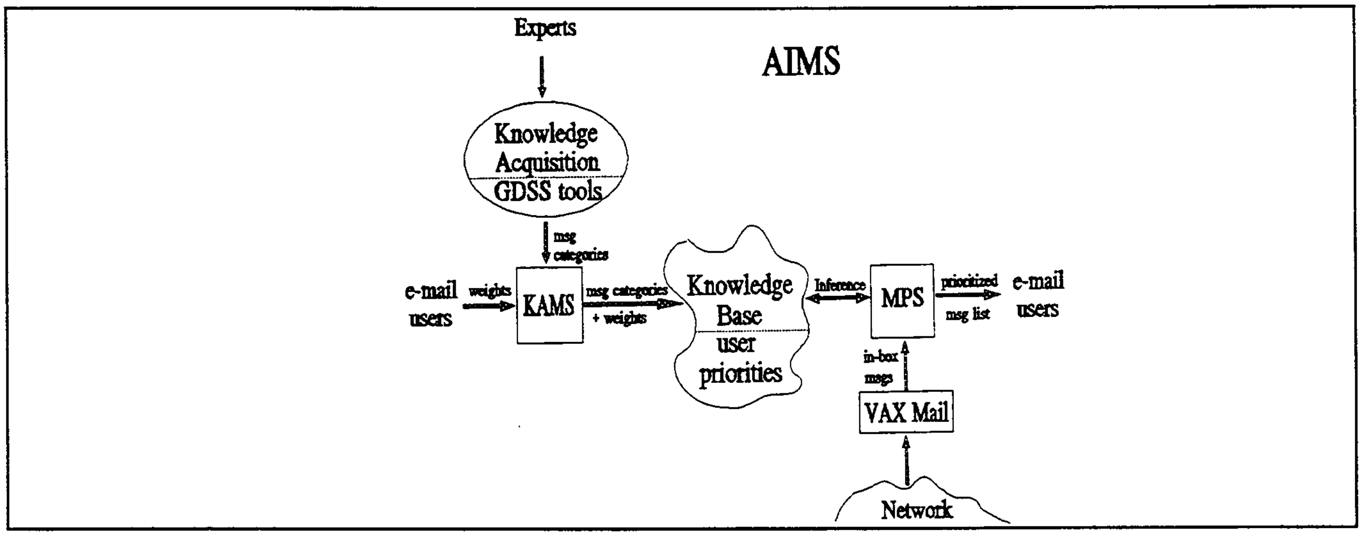


**Figure 1: AIMS Architecture**

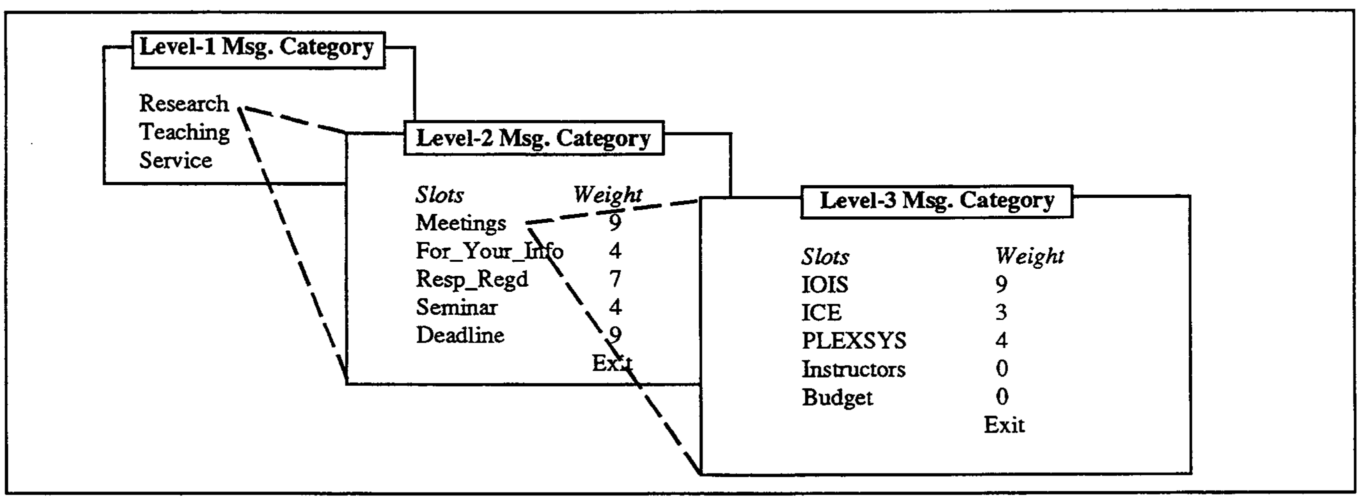


**Figure 2: Personal Knowledge Representation**

projects IOIS, ICE, etc. (Level-3 message category). At all levels the slots in the frames have only one value, namely, a WEIGHT represented as an numeric integer. Thus, the value in the WEIGHT slot represented the importance of that message category to the user. Initially, a default value of five was assigned to all the weight slots. The message categories along with the numeric weights make up the personal knowledge base of AIMS which was stored in each user's VAX account.

The second component, MPS, performs the message filtering and prioritization function. The MPS was designed as a shell over the VAX Mail system and therefore, its user interface mimics the VAX Mail interface. This makes MPS transparent to the user and minimizing interface adjustments. For example, as shown in Figure 3, the DIR command at the AIMS prompt produces a screen of prioritized messages from the user's mail in-box. AIMS defaults to the new messages directory of VAX Mail whenever there are new messages; otherwise it goes to the old messages directory (again this is similar to VAX Mail). MPS works independent of KAMS, but they both share the same personal knowledge base.

First, MPS determines whether a message belongs to RESEARCH, TEACHING OR SERVICE area with the help of a rule-based backward-chaining reasoning algorithm, written in the Pascal programming language. Pascal was chosen only because no expert system shell was available on the VAX computer at this department. The algorithm matches keywords used in the Subject of a message header with the three message categories stored in the knowledge base. Next, it proceeds to classify the message into one of the Level-2 and Level-3 message categories. Whenever a message category was identified, its corresponding weight was used to compute a composite score for the message. The composite score was computed by multiplying the numbers from the weight slots. The computation method selected was as a direct result of sensitivity analysis conducted with ten users in a pilot study.

The computation method selected during the pilot did not recognize the strong relationship that the users associate

AIMS>DIR

**Prioritized Message Directory**

| Rank | MSG No. | From | Total Score | Date | Subject |
|---|---|---|---|---|---|
| 1 | 4 | Oliver | 35 | 29 - 4 - 91 | IOIS Meeting |
| 2 | 5 | Jones | 29 | 28 - 4 - 91 | Aimail Appoint |
| 3 | 1 | Brown | 29 | 26 - 4 - 91 | GDSS Conference |
| 4 | 6 | Bird | 24 | 27 - 4 - 91 | Exp_SysSeminar |
| 5 | 2 | Bridges | 20 | 29 - 4 - 91 | Aimail Meeting |
| 6 | 3 | Smith | 15 | 20 - 4 - 91 | Lunch Today? |

**Figure 3: A Sample Screen of Prioritized Messages from AIMS**

among the message-sender, message-type (e.g., seminar) and message topic (e.g., AI or IT) in prioritizing their messages. Instead, it treated the attributes as independent characteristics. However, a discussion with the users revealed that they considered the attributes together while evaluating a priority of a message. For example, an AI seminar organized by Dr. Marvin Minsky can be of top priority, while an IT seminar by Mr. Joe Smith can be a very low priority to the user. The pilot study helped us in defining an appropriate computation method which treats the attributes as dependent variables, allowing users to assign low priority to unimportant messages. Therefore composite score can either increase or decrease as the level of the message category identified in the personal knowledge base gets more specific. For example, as shown in Figure 2, if the message has a keyword MEETING then it would receive a weight of 9, and if the message has the keywords IOIS and MEETING, the composite score received by this message is 81 (9 x 9). Similarly, if the message has keywords ICE and MEETING, the total weight of this message is 0 (9 x 0). This method allowed the users to "null out" junk messages, by assigning a weight of zero to a message category which had no value to the user. No weights were assigned to the top message category because the users wanted the three categories (research, teaching & service) to be of equal importance.

AIMS expects the e-mail users to use predefined message categories in the "Subject" of message header. A better alternative would be to use MS-Windows type interface where a pop-up window can display the keywords and let the user select them with help of a mouse. An even better alternative would be to use a natural language processor (NLP) which can interpret the message text and automatically provide corresponding message categories to classify the message. As NLP technology improves and becomes cheaper it can be easily incorporated into the AIMS architecture.

### Evaluation Phase

O'Keefe (1989) in his review of evaluation procedures for information systems found three major categories: control group experiments, attitude scales, and multiple-criteria methods. The evaluation process of AIMS differs from the general evaluation procedures of conventional information systems. A knowledge-based system is different from a conventional office automation or a transaction processing (accounting) system which were developed for completely automating clerical tasks. Knowledge-based systems, in general, are usually developed to assist users in their tasks (making decisions) and do not to replace them. The evaluation process of AIMS, discussed here, falls into the category of control group experiment but with one difference. Instead of dividing the users into two groups with one group using AIMS while other does not, our approach requires a user to perform the two tasks, namely, prioritize messages through AIMS and manually. That is, instead of comparing the effectiveness of the two groups to determine success, our approach compares the effectiveness of the same group with AIMS and without AIMS. This evaluation approach is more appropriate than the control group experiment method because it is evaluating the decision-making process of the user with AIMS.

The evaluation of knowledge-based systems (KBS) has generally been difficult and time-consuming because of the continuous development life-cycle (Gaschnig, et al.,1983) and lack of theory and guidelines (Liebowitz, 1986; O'Keefe, 1989). However, the exploratory nature of KBS makes it essential that adequate attention be given to the evaluation process at an early phase when it is less expensive and less difficult (O'Leary, 1990).

According to Gaschnig, et al. (1983), AI's scientific respectability can be increased if the evaluation process is formal and rigorous using controlled scientific methods producing statistical evidence on the system's effectiveness and should occur in phases ranging from feasibility demonstrations to "live" field tests with end users solving realistic problems. In addition, the system evaluation criteria must have the following criteria: "1) testing the quality of the system's decision and advice, 2) correctness of reasoning techniques used, 3) quality of human-computer interaction, 4) the system's efficiency and 5) its cost effectiveness (Gaschnig, et al., 1983)"

The evaluation of AIMS focused on the first three

| Demographics | Research | Service | Teaching | Overall |
|---|---|---|---|---|
| Average years in Dept. | 3.26 | 3.4 | 3.35 | 3.33 |
| Average e-mail experience (in years) | 4.32 | 3.0 | 4.11 | 4.04 |
| Average message frequency per day | 10.60 | 14.5 | 10.70 | 11.50 |
| Message representativeness | 3.50 | 3.1 | 2.70 | 3.10 |

**Table 2: Subject Background Summary by Area**

criteria suggested by Gaschnig, et al., (1983). The first two criteria, namely, the quality of AIMS's decision and advice, and the correctness of its reasoning process were evaluated with an experimental study to test the following proposition:

*A positive correlation exists between a message prioritized list generated by AIMS and a message prioritized list generated manually by a user.*

The third criteria, namely, the quality of human-computer interaction, was evaluated by an observation of the usage of AIMS (all users could operate AIMS with very little outside assistance) during the case study and by explicitly soliciting suggestions on AIMS from the users via a questionnaire. The fourth and fifth criteria, namely, system's efficiency and cost effectiveness were excluded at this stage because AIMS is a prototype system. System efficiency and cost effectiveness become critical during the full-scale implementation (production) stage of a system.

The evaluation process involved 46 e-mail users all of whom participated voluntarily. Of the 46 users, 18 were faculty members, 10 were staff members, and 18 were doctoral degree students. The background information on the subjects is summarized in Table II. Although the sample was selected out of convenience, it was made sure that the users had adequate experience with e-mail. Experience with e-mail was considered relevant because the experimental task involved the use and understanding of a e-mail system and it was used to maintain group homogeneity. The group homogeneity based on experience made it possible to control the possible effects of extraneous variables such as department knowledge and e-mail experience on the strength of the relationship between the two message lists. In addition, the departmental structure was used to stratify our sample into teaching, research, and service groups.

Three sets of message scenarios were designed, for each of the three major functional areas of the department and included in a survey form (See Appendix A). This form was designed to provide instructions on the task, request background information from the participants, and present the message scenarios. The instructions required each user to rank the ten message scenarios manually and with AIMS. A rank of one was to be assigned to the most important message and ten to the least important message without repeating any ranks. The participants were also asked to rate the representiveness of the message scenarios with actual messages they receive while working in the department. On a scale of one to five, the average rating of the message scenarios was 3.1 (see Table 2) which was slightly above the mid-point of our scale suggesting that the messages on the whole were somewhat representative. This form was pre-tested with two persons from each area.

The evaluation study was conducted in the presence of an observer. The observer's task was to assist the participants with the interface of AIMS (if necessary), answer questions concerning the instructions on the validation form, and check the transfer of ranks generated by AIMS into the validation form. The evaluation process involved three steps. In the first step, each user was asked to use the KAMS module to provide their priorities on all the message categories. This task, although cumbersome, has to be done the first time AIMS is used and whenever the user wants to change her priorities. After the first time the changes are of marginal nature only. In the second step, each user was asked to answer the survey form where one of the key tasks was to prioritize the ten messages manually. In the third step, each user was asked to use the MPS module to generate a prioritized message list of the same ten message scenarios and transfer them to the survey form with the attention from the observer.

Results used to evaluate the validity of the proposition for the three groups are summarized in Table 3. Since the data generated was in rank-order form, Spearman's rank correlation r was computed for each user using the SPSS statistical package. The overall sample mean was 0.70 and the 95% confidence interval for the mean was (.65, .75), indicating a low variance among the sample.

The confidence intervals reported in Table 3 indicate a great amount of overlap, and hence there is small difference in system accuracy across the three groups. Overall, only five of the 46 users had a correlation of less than 0.5, indicating that AIMS was accurate for nearly every user in the study.

The results provide support for our proposition because AIMS was successful in prioritizing the messages for the users, and the results were consistent among the three groups. However, it is interesting to note that the service group had a

| | Teaching | Research | Service | Overall |
|---|---|---|---|---|
| $\bar{r}$ | .69 | .69 | .75 | .70 |
| S.D. | .18 | .16 | .20 | .18 |
| S.E. | .04 | .04 | .06 | .03 |
| 95% C.I. | (.60,.79) | (.60,.77) | (.60,.88) | (.65,.75) |
| N | 17 | 19 | 10 | 46 |

**Table 3: Summary of Spearman Correlation Comparing Manual and Computer Generated List of Priorities**

slightly higher variance because of two users who scored a perfect correlation (Spearman r of 1.0). A further review of the raw data revealed that both these users found 7 of the 10 message scenarios irrelevant and opted to rank them in a sequential order (after selecting ranks for the three messages that were relevant for them). The mean and standard deviation of the service group were inflated by .07 and .03 respectively because AIMS used the same process.

Although the results support our proposition, the possibility of contamination remains due to threats to internal and external research validity. For example, users were asked to rank the same message scenarios first through AIMS and then manually. This raised the issue of task maturation because some of the users could have remembered the ranks assigned by AIMS, influencing their manual ranking. To prevent task maturation, users were prevented from looking at the results from AIMS until after they finished the manual ranking. In addition, there is a possibility that users may remember some of the keywords as they were ranking the messages manually. This is not a problem because if a user considers a message on meetings very important and gives it a high priority weight to the keyword, meeting. Now, the same user gives a high rank to the meeting message when he ranks the messages. In both situations, the user is reacting to a keyword based upon his or her priorities. Because meetings are important to this user, she gives a higher weight to the meeting keyword and when she sees a message with meeting topic it is ranked high. Furthermore, there were 150 keywords used in the AIMS prototype. In a full-scale version there would be even more keywords and hence the chances of the user remembering the keywords would be even more slim.

The focus of external validity is on considering limitations of the study such as controls imposed in selecting the sample, designing the experimental task, and procedures, and the duration of the study. Anyone generalizing the results of this study should consider the following two points.

First, the users selected for this study belong to a single academic department from a university with an average e-mail experience of four years and exchanged an average of 11.5 messages per day. The results are therefore generalizable to a population of e-mail users with equivalent experience and message frequency. However, an observation of the raw data on weights assigned by the users on the various message categories of KAMS indicates a major variance among the message lists generated manually by users in each group. This suggests that AIMS performed consistently even though the priorities of the users were vastly different.

Second, the results were based on a snap-shot observation of AIMS with each user. This does not allow determination of the consistency of the results or the robustness of AIMS's accuracy over a long period of time. For instance, the study does not make it possible to determine whether the correlation would increase or decrease when AIMS was used repeatedly by the users. In short, the present study does not allow any determination of whether AIMS would have any detrimental effects on the users in the long run.

## Conclusion

This paper has focused on addressing the issue of time management by the development of an intelligent mail system, called AIMS, which can assist users in prioritizing their e-mail messages. AIMS objective was to reduce the effect of electronic junk or provide a better technique for managing information overload for e-mail users. The success of AIMS in managing user's time is highly dependent upon the system not assigning a high priority to low priority messages and vice versa. The first error could cause the users to hate e-mail systems, while the latter could cause information overload. AIMS success is also dependent on how well the system is operated and monitored in an organization. For instance, after each message is composed, the system should assist the user in categorizing the message into one of the predefined message categories. Adequate assistance should be provided in this task. Furthermore, AIMS requires adequate monitoring to prevent users from exploiting the prioritization process by assigning certain message categories to trigger higher priority for their message. Encouraging users to be vigilant and report recurring occurrence to system administration could prevent such problems.

The current trend in many US corporations, like IBM and US West, of "flattening" their organizational structure by eliminating various positions has created more work for the remaining middle managers with a static timetable to accomplish priorities. In such an environment, an intelligent e-mail agent like AIMS can manage user's time by sorting and prioritizing messages saving users considerable amount of time (thereby increasing productivity). It can counter the undesirable effects of junk mail and/or message overload by allowing the user to focus her efforts on priority issues before attending to low priority tasks. Time-management, task-management, and information-management are just a few from a large body of e-mail functions that must be supported in the future through an integrated set of autonomous intelligent agents which can be called upon by a user to perform specific tasks.

In the future, a similar approach can be used to expand e-mail functionality to information management and task management areas. For instance, the message categories could be generalized further by the expert user group and used by the system to create portfolios (directories) where messages could be automatically archived for later use. In addition, information management mechanisms must be provided at the message dissemination end to control electronic junk. E-mail users should be provided with dynamic distribution lists instead of static distribution lists, which tend to include many unnecessary recipients. Dynamic distribution lists can be created through knowledge-based systems by inferencing the contents of the message with organizational knowledge (Motiwalla, 1992) such as, structural relationships among departments, groups and individuals and personal profiles of users. These distribution lists can reduce unnecessary message traffic caused by static distribution lists thereby controlling electronic junk at its source. Another approach would be use of neural networks that constantly monitor user priorities and automatically update weights or monitor contents from the message header to recommend updates of attributes (keywords) in the knowledge bases. These enhancements combined with the natural language processing system to automatically categorize messages into different categories would minimize some of the current limitations of AIMS.

## Endnotes

[1] a set of predefined words stored in a database

[2] an electronic form with a predefined structure for users to provide information

[3] keywords to classify all the different message types used in an organization

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