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Developing an Email Interception and Interpretation Information System to Reduce Employee Interruptions

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ABSTRACT

Currently the majority of employee email interaction is inefficient as many employees are interrupted by email as frequently as every five minutes (Jackson et al 2003a). A detailed assessment of email interaction has been carried out over the last five years and a system has been developed that will attempt to increase the efficiency of an employee's interaction with an email system through changing the way employees are interrupted. This paper details the research components of the email system and the results of a very small preliminary study.

INTRODUCTION

It has long been clear that email is more than just a simple communication system (Mackay, 1998), (Whittaker and Sidner, 1996). Email has become a central element of the way work is conducted in organisations where computers are used. It is now the source of many different office tasks, serving as the tool for receiving and delegating (Whittaker and Sidner, 1996). For today's computer user at work, email is much more than an ordinary application. It has become a part of the working habitat (Bellotti and Smith, 2000).

Workplace communication is extremely important and is a dynamic ongoing process. It enables employees to work together to achieve cooperation and to interpret ever-changing workplace needs and activities. Given that communication pervades nearly everything we do, even small improvements in the effectiveness and cost of our communication processes can have significant benefits.

In the past five years significant research has been carried out at Loughborough University (UK) into the use of email within the workplace and its impact on the employee and their job (Jackson et al 2001, 2003a, b). This research has enabled greater understanding of the dimensions of effective electronic communication, enabling email users to reap the benefits that computer-mediated communication technology provides. One of the major findings from the research was that there is a recovery time following an interruption by email. This was found to be 64 seconds[1].

The number of interruptions caused by email can affect an employee's work and cause message fatigue (Mollenhauer et al., 1994), which can lead to a decrease in the quality of work and an increase in the stress levels of an employee. To put email interaction and interrupt recovery time into a tangible context, research has shown that it costs a company over £3,000 (UK pounds) a year for an employee to communicate over email. This cost only accounts for interaction time and does not include the cost of running the software or hardware, and any disruption through email downtime (Jackson et al 2005). While an employer or employee does have the option to set the email client to receive email at less frequent time periods, there may be cause for concern if an email is important and requires immediate attention. By lengthening the time between which emails are delivered, the likelihood that an important email will be seen and dealt with efficiently is reduced. Problems arising from legitimate interruptions are not the only issue, spam or 'Junk Mail' is also becoming far too frequent in today's workplace. According to a recent survey from an email security company, nearly 15 per cent of emails received each day by British firms are spam (Nua Internet, 2002). Spam accounts for a large proportion of the email received today and therefore estimates of the cost of spam for an organisation are huge (employees may be interrupted, only to find that spam was the cause) (Edward et al., 2000).

Much of the research in the field of computer-mediated communication focuses heavily on learning which communication medium will best serve individual or group requirements. Research has stopped short of investigating the most appropriate times to interrupt and deliver different types of email messages to an employee. The authors have developed an application that seeks to determine the best time to interrupt an employee in order to improve efficiency and productivity. The application will also help to discover more about how email is generally received within the workplace.

Currently users generally receive email based on a fixed time period. This can be disruptive and lead to a reduction of productivity (Jackson et al 2005). Research by Microsoft looked at the effect of interruptions caused by instant messages, such as those seen from MSN messenger (Edward et al., 2000). Results showed that when an interruption is unrelated to the task the user is performing (which is often the case with an email), users will take longer to process the interruption and it will be more difficult to get back into the task that was interrupted. Interruptions seemed to have the greatest influence and cost when a user is searching through information or typing, as these have the greatest resume times. The research suggested that enabling the user to determine the subject of the message, before actually breaking away from their current task allows a smoother assessment of the importance of the message. The user may then decide whether to continue with the current task before stopping to read the message.

RESEARCH AIMS

On-going research at Loughborough University aims to increase user productivity by altering the way in which users are interrupted by an email system.

The authors aim to deliver email not at a fixed time but at a time which is deemed more appropriate for the user. However this should not interfere with the delivery of important messages. It is therefore clear that a scheme of assessment will be needed to judge the importance of the email and recent user activity. If the user is busy, delivery of the email should be deferred until the user is deemed available.

The aims are therefore:

- To determine recent activity and current work context of the user and make a judgement on the availability of that user and whether an interruption would be appropriate.

- To intercept the delivery of email before it reaches the users email client.
- To determine the context of the email and its importance.
- To deliver the email to the user and allow notification of the emails arrival.

BUILDING THE SYSTEM

The building of the system will be described only briefly.

Intercepting and Delivering the Email

In order to determine if an email is important it must be intercepted and analysed before it reaches the employees email client. One option is POP3 (Post Office Protocol 3) which would download the mail directly from the mail server, process the mail and then make the email available for the email client to receive. This can be done by setting the email client to retrieve mail from the localhost on port 110 and have the system collect mail from the users POP3 email box directly. This system obviously only works where POP3 servers are available, but is ideal for this type of 'proof of concept' application as it only interferes with the individual clients on which it is installed.

It was decided that using POP3 would be more appropriate then using the SMTP (Simple Mail Transfer Protocol). The system would therefore implement its own POP3 server and client shown by Figure 1.

Pre-Processing

Before an email can be analysed a number of processing steps must occur to extract useful content from the email. Figure 2 shows the modules involved in processing the email before the content is given to the Bayesian filter that decides the importance of the email. Such steps prevent meta-data, numbers and words which do not contribute to the information, from being treated as useful text.

Determining Email Importance

Probabilistic filters have made a great impact on success rates and have led to claims of above 99% accuracy with diminishing numbers of false positives (legitimate emails classified as spam). It was therefore decided to try to adapt a Bayesian filter based approach in order to determine the importance of emails.

The Bayesian filter used in this research has been based upon Paul Grahams 'Plan for Spam' (Graham, 2002) and 'Better Bayesian Filtering' research (Graham, 2003). In Graham's research he describes an algorithm that can be used to determine whether an email is spam. The user simply marks emails as junk or legitimate and, based upon Naive Bayesian probability, the algorithm records the likelihood that each word in the email is spam. However, the algorithm for this research had

Figure 1. How the system intercepts and delivers email to the end user

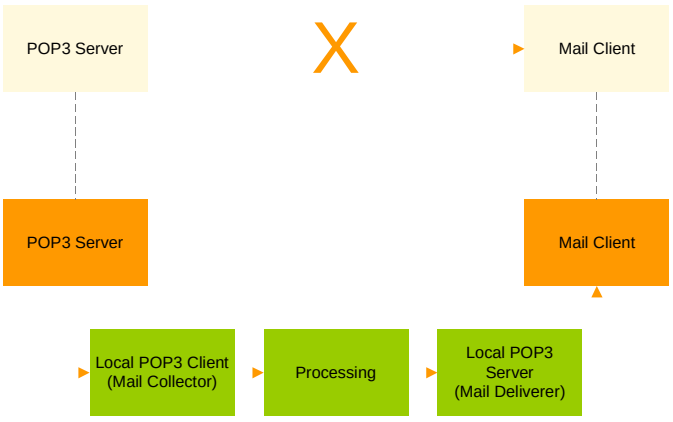
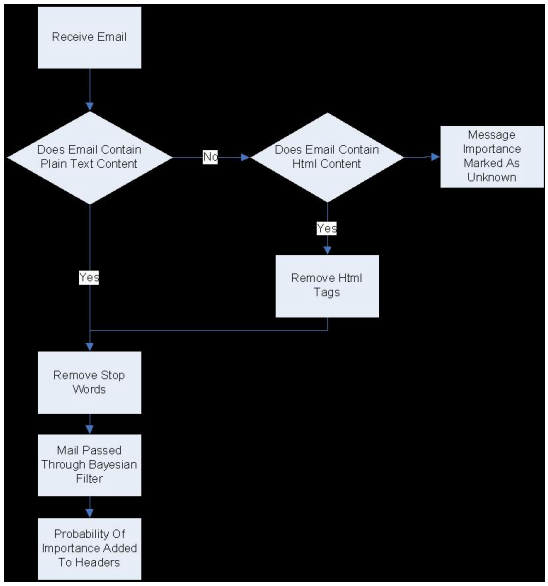


Figure 2. Modules involved in pre-processing an email



to be modified and contains some significant differences (due to the fact that the application is trying to analyse the actual content and semantics of the email and not the way in which it is presented).

As very little implementation guidance is given, a number of concepts have been assumed from Graham's research. Some key differences to note in this algorithm are as follows:

- Remove Html tags and encoding. "In spam ff0000 (html for bright red) turns out to be as good an indicator of spam as any pornographic term" (Graham, 2002).
- When analysing the content of an email to determine its importance it was decided that the colour the sender had chosen would make little difference to the importance that the recipient gave the email (White and Zhang, 2004).
- Case does not need to be preserved for similar arguments. In our filter only the subject line and the body are considered.
- Bias was also used in the spam algorithm to prevent false positives. A bias will not be added in this algorithm.
- An email of 60% importance is taken to be important and anything below this is not important. A level of 90% was used in the spam algorithm.
- The algorithm in based on Arc (a variation of Lisp) which is based on a pre-fix notation. The samples were converted into C# for our algorithm.

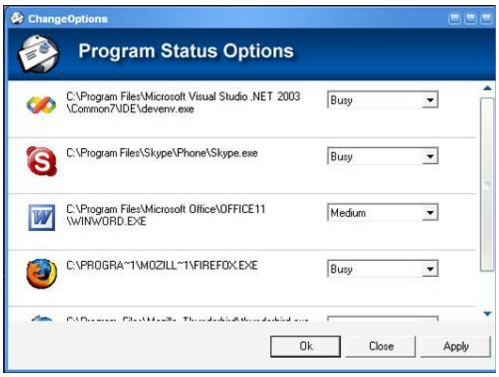
The Bayesian Filter

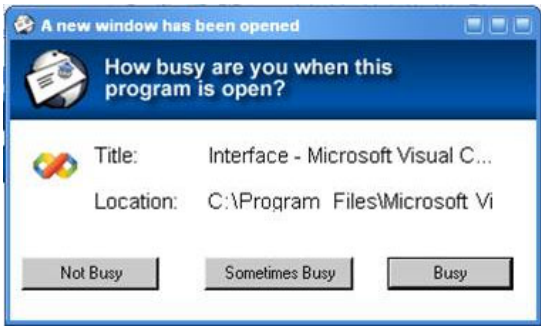
To ensure consistency, the authors' used the same notation as Graham's research. An important email was referred to as 'good' and non-important as 'bad'. When the filter is instantiated a list of previously seen words and their respective probability of being good or bad words is loaded.

When email arrives the system must first decide the probability that the incoming message is a good or bad email. The next step is to take the difference of each probability from 0.5 and sort the array on this difference. The result is either the top 15 entries, or the 15 most interesting words. Interesting means highest probability of being either good or bad. The 15 probabilities are then combined to give the overall probability that an email is good or bad.

In order to calculate the probability of each word being bad, the occurrences of that word must be counted in both good and bad emails. A record of the total number of good and bad emails was also stored. The application then calculates the number of times that the word has appeared in a good email divided by the number of good emails. This gives

Figure 3a/b: (a) User preferences can then be changed from the options menu later. (b) The window allows the user to state whether they are busy or not when the current application is in the foreground.





the number of occurrences per good email. This was repeated for the number of times the word has appeared in a bad mail. The number of times the word has appeared per bad email over the number of times it has appeared in total over the total number of emails is then calculated. The total number was obtained by adding the good and bad figures together.

Determining the Status of the User

As previous research suggested (Edward et al., 2000) interruptions have a greater effect on users who are searching or typing. It was therefore decided to monitor for searching and typing characteristics. Searching was defined as performing scrolling or typing tasks, where scrolling is moving the mouse vertical or horizontal with the left or middle (wheel) mouse button held down (or using the middle wheel to scroll).

The second condition was to determine if a user is busy and was based on the current foreground window which was deemed to be an important factor. As previously mentioned certain tasks should not be interrupted. It was therefore decided that the user should be able to choose which applications should always be interrupted and which should never be interrupted.

The user also had the option to mark applications as 'medium' or 'sometimes busy' in which case the system uses other measures to decide if the user is busy. Figure 3 shows the user interface that was used to mark a user's availability whilst working in an application.

Capturing Metrics

The Interception and Interpretation Information System has been built so it can record metrics to enable analysis of the application. The metrics that were recorded are:

- The numbers of emails judged by the system to be important and not important.
- The number of emails changed from important to non-important and non-important to important is also recorded to help judge how accurately the system is judging and to detect bias.
- The number times the system downloads email when it connects to the remote mail server. This helps to judge how many times a user would have been interrupted if their email client was set to receive email at the application default of every five minutes. This is then used in conjunction with a field which records the number of times a notification is shown to a user by the Interception and Interpretation Information System. This therefore records the number of times users are interrupted.

TESTING THE SYSTEM

The Interception and Interpretation Information System was tested at a company called Todo-Mundo Limited based in the UK. Todo-Mundo are in the service industry and offer various products in connection with Health and Safety, Electrical and the Environment etc. Five employees were questioned about their interaction with email and the problems they faced with email interruptions over a 5-day period whilst they used the system. During the 5-day period the users were asked to state how appropriate it was to have been interrupted on a scale of 1 to 5 at the point of an email being delivered. The basis of this test was to capture how often users were interrupted when they were busy.

Preliminary Results

The results returned by the system were in the form of counts in the xml file separated by day. This was therefore easy to import into xml to enable graphs to be drawn for each user. The majority of results followed a similar pattern:

- Employees spent the first few days personalising the system.
- There were a number of changes from important to non-important and vice versa.
- There was a high number of changes from messages being important to non-important (this shows that there is a bias towards importance when the system is unsure, which is likely to be due to any unknown word being given a 60% importance - this is a beneficial outcome as it can help prevent frustration when important email is not delivered).

Feedback following the first day showed:

- Employees were happier with the number of interruptions that they received.
- By the end of the trial users were on average 2.5 points (on the 1 to 5 scale) happier with their email systems.

This does suggest a positive improvement. However, results showed that the number of interruptions had not significantly decreased by the first day and over the 5-day trial they also had not significantly reduced. This could have been because interruptions occurred at more appropriate times, or because of the physiological aspect of having involvement with the system, or because the employees knew they were being monitored. Although users were happier with the interruptions that occurred, it is not possible to determine if this was because of the new system in place.

The metrics captured by the system showed that the majority of emails were not held long enough for another email to arrive and prevent an unnecessary interruption. Although in the minority, the emails that were being held for any extended period of time demonstrated that potential unhelpful interruptions were being moved to more appropriate times. It is important to note that most of the subjects studied had a relatively low number of emails arrive per day. With more email arriving, the time to actually train and personalise the system should be quicker.

As with many spam-filters the system does need significant training. Following the system training period the number of incorrectly assessed emails dropped significantly. During the first day only 10% of emails

were assessed correctly and by the end of the second day it raised to 50%, with improvement throughout the week.

CONCLUSIONS

Overall, the application to intercept and deliver email has worked well. While these results are from a small trial conducted in a small organisation, the system has to date, also been ad-hoc tested in a number of organisations, demonstrating no delivery issues. In almost all cases the content of the emails were decoded to a usable state, although there were some cases where the content could not be decoded (this was found to be due to the nature of certain types of email). Testing the system on a larger population and longer timescale would further help to remove anomalies and provide more meaningful results. However, the trial was a success as it demonstrated the systems interaction and acted as a preliminary information gathering exercise.

A large proportion of users recognised the difficulties that they face with interruption, and have shown interest in having such a system in place permanently. It is clear that interruption from emails is a problem experienced by many. Overall the system has demonstrated that there is potential for further exploration.

The authors plan a separate study into methods of assessing the context of the current users work. There were times during this study when although the system was functioning correctly, the assessment of context was inaccurate. The Email Importance Determination Module also requires further testing as findings showed that values tended to be at either end of the scale and rarely in the middle.

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ENDNOTE

[1] The recovery time was calculated by recording the amount of time that it took employees to return to their work at the same work rate at which they left it. This required an element of judgement by the person reviewing the recorded material. However, in nearly every case there was a clear point where the user ceased to move the mouse around the screen and jump between screens trying to pick up their train of thought and the production of useful work. Although this may be regarded as a rather inexact measure, the clear change as the user starts productive work means that, in practice, interpretation of the activities by different people would not have given any significant difference in the results.