# Large-Scale Analysis of Email Search and Organizational Strategies

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## ABSTRACT

Email continues to be an important form of communication as well as a way to manage tasks and archive personal information. As the volume of email grows, organizing and finding relevant email remains challenging. In this paper, we present a large-scale log analysis of the activities that people perform on email messages (accessing external information via links or attachments, responding to messages, and organizing messages), their search behavior, and their organizational practices in a popular web email client.

First, we characterize general email activities as well as activities associated with search. We find that within search sessions, people are more likely to access information and respond to messages but less likely to organize. Second, we examine the relationship between characteristics of a person's mailbox and their search and organizational practices. People with larger mailboxes tend to organize more, respond a little more, and access information less. People with larger mailboxes and folder structures search more, but the number of folders has less influence on search. Third, we extend previous work on email organization (e.g., *filers* vs. *pilers*; *cleaners* vs. *keepers*) by examining the extent to which these strategies are evident in our large-scale analysis and influence email activities and search. People who rely heavily on one organizational strategy tend to use others less. People who organize less tend to search more. Finally, we describe how these insights can influence the design of email search.

## Categories and Subject Descriptors

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval – *Search process*.

## Keywords

Email search; Email management strategies.

## 1. INTRODUCTION

Twenty years ago, Whittaker and Sidner [29] coined the term *email overload* to describe the fact that although email was designed for asynchronous communication, it was being used for multiple purposes including task management and personal archiving. The annual volume of email continues to increase around 5% per year [25], but organizational affordances in email systems have not evolved substantially. Some automation helps by classifying spam emails and estimating message priorities. Users are still left to devise and implement their own organization systems using a small set of features: deleting, filing into folders, flagging, toggling the read/unread state, and tagging. Search scales more efficiently for large quantities of email, but email search is much less studied than web search.

Most prior work on email interactions and organizational strategies involves small-scale diary studies, surveys, or logs obtained from limited deployments [3][5][13]. While informative, these studies cannot capture the broad variety of user activity. To do so requires large-scale log analyses of *in situ* email interactions. Such logs provide a picture of what happens across a wide range of individuals with different volumes of email and different email management strategies. Thus, large-scale investigation allows us to validate and extend taxonomies and hypotheses developed in earlier research.

Recently there have been a few large-scale log studies of email use. Research from Yahoo! looked at email interaction for personal web email accounts. These accounts contain a large amount of machine-generated content, so their research focus has been on automatically categorizing machine-generated emails into a small number of folders [1][12] and predicting what actions people will take on emails [7]. In the work presented in this paper, we focus on work ("enterprise") email accounts. Work email is less dominated by automatically generated commercial mail [12], and involves more email organization and keeping behaviors than is evident in personal accounts [4].

In this paper, we present a large-scale log analysis of hundreds of thousands of anonymized users of a popular web email client. Because of our interest in search, we only consider users who searched at least once during a one-week observation period. We characterize general patterns of email interaction as well as interactions that occur in search sessions. We also examine the relationship between characteristics of people's mailboxes (e.g., size, volume of email, and number of folders) and their actions and search activity. Finally, we extend prior work on email organiza-

tion by examining the relationship between different organizational strategies and actions that people take on email messages and their search activity at scale.

## 2. RELATED WORK

Several areas of prior work are relevant to the results presented in this paper, including research on email management practices and log studies of email activities including search.

*Email management practices.* For several decades, email has been one of the most common communication and personal information management technologies. Although it was originally developed to support asynchronous communication, it quickly became used for task management and personal archives as well [13][29]. Several early email studies examined how people organized and managed their email. In their study of 18 Lotus Notes users, Whittaker and Sidner [29] coined the term "email overload" and identified three common strategies for mitigating overload. **No Filers, Filers, and Spring Cleaners**. *No filers* (sometimes referred to as *pilers*) forego using folders relying instead on browsing or search. *Frequent filers* minimize the number of messages in their inbox by putting emails in folders, and *spring cleaners* organize their mail only occasionally. A decade later, Fisher et al. [11] found that these strategies were still evident using a sample of 600 Microsoft Outlook users. More recently, Grevet et al. [13] revisited these previous findings with a qualitative study of Google Gmail users and found that email overload was still prevalent, now encompassing both work and personal settings. Bälter [2] used a keystroke-level analysis to model the time required to file and retrieve email for frequent filers, spring cleaners, and folderless spring cleaners. Gwizdka [16] identified two additional email management practices, **Cleaners and Keepers**, based on clustering responses to a questionnaire about email practices. Dabbish and Kraut [6] showed that people who kept their inboxes small were less stressed. This finding was also corroborated for academics [3].

The previously mentioned email management practices depend on techniques such as filing or deleting to keep inboxes small. There are also **Information Highlighting** techniques that can visually highlight items, rather than removing them, to make them easier to find when scanning a folder or search results. Gwizdka [14], for example, showed how a graphical task view could be used to support people in completing pending tasks. Although not as sophisticated as this, most email clients, including the one we studied, allow people to make specific messages visible, e.g., by flagging or categorizing, or by simply marking as unread. Such techniques provide a way of organizing messages by visual, sometimes searchable, properties.

*Email usage at scale.* Most of the results described in the previous section were based on small samples and used qualitative methods such as interviews, diaries or questionnaires, but recently there have been larger-scale studies of people who use popular web email systems. For example, Kalman and Ravid [19] conducted a longitudinal study of the inbox-management strategies of several thousand people using an Outlook add-in. They showed that people have a more diverse repertoire of inbox management behaviors than posited by earlier taxonomies. They developed the Inbox Cleaning Index (ICI) to characterize how the volume of messages in people's inboxes varies over time. In studies of a Yahoo! email users, Koren et al. [21] and Grbovic et al. [12] showed that 70% of Yahoo! web mail users did not define any folders and 90% of the rest did not actually use folders that they created. They argued that search is an increasingly important alternative to human-generated folders and tags. Grbovic et al. [12] found that a large

proportion of non-spam email was machine generated (e.g., including e-tickets, confirmations and invoices, newsletters) and they developed automatic classifiers to organize machine-generated email into five categories. In a similar way, Di Castro et al. [7] developed a learning framework to predict the most common email actions, which in their study were read, reply, and delete. Whittaker et al. [28] examined the relationship between email management strategies and subsequent retrieval strategies for re-finding. They noticed that some users expended preparatory effort of creating complex folder structures to promote re-finding while others were more opportunistic and used search and threading to reduce the need to file manually. In a log study of 345 users, they found that people who create complex folder structures did indeed rely on them for retrieval, but that search and threading provided more effective finding. Elsweiler and colleagues [9][10][17] also studied re-finding behavior in email through a series of quantitative and qualitative studies. They found that orienteering is a common strategy used for re-finding emails. Users tend to search with short queries and navigate through their results for cues to find their intended email. They further proposed query similarity and query overlap to be good indicators of re-finding intents of users.

*Email practices in personal vs. work settings.* Individuals often have multiple email accounts (e.g., work and one or more personal accounts) and multiple devices (e.g., desktop computers, laptops, and phone) from which people interact with email. Smith et al. [27] were the first to point to a tension between work and personal email. They found that in 2003, 54% of their participants had two accounts. A decade later, Capra et al. [3] surveyed 600 university employees and found that 84% of them had separate accounts to help manage boundaries between work and personal life. These two types of accounts had different characteristics; respondents reported more frequent use of keeping behaviors and larger inboxes in their work accounts. However, there were some consistencies as well, indicating that personal preferences or prior experiences also play a role in email management practices. Grevet et al. [13] studied people who used Google's Gmail for either personal or work purposes. In contrast to Capra, they found that inboxes in personal Gmail accounts were generally larger. Cecchinato et al. [5] used a diary study to understand email management and search strategies. They found that people manage their personal and work accounts differently, and use different retrieval strategies. Work accounts were more structured and email was generally retrieved through the folder structure, whereas people had fewer folders in personal accounts and relied more on search to find email.

The research presented in this paper differs from previous work in several ways. We use large-scale log analysis to analyze interaction patterns in work (enterprise) email accounts. We examine the prevalence of email search and the activities that people take on messages following searches. We examine how characteristics of mailboxes (size, volume of incoming messages, and the number of folders) are related to people's interaction with email messages and searching. We also compare people with different email organizational strategies, again looking at differences in email activities and search. The results complement and extend previous smaller-scale and qualitative studies.

## 3. METHODOLOGY

We now describe how we performed our analysis. We discuss the dataset and formalize the problem. We then define the different measures we use, including behavioral interactions, mailbox characteristics, and organizational strategies.

## 3.1 Dataset

We sampled one week of interaction log data from Microsoft's web email service. The interaction logs contain message- and search-oriented activities with timestamps and other metadata; section 3.2.1 details the types of activities. We did not have access to any kind of email content or search queries. We focused on corporate email accounts, which were identified by a property in the logs. Because we are interested in email search, we include only users who issued at least one query during the week. To reduce variability, we further include only users in the United States, and remove people who had fewer than 10 or more than 10,000 email activities during the one-week period. The resulting dataset contained 283,000 distinct users and 145.8 million email activities.

The web email system we studied uses a standard email interface. A folder list is shown on the left side, a list of messages is shown in the middle, and the full text of the selected message is shown on the right. The snippet for each message includes the sender's name, the subject, the first few words of the email, and metadata such as the time. Selecting a result opens the full text of the message in the reading pane on the right side. The search box is located on the top left of the page. The results of a search are presented in the same fashion as the list of message described above, and the left pane contains matching folders and options for further refining the query. Exiting the search returns the user to the default folder list and view.

## 3.2 Measures

In email and web search, people seek to find and re-find information mediated by the IR affordances of the system. In web search, selecting a result link is the most common action. Email search provides a richer set of actions on the messages than are available in web search. For example, a message may be deleted, replied to, forwarded, or filed. We aggregate these actions across users to create behavior-based measures of email interaction.

### 3.2.1 Activities

We consider thirteen individual activities which are grouped into four broader classes as shown in Table 1. The classes correspond to higher-level tasks that a user performs when interacting with email – selecting messages, accessing external content, responding to messages, and organizing messages.

| Class | Included activities |
|---|---|
| Select | SelectMessage |
| Access Content | ClickLink, OpenAttachment |
| Respond | Forward |
| | Reply+ (Reply and ReplyAll) |
| Organize | Delete |
| | Move |
| | Mark+ (Flag, FlagClear, FlagComplete, MarkAsRead, MarkAsUnread) |

**Table 1. Classes of message-related activities. We consider thirteen individual activities, grouped into four higher-level classes of email tasks (Select, Access, Respond, Organize).**

SelectMessage occurs when a message is selected and its content is shown in the reading pane and allows other actions to be performed on the message. Two actions are used to access external content. ClickLink refers to selecting a link embedded in an email while OpenAttachment is the explicit user action of opening the attachment in an email. Three actions (Reply, ReplyAll and Forward) are used to respond to email messages. And, seven actions (Delete, Move to Folders, Mark As Read or Unread, Flag, Flag Clear or Complete) are used to organized emails in various ways.

SelectMessage is by far the most common activity, accounting for approximately 75% of email activities. This is because selecting a message is necessary to read a message and to perform subsequent actions such as replying or deleting. We remove SelectMessage from the activities considered since we are interested in the actions that people explicitly perform on selected messages.

In order to summarize the actions that people take on selected messages, we compute the distribution of activity types. Specifically, we compute the proportion of total email activities that each activity accounts for aggregated over the whole dataset. We report proportions rather than absolute counts of activities to accommodate a wide variation in the total amount of email interaction that we see across individuals. For example, if one person deletes 4 of the 10 email messages they receive and another person deletes 400 of 1,000 messages they receive, they both delete 40% of their incoming emails.

### 3.2.2 Search Sessions

In web search, a collection of temporally related queries and result clicks are grouped into a "search session." Analogously, in email, a search session begins with a query and is followed by zero or more additional queries and message-oriented activities. These activities include selecting a result message, opening an attachment, forwarding, replying, deleting, moving to a folder, flagging etc. (as shown in Table 1). The email search session terminates under one of following two conditions: (1) the searcher explicitly closes the search query box in the UI, or (2) there are no searches or message-related activities for ten minutes. This timeout is similar to what is used in web search and handles cases where a person stops interacting with the mail client for a long period of time.

Figure 1 provides a schematic of the relationship between activity within search sessions and non-search email activity. When people interact with their email, there is a steady stream of message-related activity, denoted a in the figure. We are interested in the subset of this stream that comprises search sessions. Search sessions begin with a search query (denoted Q), include one or more subsequent activities or queries, and end with a time-out (denoted —) or an explicit exit from search (denoted X). All activities that occur within search sessions are called search activities. And, all activities which do not occur in search sessions are called non-search activities.

In our dataset, there are 479,000 search sessions which contain 1.9 million searches. In Section 4.1.1, we examine email activities within search sessions (search activities), and in Section 4.1.2 we compare email activities that occur in search sessions with those that do not (non-search activities).
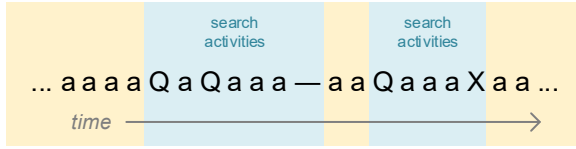
**Figure 1. Schematic of search and non-search activities. In a timeline of email activities (labeled a), a search session (highlighted in blue) starts with a query Q and terminates with either a timeout (—) or an explicit closing of the query box (X). Non-search activities are highlighted in yellow.**

### 3.2.3 Mailbox Characteristics

Prior literature suggests a relationship between mailbox size and feelings of email overload and stress [2][6][29].

The actions that people take on their email message and how often they search for messages may also be related to characteristics of their mailboxes. In our analysis, we consider three characteristics of people's mailboxes – the number of items they have in their mailbox (#Items), the number of emails they received during the week of our analysis (#IncomingMessages), and the number of folders they have (#Folders). #IncomingMessages measures email volume over a short, fixed period of time. #Items measures cumulative amount of email kept over the longer term; it includes items in the Inbox and folders but not in the deleted folder. #Folders reflects the number of folders that people use to organize their email.

We rank people by these mailbox characteristics (e.g., #Items), and group them into deciles each containing 10% of the users. (We describe in more detail how we spilt distributions into quantiles in the next section.) We then examine how these mailbox characteristics are associated with people's organizational activities (Delete, Move, Mark+) and search behavior. This allows us to answer questions like: *Do people who have small mailboxes Delete more often than those who have larger mailboxes?*

### 3.2.4 Organizational Strategies

Prior small-scale qualitative and laboratory studies of email have identified several strategies that people employ in organizing their email [9][13][16][29]. We are interested in whether we can identify behavioral patterns associated with these strategies using large-scale log analyses of *in situ* email interactions.

As an initial step, we identify email activities that are likely associated with three organizational strategies for managing email.

- Delete: Deleting emails distinguishes between Cleaners vs. Keepers [16].
- Move: Moving emails to folders reflects distinction between Filers vs. No-Filers [9][13][29].
- Mark+: Marking emails as unread or adding flags enables quick visual scanning or task reminding [14].

We first identify people who frequently use an activity such as Delete, then compare their email interaction and search patterns with others who use that activity infrequently. To do this, we compute the proportion of each person's email interactions that involve the activity of interest, that is, for a user's set of activities $A$ with class $i$:

$$Proportion = |A_i| \div \sum_j |A_j|$$

For this analysis, we first remove users who never use an activity, then split the frequency distribution into 33% quantiles. Each quantile contains the same number of users. We consider people in the bottom 33% quantile to be "Low" activity users, and the top 33% to be "High" activity users. Figure 2 illustrates this partitioning with a hypothetical activity distribution for one activity, say *Activity A*. The distribution shows the percent of total activities that are Activity A (x-axis) and the number of people who have that percent of activity (y-axis). The distribution is divided into terciles with Low and High highlighted in blue and green respectively. We compare the High and Low terciles because they represent the two extremes in usage of the activity of interest.
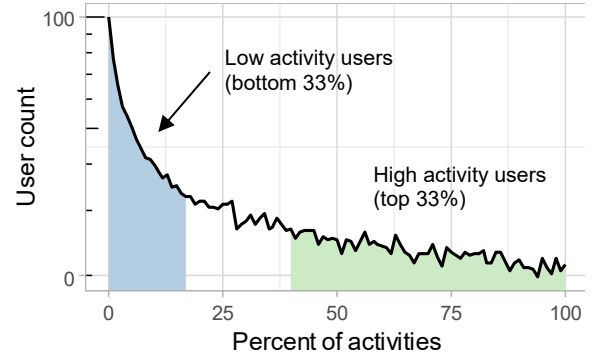


**Figure 2. Illustrative activity distribution for organizational strategies. The distribution is divided into terciles, and Low (blue) and High (green) groups are identified.**

Once the High and Low groups have been identified, we can compare the distributions of the remaining message-related activities for people in the two groups. In addition, we examine how frequently these groups search. This enables us to answer questions like: *Do people who Delete (or Move or Mark+) more search less?*

We also consider people who never used a particular activity separately; we refer to these people as "Zero" activity users. This group is interesting but difficult to interpret since people who never use an activity may simply not know about it or they may know about it but choose not to use it. In addition, while there are same number of people in the High and Low quantile group by construction, there are different numbers of people in the Zero group. There are very few people who do not use Delete; conversely, the vast majority of people never use Move and Mark+.

## 4. RESULTS

We first present results that summarize general email and email search activity (section 4.1). We then examine differences in the distributions of email activities and search as a function of characteristics of a person's email store (section 4.2) and of their organizational strategies (section 4.3).

## 4.1 General Email and Email Search Activity

### 4.1.1 Search Activities

In web search, the action that people perform on search results is simply to click a link to get to the corresponding page. In email search, however, there is much broader set of activities that people can perform on messages, as described in Section 3.2.1.

Figure 3 shows the distribution of activities that occur on selected messages in search sessions (search) as well as in general interaction with email (non-search). The distribution is computed over all search and non-search activities respectively.

In search sessions (blue histograms), we see that the two most common activities are OpenAttachment (39%) and Delete (26%). ClickLink is also a common activity (6%), as are Reply+/Forward (23% combined). It is not surprising that people search to access content and to respond to email. The prevalence of organizational activities (Delete, Move and Mark+, 32% combined) is more surprising. This indicates that people sometimes search to identify messages in order to clean up or organize their mailboxes. This is a kind of search intent that has not previously been reported in other domains. The majority of these organizational actions were to Delete messages (26%). And, in aggregate, the other organizational activities Moving (4%) and Marking (2%) messages were somewhat more common than Click Link (5%) and a little less common than Forward (8%).

Activities may be common in search sessions, in part, because they are common in general. Thus, it is also interesting to consider activities that occur outside search sessions, and compare these non-search activities to search activities. In non-search activities (red histograms) Delete (42%) and OpenAttachment (15%) are the two most common activities. Other organizational activities, Move and Mark+ (13% and 9% respectively), are also common as is Reply+ (13%). As people go about interacting with incoming email, they access information (mostly attachments) and respond to email, but most of their activities are devoted to organization, whether deleting, filing or marking.

It is interesting to compare the proportion of activities in search vs. non-search settings. We do so in the next section by showing the ratio of search vs. non-search activities.
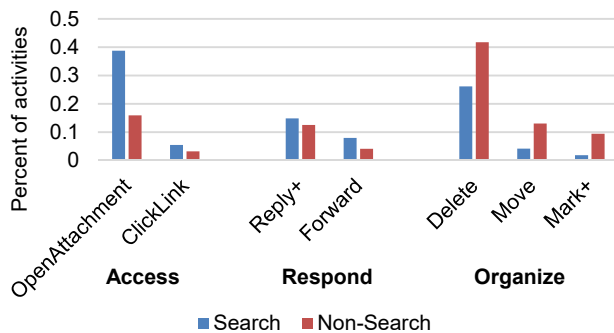


**Figure 3. Distribution of activities within (blue) and outside (red) of search sessions**

### 4.1.2 Search vs. Non-Search Activities

Figure 4 shows the ratio of the proportions of search to non-search activities, grouped by activity classes from section 3.2.1. A ratio larger than 1 indicates that the activity is proportionally more likely to occur in search sessions. For example, OpenAttachment is 2.4 times more likely to occur in a search session than outside one. ClickLink, Forward and Reply+ are also more common after a search. Thus, it appears that people search when they want to access information in attachments or links, and when they want to respond to or forward email. Furthermore, search is performed to Forward emails more than it is to Reply+ to them. A ratio less than 1 indicates that the activity is proportionally more likely to
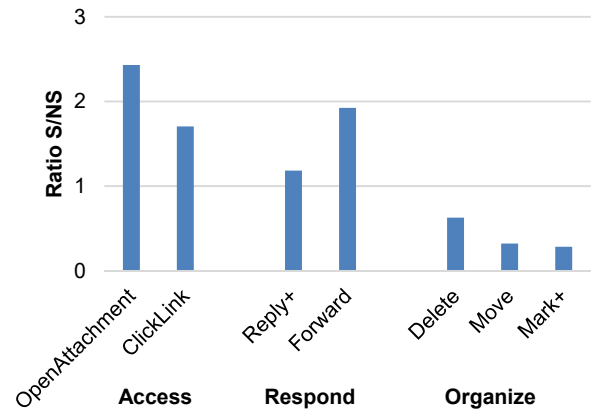


**Figure 4. Ratio of activities in Search vs. Non-Search context. A ratio larger than 1 indicates that the activity is proportionally more likely in search sessions than in general email interaction, and a ratio less than 1 in indicates that the activity is proportionally more likely in general email interaction.**

occur in general email interaction. Organizational activities (Delete, Move and Mark+) are much more common in general email interaction than after a search. People are less likely to search in order to organize their email than they are to do so in the normal course of going through their Inbox. Although we were surprised to find that Delete was a common activity in search sessions (26% of activities), it is even more common in non-search interactions (41% of activities).

In summary, Delete and OpenAttachment are the two most common activities on email messages, both in general interaction and after searches. However, in search sessions opening an attachment is more common than deleting, and the opposite is true in general interaction. When we compare activities in search sessions to general email activities, we find that people are more likely to use search to access external information via links or attachments or to find messages to respond to them. Conversely, the general organizational activities of deleting, filing and marking are more prevalent in non-search activities.

We now look at how the distribution of activities on email messages varies as a function of characteristics of mailboxes and people's organizational activities. We also look at the prevalence of search for people with different amounts of email and different strategies for organizing email.

## 4.2 Mailbox Characteristics

In this section, we examine the relationship between different mailbox characteristics (#Items, #IncomingMessages, #Folders) and activities on messages and searches.

### 4.2.1 Activity Distribution

Figure 5 shows the amount of total email activity as a function of deciles for #Items, #Incoming Messages and #Folders. Due to data publishing constraints, we show relative rather than absolute numbers.

Not surprisingly, people who have more Items in their mailbox, more Incoming Messages, or more Folders also have more overall email activities. The slopes for #Items and #Incoming Messages (blue and red curves, which overlap almost completely) are steeper than that for #Folders (green curve). As the number of incoming messages increases, simply selecting each message will add to
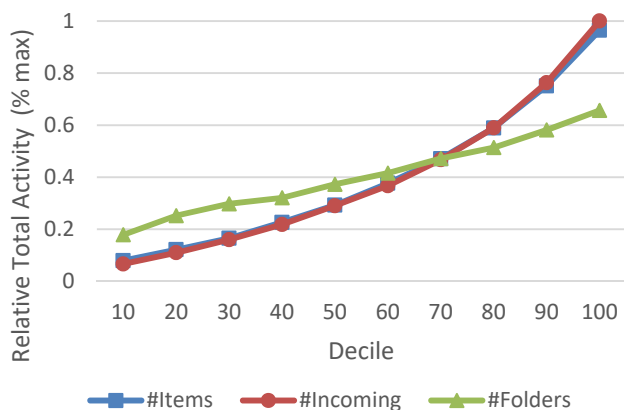
**Figure 5. Total activity by mailbox feature deciles. Total email activity is normalized by the max activity. Total Activity increases sharply as mailbox size (#Items, #Incoming) increases, and increases more slowly as the number of folders (#Folders) increases.**

the total activity. The fact that activity does not rise as quickly for people with more folders suggests that the number of folders and the number of incoming messages are not perfectly correlated.

We now examine in more detail the relationship between different types of activities and mailbox characteristics. Figure 6 shows the proportion of activities of different types (Access, Respond, Organize) as a function of the number of items in a person's mailbox (#Items). The activity distributions #Incoming Messages and #Folders are similar, so we omit them for space reasons.

As mailbox size increases, people are much more likely to organize by deleting, moving or marking (blue curve). They are also more likely to respond to email (red curve), although the slope is much shallower and the overall amount of responding activity is low relative to organizing activity. Accessing external information
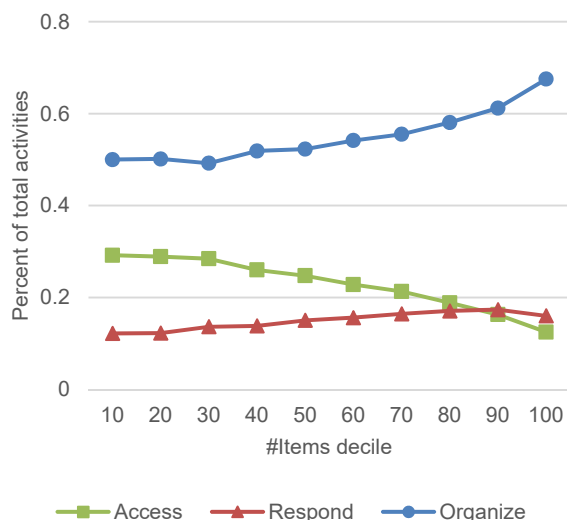


**Figure 6. Activity Type × #Items Deciles. Breakdown of total activities into Access, Respond and Organize activities. Organize and Respond both increase with #Items, but Access decreases.**

via clicking a link or opening an attachment (green curve) declines as the number of items increases.

### 4.2.2 Search Activity

Figure 7 shows the search queries as a function of deciles for #Items, #Incoming Messages and #Folders. We cannot report absolute search volume, so we normalize the counts to the maximum in any of the conditions. People with more items in their mailbox, and more incoming messages search more than those with smaller mailboxes. As the amount of information in the Inbox increases, search becomes a more important way of finding information. On the other hand, the number of Folders that people have does not influence the amount of searching as much; there is some increase in the lower deciles but the amount of search plateaus. This may be because people who have many folders navigate to those folders rather than using search to find information (see also Whittaker et al. [28]). In the email client that we studied, search operates over all folders as well as the Inbox so there is no need to navigate to folders. People may not know that search can be used across folders, or they may simply prefer browsing within folders especially when they have invested time in creating many folders.
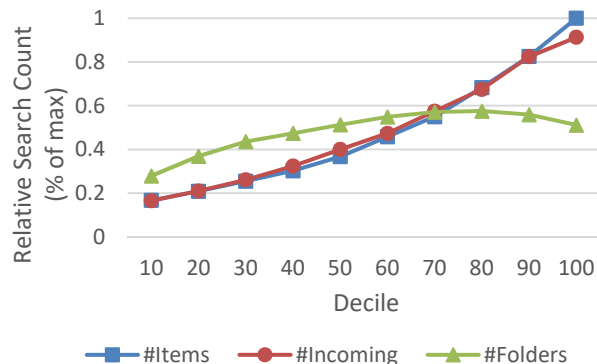


**Figure 7. Search count by mailbox feature deciles. Search count is normalized by the max searching in any condition. Number of searches increases sharply as mailbox size increases (#Items, #Incoming), and increases more slowly as the number of folders increases (#Folders).**

In summary, we observe that as mailbox size increases (#Items, #Incoming Messages), email interaction and search both increase. Much of the increase arises from more organization of email through deleting, moving or marking. In addition, people with larger mailboxes spend somewhat more time responding to mail. People with more folders, have somewhat more overall activity and search more often, but the relationship is not as strong.

## 4.3 Organizational Strategies

As described in Section 3.2.4 we consider three strategies that people commonly use to organize their email and their associated actions. Specifically, we look at Delete (Cleaners vs. Keepers), Move (Filers vs. No-Filers), and Mark/Flag (Visual vs. Not). For each, we compare people who use the feature frequently (High), infrequently (Low), and never (Zero). We now summarize the activity and search patterns associated with these different organizational strategies.

| | | Usage of Delete | | | | Usage of Move | | | | Usage of Mark+ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High | Low | Zero | Ratio H/L | High | Low | Zero | Ratio H/L | High | Low | Zero | Ratio H/L |
| Access Content | OpenAttach… | 26.9% | 25.3% | 36.8% | 1.06 | 18.8% | 13.9% | 20.3% | 1.35 | 19.5% | 14.3% | 18.6% | 1.36 |
| | ClickLink | 8.6% | 3.3% | 8.0% | 2.59 | 3.1% | 2.7% | 4.0% | 1.15 | 3.2% | 2.7% | 3.9% | 1.21 |
| Respond | Reply+ | 23.2% | 17.8% | 12.2% | 1.30 | 17.2% | 11.7% | 13.4% | 1.47 | 17.4% | 11.4% | 11.9% | 1.53 |
| | Forward | 7.9% | 6.0% | 4.4% | 1.32 | 5.9% | 4.2% | 4.5% | 1.42 | 5.7% | 4.1% | 4.1% | 1.41 |
| Organize | Delete | - | - | - | - | 35.2% | 51.9% | 40.3% | 0.68 | 26.3% | 47.9% | 44.7% | 0.55 |
| | Move | 16.1% | 19.1% | 7.9% | 0.84 | - | - | - | - | 20.1% | 14.4% | 8.9% | 1.39 |
| | Mark+ | 8.1% | 18.1% | 11.1% | 0.45 | 14.4% | 10.1% | 8.5% | 1.43 | - | - | - | - |
| Search | Search | 9.2% | 10.4% | 19.6% | 0.89 | 5.3% | 5.6% | 9.0% | 0.95 | 7.7% | 5.3% | 7.9% | 1.46 |

**Table 2. Activity distributions including search, with ratios of high to low activity use. High Delete users use other organizational activities relatively less frequently, while High Move and High Mark+ users delete relatively less. Access and Respond activities are more common for High vs. Low organizers of all types. Patterns for Zero users vary, because few people never delete, but many people never Move or Mark.**
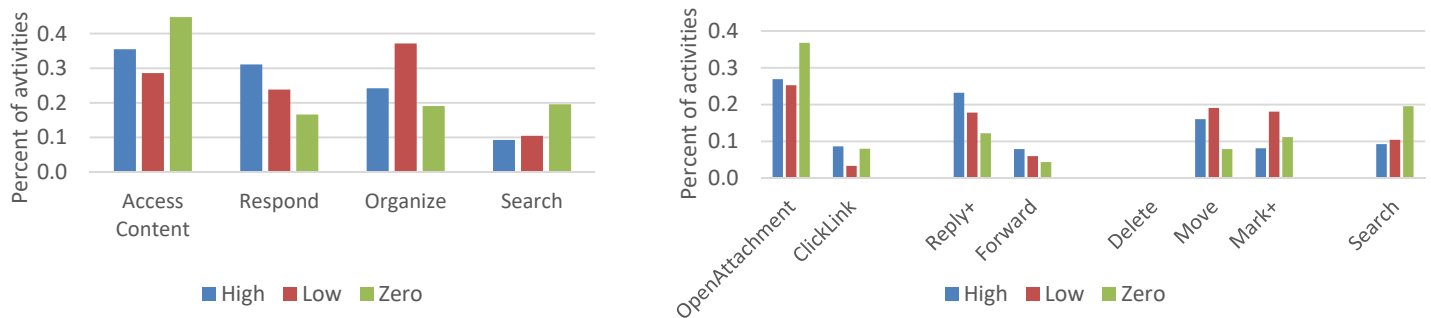


**Figure 8. Histograms of the Delete data in Table 2. The left figure aggregates activities from detail in the right figure into activity classes. Searches increase, and Respond activities decrease with Delete use. Organization is more common with low Delete, accessing content more common for people who never delete.**

### 4.3.1  Activity Distribution

Table 2 shows the proportion of each activity for High, Low and Zero people for each of the organizational strategies (Delete, Move, Mark+). The table also shows the ratio of activities for High vs. Low users which makes it easier to compare the proportions of each activity across these two groups.

*High vs. Low Deleters (Cleaners vs. Keepers).* We start by considering the first four columns representing people who use Delete with different proportions. Figure 8 shows these results graphically. High Deleters use other organizational strategies (Move and Mark+) less often than Low Deleters. This suggests that different organizational strategies are complementary; people who use one frequently tend not to use others as much. Indeed, only 7% of people who are High Deleters are also High Movers and only 6% of High Deleters are also High Markers. It is interesting that Low Deleters mark twice as much as High Deleters, perhaps because they don't delete much and need to rely on other techniques to support their ability to get back to email. High Deleters access

content and respond to mail more that Low Deleters, perhaps indicating that they spend more time in email.

While it is straightforward to compare High with Low Deleters, it is more challenging to compare either with Zero Deleters. By definition, one third of the people are High and one third are Low Deleters. There are, however, very few people who did not delete any email during the one-week period. And, these people differ in other ways, notably they have fewer email activities in general. With this caveat in mind, we find that Zero Deleters do not spend much time organizing. In addition, they access more content (via links or attachments) but respond (reply or forward) less, which suggested that they are using email more to get to information than to communicate with others.

*High vs. Low Movers (Filers vs. No-Filers).* We now consider the middle four columns representing people who use Move differentially. High Movers delete proportionally less often than Low Movers, suggesting again that these two strategies are complementary. As noted above, only 6% of people are both High Deleters and High Movers. High Movers mark items more than Low Movers, and about 12% of people are both High Movers and

High Markers. This may be because High Movers keep their inboxes small (by filing a lot), thus visually highlighting items may be more useful to them. Overall, about 50% of their activities involve organization. High Movers access content and respond to mail more than Low Movers, perhaps indicating that they spend more time in email.

*High vs. Low Markers.* Finally, we consider the last four columns representing people who use Mark+ with different frequency. High Markers delete much less and move more than Low Markers. Overall, they devote fewer of their email activities to organization. High Markers access content and respond more than Low Markers.

Move and Mark+ are not common activities, so the Zero Move and Zero Mark+ groups represent a large portion of the users in our sample. Thus, their behavior mirrors aggregate email activity that we described earlier.

### 4.3.2 Search Activity

Search activity is shown in the bottom row of Table 2. For Delete and Move, there is a clear trend between the amount of organizational activity and the amount of searching. The more people delete or move, the less they search. For people who never delete, searches compose almost 20% of their activities. This is perhaps what Google was envisioning when they released the original version of Gmail without a delete option.

For Mark+ activity, there is no relationship between marking and searching. If anything, the more people mark items, the more they search. We believe that marking is used more for task management than to make items in search results more visible.

In summary, we extend previous work on email organization by examining the extent to which these strategies are seen in large-scale logs and how they influence email activities and search. People use different strategies to organize their emails and these strategies are generally complementary. For instance, people who delete their email a lot tend to not use folders for organization and vice versa. We also find that people who organize less tend to search more. Finally, spending time in organizing email indicates a higher level of engagement with email. People who organize more (i.e., High Deleters, Movers and Markers) also access content and respond to their emails more than low organizers.

## 5. DISCUSSION AND FUTURE WORK

In this paper, we used a large-scale log analysis of *in situ* email interactions to study how people interact with email messages in general, the organizational strategies they use, and their search activity.

We first compared email activities in search and non-search context. In a non-search contexts, organizational activities are prevalent. Delete is by far the most common activity accounting for 42% of all activities; and other organizational activities (Move 13% and Mark+ 9%) are also common. Within search sessions, people are proportionally more likely to access information and respond to messages than they are in non-search contexts. Accessing external content via attachments or link clicks is 2.1 times as common in search sessions (44% vs. 19%), and responding to emails via reply+ or forward is 1.6 times as common in search sessions (23% vs. 15%). The prevalence of using search to access external content suggests that search snippets could be enhanced by highlighting the names of attachments or the anchor text of links.

We also examined the relationship between characteristics of a person's mailbox and their email activities and searches. People with larger mailboxes (measured by #Items and #Incoming Messages) have more total activities and conduct more searches than those with smaller mailboxes. The difference in search reflects how more information stored increases difficulty of re-finding. People with more folders (#Folders) show much smaller increases in the email activity and number of searches. People who have many folders seem to rely on their folder structure rather than search for re-finding information. They may not realize that search works across folders, or they may simply want to use the folders that they have invested in developing as Whittaker et al. [28] observed.

Finally, we extended previous work on email organization by examining the extent to which different organizational strategies are seen in large-scale logs, and the relationship between organizational strategies and email activities and search. We used the Delete activity to distinguish between cleaners and keepers, the Move activity to distinguish between filers and pilers, and various Mark activities to identify people who might use visual features to quickly find items. People who use one organizational strategy heavily tend to use others less. In addition, people who organize less tend to search more.

The analysis we presented in this paper is just a first step toward understanding email organization and search practices in situ and at scale. We see several directions for future work. First, we would like to examine techniques for determining the success of email searches. In the context of web search, models have been developed to link implicit interaction (such as dwell time) with search success and it would be interesting to do similarly in email where we also have actions performed on results. Second, we would like to examine re-finding that occurs in ways other than search. Many email messages are retrieved by simply scanning through the inbox and we have not taken this into account in our current analyses. Finally, we would like to extend our analyses to include personal as well as work email, and to explore how email interaction pattern depend on the device being used. In particular, differences in interaction patterns on desktop and mobile clients could reveal the kinds of task that people tend to perform on each (e.g., quick triage vs. more complex information gathering and analysis) and used to optimize the email interface on different devices.

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