# Hoarding and Minimalism:
# Tendencies in Digital Data Preservation

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## ABSTRACT

Digital data, from texts to files and mobile applications, has become a pervasive component of our society. With seemingly unlimited storage in the cloud at their disposal, how do people approach data preservation, deciding what to keep and discard? We interviewed 23 participants with diverse backgrounds, asking them about their perceived digital data: what "stuff" they kept through the years, why, how they used it, and what they considered important. In an iterative analysis process, we uncovered a spectrum of tendencies that drive preservation strategies, with two extremes: hoarding (where participants accumulated large amounts of data, even if considered of little value) and minimalism (where they kept as little as possible, regularly cleaning their data). We contrast and compare the two extremes of the spectrum, characterize their nuanced nature, and discuss how our categorization compares to previously reported behaviors such as filing and piling, email cleaners and keepers. We conclude with broad implications for shaping technology.

## ACM Classification Keywords

H.3.m Information Storage and Retrieval: Miscellaneous

## Author Keywords

Data management; data preservation; individual differences

## INTRODUCTION

Economists argue that digital data has become the most valuable resource of the 21st century [41]. Like oil, it is a resource that big companies are trying to control and extract from people in large quantities, because it drives economic transactions [38]. Every day people produce, store, share, and interact with an increasingly large amount of data, including pictures, texts, files, mobile applications and the data they contain.

Cloud platforms are one of the solutions that leading technology companies have proposed to deal with the increasing amount of data. These platforms often cause confusion [30] and raise privacy concerns [19, 44], but they offer seemingly unlimited storage that requires little maintenance on the user side. This explains why they are an increasingly popular choice to store digital data for everyday users [44]. Storage is either cheap or outright free. Google Photos, for example, offers unlimited space for pictures (although at reduced quality).

This is the "seductive" digital landscape that Marshall [25] predicted a decade ago when studying long-term preservation of digital items. At the time, a similar change was taking place: hard drive storage was becoming cheaper, giving users the option to store nearly "everything" [26]. The pervasiveness of the cloud is once again reinforcing this possibility. Now that we are living in this seductive landscape, how are data preservation practices changing? It is critical to understand how users are experiencing this new world, as we are just in its foothills. As storage gets cheaper and digital data more of a commodity, how do users deal with this new environment?

We are interested in the act of *preserving* data, by which we mean deciding what data to keep and discard. As Whittaker [47] points out: little is known about "when and why people keep or delete different types of information." Therefore, we focused on a main, broad research question: how do people approach digital data preservation in the cloud age? How do they decide what to keep and discard?

We interviewed 23 participants from diverse backgrounds, focusing on their current and past digital data practices. We asked them what "stuff" they kept through the years and why, how they used it, what they considered important, and how they made sure not to lose it.

While we expected to focus on low-level values people refer to, we found that participants approached data preservation driven by a range of underlying tendencies, living on a spectrum with two recognizable extremes: hoarding (where participants tended to accumulate a lot of data even if it had little value, rarely deleting it) and minimalism (where they avoided storing too much data or regularly engaged in a cleanup process).

First, we characterize in depth the spectrum and its extremes, showing the nuanced nature of preservation tendencies. Then, we compare and contrast different preservation strategies, focusing on the extremes of the spectrum, elaborating on how they helped participants build their identity, a practice commonly associated with possessing data [20]. Finally we discuss, among other things, how our categorization relates to previously reported behaviors (e.g., filing and piling [23], email cleaners and keepers [11]) and the broad implications to shape the current technological landscape.

## RELATED WORK

### Framing preservation in the context of data management

We use the expression *data preservation* to indicate subset of what is commonly thought of as data management, as others have done before [21, 25]. Challenging traditional views on information management, Whittaker [47] argues that users experience an information *curation* cycle. He describes three different stages or broad activities that people engage in during curation: *keeping* (deciding what to keep or discard), *managing* (actually organizing what has been kept using folders or other structures), and *exploiting* (searching for, finding, and using what has been kept). Our investigation of data preservation focuses on keeping and discarding data.

To further contextualize data management, we refer to Vertesi et al. [44], who give an excellent overview of what management entails today. They show that digital data includes many types and lives in *ecosystems* with multiple devices and relationships, with online platforms being more and more prominent. People face a tension between sharing and safeguarding data from others. They make decisions based on moral convictions about what they think is the "right way" to manage data. In essence, this is the *moral economy of data management*, the framework we adopt as a backdrop for our analysis. We build upon Vertesi et al.'s work and borrow their general approach, although with a specific focus on preservation.

### Data preservation

Although preservation is often overlooked in favor of other curation stages [47], there are clues in previous literature about general practices and values users refer to. However, we argue that there are gaps in the current literature.

It has been found that, in general, users take a neglectful approach to preservation: they do not think carefully about long-term preservation expecting data to somehow survive without planning [26], they have inconsistent strategies for short-term preservation with a mix of "planned" (e.g., doing a manual backup onto an external hard drive) and "unplanned" methods (e.g., emailing documents to other people as part of other activities) [21], they make no clear distinction between short-term and long-term preservation, using terms like "storing", "archiving" and "backing up" interchangeably [21, 26, 37].

When people preserve data, they do it, among other reasons, to build an identity [5, 7, 20, 31]. Cushing [4–7] has extensively studied the phenomenon of digital self extension (i.e., the role of possessions in defining personal identity) and found that not all "stuff" is created equal. In the case of digital data, people only recognize some digital items as their own possessions [7]. Other studies also point to the notion that people refer to personal values to determine the importance of digital items: utility and recency, emotional attachment, replaceability [7, 9, 29]. Sometimes these values are shared between physical and digital items, but often digital items are considered less unique because they lack the material qualities and physicality of analog items [9, 29]. From these studies we borrow the technique of asking participants to give a tour of their data. We also build upon the idea of building an identity, and further explore data values.

What is missing in the current literature on data preservation is a holistic understanding that can explain the broader context of these values against changing technologies. While insightful, previous studies often either focus only on computers [21] or specific populations (e.g., academics [20], photographers [37]), or predate the current technological landscape and its significant changes [20, 25, 26]. With a broader approach, we aim for a more comprehensive understanding of user practices.

### Digital hoarding

Digital hoarding is not an entirely new phenomenon, but we know very little about it. Coming from a background in psychiatry and neuroscience, van Bennekom et al. [43] present in 2015 the first clinical case of digital hoarding with one patient who suffers from a hoarding disorder that leads him to take 1,000 pictures every day. They define digital hoarding as the "accumulation of digital files to the point of loss of perspective, which eventually results in stress and disorganization." They also propose to categorize digital hoarding as a subtype of the hoarding disorder and point to the lack of scientific papers on the subject. In fact, the topic is just now gaining interest in the broader scientific research community, as evidenced by an additional study to be published in 2018 [32].

In a recent review of published literature, Gormley and Gormley [10] discuss in general terms the costs associated with data hoarding and digital clutter based on previously published literature: for example, hoarding data can result in costs for storage space and management overhead. However, the research literature on the subject is extremely scarce compared to hoarding of physical objects, a much more widely studied phenomenon, with tools to measure it and diagnose it [8]. In addition, all of these studies are from outside the HCI literature, where these terminologies are not well recognized and only mentioned in a few studies [14, 15, 36]. Before running our study and encountering hoarding and minimalism, we were not aware of research on the subject. We note, however, that we refer to hoarding as a set of everyday tendencies, not as a disorder. We are not in a position to diagnose participants.

## METHODOLOGY

**Participants**: We interviewed 23 participants (16 females, 7 males) in Vancouver, Canada. We used purposive sampling to gather a relatively varied sample in terms of age, ethnicity, background. Participants' ages ranged from 21 to 64 (average: 35.4, median: 30, SD: 12.5). Occupations included business consultant, cook, mental health worker, server, researcher, research coordinator, retired accountant, special educator, social worker, software tester, stay-at-home parent, trader, university-level coordinator, in-between-jobs, in-between study and work, full-time graduate and undergraduate students (8 with backgrounds in Architecture, Archiving, Commerce, Education, Electrical Engineering, Kinesiology, Mechanical Engineering, Organizational Behavior), part-time graduate students who were also working (2 with backgrounds in Arts and Gender studies). The majority of participants (15) had basic technical skills, followed by average (4) and above average (4). Participants were compensated 15$ each.

**Procedure**: After conducting three pilot interviews, we recruited participants through mailing lists and posters in several community centres in the city. We conducted semi-structured interviews, each lasting on average 45 minutes, at a location chosen by participants. One member of the research team conducted all interviews. We asked participants to bring their main interactive devices (e.g., laptop, smartphone, tablet) to the interview. All interviews were conducted in English. We recorded the audio of the interview, took hand-written notes, and later transcribed them for analysis.

**Data collection**

After collecting demographic information, we asked participants to talk about and show us their digital data, whether it was files, data from mobile applications, or other examples. Following the example of Vertesi et al. [44], we did not impose a specific definition of digital data. However, unlike Vertesi et al. [44] we asked participants to *show us* the data, although they were free to choose what to show so as to respect their privacy. Participants gave an overview of their devices and then a more detailed tour of each, explaining what they used them for, what data they had on them, and why they had kept it. Then, we asked participants to imagine what they would want back if their devices broke down or were stolen, focusing on what was the most important data they had on them and why they considered it important.

The second part of the interview revolved around a light version of the life history method, a technique used to relive the life an individual through their narration [24]. In the context of our study, we asked participants to relive their digital life history, focusing on the devices they used through the years, asking them to remember what they used them for, what data they had on them, whether they kept it or not, and why. We also encouraged them to sketch a chronology of their digital life history on paper to help them think through it. Life histories are useful to understand individual experiences in the social context where they take place and how individual understanding evolves through time [24].

We also asked participants to think about their data one and ten years into the future, to know what they anticipated as something worth keeping and why. We concluded focusing on positive and negative aspects of their data management.

During the interview, we had additional specific questions about archiving, backups, and data loss. However, we do not report on them here, focusing on the rest of the interview.

**Data analysis**

We analysed the interviews using the Braun and Clark approach to thematic analysis [2], where "coding is flexible and organic and evolves throughout the coding process" [3]. We did both an inductive and deductive analysis (based on the "data economy" framework [44]). We used open coding with all members of the research team looking and discussing the data collaboratively in an iterative and reflective process. Each member could see how others were coding the data, discuss the interpretations, and propose alternative explanations. Throughout this process, we regularly met for lengthy in-person discussions of the interpretations, making sure they were coherent,

comprehensive, reasonable, and reflective of the actual data. We did not use inter-coder reliability, as this implies an unequivocally "true" way of interpreting data, which is not in line with our philosophical assumptions [3]. Instead, we see the use of multiple collaborative coders as a way to get close to *crystallization* [34], the idea of adding complexity to the understanding of the topic through multiple perspectives [42]. We later grouped codes into categories and went back again to the interviews to check for consistency. Examples of categories include "data values," "user concerns," "cloud vs. hardware."

We looked at preliminary trends after the first batch of interviews, adjusted our research foci and proceeded with additional interviews until thematic saturation. That is, when we got to P20, we noticed interviews were starting to closely repeat ideas from previous participants, therefore we stopped at P23. In the later stages of the analysis, we paid attention to the contrast between hoarding and minimalism. These terms came up halfway through the study, when some participants used them to describe their approach to data preservation.

We do not present counts for specific occurrences of behaviors, as we focus on recurring patterns of behaviors *across* and *within* participants to characterize hoarding and minimalism. We agree with Braun and Clarke that "frequency does not determine value" [3]. Our goal in reporting is to characterize the essence of hoarding and minimalism, not their distribution, as our methods simply do not allow us to give a distribution.

*Epistemological stance and reflexivity*

In our analysis, we took a constructivist epistemological stance within a bounded relativist ontology [27]. In the context of HCI, we position ourselves in the so-called third paradigm, where meaning-making is a central focus [13]. Our approach is similar to a constructivist grounded theory approach [1]. Taking a constructivist approach means that we saw interviews as an interactive process of meaning-making: we built knowledge with participants. Therefore, we do not claim absolute truths about people's behaviours, but a shared understanding grounded in their reasoning and experience, reflective of their broader cultural environment. Focusing on the words used by participants, we arrived at the notion of hoarding and minimalism. These terms are socially constructed in the sense that they embody cultural connotations: we debated whether they were appropriate, reflecting on our assumptions about what they point to. Ultimately, we use them to fairly represent the shared understanding we constructed with participants.

In line with our constructivist approach, we critically reflect on our position as researchers and its influence on the analysis. Throughout the analysis, we reflected and discussed our own experience with data preservation, since it is something we deal with on a regular basis. In particular, one team member considered themselves to have mostly minimalist tendencies, one had a mix of both, and another one reflected on a tendency to hoard pictures. Additionally, we frame data preservation as a challenging task worth investigating but others might have different perceptions. We also acknowledge that our Western cultural background and its values inform our view. This points to the inherently interpretive nature of our work taking place in the the current socio-technical landscape.

**FINDINGS**

First, we present contextualizing information about the data that participants discussed in the interviews. Then, we focus on the cross-cutting theme of hoarding and minimalism, giving an overview of the recurring behaviors across participants.

**Contextualizing information**

Similar to what Vertesi et al. [44] found, participants considered a variety of data sources: computers, smartphones, tablets, wearable devices, online platforms, and mobile applications. They talked about files, text conversations, pictures, videos, bookmarks, logs, profile settings. Pictures were consistently regarded as one of the most important pieces of data because of their sentimental value. Participants mentioned how photos served as a tool for remembering and how it would be hard to take them again if they lost them: "I can't retake those photos [. . . ] I'm emotionally attached to them [. . . ] Music, I can always download again. It seems like photos are less replaceable." (P3) Other factors determining the importance of data were recency, utility, time invested to craft it, its role as a record. We are not the first to report these values [9] but we elaborate later on the important role of data as a memento in relation to hoarding.

**Uncovering hoarding and minimalism**

Halfway through the data collection process we met with Sarah (pseudonym for P13), the participant who introduced us to the approach of data minimalism.

Sarah is a graduate student and mental health worker. She manages all her data on her laptop. She does not use cloud platforms. She has a phone, but it is not a smartphone. It is a "dumb" flip phone. She explains that she grew up in a small community where people did not use tablets or smartphones. She does not want one, "never", because "otherwise she'll be on the bus [demonstrates hunching over the phone]" and instead she wants to "look outside and talk to people."

On her laptop, a small MacBook Air, there is only one main folder simply called "Life." "Everything is kinda organized," she explains. "My apartment, inspiration, beautiful photos, photos of my family." When we ask her why she called it "Life" she takes a moment to think. "Well, I was thinking about it. [. . . ] And I was like, OK, what could this be? Well, it is my life. My family, my school. I mean, my life is so much more than that. But I couldn't think of a better name." She then explains how data helps her build an image of herself, an idea that will become important to understand the broader role of preservation tendencies:

> "I think humans are always trying to find things outside of themselves to make them feel they're more than they are. If I like a song, it's part of me, me kind of building up the image of myself. So I think it's me being like 'Oh yeah, my life, school and this and that.' We don't need things outside ourselves, but we are always looking for things to make us feel complete." (P13)

At the end of the interview she summarizes her approach to deciding what to keep and discard: "It's very minimal. I try to delete everything that I don't need as fast as I can. [. . . ] Do most people have a lot of stuff?"

Yes, they did. Compared to what we had observed up to that point in the study, her's was a very different approach. In retrospect, it was clear that until that point we had mostly seen strategies closer to another extreme: hoarding. We thought Sarah might be a "unicorn" and that we would not meet other participants like her. But we did. And then something similar happened when other participants self identified as hoarders, even though we never used these terms in our questions. In fact, looking back, we saw that some participants had specifically mentioned "hoarding" before we interviewed Sarah, but it had not jumped out to us. Altogether, it became more and more clear that participants adopted a range of data preservation tendencies that lived across a spectrum between hoarding and minimalism.

We start by describing and characterizing the tendencies participants reported, largely grouping them along the two extremes of a spectrum: hoarding and minimalism. Throughout the results, we point to instances of nuance within individuals, with some participants being highlighted in both sections on hoarding and minimalism, or displaying interesting exceptions to their general approach. Broadly speaking, some participants were stronger in their tendency towards hoarding (P1, P2, P3, P8, P9, P11, P12, P15, P17, P20, P23) or minimalism (P10, P13, P16, P19, P21, P22), while others displayed a much more even mix of both (P6, P7, P18) or were not easily classifiable (P4, P5, P14). However, this is an over-simplistic categorization, given the nuanced nature of the tendencies and the fact that they represent a spectrum of behaviours within two recognizable extremes.

We also touch on the actual organization of data that participants displayed (e.g., being organized or messy, using folder hierarchies or not), showing that it appeared to be orthogonal to their tendencies—some participants were organized, some were not, independent of the tendencies they displayed.

**HOARDING**

Hoarding was characterized by the tendency to have large amounts of digital "stuff", rarely deleting any of it. Participants often kept data even if they described it as having no value. The practice had both an emotional component (where it was a response to the fear of forgetting and letting things from the past go) and a practical component (where it was related to job or external requirements). When discussing hoarding, participants often reported challenges and frustrations with managing and "being on top" of data.

**Self-identifying with hoarding**

Similar to what happened with Sarah, we were surprised when some of the participants self-identified as "hoarders." "I am a hoarder, I hoard things," said P17, explaining why he had a large number of ebooks. Or:

> "I consider myself a hoarder because I didn't delete them, cause I didn't clean them or delete, and I've kept all of them, except a few." (P20)

"I'm a bit of a hoarder, I just keep all the stuff and nothing ever goes away." (P12)

However, not all participants were comfortable identifying with hoarding. At one point during the interview, P8 said: "I am not a hoarder, really I am not!" And added that she could delete stuff if needed. However she later explained that she "keep[s] everything" because she "like[s] to keep things." In fact, she had digital data going back to her first computer from when she was 10 years old—she was now 25.

**Lots of data, often spanning years**

The first point that characterized hoarding tendencies was the large amount of data participants had kept through the years. P12, for example, had a large number of old files on her computer from decades ago that she never looked at and was surprised to occasionally discover. She also had a large number of pictures on her phone and a lot of unrecognized documents on Google Drive. P17's ebooks were in the thousands. P3, who had recently taken a trip around multiple countries, had around 6,000 pictures just from that one trip on a hard disk, which admittedly was "a lot to deal with."

Although they had kept it for long time, participants often dismissed most of their data, describing it as not needed. For example, P23 had four external hard drives in which she stored videos taken at public events like concerts or festivals. She had kept them all since the 1990s:

"I've always kept them, I know I don't need them anymore, but [I just keep them]. I guess I hoard things. At least with data it just takes the drives. It's not like it accumulates or takes the space in your room. Before I used to [go] shopping to buy clothes and clothes would add up. And then, OK, I'm running out of space! Get rid of the old stuff, right? So I kinda stopped that now. But I guess I switched over to data!" (P23)

This hoarding tendency did not seem limited to videos: her phone had multiple screens full from top to bottom of application folders, each with several applications. However, she reported regularly using only a few.

Sometimes participants even went as far as describing the data they had kept in rather uncomplimentary words; for example P12 said: "Crap. All kind of stuff. My bills, recipes." She did not know why she had kept it all through the years: "I don't know, might need it." At the end of the interview, she asked if other people did the same: "Are there people who don't have tons of crap on their devices? Do you get rid of your messages? Do kids do that? Do kids get rid of everything?"

**Rarely deleting data**

The large amount of stuff participants kept might be explained by the tendency to avoid or to rarely delete data. Participants lamented the effort it takes to curate and delete data: "I don't think anything is going to go. I'm just going to add more, because it costs so little to add stuff but it takes a lot of time to sort the stuff you want to delete." (P2)

At the same time, having access to larger storage space than in the past (whether on hard drives or in the cloud) tilted the choice towards inaction:

"I can just put it there and forget about it and don't have to actually select. If I couldn't backup to a physical hard drive and I could only backup to the cloud with a limited capacity, that would force me to clean up a little bit of the files. But because I have plentiful storage space, I don't think about it too much." (P3)

In cases when storage became an issue, getting additional storage appeared to be the easiest solution. P9, for example, described regularly buying new hard disks to accommodate her growing set of data: "I think the reason I have my second hard disk is because the first is filling up, because I don't like to delete stuff." P8 explained a plan to keep everything in the future: "Oh, I'll keep all of it! Well, I'll have to get a bigger hard drive [. . . ] And if it doesn't fit, I will use Google Drive again if I run out of space on Dropbox."

**The emotional value of hoarding**

The costs associated with curating data in the first place might explain why participants rarely deleted data. However, this tendency also appeared to be an emotional response to the underlying fear of letting things from the past go and forgetting, a sentiment that participants often brought up. "I like to keep memories. I don't like letting go of things," (P8) "I tend to keep everything. It's more like, I don't want to forget things that have happened to me in the past," (P11) "I have not learned how to let go of things." (P17)

In fact, while in some cases participants described their data as having no apparent, concrete value, it had a deeper, emotional value. Such is the case with P15, a stay-at-home mother of two, who had over 20,000 pictures on her laptop:

"I'm sentimental. As a mom, both my children, 15 and 18, they encapsulate memories. And sometimes it feels I have to hold on to those because that's all I got left in some sense. Sometimes it feels like that. So the pictures represent something that's important to me, that's precious. The experiences with my children. [. . . ] There's maybe this impression that things that are digitalized are somehow permanent and maybe it's an attempt to try and hold onto things, in spite of the passing of time."

Here hoarding was a proxy to remember life. It provided emotional support, with the large amount of stuff representing a large amount of experiences to go back to.

**The practical value of hoarding**

Along with an emotional value, hoarding tendencies also had a practical component, related to job requirements or external factors. For example, P14 reported keeping all tax documents for the previous five years, to comply with government regulations. P3 explained that a large number of pictures from a trip could act as a record for other people when looking for a job:

"We really value these pictures, they're useful for us to keep as memories and also for employment. When they say 'Why did you have this 9-month gap in your history?'

We can say 'This is what we did,' this [the travel pictures] is proof I wasn't somewhere else." (P3)

Another participant, a student in architecture who was close to graduating, explained keeping Autocad files of all of her school projects because they might come in handy when looking for a job:

"Much of the stuff is school work. When we want to apply [for a job], make a portfolio, I've heard they ask you to send Autocad for specific projects [. . . ] I will need a job after I graduate." (P9)

Keeping all files offered assurance that she would have the right piece of work to show when the right moment came. However, P9 was frustrated by how increasingly challenging this practice was: "I think it's not very efficient: files are getting bigger and bigger, but my hard disks aren't, except if I get more hard disks." (P9) She was not alone in expressing frustrations with hoarding.

### Challenges when hoarding

The large amount of data that characterized hoarding tendencies often led to frustrations. Participants reported issues in 1) keeping up with their data because of how much they had, 2) knowing what exactly they had, and 3) knowing where they had stored it.

For example, P15, who valued the 20,000 pictures stored on her laptop for their emotional role, described also being overwhelmed by the sheer amount: "It's hard to keep on top of. I wish I was more organised in the beginning 'cause now it's overwhelming going back and organising things [. . . ] On one hand, you can take 30 pictures and have one that's good, but 30 pictures take time to go through." She aspired to become more organized and minimal in her approach, to reportedly *do things right* [44]: "I'm hoping that by organising I can get rid of things, then I have more space. I hope it will be more efficient, so that whatever I have, I am valuing it and enjoying it." The problem was, she did not know how to go about changing her approach.

### Hoarding in relation to data organization

The large amount of data also made it difficult to know what exactly participants possessed and where it was stored. This did not appear to be an effect of general disorganization. P6, who was in general methodical with her organization, had six different Google accounts that she used in the past to *segment* [46] her email usage. She also used them with Google Drive, but she had a large amount of data, so it was hard to know what it was: "I don't know what's on everything, just random stuff." Similarly, P12 had a rather organized computer, making use of folders and sub-folders. Yet she had no idea what she had kept through the years, simply because it was a very large amount of data: "I look at things and I'm like 'What's even in there?' And there might be folders inside those folders."

Some participants did not appear to be bothered by their approach and characterized themselves as being "just lazy", displaying a rather care-free attitude: "Occasionally I have some weird stuff here, like this ebook, I don't know what it's doing here, this is probably my stuff from 2015. I'm too lazy to move it so I just leave it." (P6)

### MINIMALISM

Minimalism was characterized by the tendency to keep a small amount of digital data. Participants used both preventive and reactive strategies to keep as little as possible: they set a limit on the amount of data to acquire, or they regularly went back to cull it and delete it. Participants described minimalism as a way to be in control of data and life, but they also hinted at underlying anxieties behind it, and in some cases they felt detached from their data.

### Prevention: limiting the amount of data

Similar to what happened with hoarding, some participants were explicit in calling out their minimalist approach. As an example, P19 had recently switched from a Macbook to a Chromebook, which she found cheaper and more "basic". She explained how the change affected her data practices: "I am more of a minimalist now. Really keeping what I need." (P19) Her minimalist approach encompassed several types of data, including, for example, mobile applications on her iPhone: "My phone, again, minimalism. I do not like having tons of apps. And the apps I don't really use, I put them here [a folder]. But other apps, I was so happy when they [Apple] said you could get rid of them." (P19) Interestingly, the exception to her minimalist approach was a collection of articles from the "New Yorker" magazine: "I am obsessed with The New Yorker, the magazine. I have all different sections of it. Every time, I download it and then I read it. And I save the ones that are amazing and I want to re-read in the coming years." (P19)

With minimalism, some participants limited the amount of stuff to keep in the first place, and this worked as a self-imposed preventive measure: "I try not to have too much stuff here [the desktop] [. . . ] And I try not to download too much, 'cause it is primarily for school." (P13) Referring to her pictures, P6 explained that she was selective and therefore chose to not use automatic uploads in the cloud: "Most people auto upload them to Google Photos, but I don't, because I don't want to save every single photo." (P6) It is interesting to note that P6, outside of her pictures, displayed a tendency to keep a lot of data.

### Reaction: cleaning up data

Another recurring behavior participants displayed was going back to the data so that they could cull it, clean it up, and delete it as needed: "Every couple months I go through all the old photos and delete them." (P21)

They articulated a thoughtful process of evaluation based on future utility and personal values:

"With my phone, I guess I tend to only keep things that I think will be useful. For example, if I went out and took a lot of photographs in a single day, in that evening I might clean up the photographs that I didn't like or that I wouldn't think would ever be of interest to anyone else. If I don't like them, I don't think others will, and I don't see the point of keeping them. I'm generally quite clean with what I do." (P22)

In some cases, getting rid of things was the ultimate goal of being organized, an activity participants sought out: "[I] organize, so that I know what to get rid of." (P19) But while some participants were very organized, this was not always the case with minimalism. For example, P21, who had a minimalist approach with the data on his phone, said he was "not an organized person whatsoever," relying entirely on the automatic organization his iPhone provided. Similarly, P16 did not have many documents on her laptop and she stored them only on the desktop: "I have a tendency to keep my stuff on the desktop, all the time. It's not a good habit in terms of organization but [...] It's there, it's easy to find." Having a limited amount of data might have made it possible to be less organized and still be able to use it efficiently.

### Underlying anxieties in minimalism

A minimalist approach was often described as a habit: "I clean it out regularly. I don't really know why, just a habit I guess. It seems kind of busy. So, I like having clean files I guess." (P10) However, participants with minimalist tendencies sometimes displayed underlying anxieties behind their approach that we did not see reflected in hoarding.

Curbing the amount of data with preventive and reactive actions appeared to be a way to have control of one's data and, by extension, life: "It's probably a way for me to stay clear." (P13) In some cases the need to be in control extended beyond data:

> "For me, being able to see on Gmail that I have less than a hundred emails that are unread and not having to rely on too many apps, it makes me feel calm inside. I do not like clutter. Clutter? I hate clutter! Visibly, physically, I like clean, I like washing clothes, I like seeing everything clean on the table and house. I'm not like a clean freak, that's my mother. I'm somewhere in between." (P19)

When talking about minimalism participants also expressed a need to limit the time spent with technology, displaying a general avoidance for it: "I really don't like how much time I have to spend on it. I would rather be not staring at the screen for hours." (P13) They placed greater importance on face-to-face interactions, as if technology was in itself negative: " I like spending time with people one on one, talking, I don't like chatting." (P19) This is an attitude that did not surface in participants with stronger hoarding tendencies.

Some participants also reported worries about external factors, such as money. For example, P16 used a very old computer and a four-year old iPhone, because she was trying to be economical and have a rather frugal lifestyle. She also was in a phase of her life where she did not have large amounts of data in the first place: "I try not to do a lot. I don't have to do a lot of documentation for school, I'm done with school, so I don't have a lot of essays." (P16)

Similarly, P21 had recently "downsized" his digital life: he went from owning a Mac computer to having just an iPhone for all his data. This change, that "did not come from within" (implying again that minimalism was in part a reaction to financial constraints) imposed a limit on the amount of space at his disposal:

> "[When] I had more space, I would save almost every stupid photo to the computer and have photos of my background, have photos of my thumb. And now with limited space I have to be more choosy [...] I never needed all those photos [...] I do enjoy this [the iPhone] because it simplifies everything a little more." (P21)

The exception to his approach were texts. P21 explained the need to keep all of them because they were important for work and having a record of what people said.

### Detachment from data

Minimalism sometimes translated to a level of detachment from the data itself, to the point of being at ease with the possibility of losing it. P21, for example, related how his approach evolved after downsizing:

> "After awhile, you know, they're just photos. And life is ongoing really. There was that big need before to hold on to every little type of thing. And now, you know, it wouldn't be the end of the world if I lost these things." (P21)

External factors such as money appeared once again to be important in determining the contextual value of data. This was the case more with minimalism than hoarding:

> "I would rather not [lose it] obviously, but I don't think it would be that critical. I would get over it pretty quickly [...] I would go to some lengths to get it back, but if it was to cost me some money, I'd rather lose the files than money. Money is more important to me I guess." (P22)

That is not say that in minimalism data did not have value. Participants reported how the limited data they kept was a part of themselves: "The things I use more frequently are in this file. This is my D&D, I play Dungeons and Dragons. It's a big part of who I am." (P22) However, they also reported being at ease with the possibility of losing data. As P16 summarized: "That's OK, if I lose it, I lose it."

## DISCUSSION

### Variation and nuance within individuals

In introducing a spectrum of tendencies, questions about their nature arise. Are you innately more aligned towards minimalism or a hoarding? Can you move across the spectrum? Can you embody aspects of both extremes at the same time?

*Tendencies across a spectrum*

We start by addressing terminology. We talk about a spectrum of tendencies with hoarding and minimalism at two extremes, rather than categorizing participants as either "hoarders" and "minimalists." This is because we saw variation both *across* and *within* individuals, and also across data types. P21, for example, had a minimalist approach with most of his data because of external factors: once he sold his computer, he became choosy with what to store, except with texts. Similarly, P6, who was highlighted in both the hoarding and minimalism sections above, displayed tendencies on both extremes throughout her various devices, hoarding the majority of stuff, while also displaying exceptions for specific types of data (e.g., photos). P19, with the strongest minimalist tendencies,

displayed an exception in collecting articles from the New Yorker. Several participants shared similar patterns of behaviors, suggesting that the tendencies were context-dependent and not a clear-cut binary. Therefore, our goal was to categorize behaviors across a spectrum, not individuals.

*Individual variation is common*

A growing body of literature shows how people segment their digital data into multiple mental places: an account for work stuff and one for personal stuff [46]; a messaging application for friends, one for family [28]. This mental segmentation adds to the idea that there is variation within an individual: people approach data differently depending on the social context they build around it. Therefore, a single user can actually incorporate multiple behaviors, influenced and dependent on the specific context she needs to manage at a specific time, something that other work on individual differences actually highlighted [12, 16].

The concept of *schemas* in psychology also reinforces this idea: people act differently in front of different people and different situations [39]. In this light, it is not hard to see how one might be closer to the hoarding extreme for all that is work related, or only with pictures, but might have at the same time a more minimalist approach with texts, for example. These tendencies are dependent on the social and cultural context where they take place. Having said that, our data suggests that most people might lean to one extreme or the other with respect to most of their data (with perhaps some exceptions for particular data types), and that a smaller subset of people might more strongly embody one extreme of the spectrum. The bottom line is that it is not a binary categorization but a spectrum.

## Comparing and contrasting hoarding and minimalism

As two ends of a spectrum, hoarding and minimalism appeared to be radically different opposite approaches. But while there were indeed differences in required effort, they both served a similar function in helping participants construct their identity.

*Identity construction*

Tendencies across both hoarding and minimalism appeared to often have the implicit goal of providing participants with a framework for building their identity. This is a practice closely tied to data preservation [5, 7, 20, 31]. Participants looked at themselves in relation to data, context, and other people. Here we refer to the several quotes where participants asked what other people did with data compared to them: "Do you get rid of your messages?" (P12), "Do most people have a lot of stuff?" (P13) Similar questions were a common occurrence during the interviews. Towards the hoarding side of the spectrum, the large amount of data appeared to provide emotional support against underlying worries and concerns of time passing. Data was a symbol of experiences and memories (*I have data therefore I am*). On the contrary, limiting the amount of data in minimalism seemed to provide a way to gain independence from technology and detaching from data (*I am more than my data*, paraphrasing P13).

*Costs and effort*

Tendencies at both extremes came with costs, although at different stages of the preservation process. Hoarding tendencies seemed to have no upfront costs (e.g. P3: "I can just put it there and forget about it"), but later revealed themselves to not be an optimal preservation strategy if the amount of data became too large. Hoarding was a way to offset any upfront costs. Minimalism, on the contrary, required both an initial investment and ongoing dedication: setting a preventive limit and regularly going back to clean up data. In short, minimalism required ongoing effort, while hoarding seemed to require effort only once problems started arising, if at all.

## Past clues about hoarding and minimalism

Previous studies contain clues about the notion of a spectrum of behaviors falling between hoarding and minimalism, but they rarely use these terms. For example, Spurgin [37], in studying photographers, talks about how some people delete all pictures, some do not, most fall in the middle. Henderson [14, 15] talks about filing and piling (two common strategies for organizing documents [23]) and mentions participants who self-identify as hoarders. Schiele identifies hoarding as a recurring storing behaviour [36] among users of the bookmarking website Pinterest. We also see similarities between minimalism vs. hoarding and cleaning vs. keeping email [11], where participants either cleaned their inbox or let messages accumulate.

All these different categorizations of individual differences are neither in conflict nor duplicates. What we provide is a broader and more comprehensive lens on user behaviours that builds on top of and extends previous categorizations.

By focusing on a broad range of data types, we provide a broader context for previously reported behaviors that come from studies in specific, narrower settings (e.g. personal documents, email). That is, the spectrum of tendencies that we uncovered appeared to encompass several types of data, suggesting that it represents an overarching phenomenon not limited to a specific domain. We focused on data preservation, but we speculate that these tendencies might play a role in other user behaviors (e.g., tab usage in browsers or notification management). Further, we believe that looking at the different prior categorizations together in relation to hoarding and minimalism might lead to building an even more comprehensive and exhaustive spectrum of data related behaviors.

## Reflecting on hoarding and forgetting

The tension in using the term "hoarding", as we pointed out in the Methodology section, is that the word itself often embodies negative cultural connotations, evoking images of people buried alive by their possessions. This might explain, for example, why P8 was so emphatic in saying that she is "not a hoarder!" But we saw how hoarding tendencies had an important role for participants, providing them with an emotional support for the fear of forgetting things, a finding that further supports the link between digital possessions and their role for identity shaping. Kaye et al. [20], for example, titled their paper about personal archives "To have and to hold," highlighting the importance of holding onto to things.
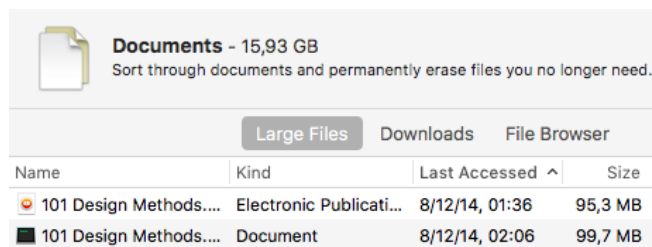
**Figure 1. macOS Sierra shows users large files on their hard drives, displaying the size and the last time they accessed them.**



**Figure 2. Files Go is a new Android application by Google that gives users recommendations on how to free up storage.**

It is interesting to compare the emotional need of never forgetting to recent neuroscience studies about memory. Researchers suggest that forgetting is in fact a useful function of the human brain, essential to make decisions [18, 33]. Other studies show how taking pictures of every moment does not actually help in remembering them [17, 40]. There are even specific circumstances (e.g., the breakup of a relationship) where disposing of digital possessions is seen as a necessary act to avoid negative emotions [35]. Considering these findings, a worthy question to pose is then whether attempting to store and keep *everything forever* still allows the space for forgetfulness and how.

**Implications for shaping technology**

Leading technology companies like Apple, Dropbox, Google, and Microsoft have an interest in encouraging users to move their data onto cloud platforms and accumulate large amounts of it: the more data, the more space users need. The more data, the more possibilities to thrive as a platform [38]. Unlimited storage for pictures on Google Photos might seem a generous offer, but generosity is not necessarily the main motive if we consider a larger business model where data is an essential resource for machine learning and AI training [22].

In this context, how much do technology applications influence data preservation behaviours? Some participants mentioned the amount of storage at their disposal as a decisive factor for keeping large amounts of data, while others were accumulating independent of it. At the same time, some participants gravitated towards a minimalist approach because of the limited storage on their devices. So we do not have a definitive answer to our question, but we do believe that considering the spectrum of tendencies we present can inform design decisions. What we offer are not specific design recommendations for user interfaces, but rather broad implications that could help shape technology.

Seeing these tendencies as living on a spectrum with two ends lead us to advocate for ways to mitigate the costs that characterize both sides. Some recent changes in interfaces show that mitigation is possible. For example, the latest version of Apple's macOS has a panel, although rather hidden, to explore how storage space is used (Figure 1). It shows what are the largest files on a user's hard drive, their size and the last time they were used. This is information that the operating system can easily access and can be helpful to users to inform decisions about data preservation. Similarly, Google has released at the end of 2017 Files Go, an Android application that
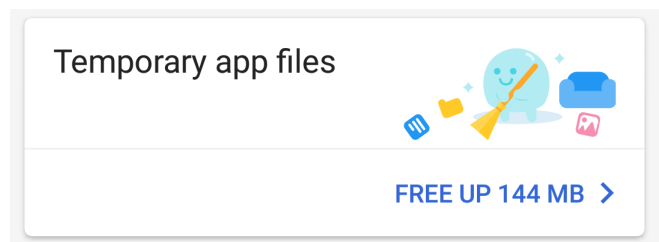
suggests to users how to free up storage space on their mobile devices by deleting, for example, old apps and temporary files (Figure 2).

Even though it is not clear how many users are aware or regularly take advantage of such features, their existence provides some evidence that companies are at least somewhat conscious of the frustrations experienced with the accumulation of large files. The strength of these features is that they accommodate multiple tendencies without prescribing a specific set of actions: they can bring self-awareness of hoarding or they can be a tool for the preventive and reactive strategies in minimalism.

We recommend more user support along these directions, namely, finding ways to increase awareness for these features, and making them more visible during daily usage or at specific moments. For example, during an operating system upgrade, users could be encouraged to engage in a little "spring cleaning," since we know that worrying about their data is one of the main concerns users have before an upgrade [45]. How to incorporate and display other attributes, such as emotional value, is another direction worth exploring and one that could potentially change how we approach data containers.

We also wish for users to be able to explore alternative approaches. A recurring theme for participants was the need to compare themselves to other people. Think, for example, of P15 and her wish to become better organized, maybe even more minimal. But exploring and learning from others is not easily done. Data practices are often thought of as an individual activity that takes place in a vacuum, without considering the broader ecosystems where data lives [44] and the broader cultural environment that shapes data practices.

Cloud storage offers the opportunity of having data from different users all in the same connected platform. Therefore, it could provide visual representations of alternative approaches, which users could explore as possibilities that might better fit their needs. Through doing so, users may gain a better sense of their own identity and understand how tendencies shape their behavior.

**LIMITATIONS AND FUTURE WORK**

In studying data practices, we chose a broad and varied sample in terms of backgrounds and devices. We did not notice any apparent links between backgrounds, technical skills, age, gender, or specific devices and the tendencies displayed by participants. The same applies to the level of organization,

which appeared to be orthogonal to the two tendencies. However, a broader sample might tease apart both the distribution of behaviours across the spectrum and correlations between different factors. That was not the goal of our study, as we intended to focus on characterization and description, but it is a worthy avenue to explore. For example, future studies could look at the impact of different approaches on user satisfaction or the relation with busyness and other personality traits. They could take a closer look at the evolution of technology capabilities and see how they relate to user behaviours. Or they could compare everyday preservation strategies with digital behaviours and explore whether there are differences or consistencies.

Another avenue for future work is to study how different tendencies affect collaboration, given the increased support for collaborative data production and management in current platforms. What happens when people with different tendencies have to work together on the same set of data?

In general, we would want future studies to take into considerations this spectrum of tendencies, so that we can build a more robust theory of how people behave through different types of investigations and sources of data. A next step is to build tools to semi-automatically identify a person's tendency across the spectrum.

To summarize, our work provides the basis for additional studies that can address several unanswered research questions:

- How to identify tendencies across the spectrum of hoarding and minimalism?
- What is their distribution in the broader population?
- In what other domains do they play a driving role?
- How do they affect collaboration?

**CONCLUSION**

We have shown how participants approached digital data preservation driven by a spectrum of underlying tendencies with two extremes: hoarding (where they accumulated large amounts of data, sometimes considered useless, experiencing in some cases challenges with managing it) and minimalism (where they tried to keep as little as possible, preventing or reacting to data as a way to be in control of it). There was nuance and variation within individuals, but tendencies close to both extremes of the spectrum appeared to be a way for participants to build their own identity in relation to data (*I have data therefore I am* vs. *I am more than my data*).

The contribution and value of our work lies in: 1) bringing to light a spectrum of tendencies with hoarding and minimalism on two ends, characterizing them in depth, 2) comparing and contrasting different user behaviours, showing their common role for identity construction, 3) putting them in context compared to previously reported behaviors in the literature.

These findings move forward our understanding of how people preserve digital data, a generally under-unexplored topic. Furthermore, they have broad implications for shaping technology, opening rich possibilities for future work. Now that we are in the foothills of a new world where seductive cloud storage is pervasive, it is critical to understand what drives people's behaviors so that we can shape this world in a way that promotes informed decisions and well-being.

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