DEPARTMENT: VISUALIZATION VIEWPOINTS

Databiting: Lightweight, Transient, and Insight Rich Exploration of Personal Data

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As mobile and wearable devices are becoming increasingly powerful, access to personal data is within reach anytime and anywhere. Currently, methods of data exploration while on-the-go and in-situ are, however, often limited to glanceable and micro visualizations, which provide narrow insight. In this article, we introduce the notion of databiting*, the act of interacting with personal data to obtain richer insight through lightweight and transient exploration. We focus our discussion on conceptualizing databiting and arguing its potential values. We then discuss five research considerations that we deem important for enabling databiting: contextual factors, interaction modalities, the relationship between databiting and other forms of exploration, personalization, and evaluation challenges. We envision this line of work in databiting could enable people to easily gain meaningful personal insight from their data anytime and anywhere.*

A s device hardware and software advance, enabling broader access to personal data, new opportunities for mobile data exploration arise: mobile data exploration has the potential to intertwine with our lived experiences and day-to-day activities. However, conducting data exploration in on-the-go scenarios of use poses unique challenges. It is crucial that exploration does not hinder, but rather assists, a wide range of scenarios and contexts in which we find ourselves seeking insight.[1] In this article, we advocate for the visualization and personal informatics research communities to focus on the development of lightweight and transient exploration techniques that enable insight rich access to personal data.

Current systems offer one of two approaches to mobile data exploration. Glanceable and micro visualizations have been widely adopted in mobile applications,[2] at times combined into dashboards (Figure 1 left). They provide concise and focused representations of information in a limited space and context for users to easily grasp information at a glance. However, despite their popularity, they offer only specific insights and allow limited interaction, leaving users without the ability to cater to their personal and situational needs. In contrast, heavyweight applications have been designed to enable more comprehensive data exploration (Figure 1 right). These applications often require considerable time and knowledge to use. These barriers make them at times inaccessible or inconvenient (e.g., during physical activity, while walking a pet, or while cooking). Between these approaches, a significant gap in the field of personal informatics and visualization arises: limited information richness hinders users' ability to better comprehend and leverage personal data through exploration that can be efficiently undertaken during broader contexts.

We discuss the notion of *databiting*, a term we coined to indicate lightweight, transient, and insight
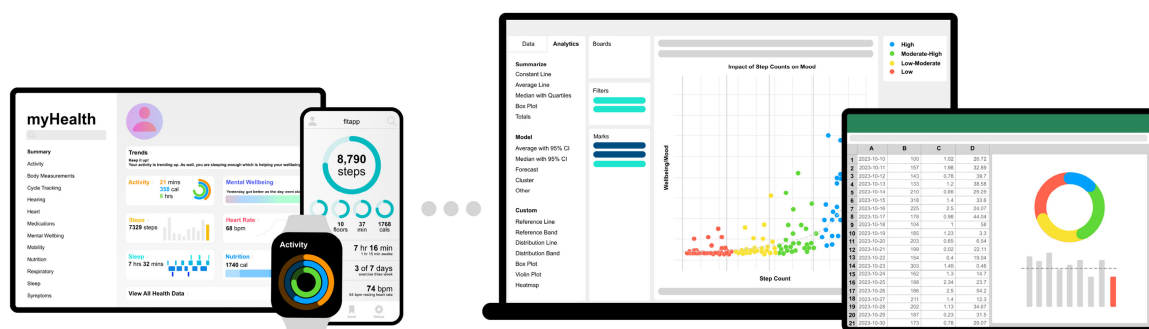
FIGURE 1. Representations of current mobile data exploration applications are highlighted, grouped by general information richness: applications which afford glanceable and micro visualizations (at times combined into dashboards) (left) and applications, which provide potential for heavyweight data analysis (right).

rich exploration. Achieving higher levels of information richness often proves challenging. However, we should actively seek ways to enhance accessibility and ease in obtaining greater insights. By embracing the approach outlined in this article, we can empower individuals to effortlessly gain insights from their data as needed, transforming the way they explore and interact with personal data on-the-go. Together, this recognizes the importance of our interactions with personal data and emphasizes the significance of seamlessly integrating rich personal insights into our daily lives.

To better conceptualize databiting, we provide a storied real-life example (Figure 2). While this example highlights the use of a smartwatch, databiting can be beneficial for any device on which personal data can be explored. Imagine Sam, while hiking, checks their smartwatch and becomes aware of a possible shortfall

in their exercise. The smartwatch initially displays only current metrics. Seeking a deeper understanding, Sam taps and holds on the pace number, and adds a natural language query, stating *"Compare to my last 6 hikes."* In response, a graph appears indicating a relatively slower pace for the day. With this insight, Sam decides to increase their pace for the remainder of the hike, determined to reach their average by the end of the trail. This seamless exploration of personal data during an activity is made possible through databiting, during which individuals can quickly and easily gain meaningful insight into their data on-the-go.

In this article, we introduce the concept of databiting and argue for its potential value. We then delineate five research considerations—contextual factors, interaction modalities, the complementary relationship between databiting and other forms of exploration, personalization, and evaluation challenges—focused

FIGURE 2. To the left of the red dashed line is one example of the current state of exploration for mobile data visualizations. To the right, databiting is enabled for physical activity related information. This has the potential to provide greater influence and insight of the current activity taking place. Notably, more in-depth long-term data exploration is left for a later time.

toward enabling and understanding databiting. Importantly, these research areas can work in concert to provide lightweight and transient access to richer personal insight anytime and anywhere.

PERSONAL DATA EXPLORATION

Personal informatics, an interdisciplinary field encompassing human–computer interaction and visualization research, emphasizes the collection, comprehension, and utilization of personal data.[3] At its core, personal informatics aims to leverage data for enhanced personal insights and actionable knowledge. Achieving this goal involves a multifaceted approach that entails understanding people's unique needs and patterns of usage, as well as designing and evaluating innovative technologies, interaction modalities, and data representations.

Thanks to the increasing capability and prevalence of mobile and wearable devices, the collection of and access to personal data is quickly growing. From this data, people have the potential to gain insights into their behaviors and various aspects of their lives, such as health, finances, and social connections. While collecting and presenting personal data is essential, true value emerges when individuals can explore and interact with their data in meaningful ways.

From glanceable and micro visualizations to interactive dashboards on mobile and desktop devices, the aim is to create interfaces that empower individuals to effortlessly explore and gain insights from their personal data (e.g., uncovering patterns, trends, and correlations). However, current interfaces on mobile devices often lack affordances to provide richer and personalized insight. For example, dashboards only offer a limited number of set filtering options, and glanceable and micro visualizations are predefined without interaction. This inability to further explore personal data can be seen as a form of limited functionality, which is one cause of frustration and even abandonment of wearable devices.[4]

We recognize that exploration of personal data can be embedded within activities and experiences (i.e., in-situ). We must strive for innovative solutions that empower people to easily explore their data whenever they see fit, enabling them to derive meaningful insights and make informed decisions. As we establish and refine the notion of databiting, we seek to expand ways in which individuals can perform visual data exploration in a wide array of usage scenarios.

THE DATABITING CONCEPT

We conceptualize *databiting* as the act of interacting with personal data to gain increasingly rich insight through lightweight and transient exploration. The result is a *databite*, concise personal insight that extends upon what can be derived from glanceable or micro visualizations. Databiting as both a new concept and a topic for research is fluid in nature: Boundaries defining insight and data exploration methods allowing for such insight are not rigidly defined or fixed.

To illustrate this concept, we draw upon analogy. Databiting can be seen as equivalent to eating a small and easily consumable snack. The size of a snack and the number of bites required may vary from person to person and from context to context. Yet, what remains constant is the lightweight and transient nature of snacking compared to consuming a meal (often a reasonably large amount of food). In the context of data exploration, databiting equates to the consumption of bite-sized information that provides rich insights or sustenance in the moment. This builds upon simply viewing a mobile data visualization and does not require more in-depth and long-term data exploration, which can be done later when necessary or more appropriate.

Importantly, databiting is not meant to replace either in-depth exploration of data or shorter-form viewing of glanceable visualizations; rather, it is complementary to them. By bridging the gap between the two forms of exploration methods, databiting offers a new form of complementary exploration that pushes the boundaries of what is attainable. This integration of exploration methods can foster a more comprehensive, valuable, and unique (i.e., richer) understanding of personal data, yet remain accessible in a lightweight and transient manner. By offering a range of exploration options, across devices and throughout a range of usage scenarios, we expect individuals can derive greater benefits from their data-driven insights anytime and anywhere.

Lightweight, Transient, and Insight Rich Exploration

Time and effort, which should remain small, are key factors in the context of databiting. Glanceable and micro visualizations excel at providing quick and easy data engagement, however, remain limited in their level of insight conveyed.

We envision that there remains a huge opportunity to enable access to more information rich insights while maintaining a lightweight and transient approach (Figure 3). Consider a scenario in which a runner is stopped at a traffic light, waiting to cross the street. The primary task is their run and the focus on the surrounding environment. Secondary to this, they look at their heart rate zone data. Seeking a databite they simply tap on a
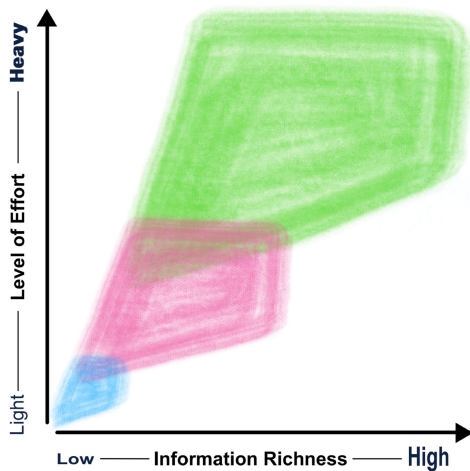
FIGURE 3. In *blue*, we highlight glanceable and micro visualizations for data exploration. In *green*, we highlight heavyweight data exploration and analysis. In *pink*, *databiting*, as a concept, promotes the need for increasing information richness while exploration remains lightweight and transient. We encourage the reader to envision how visual data exploration can consume this area of the graph. We present these rectangles as *sketched* illustrations to signify the fuzzy boundaries of these forms of exploration and potential variance within them.

stacked bar chart, which highlights their current heart rate zone. This action reveals increasingly detailed insight into the time spent in each heart rate zone, enabling the runner to concentrate on entering or maintaining a specific zone as they proceed with their run.

As can be seen, databiting can offer richer insight without requiring substantial effort, engagement, or time. This allows data exploration to occur as secondary tasks, alongside a primary ongoing activity (e.g., while out for a walk) or during a recurring daily activity (e.g., riding a bus home). Through the prioritization of simplicity rather than detail and complex insight, the small "size" of databites ensures that it can be easily and appropriately consumed.

Device Agnostic Exploration
Due to their highly portable nature, the immediate availability of data being collected, and the smaller form factors limiting heavier exploration, databiting is particularly well-suited for smartwatches and other wearable devices. However, the emphasis of databiting is not on the specific device used or insights gained but is in the manner in which data are accessed. As such,

databiting can be seen as device agnostic and can be done on any device that grants access to relevant data, ranging from wearables, smartphones, and tablets, to laptops. For instance, before switching to a different task on a laptop, a researcher first quickly checks the current screen-time information. With simple mouse interactions, they learn about a negative trend that results from increasing the duration of one continuous work block and, thus, decide to take regular breaks, starting with an immediate break. Similarly, a tablet user exploring their financial data while in transit could use the stylus to circle a transaction and draw a line to another to view how they are related. Taking the interaction a step further, the user could employ predefined gestures to accomplish further exploration (e.g., displaying a transaction timeline or finding similar transactions). Multiple databites could be made throughout their journey as they look through their most recent bank statement.

Data Agnostic Exploration
The versatility of databiting extends beyond that of personal data, making it applicable to a wide range of domains and contexts involving data activities. While the initial conceptualization revolves around personal data for individual insights, the fundamental principles of lightweight, transient, and insight rich exploration can be seamlessly applied to various data categories. For instance, in the business context, professionals can benefit from quick insights (e.g., during a meeting). Databiting can enable easy access to necessary insights to foster discussions and inform decision-making without the need for extensive data preparation or analysis. In the context of scientific research, researchers running a Prolific (pilot) study can use databiting to garner quick insights about the amount and quality of collected data. This can help them decide to continue or stop and refine, if needed.

EXPECTED BENEFITS OF DATABITING
We discuss envisioned benefits of databiting that have the potential to overcome limitations and challenges of the current capabilities of mobile data exploration. Further study is needed to identify and demonstrate any tangible benefits that may exist.

Introductory and Intermediary Access
As highlighted earlier, databiting has the potential to bridge the gap between brief information access and substantial knowledge gain. Offering lightweight, transient, and insight rich access to personal data allows

for engagement with smaller bite-sized snippets of timely information. This approach provides an accessible entry point for individuals new to data exploration to explore and understand their data.

Furthermore, a bite-sized approach to exploring data can serve as an intermediary step, providing individuals with a gateway for more in-depth data exploration. By offering exploration in easily consumed pieces, databiting can spark further interest, familiarity, and excitement. When presented with quick and accessible personal insights, individuals may become more curious and motivated to further explore their data. Over time, this increased engagement may foster a greater sense of familiarity and confidence with data; ultimately facilitating further exploration and a deeper understanding.

Increased In-Situ Insight

Due to the lightweight, transient, and insight rich nature, we anticipate databiting will be beneficial for obtaining data-driven insights during in-situ exploration. In-situ instances of exploration refer to moments in which data analysis and reflection occur closely related to an ongoing activity, enabling immediate and direct impact.[5] Databiting can extend in-situ data access, currently offered through glanceable and micro visualizations and dashboard manipulation, by providing further information richness. This leads to increased actionable insights that are directly relevant to the ongoing activity. Whether it is using a smartphone to explore caloric intake for the day while cooking, asking a smart speaker about your home energy consumption for the day as you arrive from work, or checking productivity on your laptop while studying, databiting can empower individuals to gain valuable personalized insights that inform immediate decision-making while in situ.

Perceived Usefulness

A current challenge concerning devices and applications that allow for personal data access and exploration is a lack of perceived usefulness.[4] Current offerings often fail to meet expectations, resulting in the abandonment of devices, applications, and even the collection of data altogether.[6] While addressing perceived usefulness is a multifaceted challenge, databiting can serve as a promising start. Increased information richness and personalized insights enabled by databiting have the potential to enhance the perceived usefulness of the devices and applications used for databiting, and the value derived from collected data. In turn, this could lead to greater overall outcomes as the collection and exploration of personal data are not outright abandoned.

RESEARCH CONSIDERATIONS

In this section, we discuss how we can begin to enable databiting through research, to achieve increased access to personal data anytime and anywhere. Specifically, we discuss research considerations that aim to overcome existing challenges and benefit from promising opportunities.

Contextual Factors

Contextual factors can become increasingly integrated with databiting, shaping both the recognition of potential exploration and the integration of relevant data. Unlike conventional data exploration, in which context might be analyzed as an additional factor later on, databiting can be seen to easily integrate context. Glanceable visualizations, being static in nature, offer limited contextual impact. At most, they present predefined visuals, such as showing a sleep chart immediately upon waking up.

Yet, due to the potential for databiting to cater to an array of in-situ scenarios, contextual information can and should be incorporated. Imagine Dani, a traveler, using a mobile app to explore a new city. Basic on-screen insights might reveal Dani's location in relation to nearby attractions. However, when databiting, Dani, and even the app itself, can leverage contextual data such as time of day, personal preferences, and location history. This integration of contextual data can enhance the overall experience and provide the potential for increasingly relevant in-situ insights.

Focusing research on incorporating contextual factors within data exploration can significantly impact databiting. For example, we can study techniques to incorporate contextual attributes into data visualizations, develop context-aware recommendation algorithms, and look to gain a better understanding of how context can be incorporated into queries desired for databiting. By embracing contextual data, databiting can further in-situ exploratory capability and insight.

Interaction Modalities

Enabling databiting requires considering appropriate interaction modalities that are not only efficient but also cater to the unique constraints of in-situ scenarios. This is not straightforward, especially because we aim to increase the level of data accessibility across devices with potentially limited interaction spaces (e.g., smartwatches, smartphones, augmented reality glasses).

To facilitate lightweight, transient, and insight rich exploration of personal data, a multimodal approach through natural language and the device's primary interaction method can be used (see Figure 2). The primary input modality (e.g., touch) allows for direct

manipulation, discrete selections, and when natural language keywords cannot be remembered.[7] Importantly, natural language (e.g., speech) benefits from enabling fast and flexible expression of complex queries.[8] Recent research in personal health applications on smartphones has demonstrated the benefits of multimodal touch and speech interactions for gaining insights into personal health data.[7] Notably, individual and combined interactions were often used for differing, yet equally important, components of the data exploration process. Touch and speech combined showed promise for refinement of an initial query or displayed graph, much like databiting may extend upon glanceable or micro visualizations. However, a better understanding of individuals' personal data query requirements needs to be further addressed to fully recognize the interactive needs of databiting, and is beginning to see effort.[9]

Furthermore, exploring alternative output modalities can complement currently available data visualizations. Devices such as headphones, earbuds, and home assistants offer opportunities to incorporate natural language responses when databiting. This can appropriately provide access to data when people's visual systems are overloaded.[10] There is limited work on the requirements for natural language responses to personal data queries. Further research can focus on formulating efficient responses, determining the level of conveyed insights, and ensuring the memorability of responses. Integrating these findings with existing data visualization approaches can optimize access to personal data.

Databiting and Broader Exploration

The nature of databiting invites opportunities to consider a relationship with further in-depth data exploration. Understanding how people can transition from one to the other and how previous in-depth exploration can inform future databiting will contribute to a cohesive and personalized data exploration experience. However, it is crucial to recognize that the seamless transition between databiting and broader exploration experiences will likely require extensive device and app interoperability. Future research is needed to address these technical hurdles.

Databiting can afford a stepping stone for people to delve into in-depth data exploration when more appropriate. For example, as seen in Figure 2, Sam may recognize that their pace has been on a decline for a while. Not sure why, they can save the databite such that they are reminded to further explore for an external cause (e.g., less sleep) at a later time (e.g., while at a desk) and on an appropriate device (e.g., on

a tablet). It becomes important to understand how individuals can save and manage databites, and any new questions that arise, for future exploration.

Conversely, the results of prior in-depth data exploration have the potential to influence and enrich future databiting. For example, an individual may have taken the time to pore through their credit card statements, itemizing transactions into categories and noting a budget limit for each. When in the store, this past exploration may influence databiting which is directed toward understanding if a purchase can and should be made within a predefined category.

These examples further highlight an underlying challenge concerning interoperability. Currently, fragmentation and nonstandardized access to collected data hinders cohesive personal data exploration. For instance, data saved on one device may not seamlessly integrate with a user's preferred in-depth exploration tool on another device (e.g., to analyze collected data from an Apple Watch in Tableau, exporting and importing of data is required). Furthermore, data collected on multiple devices may be stored using different protocols and formats. Without a concerted focus on interoperability, the potential for databiting to seamlessly complement broader exploration methods, and vice versa, may be hampered, limiting overall effectiveness.

Personalization

Studying and supporting personalization is crucial for optimizing databiting and enhancing the exploration process. By tailoring insights, recommendations, and visualizations to individuals and contexts of use, personalization ensures that relevant information is efficiently presented. This reduces the required time and effort, enabling people to quickly access valuable insights and make informed decisions.

Through personalized databiting, technology mediation (i.e., artificial intelligence, machine learning, etc.) can alleviate individuals from manual data analysis. For example, a personalized databite may provide instant workout recommendations. A potential reduction in temporal workload allows people to focus on the actionable outcomes of databiting rather than the exploratory process. Furthermore, serendipitous discovery is a benefit of visual data exploration. Personalization can be used to mediate tailored serendipitous insight, even with lightweight and transient exploration.

Evaluation Challenges

To realize the full potential of databiting, it is essential, yet challenging, to understand an individual's needs and

goals when interacting with personal data. Modest methods such as sketching or surveys lack real-world data, while heavyweight approaches through the creation of working mobile applications are costly and time-consuming. Balancing methods through data engagement interviews and Wizard-of-Oz studies can help capture needs in various daily contexts, although in-lab study methods may suffer from recall bias.[11]

To assess the value of databiting, measuring effectiveness of personalized exploration and insight enabled by databiting is important. Longitudinal studies can capture behavior change over time, but studying and capturing the immediate influence of databiting is not straightforward. Understanding the impact of databiting compared to glanceable and micro visualizations, and longer form data exploration would also be valuable.

With the above in mind, accommodating in-situ studies is crucial for a comprehensive understanding of databiting. Current methods such as experience sampling[12] and diary studies,[13] while valuable, have limitations in capturing the full range of potential scenarios. Further developing appropriate research methods within situated environments is required. By capturing real-world usage and contextual factors, we can gain a more nuanced understanding of how individuals engage with databites in their everyday lives, further advancing the field and maximizing potential.

CONCLUSION

We conceptualize *databiting* as the process of extracting rich insight through lightweight and transient data exploration. Fueled by the widespread use of ubiquitous high-performance sensing and interactive devices, coupled with the increasing collection of personal data and situated environments of use, this form of exploration has the potential to transform the way people interact with and understand their personal data in their daily lives. By bridging the gap between glanceable and micro visualization and heavyweight visual exploration, databiting can provide complementary insight, enabling people to better access their personal data.

In this article, we have introduced databiting, provided examples and expected benefits, and delineated research considerations that remain to be undertaken. We envision that this key, yet underexplored, concept of personal informatics may soon become a reality. We hope this work inspires research communities toward the creation of applications and tools that enable databiting. We anticipate that both exciting challenges and opportunities will arise, which in turn will shape the future of databiting, and access to personal data anytime and anywhere, for the better.

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