

Into the archive of ubiquitous computing: the data perfect tense and the historicization of the present

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Abstract

Purpose – This paper theorizes ubiquitous computing as a novel configuration of the archive. Such a configuration is characterized by shifts in agency underlying archival mechanics and a pronounced rhythmic diminution of such mechanics in which the user's experiential present tense is rendered fundamentally historical. In doing so, this paper troubles the relationship between: archival mechanics such as appraisal, accession and access; the archive as a site of historical knowledge production and the pervasiveness of data-driven daily life.

Design/methodology/approach – By employing conceptual analysis, I analyze a classic vision of ubiquitous computing to describe the historicization of the present tense in an increasingly computerized world. The conceptual analysis employed here draws on an interdisciplinary set of literature from library and information science, philosophy and computing fields such as human-computer interaction (HCI) and ubiquitous computing.

Findings – I present the concept of the data perfect tense, which is derived from the future perfect tense: the “will have had” construction. It refers to a historicized, data-driven and fundamentally archival present tense characterizing the user's lived world in which the goal of action is to have had created data for future unspecified use. The data perfect reifies ubiquitous computing as an archive, or a site of historical knowledge production predicated on sets of potential statements derived from data generated, appraised, acquisitioned and made accessible through and by means of pervasive “smart” objects.

Originality/value – This paper provides foundational consideration of ubiquitous computing as a configuration of the archive through the analysis of its temporalities: a rhythmic diminution that renders users' experiential present tenses as fundamentally historical, constructed through the agency of smart devices. In doing so, it: contributes to ongoing work within HCI seeking to understand the relationship between HCI and history; introduces concepts relevant to the analysis of novel technological ecologies in terms of archival theory; and constitutes preliminary interdisciplinary steps towards highlighting the relevance of theories of the archive and archival mechanics for critiquing sociotechnical concerns such as surveillance capitalism.

Keywords Ubiquitous computing, The archive, Archives, Data qua record, Temporality, Data perfect tense, Human-computer interaction, Documents

Paper type Conceptual paper

Introduction

Thirty years ago, nestled in the pages of a Scientific American, Sal woke up (Weiser, 1991). Upon waking, she became the fictional representative of a then-futuristic world where computation was ubiquitous. As the data practices of Sal's morning – the ways in which she interacts with data that represent and construct her lived world – become reflected in the everyday, contemporary worlds of *users*, they limn a historical condition at the contentious intersection of archives, *the archive* and computing. This condition resides at a disciplinary



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point of overlap as HCI scholars call for more systematic understandings of the relationship between HCI and history (e.g. [Soden et al., 2019](#)), information scholars trouble the ways in which time affects and effects information practices (e.g. [Haider et al., 2020](#)) and scholars of archives continue to consider their role – and the role of archives – in the production of knowledge (e.g. [Cook, 1997, 2011](#); [Giannachi, 2016](#)). In this essay, I argue that the historical condition manifest in the ubiquity of computing is a historicized present tense subtended by the documentality of data *qua* records appraised and accessioned into an archive of ubiquitous computing through and by means of its ever-expanding ecology of “smart” objects and their agency. The characteristics of the archive of ubiquitous computing inform each of the three overlapping research areas outlined above.

Sal’s data practices form the kernel of the *historical a priori* condition of the 21st century – the bounded set of possible statements which are taken as foundational to a historical era and which represent an identifiable topology of *the archive* ([Eliassen, 2010](#); [Foucault, 1972](#)). This is what I will refer to as *the archive of ubiquitous computing*: the point at which separate and separable archives of data born of users’ interactions with discrete devices aggregates through networking, connectivity and the economic motivations of surveillance capitalism ([Zuboff, 2019](#)) to form a present tense that is experienced through fundamentally historical modes of knowledge production.

The analysis I present here focuses on aspects of ubiquitous computing drawn from scholarship close to the center of ubiquitous computing: Weiser’s “The Computer for the 21st Century” (1991). Although Weiser’s vision of ubiquitous computing was grounded in a well-defined set of philosophical positions ([Takayama, 2017](#)), I work in the received condition of ubiquitous computing: that is, the ubiquity of computation, rather than the realization of Weiser’s specific vision. This condition is characterized by the prevalence of surveillance capitalism ([Zuboff, 2019](#)): a Heideggerian-like condition in which human users are transformed into standing reserve for the harvesting of data ([Heidegger, 1977](#)). I focus on the illustrative “Sal scenario” contained within Weiser’s vision (1991, pp. 102–104) and conduct a conceptual analysis ([Laurence and Margolis, 2003](#)) of how Sal’s world is constructed through and by means of data: the kernels of the archive of ubiquitous computing which are generated, appraised and accessioned not by expert archivists, but through users’ adoption of technologies designed to traffic in data.

I employ a multi-faceted conceptual lens that draws on work in HCI, ubiquitous computing, library and information science and philosophy. As a result of this analysis, I present a preliminary explication and discussion of the data perfect tense: a sociotechnical configuration wherein the “will have had” structure of the future perfect tense describes the motivations for present-tense action in relation to the act of generating, appraising, accessioning, analyzing and communicating data, resulting in a profound rhythmic diminution of traditional archival mechanics. Such rhythmic diminution – the scalar reduction of measurable increments of time – renders the users’ present tense as both historical and records-based.

Background and relevance

The difference between archives and *the archive* can be subtle. In this paper, the term “archives” refers to bodies of institution-specific records that are appraised, accessioned, preserved and made available because of a perceived value to the institution responsible for them. (NB: Here, “institution” refers to a broad category of sociotechnical actants ranging from governments to corporations to platforms.) *The archive*, on the other hand, is used to refer to a conceptual field site for historical knowledge production that is characterized by sets of possible statements, power and the violence of knowledge production ([Derrida, 1998](#); [Foucault, 1972](#)). Archives are bounded by their contents and the agency responsible for the

appraisal, accession, preservation and accessibility of those contents (i.e. the archival mechanics); *the archive* bounds the mode of historical knowledge production that occurs within and through archives.

In this section, I situate my treatment of the archive of ubiquitous computing and the emergence of the data perfect tense in common conceptualizations of *the archive* and archives. Such conceptualizations are drawn first from the literature in archival studies. I then turn to a set of interdisciplinary work, which identifies productive misalignment between archives as sites of materially grounded practice (e.g. appraisal, accession, access) and *the archive* as a site of historical knowledge production.

Archives: a view from within

As stated above, the ubiquity of computation gives rise to the archive of ubiquitous computing: a site for historical knowledge production of the present tense. Yet any attempt to situate Sal's (Weiser, 1991) daily life in terms of *the archive* must necessarily grapple with the tendency towards metaphoric inflation (Manoff, 2004). Such potential inflation is dangerous: it risks the profound and harmful alienation of multiple sets of domain experts (Caswell, 2016), which is emphatically not my intention here.

Drawing upon Giannachi's (2016) recent treatment of Archives 0.0 through Archives 4.0 – itself built upon Shanks' (2008) previous treatment that builds towards an animated archive – I assume a historical trajectory characterizing the discourse of archives, which necessitates open discussion and interdisciplinary work between scholars from multiple domains. Archives evolve alongside the forms of media they contain (Røssaak, 2010). In this regard, the practical sites of archives are themselves discourses within the broader historical field site of *the archive*. Such an assumption broadly motivates other contemporary work which situates archives alongside emerging technologies (e.g. Marciano *et al.*, 2018; Stančić *et al.*, 2017; Theimer, 2011), and continues in the tradition of core work in archival studies, which seeks to understand the transformations of what constitutes records, their creation, their use and their social implications (Cook, 1997, 2011).

Given the intended interdisciplinarity of this essay, I turn to core conceptualizations of archives and engage with definitions presented by the Society of American Archivists (SAA) [1]. I do so in order to clearly demarcate a starting point: not an exhaustive map of scholarship about archives, but a functional set of signposts intended to orient non-specialists quickly to the meetings points of *the archive* and archives.

A few key points from definitions provided by SAA deserve consideration. First, archives are comprised of records. Second, the comprisal of archives by records aspires to completion. Third, such comprisal is predicated on the appraised value of records. Each of these characteristics speaks to the historical value of archives: their relationship to *the archive* as a field site for historical knowledge production. Indeed, forward-looking contemporary theorizations of the archive adopt a historical posture (e.g. Manoff, 2010) and grapple with archivists' role in the production of memory (Ketelaar, 2001) and by logical extension, the social imaginary (Taylor, 2004) – it would be naïve to assume that records are always faithful to that which they represent (Trace, 2002).

At least two gains are achievable through the appraisal, accession and accessibility of records: the completion of the past as something knowable; and the utilization of the past so as to inform the present. The former is roughly aligned with the Enlightenment history of objectivist knowability (Giannachi, 2016); the latter with an increasingly nuanced temporal division between the past and the present which presents monetizable gains in the current culture of surveillance capitalism (Zuboff, 2019). Both of these gains motivate the process of appraisal by which records gain admittance to archives in the context of ubiquitous computing.

In the case of the archive of ubiquitous computing – a conflation of archives and *the archive* effected by the inter-institutional infrastructure of ubiquitous computing – data in

their rawest form become records. That is, data are the stuff – the kernels – of *the archive*, which itself comprises multiple heterogeneous archives relative to a diverse set of actants (e.g. users, platforms, corporations, governments). By “data,” I mean generally computer-readable representations of events in the world of human experience that are translated into the dominant epistemology and the pseudo-phenomenology of computation from which such epistemology emerges: records of events that are generated in the form of data, stored and saved for future use, where “use” refers implicitly to some form of computational analysis that is roughly aligned with the broadly scientific (i.e. objectivist) epistemology that computation inherits and materializes.

The analysis of the data *qua* records that comprise the archive of ubiquitous computing is performative: it is not a completion that arises through the exhaustiveness of the archive itself, but through the enrolling or acquisition of ever more data into the archive. Nor is it a completion that arises through careful, human-mediated processes of accession or acquisition: the use of a device (e.g. a FitBit, a smartphone) becomes the point and sole criterion of acquisition. Use – and its associated condition of being a *user* – constitutes not only the moment of acquisition, but also the jussive and sequential violence of appraisal (Derrida, 1998). In light of careful and conservative approaches to the expert task of appraisal (e.g. Cox, 2003), I argue that in the archive of ubiquitous computing, use stands in for the process of appraisal and builds the archive according to the assumptions of surveillance capitalism.

The archive: a view from without

Critical engagement with archival theory often begins within, but extends well beyond LIS into fields such as science and technology studies (STS), the computing fields, cinema and media studies and media theory. Much of this engagement occurs through the lens of the document or file (Buckland, 1997; Day, 2008, 2014; Rayward, 1994; Vismann and Winthrop-Young, 2008), critical engagement with the standard data-information-knowledge-wisdom (DIKW) hierarchy (e.g. Bawden, 2007; Frické, 2009) or the archive and its theories (Bowker and Star, 2000; Ernst and Parikka, 2013; Farge *et al.*, 2013; Manoff, 2004; Røssaak, 2010; Seberger and Bowker, 2021).

Although the power of archives has been a central topic of study among archives scholars for some time, it was popularized across disciplines in the works of Foucault (1972) and Derrida (1998). Such popularization effects a confounding, yet productive blur between archives and *the archive*. Recent interdisciplinary work includes investigations of the archival value of self-tracking data (Trace and Zhang, 2019), the consideration of human remains as documents (Berryman, 2019) and explorations of the conceptual and practical value of community archives (Poole, 2020). It is clear that theories residing at the intersection of archives and *the archive* remain widely relevant and deserve more detailed, speculative consideration within the broader computing fields (Bunn, 2015).

One topic that has received a good deal of attention within the computing fields is that of the personal life archive (Dang-Nguyen *et al.*, 2018; Hayes, 2006; Kaye *et al.*, 2006; Zhou *et al.*, 2017). Such coverage is broadly motivated by questions of the following ilk, as asked by Sellen and Whittaker (2010, p. 70): “What if we could digitally capture *everything* we do and see? What if we could save every bit of information we touch and record every event we experience? What would such a personal digital archive be like, and how might it affect the way we live?” Such questions lead to innovative designs that foster interaction between users and archival data: nostalgia-inducing, algorithmically generated playlists of music based on archives of listening habits held by last.fm (Odom *et al.*, 2019); the development of “finding aids” tailored to personal email archives (Hangal *et al.*, 2015); and the explicit instantiation of certain value codes within population-specific archives (Fiesler *et al.*, 2016). The extent of such

archival structures is limited only by the breadth of the ecology of devices that collect such traces. (See, e.g., the strange and wonderful case of the Carolan guitar (Benford *et al.*, 2016)).

The actions that subtend personal life archives initially appear to fit within the traditional model of archives – accession based on perceived value, preservation for an unspecified future use (Olgado *et al.*, 2020). But coverage of these forms of archive does not adequately consider the shifting agency of accession within the broader ecology of ubiquitous computing. The data contained in and comprising social media profiles are increasingly enfolded into the conceptual framework of traditional archives (Acker and Brubaker, 2014; Zhao *et al.*, 2013) in a normative way. That is, such approaches fit contemporary technological practices to the known mechanics and agencies of archives. Yet, I contend that it is necessary to effect an inversion (Bowker, 1994): to see archives through the ubiquity of computation, rather than the ubiquity of computation through traditional views of archives. When computational objects are designed to automatically collect data, the agency of such objects is the locus of appraisal and therefore the basis for the archive of ubiquitous computing.

Speculative archives: the view from ahead

The infrastructural qualities of ubiquitous computing – invisibility achieved through ubiquity (Star and Ruhleder, 1996; Weiser, 1991) – constitute it as an emerging configuration of the *archive*: a set of possible statements (including actions and events (Foucault, 1972)) that prescribe and proscribe modes of interacting with the world because of the roles that ubiquitously collected data play in its configuration. As I will argue, in the case of ubiquitous computing, the transformative violence (Derrida, 1998) of the archive is derived from the otherly origin of computational data that is ostensibly collected through the bypassing of the human. The archive bifurcates along the lines of two incommensurable phenomenologies: that of human embodiment and that of computational prosthesis (Seberger and Bowker, 2021). Not only is the archive of ubiquitous computing characterized by a rhythmic diminution of archival mechanics which renders the present tense fundamentally historical, but by the emergence of novel forms of agency responsible for the execution of archival mechanics.

Where computing has, indeed, become ubiquitous, questions of its archive emerge as ubiquitously relevant. If data are collected, then at the moment at which they are collected, the phenomena they represent are rendered historical-archival: the translation of phenomenon to representation is always already one of “now” to “then.” When, as in the implicit computational infrastructures of Sal’s retro-futuristic morning, the world of human experience is recorded and expressed as data, her present tense becomes an archival-historical tense. Within the greater milieu of surveillance capitalism (Zuboff, 2019), it is undeniable that minute data traces are collected and preserved – albeit for highly variable durations – based on their presumed value. An experiential world undergirded by data sensing, collecting and processing is always already an archival world; but it is an archival world where the longer form past tense of the archive – that which has historically been preserved for long durations of time – diminishes to match the increased tempo of generation, appraisal, accession, analysis and feedback. Every moment of use, every automatic collection of data by a smart object becomes a moment of appraisal and acquisition.

To gain a suitably nuanced view of ubiquitous computing’s archival effects – the extent, on the one hand, to which ubiquitous computing diminishes the rhythms of the archive; and the extent to which ubiquitous computing constitutes a functional *archive of the present tense* born through the agency of non-human actants – one must adopt an interdisciplinary perspective. Where computation is ubiquitous, its effects carry through the walls of disciplinary silos. It is only possible to perceive of an emergent phenomenon in some form approaching entirety when the spaces demarcated by silos are combined.

In what follows, I outline a theory of the archive of ubiquitous computing and its data perfect tense by identifying and analyzing several user interactions within Weiser's (1991) Sal scenario. Following identification of these interactions in the next section, I engage with them through the lenses of work in computing, library and information science and philosophy before presenting an initial definition of the data perfect tense.

Case study

We have already met Sal, or at least we have seen references to her. To clarify: Sal is a fictional character who illustrates what daily life might look like in a world of ubiquitous computing. She is a main figure in the imaginary of ubiquitous computing and a foundational example of the process of "envisioning" through which computing futures are imagined and communicated (Reeves, 2012).

Sal's morning unfurls between pages 102 and 104 of the September 1991 issue of *Scientific American* on either side of a full-page ad (page 103) for four-megabyte diskettes produced by 3M. Despite the article's age, it is still highly cited – Google Scholar shows around 3,000 citations since 2016 [2]. In the short scenario, Sal engages with ten context-aware systems across three broadly defined contexts (Indulska and Robinson, 2009). I focus on two of those systems because of their specific characteristics: the ways in which they imply an archival structure predicated on data generation, appraisal, accession and feedback as the foundation of the Sal's experiential present tense.

Sal's morning: two interactions

First, Sal avails herself of data traces to gain a descriptive overview of the morning's activity prior to her waking:

Sal looks out her windows at her neighborhood. Sunlight and a fence are visible through one, and through others she sees electronic trails that have been kept for her of neighbors coming and going during the early morning. Privacy conventions and practical data rates prevent displaying video footage, but time markers and electronic tracks on the neighborhood map let Sal feel cozy on her street.

Glancing at the windows to her kids' rooms, she can see that they got up 15 and 20 minutes ago and are already in the kitchen. Noticing that she is up, they start making more noise (p. 102)

Here Sal gathers information about her kids, who woke up 15 and 20 minutes before her, through engagement with the computational objects that constitute her standard assemblage of devices – her *habitèle* (Boullier, 2014). Notably, this *habitèle* includes augmented features of her home: windows that both reveal *and* display. Sal similarly checks on the status of her neighborhood by looking at a window that displays data traces of activity on her street in order to monitor whether anything is out of the ordinary.

The line between the natural world and the artificial world is blurred. The double-meaning of "windows" effects this blur. The windows exist doubly as transparent panes through which an outside world might be seen from inside the home, but also as displays for digital information. (It is difficult to imagine that Sal – a character for whom the quaint term "cozy" is descriptive – would actually have transparent panes of glass separating her bedroom from her children's room or rooms.) Sal's is a room with many views: windows into both the physical world as sensed and perceived through the condition of embodiment, as well as through the prosthetic sensation and perception of what we would now call smart objects.

Although it is a rudimentary inference, the windowed displays of Sal's room imply that the data collected by Sal's various devices – and by extrapolation the various devices employed by everybody else who resides in her world – are stored somewhere. The possibility of being

recalled, post hoc, for display implies a place of storage from which to be recalled. A proto-archive of data emerges, drawn upon to communicate information in a present tense. Her choice to install such windows (or perhaps buy or rent a home with such windows) motivates the accession of data *qua* records those windows collect. By virtue of their implied constant connectivity with other smart objects, Sal's smart windows are always appraising, always acquiring data. These data comprise the functional records of the archive of ubiquitous computing. The *prima facie* value of such data *qua* records – the implication that such data can be used to inform present tense decisions – gives a first glimpse at the archival nature of ubiquitous computing, albeit at a profoundly rhythmically diminished tempo. As seen through Sal's smart windows, the archive of ubiquitous computing is not one of centuries, decades or even years, but of hours and minutes.

Notably the data *qua* records generated and accessioned by Sal's windows are amended by Sal's own biologically derived information: she hears her kids in the kitchen. The present tense of Sal's morning combines stored data drawn from a blackboxed and external source, as well as "data" (e.g. sensory stimuli) collected and processed in the real-time of human experience through and by means of her embodiment. Relative to her kids, computational data is complemented by human-readable stimuli; relative to the activity on her street, computational data is outputted and processed *as* human-readable stimuli. The datafied past – as constructed through the generation, appraisal, accession and communication of data – informs Sal's experiential present. Indeed, it constructs the experience of her present tense, blurring the line between the expected historicity of archives and the rhythmically diminished and agentially ambiguous mechanics of an archive of ubiquitous computing.

Second, Sal uses a "foreview mirror" while driving:

On the way to work Sal glances in the foreview mirror to check the traffic. She spots a slowdown ahead and also notices on a side street the telltale green in the foreview of a food shop, and a new one at that. She decides to take the next exit and get a cup of coffee while avoiding the jam.

Once Sal arrives to work, the foreview helps her find a parking spot quickly. (p. 102)

The foreview mirror in Sal's car effects outcomes that a range of current apps effect: the ability to avoid a traffic jam (e.g. Waze), the ability to find an open parking spot (e.g. Bosch's Parking Lot Sensor) and the ability to identify roadside points of interest (e.g. GoogleMaps, Apple Maps, Waze). Where, relative to her kids and her street, Sal's present tense extended into a near past tense – that of her street's relative past, the earlier morning in general and the recent past of fifteen minutes prior to waking – through the functionality of her car's foreview mirror, her present tense also extends into a near future: other places and other spaces that exist presently to Sal as future destinations.

The connectivity and networking of her foreview mirror allows her to transcend the limits of her physical location and the sensory stimuli that such a location presents. She gains access to the stimuli of a place to which or through which she will travel. Notably – as such transcendence has historically been achieved through direct human engagement with such devices as the telephone, the television, etc. – the process by which Sal gains access to distal present-tense information is wholly automated. What we would now term "smart" objects mediate processes of appraisal and acquisition (i.e. sensing and collecting data), preservation (i.e. the maintenance of such data for future use) and access (i.e. the presentation of algorithmically-determined "relevant" data). Appraisal – the valuation of something worth saving – is implied through the use of the device. Adoption of the device always already implies the perceived value of the data *qua* records it generates.

This process – the mode by which Sal accesses her daily world – arises through and by means of a computational infrastructure responsible for sensing, collecting, storing and communicating data. It is outputted as human-readable – "Turn right at the next exit to avoid

a traffic jam” – but emerges through a phenomenologically inaccessible mode of appraisal, accession, processing and output. Computational knowledge born of sensors and protocols is enfolded into Sal’s morning routine. Thus the constructed world in which she resides is predicated on her existence as a “user”: an agent intimately bound up in the cycle of data generation and consumption. In Sal’s world, human experience of the present tense is interpolated by computational data: a world seen through the prosthetic and archival eyes of computing, which see at a rate much faster than that of the human eye.

Analysis

In this section, I introduce and explicate concepts from several different scholarly domains in order to interpret the archival characteristics of Sal’s interactions described above. I do so in order to build an interdisciplinary lens through which we might productively discuss the relationship between ubiquitous computing, the structure and temporality of the archive of ubiquitous computing and ultimately the ways in which ubiquitous computing impacts the ontology of the user in a new *historical a priori* condition – a new epoch.

The imaginary of IoT

The Internet of Things is perhaps the clearest and most successful descendant of ubiquitous computing. However, IoT is not commonly considered through philosophical lenses ([Bardzell and Bardzell, 2019](#); [Seberger, 2019](#)), let alone the philosophical lenses that underpin Weiser’s original vision of ubiquitous computing ([Takayama, 2017](#)).

IoT and ubiquitous computing share similar modes of envisioning ([Reeves, 2012](#); [Wong and Mulligan, 2016](#)) by which their stakeholders enroll potential users into the social imaginary of use (See, for example, Greengard’s day-in-the-life scenario ([Greengard, 2015](#))). Given the lineage between ubiquitous computing and IoT, as well as its similar modes of enrollment ([Callon, 1986](#)), the foundations of IoT can tell us much about the archive of ubiquitous computing.

In 1999, several years after Weiser laid the foundations of ubiquitous computing in the public imaginary with his story of Sal, Ashton coined the term “Internet of Things.” Although records of the meeting at Proctor and Gamble in which this phrase was ostensibly first uttered are unavailable as a primary historical record, Ashton described the event a decade later ([Ashton, 2009](#)). Ashton describes IoT as a means of compensating for and overcoming human inadequacies relative to the digital representation of the world. He notes that the vast majority of the digital information about the world was produced by human hands, but that such hands (and minds) are particularly fallible. They are prone to errors in data entry and limited attention spans:

Today computers – and, therefore, the Internet – are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes [. . .] of data available on the Internet were first captured or created by human beings – by typing, pressing a record button, taking a digital picture or scanning a bar code. [. . .] The problem is, people have limited time, attention and accuracy – all of which means they are not very good at capturing data about things in the real world ([Ashton, 2009](#)).

He continues by presenting a solution to the problem of human information-fallibility in very broad strokes:

We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. RFID and sensor technology enable computers to observe, identify and understand the world – without the limitations of human-entered data ([Ashton, 2009](#)).

One of the problems with this framing of IoT is that it relies on a representationalist cognitive schema. The world “out there” is something to be represented within the cognitive system of

an actant. For Ashton, the primary problem of data appears to be the veracity of representations, not the representations themselves. That is, the world appears always already prepared for datafication: the problem with the internet before IoT, as Ashton sees it, is that this process of datafication is lossy and inaccurate. The human – the pre-IoT actant primarily responsible for data extraction and representation – has limitations. These limitations play out in the form of incomplete or inaccurate data. Ashton's answer to this problem is to bypass the human in the process of data generation, appraisal, accession and access: the process by which the world is represented and passed through the computational.

In order to bypass the human in the process of data collection, a new category of objects emerged in IoT. These are so-called “smart” objects: objects that confound the traditional subject/object dichotomy in that they exert agency through the acts of sensing, collecting and communicating data. Where computational objects gain a form of agency, that agency is exerted. The object of its exertion is, paradoxically, the subjectual *umwelt* (Von Uexküll, 2009) – the experiential niche – of the human. In the archive of ubiquitous computing, these actants assume the responsibility of data generation, appraisal and accession. They are cold and prosthetic archivists creating an archival condition in which data, by virtue of *being data*, are valuable.

The world as created through the ubiquitous data-sensing and collecting of IoT is a world constructed through and by means of an otherly phenomenology: this is the phenomenology through which appraisal and accession occur in the archive of ubiquitous computing. This is the world that Sal saw through her windows and her foreview mirror. When the end-user engages with this world and takes action based on its informational outputs (e.g. recommendations, nudges), that user enfolds the phenomenology of the computational into the phenomenology of the human. They come to reside in an archive. That which appears primarily to the computer appears secondarily to the human end-user. The end-user's daily life unfolds within the subtly historical outputs of their devices.

In Weiser's scenario, Sal knows her world through a combination of embodied and prosthetic forms of information processing. The world of her street passes through the prosthetic senses of the computational first, and Sal engages with its product (i.e. outputs) second. Still, she is embodied within her world of ubiquitous computing, blending her physical perceptions of her kids in the kitchen with the prosthetic and computational memory-sensations of what we would now call her smart home. The epistemological and archival importance of this subtle distinction – between knowledges produced by the prosthetic sensation of agential objects or the embodiment of human subjectivity – become clearer by more deeply considering the ontology of data.

Capta, description and acquaintance

The verisimilitude of IoT-born data – and therefore the characteristics of an archive of ubiquitous computing that manifests itself at the meeting point of such data and human experience – rests upon a *petitio principii* fallacy. It begs a question. One must accept the representativeness of data – the universal truthiness of computerized empiricism – in order to assert or accept that IoT-generated data can be fundamentally more accurate than human-generated data, rather than simply *differently* accurate.

As Drucker (2014) has argued, data are not endogenous to the world. Rather, they are created through inquiry. To know the world through the collection of data is to know only the world such data represent through their fundamental reductive creativity. Thus, where data are collected through the prosthetic sensations of ubiquitous computing devices that bypass human sensation and perception, they create the world in a computational way. Although her treatment of capta does not go quite so far as to draw a line between human-derived data and computer-derived data, Drucker uses the term “capta” to identify this critical epistemological

stance. Capta becomes a critical sticking point: if data are not endogenous to the world, but created, then the agency responsible for their creation must be accounted for in understanding those data's social, epistemological and ontological effects.

Bertrand Russell's work on knowledge production is apropos here. [Russell \(1951\)](#) distinguished between knowledge by acquaintance and knowledge by description. Notably, both of these forms of knowledge are mired in the objectival problems of phenomenology: objects recede. And yet assuming that we may ever, indeed, *know* something relative to the objects out there in the world, there is a clear epistemological hierarchy between acquaintance and description. Russell writes:

It is only [knowledge by acquaintance] that brings the object itself before the mind. We have acquaintance with sense-data, with many universals, and possibly ourselves, but not with physical objects or other minds. We have *descriptive* knowledge of an object when we know that it is *the object* having some property or properties with which we are acquainted; that is to say, when we know that the property or properties in question belong to one object and no more, we are said to have knowledge of that one object by description, whether or not we are acquainted with the object. Our knowledge of physical objects and other minds is only knowledge by description, the descriptions involved being usually such as involve sense-data ([Russell, 1951](#)).

There is a lot to unpack in this quote. Let us start by assuming that the phenomenal world is a complex object, or a fluid assemblage of proto-objects. These proto-objects are constituted as objects in relation to an observing subjectivity. Potentially simultaneously, these objects constitute phenomena when they are complemented by a subjectivity possessed of embodied agency ([Gibson, 1977](#)), where perception is intimately derived from sensation as in "sensation and perception." We know something through acquaintance when it reveals itself to us through subjectival-objectival complementarity: when the object out there (be it a car crash, a leaf, a Tweet, or an algorithm) meets with the sensorial boundaries of us "in here." In the absence of such a meeting – particularly the case in terms of such objects as algorithms, which have no direct point of complementarity – we are left with knowledge by description. This is knowledge at the formal remove of logic and inference. Such is the status and category of "data" within the envisioned futures of IoT.

And yet, this knowledge by description also manifests itself as a form of knowledge by acquaintance. The observer is not acquainted with that which data ostensibly represent, but rather the representations that data constitute. Users are acquainted *with* description. In Sal's case, she was acquainted with the computationally-derived description of her street, her kids, and her commute. She sees what has already been seen and remembered by the computational Other. In being acquainted with computational descriptions of these actants, Sal is first and foremost acquainted with an archival representation of them: representations that emerge from the archive of ubiquitous computing, the sets of possible statements *made possible* through and by means of prosthetic data collection. In this light, the nature of Sal's acquaintance with her described world is documental. The archive of ubiquitous computing presents to the end user as a real-time, phenomenological document that draws from both the phenomenology of the human (e.g. acquaintance with description) and the phenomenology of the agential, data-sensing and data-collecting object (e.g. description). The archive of ubiquitous computing extends beyond the bounds of traditional archives because of the phenomenologically foreign agency responsible for its core mechanics: appraisal, accession and access.

Texts and documents

Through the lens of IoT, the world of ubiquitous computing is not only one co-constructed through more data, but ostensibly better data ([Ashton, 2009](#)). Yet, through a more philosophical lens, the existence of data – whether in great magnitudes or relative dearth – brings the reader/analyst no closer to the phenomena that data represent ([Russell, 1951](#)) than

representation itself. When these two notions are combined, we are left with interpretation. The world of data becomes the world-as-text – albeit a text that is rhetorically founded in the truthiness of computerized empiricism. Here I take a relatively broad approach to the concept of text, relying on its treatment by McKenzie (1999): organized and materially-bound presentations of data – be they human- or computer-readable. McKenzie’s treatment is germane because of the profound multimodality of ubiquitous computing texts: when everything is computational, displays and points of interaction abound.

In relation to the concept of text – *texere* – Sal’s world appears as hyper-woven. The interactivity of those texts renders them documental: her devices’ outputs stand as proof of a world known through computation, which overlaps with the world as it might be known through her embodied modes of sensation and perception. While it has been noted that theoretical treatments of the concept “document” pale in comparison to treatments of “text” (Lund, 2010), commonly accepted definitions are available. Notably, that of Suzanne Briet: grounded in the etymology of “documentation,” Briet argued that a document is fundamentally a record of proof in support of a fact (Briet, 2006). In the context of Sal’s morning, her world – her street, her kids, her commute – exist as proof of the proposition that the world is knowable and can be known through data *qua* records: through documentation of the world as it is constructed and expressed through and by means of computational devices. Confoundingly, the documental outputs of her ubiquitous computing devices describe one archive – the phenomenological archive of knowledge by acquaintance that emerges through and by means of one’s condition of embodiment – and constitute another.

Where ubiquitous computing constructs a world through and by means of computational and automated data creation, appraisal, accession, preservation and access, it outputs documents not in the form of papers or artifacts, but in the form of possible statements: possible actions within the world grounded in the creativity of data. In this way, the outputs of the archive of ubiquitous computing extend documentality beyond the border of any given materiality and extend into the human experience of documentality (cf Buckland, 2014; Lund et al., 2016). The mental and experiential dimension surrounding the outputs of the archive of ubiquitous computing are in line with recent work in theories of documentation, which challenge not only the required durability for something to be considered documental (Olsen et al., 2012), but also the foundation of documentality in human – and exclusively human – expression (Lund, 2010). Such outputs, represented by Sal’s interactions with her street, children and commute, allow statements – again a category that includes actions and events – through and by means of embodied *acquaintance with computational description*. The real-time, experiential document that is created through output – visual display, auditory display, haptic display, recommendations, nudges, etc. – is subsequently interpreted and acted upon by the end user. The world that Sal knew was a world co-created through the documentality of its devices’ outputs: data *qua* records, communicated as outputs on her smart window. The archive of ubiquitous computing, therefore, gives rise to an experiential world grounded in extrinsic information (Gorichanaz and Latham, 2016): one that emerges in relation to the intrinsic qualities of the documental outputs that describe it. The way the world appears as a site of possible statements is a function of the way its documental components *are*: it comprises a *documental becoming* (Lund et al., 2016) that extends beyond the materiality of a document into the experience of the user whose world a document describes.

When the end user reacts to a documental output from one of their devices, they are enfolded into a documental world: a world that is expressed through the communication of data *qua* records. This is a world where data *qua* records assume the representational functionality of documents. Not a world that is described by documentation, but a world wherein phenomena – statements – are founded in documentation. In the archive of ubiquitous computing, the phenomenal world of the end user – literally that which appears to the user – is first and foremost a document of the computational world. Where documents are

representations, they exist post hoc: something must already be or have been to be represented. That which is collected recreates the phenomena it describes in its image. The map becomes the territory (Siebert, 2011): the experiential present tense of human embodiment becomes *the archive* of computational data *qua* records.

Within the rhythmically diminished archive of ubiquitous computing, the experiential present tense of the user – Sal in this case – becomes a historical-archival tense where experience is mitigated by acquaintance with that which has already been described. It is a present tense predicated on the creative destructiveness of capta: a future perfect tense in which each present is preserved for and analyzed in a fundamentally historical mode of knowledge production grounded in the phenomenology of prosthetic and computational sensation and perception – data sensation, collection, analysis and output/communication.

Findings

As Internet of Things objects such as virtual assistants (e.g. Alexa), navigation apps (e.g. Waze) and self-tracking devices like FitBits proliferate, they effect the ubiquity of computing. More and more aspects of users' daily lives are recorded, appraised and accessioned into the archive of ubiquitous computing through and by means of use, where the perpetuation of use is the primary criterion for the value of the data that such use generates.

When Sal woke up in 1991's tomorrow, she woke up into a daily world that routinely and invisibly enfolded data-driven representations of other places, spaces and times into her experiential present tense. These were places, spaces and times created through capta and output through user interfaces in human-readable formats. As I argued above, these outputs – descriptive representations of her neighborhood, her kids, the status of traffic – are documental in form. They are proofs of phenomena that fall outside the range of Sal's natural modes of sensation and perception, but which constitute the core of the prosthetic computational Umwelt. In being proofs, they are documents providing an object with which Sal's subjectivity can couple to create a phenomenon: an acquaintance with a description; a second-order phenomenology in which that which appears to the human has already appeared to the computational. In this way, Sal resides within the archive of ubiquitous computing: a historical modality of daily life in which the present tense is co-constructed through the accessibility of data *qua* records appraised and accessioned through the agency of computational objects.

And yet in being functionally documental, the outputs of Sal's ubiquitous computing world paradoxically historicize the present tense. Logically, phenomena of the experiential present tense cannot be documental in a material way because they have yet to pass into a past tense that can be *documented*. There is also no need for documental representation in or of the present tense unless the focus of that present is a category or prototypical object that extends itself beyond the experiential present. Yet the experiential present tense in ubiquitous computing extends beyond purely temporal characteristics: where the present tense is distinguished along the temporal axis from the past and the future, it is also distinguished along a spatial axis. The experiential present tense – Sal's morning, for example – is bounded by embodiment; yet those phenomena that occur beyond the boundaries of Sal's interactive embodiment are enfolded into her experiential present tense through their presentation as capta: descriptions with which she might become acquainted. Capta describing phenomena "over there" (e.g. a traffic jam up ahead, neighbors' activities down the street) become implicitly historical: they are collected and in being collected they are thrown into a paradoxical past tense; they are analyzed, or subjected to processes of description; and they are communicated to Sal in such a way as to homogenize her experiential present tense with the archival modality of data *qua* records expressed as documents.

The temporality of Sal's morning was one of homogenized heterogeneity: first of her own experiential present tense unfolding at the edges of sensation and perception; and second of document-like representations of phenomena from other spaces and other places – other experiential present tenses. Representation necessitates a temporal transformation; that which is represented is always already historical in nature, having passed into a past tense through the act of being represented. Sal, therefore, lives in a historicized experiential present tense: a tense in which she experiences her world in part through the historicity of the documents that co-construct it.

This is perhaps the most pressing humanistic concern that arises from an archival view of ubiquitous computing: when the user's world is always already documental, the user or the capta-based representation of them is implicated in the construction of the world-as-document; when the user's objectified, capta-based representations are implicated in the computational outputs that comprise the documentality of their present tense, the user implicitly encounters themselves as an object that has already appeared to the computational as a prosthetic phenomenon. By way of the archive of ubiquitous computing, the user becomes an object within that archive: a narrative of potential statements constructed through the algorithmic linking of data *qua* records collected, accessioned, preserved and made accessible through and by means of smart objects.

In the archive of ubiquitous computing, the user exists as external to themselves: a description of themselves with which they might subsequently become acquainted. When the user is acquainted with descriptions of themselves, they are acquainted with a documental-historical version of themselves. The archive of ubiquitous computing comes to contain them, thus effecting an ontological shift: the user becomes a product of the otherly phenomenology of the computational. This is an interpolation that gives rise to an *interpellation*: an insertion of pre-processed phenomena into the experiential present tense of the human lifeworld, resulting in the interpellation of the human-as-user: its creation as a valid and conceptually infrastructural discourse of “the human.”

Towards the data perfect tense

For Benedetto Croce, all history [was] a history of present tense (Croce, 1921). For Pascal, by way of Pierre Nora, “all history that is not contemporary is suspect” (Nora, 1972). And yet a fundamental discursive divide separates the past, the present and the practice of historical knowledge production. The past is something to be seen relative to the subjectivity that sees it. The past is an object represented and rendered durable (if lossy) through its representations. When the past – however near or far – is observed in the form of data through the eyes of the computational, it becomes alien. When that alien output – the documentality of the experiential present tense – is ubiquitous as in the vision of ubiquitous computing, the present tense takes on characteristics of the historical. The archive of ubiquitous computing becomes a historicization of the present tense: a mode and means of knowing the present tense predicated on the documental expressions of data *qua* records. That is, the present tense becomes describable as if from the remove of history. The user resides within the historical present tense rendered through the rhythmically diminished archival characteristics of ubiquitous computing's smart objects.

Up to this point, I have taken a broadly Foucauldian approach to the theory of *the archive* as it relates to ubiquitous computing. I have discussed the archive in terms of sets of statements that contribute to an identifiable historical *a priori* condition, arguing that the onto-epistemological status of our current historical *a priori* condition is undergoing a transformation by way of the ubiquity of computing and the prosthetic phenomenology of agential objects which are now responsible for previously human agencies such as appraisal, accession and access. I have implicitly focused on the extent to which “statements,” for

Foucault, are not limited to utterances or inscriptions, but also include actions and events – phenomena which appear through a given subjectivity. Along those lines, I have identified possible statements – modes of data collection and presentation – that emerge from within the dominant vision of ubiquitous computing: computational actions and events that are presented to end users (e.g. Sal) in oddly documental forms, thus rendering the user’s experiential present tense documental and therefore historical in nature. Presently, however, a strictly Foucauldian approach falls somewhat short and requires input from another thread of archival theory.

The Foucauldian approach falls short because, for Foucault, *the archive* did not and could not encompass the present tense: its modes of accession relegated its contents to past events-turned records. Foucault’s archive was/is a historical domain accessible solely through documentation, where documentation was in Foucault’s time strictly historical. (This is the meeting point of *l’archive* and *les archives*.) While I contend that the historicity of the archive remains, I similarly contend that through the ubiquity of computation such as it is envisioned in Weiser’s (1991) Sal story, its historicity extends into the present tense and interpolates it: the data of ubiquitous computing are generated, accessioned, preserved and rendered accessible at speeds that were simply not possible in Foucault’s historical, paper-based materiality. The historicity of the archive extends to the present tense of ubiquitous computing. The archive of ubiquitous computing manifests through interaction with ubiquitous computing devices precisely because their core functions render present tenses documental. Where such devices are agential objects – sensing, collecting and communicating data-derived descriptions of the world – the phenomenological roots of the archive come into question. The world “out there” appears to the computational as phenomena; those phenomena are sensed, collected, analyzed and communicated from the computational to the human through a process of human-readable transformation. And yet phenomena – literally that which appears – are not reducible to one another when they appear to different actants.

In the Foucauldian tradition, the phenomenology of the archive – the extent to which the discourses and statements of the archive *appear* – is relegated to the embodied experience of doing archival research (Farge *et al.*, 2013). That is, Foucault’s theory of the archive as a site of historical work emerges from within the bounded physicality of archives. Such archives are, at best, a context in which archival-discursive research – what Foucault calls archaeology – occurs, but it is not the focus of archaeology or even a conceptual variable that is well-accounted for. But through and by means of ubiquitous computation, the documental components of the archive do not reside in dusty rooms and are not found in *fonds des archives*: Sal interacted with a documental world regularly. It just so happens that the documentality of her world is predicated on the automatic appraisal and accession of data qua records which unfolds at such a rhythmically diminished rate as to appear non-archival. In the archive of ubiquitous computing, documents appear to the person *in situ*: in a world of interaction – of acquaintance with description – that is increasingly mediated by computation. Where the archive resides or instantiates itself not in dusty rooms but in the daily world of lived experience, embodiment must be accounted for. Phenomenology becomes central, and it is a complex phenomenology spread across conditions of human embodiment and the grotesque homunculi of smart objects and their fledgling modes of sensation and perception (Seberger and Bowker, 2021).

As I have argued above, in the archive of ubiquitous computing, documents come to bound experiences because in the dominant vision of ubiquitous computing, experiences are predicated on pre-processing: on the presentation of data-driven descriptions with which human subjects (i.e. users) will become acquainted. Sal lived within the archive *and* in real-time: she was acquainted always already with archival description through the outputs of her various devices. The world as created through *capta* becomes discursively bound by the

machinations of its rendering: we see through a display darkly. The archival mode that subtends Sal's morning – and many mornings beyond – is the data perfect tense: a sociotechnical condition predicated on the descriptive powers of data and the end user's ability to acquaint themselves with those descriptions in a near-real-time, but which is in fact historicized through its reliance on data; an archival temporality in which end users take action so as to have generated data about such action and in order to take future action based on such data. More than that, the data perfect emerges as a *modus operandi* for agential objects. It emerges as the core grammar of a variant of what Bowker has described as the Epoch of Potential Memory (Bowker, 2005): a sociotechnical condition in which knowledge about the present tense is produced, ad hoc, through the feedback of data generated through technological use, implicitly appraised in relation to the economics of surveillance capitalism and accessioned into a rhythmically diminished archive through and by means of agential objects. The data perfect presents as the mode by which *the archive* emerges from archives: an archive that is as ubiquitous as its means of data generation and accession, and which extends beyond individual archives through the inherent connectivity of its devices. The realization of ubiquitous computing is part and parcel with a ubiquitous archival reach, the historicization *qua* archiving of a general present tense such that it and its experiential subsets can be presented to end-users in real-time in the form of documental representations. The data perfect is an onto-grammatical tense in which agential objects sense, collect and communicate data so that a human-experiential present tense can emerge through and by means of ubiquitous computing; it is a present tense that exerts itself in the form of description such that end users' worlds of acquaintance might be colonized by description, thereby ensuring the concretization of ubiquitous computing as infrastructure.

In the archive of ubiquitous computing, the human becomes the user, resident in two simultaneous sets of *archives* – sites of historical theory. The first is that which arises from direct phenomenological acquaintance with the world. This is the archive of acquaintance: an archive that possesses as statements and discourses the modes of interaction with which Sal, as embodied actant, exerts agency within her *umwelt*. The second is that which arises through acquaintance with pre-processed description, where pre-processing occurs through the agency of objects thus deriving from a fundamentally inaccessible form of prosthetic phenomenology. This is an archive of description: an archive that emerges through the receipt of information derived from the data processing capabilities of agential objects. As ubiquitous computing continues to sense and collect data about an ever-growing subset of worldly phenomena an accretion is effected. Sal's phenomenological world of acquaintance becomes increasingly subtended and interpolated by computational description. Her phenomenological world – that which appears to her through and by means of her embodiment – becomes increasingly predicated on the ubiquity of pre-processing: of descriptions outputted by agential objects. As yesterday's tomorrows incrementally accrete to form our emergent infrastructures, we (as users) and our ubiquitous devices effect an archival transformation: our experiential present tense becomes oriented towards the data of a future perfect tense. Bound up in the economics of surveillance capitalism (Zuboff, 2019), users act so as to have produced data such that they might see the world as it is already seen – sensed, collected, processed, outputted – by means of the computational.

In so acting, "the user" interpellates itself as a discourse within the archive of ubiquitous computing: a discourse that supplants that of the human who was once ostensibly unentangled with the problematics of surveillance capitalism (i.e. data-driven exploitation), and the ubiquitous trade-offs between the ability to see the world as it is seen by the eye of computation and the invasive, reciprocal necessity of being seen as a function of that eye. When we, as sociotechnical researchers, develop an interdisciplinary and exploratory eye toward the meeting point of archives – their theories, mechanics and places – and the agency of ubiquitous computational devices, it is possible that we may shake loose solutions to

deeply entrenched problems such as fundamental power imbalances between users and app-assemblages (Seberger *et al.*, 2021) and the cultivation of digital resignation (Draper and Turow, 2019).

Conclusion

In this essay, I have theorized the historical status of the present tense – the lifeworld of the human-as-user – as it asserts itself through the archive of ubiquitous computing. I presented a theorization of the means by which the historicity of the present tense is shifting within the imaginary of computational-everything. Such shifting constitutes a rhythmic diminution in which the experiential present tense of the user is constructed as a historicized past tense through the ubiquity of computation. Such rhythmic diminution is effected through the shifting agency responsible for archival mechanics: appraisal, accession, preservation and access. Where computational objects (i.e. smart devices) are responsible for these mechanics, they occur at speeds phenomenologically inaccessible to the human user and present the user with documental outputs that describe their lived world in real-time. I focused specifically on a well-known scenario from the ubiquitous computing literature – a fictional morning lived by a woman name Sal. In so focusing, and by interpreting this scenario through the critical lenses of epistemology, capta/data and documentality, I argued that the archive of ubiquitous computing effects a historicization of the present tense: a data perfect grammatical-historical mode in which the end-user’s experiential present is subtended by always already historical documents constructed through the agency of computational objects. Such historicization of the present tense evidences an increasingly archival present tense grounded in the accession, processing and output of computationally-derived data. Such historicization further argues for increased interdisciplinary work between domain experts in the library and information sciences and scholars in the fields of HCI and ubiquitous computing who are increasingly tasked with understanding the historical, ethical and values-sensitive implications of their work.

Notes

1. <https://dictionary.archivists.org/entry/archives.html>
2. I present a reference to Google Scholar not to reify the value of the platform, but rather to provide a broadly accessible metric of citation, which serves as a proxy for relevance.

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