'That's Not Me': Surprising Algorithmic Inferences

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Abstract

Online platforms such as Google and Facebook make inferences about users based on data from their online and offline behavior that can be used for various purposes. Though some of these inferences are available for users to view, there exists a gap between what platforms are actually able to infer from collected data and what inferences users are expecting or believe to be possible. Studying users' reactions to inferences made about them, especially what surprises them, allows us to better understand this gap. We interviewed users of Google and Facebook to learn their current beliefs and expectations about how these platforms use their data to make inferences, and identified four common sources of surprise for participants: irrelevant inferences, outdated inferences, inferences with no connection to online activity, and inferences related to friends or family. We discuss the implications for designing inference-generating systems.

Author Keywords

algorithmic inferences, data collection, ubiquitous computing, facebook, google

CCS Concepts

•**Security and privacy** → **Social aspects of security and privacy;** •**Human-centered computing** → **Empirical studies in HCI;**
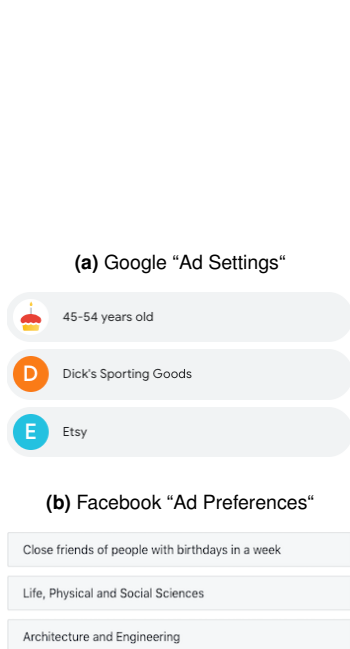
Introduction and Background

Inferences—information associated with specific individuals that has been algorithmically derived from data collected about them both online and offline—allow platforms like Google and Facebook to learn much about their users, whether to refine their products or for advertising purposes. Prior research has demonstrated that a gap exists between people's beliefs about the use of their data and the reality of how algorithms process it to make inferences [7]. This gap is likely to deepen as the models used for such inferences change and evolve, and as such systems become a part of daily life to the point where some individuals perceive trying to prevent information collection as "a lost battle" [5]. The conviction can be so strong that individuals who believe platforms use highly accurate algorithms to create up-to-date and relevant inferences about their users find ways to justify errors in inferences about them [3].

Gaps in a user's mental model of how inferences are generated from their online behavior can lead to an incomplete understanding of what data platforms collect, whether to consent to the collection and use of such data, and where it is sent. Yet for all the predictive power of such invisible systems, they are hardly flawless, and they are most visible to users when they fail to function as expected. Presenting users with inferences associated with them and eliciting their response is a way of revealing the points where the platform does not align with an individual's perception of how information is collected and utilized.

Previous studies have asked participants to articulate their mental models of how systems treat their data [4, 6], identify information they consider private and sensitive [8], or react to information about themselves that is inferred accurately [7, 5]. Though inaccurate information can be flattering when it presents a more idealized version of the individual [9], it can also produce feelings of vexation. At least one study suggested individuals may perceive inaccurate inferences about themselves to be an equal violation of their expectations of privacy as accurate inferences [2]. These examples indicate that expectations, the patterns of anticipated behavior that serve to shape social interactions between individuals as well as how they perceive such interactions [1], also exist for platforms such as Facebook and Google. There is a need to further investigate the nature of such expectations and how they affect behavior.

This study explores user reactions to how systems capture their data and assign information to them. Using data from semi-structured interviews discussing specific inferences that Facebook or Google made about participants, we focus on identifying surprising inferences to gain insight into perceived connections between online behavior and inferences, how these perceptions may shape user expectations and decisions to use platforms, and how they respond when these expectations are violated. We highlight four themes in inferences that surprised participants: irrelevant inferences, outdated inferences, inferences with no perceived connection to online activity, and inferences related to friends and family. These themes reveal the nuances of expectations that users hold for inferences, particularly about the relevance of inferences to them as an individual. Our findings, in turn, hold implications for approaches to designing such systems.

Method and Analysis

We first conducted an online survey to gather information about the inferences associated with respondents by either Google or Facebook. These platforms were selected as they present a webpage to logged-in users displaying inferences that the platform has made about them (Figure 1). After consenting to the survey, respondents were randomly

(a) Google "Ad Settings"

👑	45-54 years old
D	Dick's Sporting Goods
E	Etsy

(b) Facebook "Ad Preferences"

Close friends of people with birthdays in a week

Life, Physical and Social Sciences

Architecture and Engineering

Figure 1: Ad inferences webpage excerpts From Google (https://adssettings.google.com/) and Facebook (Facebook: https://www.facebook.com/your_information/) showing categories that were assigned to one of the authors.

Survey participants answered three questions about each inference assigned to them by Facebook or Google (7-point Likert scale, Strongly agree – Strongly disagree):

Sensible: It makes sense that [inference] is associated with me.

Relevant: [inference] is relevant to who I am as a person.

Accurate: [inference] is an accurate description of my everyday activities.

	Surv.	Interv.
Man	28	9
Woman	66	12
Other	1	0
Avg. age	39	43
Facebook	44	8
Google	51	13

Table 1: Survey and Interview participant demographics.

assigned to answer questions about either Google or Facebook. They then downloaded their ad inferences webpage, and uploaded a copy of the file to the survey. Custom JavaScript parsed the inferences out of the file, generated three survey questions about each inference (see sidebar at left), and then deleted the file. Facebook respondents had an average of 12 inferences assigned to them (*Min*=3, *Max*=33); Google respondents had 68 on average (*Min*=1, *Max*=131). To keep the length of the survey manageable, respondents were asked about no more than 85 inferences, selected at random. All 95 valid survey respondents were at least 18 years old, users of either Google or Facebook, and not currently university students. Respondents received $5 for completing the survey, which took 32.5 min to complete on average. 75% of 44 Facebook respondents and 90% of 51 Google respondents reported they had not seen their ad inferences webpage before the survey.

Survey respondents who expressed interest in being interviewed were invited in random order to come to our lab for an in-person interview. Scheduling prioritized balance in terms of gender and platform (see Table 1 for participant age and gender demographics). We also aimed for diversity in age and the number of inferences assigned. Our 21 interviewees ranged from 28 to 71 years old, with 14 to 104 inferences assigned to them. 71% of interview participants indicated that they were currently professionally employed, 10% were retired, 15% were in manual labor or volunteer occupations and 4% were stay-at-home parents.

At the beginning of the interview, after consenting to the study, each participant was shown a printed report showing them the inferences they had answered questions about in the survey, and the average of their answers to the three questions about each inference. Participants were invited to review the report and mark any inferences that stood

out to them or that they wanted to talk about. They were then asked a series of questions to elicit why they chose those inferences, why they believed the inferences were in their list, and how they thought that information came to be associated with them. They were encouraged to speculate or think out loud about their reasoning. The report also showed them information about how their assigned inferences compared with aggregate information about inferences that were assigned to the other people who participated in the survey, and their reactions to these inferences were probed with similar questions. Finally, participants were asked to reflect on what they believed the purpose of these inferences was, how they thought other people might react to this information, and some general questions about their usage of Google or Facebook.

Once the interviews were transcribed and anonymized, two of the authors reviewed them and conducted an inductive, iterative process of identifying themes. This produced a final codebook with 45 codes. One of the prominent themes that emerged from our analysis was surprise about inferences. These were the times a participant indicated surprise directly (responding to a direct question asking them to identify what surprised them) or made statements implying the presence of certain information was unexpected. We made a second analysis pass through the data, grouping and summarizing the themes that related to surprise. We note that these interviews were conducted before Google updated its inferences page, which now allows users to view an explanation for how a specific inference was associated with them. As such, our data does not account for these explanations or how they might be viewed.

Findings
Participants expressed surprise about several inferences associated with them by Google or Facebook. We grouped

surprising inferences into four major themes: irrelevant inferences, outdated inferences, inferences with no perceived connection to online activity, and inferences related to friends and family. Even in the absence of prior exposure to the inferences, participants' reactions revealed pre-existing expectations not only about the types of information collected by Google or Facebook, but how such information was collected, how it was maintained, and whether Google or Facebook associates information from other individuals with a user. Generally, these responses signaled an expectation that inferences are accurate, are formed through a comprehensible (i.e. human-like) logic, and reflect the present state of the individual they are associated with. Our findings show that even among professional, educated individuals, how inferences are generated and updated is an obscure and confusing topic.

Irrelevant inferences
A majority of participants (81%) expressed surprise when inferences they deemed completely irrelevant to themselves appeared in their report, with irrelevance defined as an absolute lack of perceived logical connection between inferences to their interests and activities. Participant reactions ranged from mild confusion about how such inferences were connected to them (usually expressed as "I have no idea" and "I don't know"), to strong irritation and even being insulted when inferences that contradicted their interests appeared. **P05**'s response, in the sidebar at left, is one of the more explicit examples.

Common inferences that prompted participants to declare something irrelevant to them were related to TV shows, parenting, music, sports, and other leisure activities such as shopping and travel. Some inferences (e.g. "talk shows") elicited uncertainty from participants who were unclear what it encompassed, and acknowledged that the inference

might be relevant depending on what it actually meant. Participants that encountered irrelevant inferences often believed that inferences were a reflection of actions they took online (searching, browsing, clicking) even when they could not recall taking any specific actions that would have led to the inference being associated with them (as described by **P17**, sidebar).

P03 and P22 theorized that some mistaken inferences may have been applied to anyone who was part of a certain demographic. This was also cited as a possible explanation for *correct* inferences by other participants, though those responses are outside the scope of the present paper. Generally, participants were surprised when inferences did not appear to reflect 'themselves' or things related to themselves in some way, implying an expectation that inferences should represent individuals.

Outdated inferences
Outdated inferences were things that participants did not consider completely irrelevant to themselves, but were nonetheless presently incorrect, and was brought up by more than half (57%) of participants. Some of these inferences were modified by time ('recent mobile change,' 'recent home owner') or categorized participants in some way (music interests, multicultural, political, level of engagement, income, age). Participants would sometimes express confusion or lack of clarity about what a category meant, which affected to what degree they considered it outdated instead of irrelevant.

Participants frequently observed one or several inferences relating to information that had ceased to become relevant to them over time or were in some form out of date (**P08**, sidebar). Participants did not tend to offer any theories on why Facebook and Google were retaining outdated inferences. Three participants (P07, P10, and P20) attributed

their inaccurate ad inferences to algorithms that might be "stale" or needs to be fixed (see **P07**'s comment, sidebar, previous page). P20 noted that Facebook's characterization of him as being "away from hometown" was surprising because he currently lives in a city neighboring his hometown, leading him to speculate Facebook might be using outdated info because he'd created his Facebook account in another city before moving back to his hometown. Overall, participants' surprise at outdated inferences indicates that they expected inferences to be specific and context sensitive, with the ability to be promptly updated in response to changes in an individual's condition.

Inferences unrelated to online activity
Participants expressed surprise when they saw inferences that they could not connect to any online activities—deliberate, specific actions taken by users while online. Typical activities included searching, site browsing, online purchases, or interacting with posts on Facebook. Some participants proposed alternative explanations for how these were connected to them, such as relating them to recent experiences (see **P14**, sidebar) or suggesting that what a category 'means' to Google or Facebook might be ambiguous enough to be associated with activities that they did recall. For example, P22 could not see a connection between her online activity and 'convenience stores,' but noted that she visits the Walmart website, which might count as one.

Reactions generally consisted of confusion. P02 initially indicated discomfort at seeing the political inferences on her Facebook report, but reconsidered her position when she recalled that she is a registered voter so her political information is already 'out there.' However, she was not clear on how this data might have found its way to Facebook and her profile. The surprise around these inferences implies that participants generally assumed that inferences are primarily

or wholly derived from online activity. They rarely consider how inferences might also be based on other types of information. Being presented with inferences that did not fit in with these assumptions served as a prompt to engage in further speculation.

Inferences related to friends and family
A final category of surprising inferences was inferences related to people close to the participants, but not the participants themselves. Sometimes this took the form of a participant initially identifying an inference as inaccurate or irrelevant, but then later retracting the statement to say that the inference is accurate (see **P22**, sidebar, next page). Other participants, however, confidently identified the inferences as related to friends and family members after an initial reaction of surprise.

Participants suggested various possible explanations for why the platform was picking up information from other people and associating it with their profile. One reason was shared devices in the home, where a family member would use a device with a participant's account logged in. This raised the question of whether Google/Facebook was able to maintain a distinction between information that was about 'themselves' and 'others,' or if they were perceived as a single person. Participants described searching for things for other people, either because they were requested to look it up (see **P04**, sidebar, next page), they were looking for a gift, or it was related to an activity that a friend or family member engaged in. Participants also made connections between friends' interests and their own. Some participants thought certain inferences were due to their interactions with friends' posts, or because platforms knew that they were associated with people interested in certain topics.

Participants seemed to hold different degrees of surprise around data belonging to other people. When the data was

about people closer to them, such as immediate family, they were more readily able to suggest ways that inferences were formed. In some cases, they appeared to accept that some inferences can be based on communal information, but in cases where they believed that information should not be easily obtainable, they expressed discomfort (**P15**, sidebar). This suggests participants have expectations about inferences involving information about people related to them that change depending on what information is involved.

Discussion

We sought to identify what surprised participants about the inferences associated with them by Facebook and Google, and organized them into four different themes. Our participants primarily understood inference generation to be an activity driven by and responsive to their online actions tracked over time, rather than their choices about what to have associated with them. These beliefs restrict people's ability to conceptualize actions they can take to maintain control over their own information, including recognizing the violation of expectations and how to respond to such violations. Systems that automatically associate inferences with users place the greater burden of labor on the individual to recognize and correct inferences, while also providing little assistance in doing so. This can also obscure how data about individuals may be used to generate inferences about larger groups.

We found that participants have varying levels of surprise about different inferences, which suggests differences in the expectancies they held beforehand. A stronger expression of surprise may indicate a greater violation of a well-formed, existing expectation. However, expectations are not set in stone: as people encounter new experiences, what is surprising today can be the usual order of business tomorrow. By continuing to map users' existing understandings, it is

possible to see how these evolve over time in response to the systems they interact with, and develop systems that respond more dynamically to these shifts. We noted earlier that Google has rolled out features to explain its ad inferences page since the data collection for this paper was concluded, and future work will explore how users respond to these new affordances.

Inferences about users are not inherently harmful. They can provide assistance to users in many ways, including enabling functionalities like prioritizing seeing content that is most relevant to them and reducing the manual labor of sorting through vast amounts of information. But users have expectations about what inferences are associated with them, regardless of whether they are able to articulate a technically accurate view of how they are generated. They can experience confusion and distress when there are discrepancies between what they envisioned and the reality of the inferences being formed about them. Moments of surprise, such as those discussed here, should be treated as opportunities to identify what expectations users hold about inferences, and inform design considerations around systems that generate inferences. Given the increasingly integral role of these systems—visible or not— in people's daily lives, it is vital to maintain a discussion around them supported with critical research. Only then will it be possible to equitably negotiate these expectations between users and platform designers.

Acknowledgements

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