Automated Vision

Apple Memories and Automated Memory-Making

The Networked Image Inside the iPhone Chip

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Abstract

In 2016, for the first time Apple introduced what it called "advanced computer vision" to organise and curate users' images. The key selling point for Apple Memories was that all computation would happen inside the user's device, relying on the privacy afforded by Apple's widely used smartphone, the iPhone. This article offers a case study of Apple Memories and its automated memory-making, focusing on three dimensions: the vision of Apple Memories; how this vision gets infrastructured through the A11 Bionic chip; and how Apple Memories engages users in automated memory-making. This analysis raises important questions regarding privacy and surveillance capitalism as, even if operating on-device, Apple Memories still relies on the datafication of the personal archive via the automation of image analysis (computer vision) and personalisation. Building upon Mackenzie and Munster's (2019) notion of "platform seeing", I argue that control over the networked image today goes beyond data brokering for behavioural analysis and advertising. Apple Memories' framing of computer vision as an intimate, always-on and personal way of remembering is part of a wider goal of exploiting personal data to bolster user engagement, generate even more data, and ultimately accumulate infrastructural power across Apple's "walled garden" digital ecosystem.

Keywords

Surveillance Capitalism, Infrastructure, Computer Vision, Networked Image, Platform Vision

Apple Memories and Automated Memory-Making: The Networked Image Inside the iPhone Chip

In 2016, for the first time Apple introduced what it called "advanced computer vision" (Federighi 2016) to organise and curate users' images. This move marked a shift from the company's previous focus on creating easier ways for users to sort through their own content. The new application, Apple Memories, "automatically

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creates curated collections of your most meaningful photos and videos" through a colossal "11 billion computations per photo" (Federighi 2016). The timing of this announcement was conspicuous, as just a year earlier a similar application had been released: Google Photos, a cross-platform app that automatically organises images uploaded to Google's cloud service. What was particularly new about Apple Memories, and what became its key selling point, was that all computation would happen inside the user's device, relying on the privacy afforded by Apple's widely used smartphone, the iPhone.

Before the digital era, personal archives were primarily composed of laminated pictures, cassette tapes, letters and other memorabilia that were stored and shared mostly in the private sphere. Digitisation transformed these archives into digital objects, accessed and managed through software and networks (van Dijck 2007). Images and videos became data: shared through platforms as well as "analysed and remapped to new contexts via algorithms" (Rubinstein/Sluis 2008: 21). Apple Memories continues this history by bringing computer vision analysis and personalised recommendations to remediate images and videos into "Memories": automatically curated and labelled collections one can export as videos or just save for future appreciation. As the algorithm operates on the iPhone itself, the promise is that the simpler past of personal archives organised as carefully-kept boxes can be revived, as opposed to other companies' reliance on the ethereal "cloud".

Just a year before the launch of Apple Memories, the term "surveillance capitalism" was proposed by scholar Shoshana Zuboff. Zuboff used this term to address the "institutionalizing practices and operational assumptions of Google Inc." (2015: 75) and other large Internet-based firms, particularly in how they extract and collect data to predict future user behaviour for advertisement targeting. As she further develops in her 2018 book, surveillance capitalism does not only seek to know people's behaviour well enough to predict their next steps, it also aims at modifying behaviour. This, she argues, puts individual autonomy, what she terms "the right to the future tense" (Zuboff 2018: 329), under threat. Zuboff's arguments, though subject to criticism from some scholars (cf. Doctorow 2020; Morozov 2019; Sadowski/Ongweso Jr 2020), have found much resonance in scholarship, popular media (e.g., Orlowski's *The Social Dilemma*, 2020) and the wider public debate, particularly in discussions around personal data privacy and the political economy of digital capitalism.

Although very critical of Google and Facebook, Zuboff is quite lenient on Apple, even arguing that the company "has so far drawn a line, pledging to abstain from many of the practices that I locate in the surveillance capitalist regime" (2018: 23). Indeed, already in 2014, Apple's CEO Tim Cook declared the company's intentions on privacy by saying: "Our business is not based on having information about you. You're not our product" (Wakabayashi 2014). As the company's business model relies on selling hardware products and services, not advertisements, Cook's argument is that Apple and its privacy-oriented applications such as

Apple Memories are the antidote to Google and Facebook's surveillance capitalist practices.

However, even if operating on-device and in a privacy-preserving manner, Apple Memories still relies on the datafication of the personal archive via the automation of image analysis (computer vision) and personalisation. As I argue through this article, control of the networked image today goes beyond buying and selling data for behavioural analysis and advertising. Building upon Mackenzie and Munster's (2019) notion of "platform seeing", my argument is that the infrastructures of machine seeing are important means for the consolidation of platform power. To engage in this issue, this article offers a case study of Apple Memories and its automated memory-making. It focuses on three dimensions: 1) the vision of Apple Memories; 2) how this vision gets infrastructured through the iPhone hardware (the A11 Bionic chip), and 3) how Apple Memories engages users in automated memory-making. By bridging these facets, I discuss the consequences Apple Memories raises for notions of privacy and surveillance capitalism, making the suggestion to think instead of platform and infrastructural power.

This article is framed on a methodological sensitivity to both the "algorithmic imaginary" (Bucher 2017: 31) proposed by Apple, and how it is transformed into materiality – the iPhone's chip as well as the app's interface and affordances. Aligning with previous scholarship that avoids the "immaterial trope" (Blanchette 2011: 1043), this strategy of engagement opens "a space to examine how objects and object properties frame cultural practice" (Dourish 2017: 47; Parks 2015). Algorithmic formations are thus not only technical, but sociotechnical – formed by intricate relations between software, hardware, institutions, people and other non-human actors (Seaver 2017; Amoore 2020).

I begin this article by reviewing previous literature on the relations between memory-making, networked images and computer vision. Then, I move on to three analytical sections. The first engages in a critical discourse analysis of the vision behind Apple Memories, particularly how it is marketed as an experience by its developers. The materials analysed are Apple's rhetoric on the Memories feature during its conferences for software developers, WWDC (2016 to 2018). The second analytical section focuses on the A11 Bionic chip and its "infrastructural politics" (Parks/Starosielski 2015), engaging with Apple's presentation of it (iPhone X unveil and press materials describing the chip) as well as its particular architecture.[1] The third analytical section offers a brief reflection on the actual user experience of the application. Though not discussed in depth here, this finding originates from a broader systematic analysis of Apple Memories' interface and affordances (Bucher/Helmond 2017), which followed the walkthrough method

1 To understand the emerging dynamics of chip architecture, I consulted hardware design books and conducted two expert interviews with chip design researchers.

proposed by Light, Burgess and Duguay (2018).[2] Finally, in the discussion section, I argue how Apple Memories' shift of computer vision and personalisation to the intimacy and proximity of the smartphone entails important questions about platform and infrastructural power.

Memory-Making in the Age of the Networked Image

Technology and memory-making have always been interconnected. As described by philosopher Bernard Stiegler (2010), embodied memory-making (i.e. what we recollect or remember as we go through the world) has always related to different forms of technical exteriorisation. These exteriorisations have moved through different kinds of objects, records and traces in the history of humanity – from cave drawings to photographs. What is particularly recent, though, is the digitisation of memory-making. José van Dijck suggests thinking about this digital shift as mediated memory-making: "the activities and objects we produce and appropriate by means of media technologies for creating and re-creating a sense of past, present, and future of ourselves in relation to others" (2007: 21). Digitisation, she argues, comes with decisive consequences and "is likely to affect our very concepts of memory and remembering" (ibid.: 50).

This article is concerned with the important role that images and videos play in our mediated memory-making today. The Internet and its networked character have undoubtedly brought seismic changes to the "production, distribution, consumption and storage of images" (Rubinstein/Sluis 2008: 9). We not only produce an enormous number of images every day, but also constantly share them through social media platforms and other networks (cf. Leaver et al., 2020). These images have led to new photographic practices, connected to "a more alive, immediate and often transitory practice/form", one that is often an "immediate, rather fleeting display of one's discovery of the small and mundane" (Murray 2008: 151). Beyond the content of these images, a key shift is how photos are now born-digital "data pieces" that afford automated organisation and classification (Mackenzie/Munster 2019). As images become data, they are now "influenced by computational processing, algorithmic query, automation, and dynamism, not to mention social conditions, user expectations, technology dependencies, storage requirements, and a host of other characteristics of how we create and use technology" (Bailey 2013). Throughout this article, I refer to the networked image as this recent paradigm of image relations marked by networked and datafied condi-

2 As part of the larger project from which this article stems, I employed and further analysed the app using the tools of "step-by-step observation and documentation of an app's screens, features, and flows of activity", as suggested by Light, Burgess and Duguay (2018: 882).

tions, which is intricately tied to the emergence and popularisation of the smartphone as a sensing technology (McCosker/Wilken 2020).

The networked image's "information overload" (Seaver 2019) has led companies to offer services for curating and remixing our images for us. Among others, Apple Memories and Google Photos have become popular products, with features to automatically cut through the clutter of our personal archives using personalised algorithms. This shift towards "automated memory-making" (Pereira 2019; Jacobsen/Beer 2021) embeds an algorithmic and predictive logic into how we remember and forget. In these applications, the archive is no longer a static collection of images, but formed of relational elements in a computerised network, where the algorithm "autonomously [classifies] and [ranks] people's past content to produce and deliver these ready-packaged 'memories'" (Jacobsen/Beer 2021: 22). A crucial driving assumption that enables this shift to automation is that the networked image, much like all else in the world, is data: "made of things that fit in stable and distinct categories" (Mackenzie 2015: 433; cf. Jacobsen/Beer 2021: 34-35). That means the system is based on a particular set of assumptions of what images and memories can be, and how much they (supposedly) matter to individuals.

As argued by scholar Benjamin N. Jacobsen, automated memory-making applications such as Apple Memories create "narratives about people's lives in everyday life" (2020a: 1). Through the concept of "algorithmic emplotment", Jacobsen suggests how these narratives are constituted: "data, people, objects, events, and temporalities are variously correlated and woven together, construed into coherent narratives, where causation and intelligibility are given" (ibid.: 13). It is important to foreground how the creation of such algorithmic narratives relies on automated decisions on what to prioritise and make visible (c.f. Amoore 2020; Gillespie 2014). This form of giving power to substitutes that act for us is much akin to what Hito Steyerl (2014) has termed "proxy politics": "Does your camera decide what appears in your photographs? Does it go off when you smile? And will it fire in a next step if you don't?" Algorithms, these "intricate, dynamic arrangements of people and code" (Seaver 2019: 419), affect people as they surface some narratives as opposed to others, shaping the way people interact with their archives by defining what is meaningful (Jacobsen 2020a: 7).

This algorithmic character of automated memory-making is not only present in what images it surfaces, but also in the algorithmic analysis of the images themselves. Computer vision, the algorithms for interpreting images into data, allows for different forms of visual perception, such as scene analysis and object recognition. Although these systems present themselves as efficient and objective, they have been described by critical scholarship as limited "calculative practices", marked by ways of seeing with "human-machine prejudices such as those related to gender and race" (Azar et al. 2021: 1095). In short, applications such as Apple Memories rely on the automated reduction of all the possibilities of what is in an image into "a single human-readable and actionable meaning" (Amoore 2020:

156). This reduction, for example, does not consider each particular image's "context, history, and subtext" (Pereira/Moreschi 2020: 1202).

Finally, automated memory-making also implies a form of "dataveillance", a "continuous surveillance through the use of (meta)data" (van Dijck, 2014). Users give algorithms access to their images to sort through them, most often operating under-the-surface and generating information which is shared inconspicuously with other algorithms, part of what Paglen (2016) called "machine-to-machine seeing". Algorithmically generated information about images may be used to feed memory recommendations in an app, but also for targeted advertisement or other forms of monetisation. It is most often very difficult to note and trace these operations, which explains why much scholarly discussion has focused on how dataveillance operates in "the cloud" (see van Dijck 2014; Myers West 2017). However, this is not the only architecture possible. As will be discussed in this article, the smartphone can also serve as a technology for automated data extraction and analysis.

The Vision of Apple Memories: Emotive and Private Technology

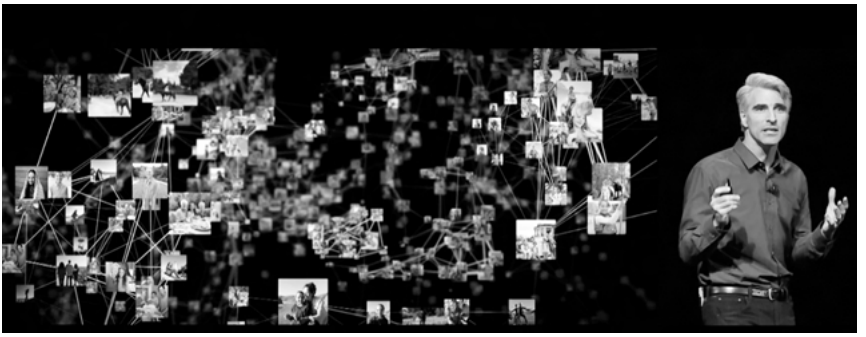
The algorithm is a proxy for automated memory-making in Apple Memories, defining how images and videos are sorted, organised and ranked (cf. Jacobsen/Beer 2021). But how is this relation framed by Apple? I now focus on analysing how Apple's marketing presents its automated memory-making, depicting the algorithm as an emotive technology that can conveniently and efficiently surface the users' affective relations with their networked images. However, this intimacy is only to be trusted due to the way it functions privately and offline ("all on device").

Apple Memories was first presented at WWDC 2016, during a keynote by Apple's senior VP of Software Engineering Craig Federighi. Apple Worldwide Developers Conference (WWDC) is a yearly event held by Apple in San José, California (USA). It is directly targeted towards software developers and has an attendance of around 6,000 people. The conference has existed since 1983, with the main proposition of engaging its developer community in technical and design-focused sessions, hands-on labs and other activities. In the past two decades, Apple began to unveil new hardware, software and operating systems during the conference. The audience, composed mostly of technophiles, is always hungry for the release of new and improved technologies, and Apple capitalises on their presence as a way of both generating buzz on new products and further connecting them to the company's "walled garden" ecosystem.

Touted as "the big news in Photos", the advanced computer vision in Apple Memories was described as a way to analyse users' pictures and videos completely on-device by "taking advantage of the power of the advanced silicon". Federighi (2016) started his presentation by explaining that deep learning would now be used not only to recognise people's faces, but also objects and

scenes. He boasted: "we do 11 billion computations per photo to be able to detect things like: there's a horse, there's water, there's a mountain" (ibid.). That, he said, allows for you to search images on device, but "the magic in experiencing your photos isn't just about finding the photo you're looking for, it's about being reminded serendipitously of a memory that would be so special" (ibid.). Behind this serendipity would be the algorithm of Apple Memories, based on a state-of-the-art artificial intelligence that "clusters together photos and relates them based on location, the people involved, the scenes" (ibid.) (see Fig. 1). That was the first time that Apple had announced a shift from empowering users to curate their own images to the implementation of an automated process, whereby an algorithm selects and curates the user's archive into video collages, albums and search results.

Fig. 1: Screenshot from Federighi's 2016 WWDC Keynote: In the image, photos of a trip are clustered together (location, people involved, scenes) in an imaginary tridimensional network.



The most striking aspect of Federighi's presentation of Memories in 2016 is how strongly it proposes this new technology as having an emotive character. I use the word emotive here to signify "arousing intense feeling" (Stark 2019: 120), thus "intensifying affect, feeling, sensation, and even emotion" (ibid.: 121). In this sense, the AI behind Memories is presented as capable of surfacing the underlying affective relations of one's archive by connecting images' metadata (location, time) and content (people, scenes, objects) (see Fig. 1). Federighi's (2016) argument is that we take too many pictures, but "we never go back to actually assemble them into something we'd want to watch". The benefit of the user experience of Apple Memories relies precisely on automating the affective relations of image curation: "we can figure out that you might want to see photos of a highlight reel of the last weekend or the last year and offer those to you at just the right time" (ibid.). What sets these connections apart, in Federighi's words, is that they are the "most relevant to you", "people that are special to you", "the most special photos" or "highlights" (ibid.). The algorithm is described as an emotive technology, with

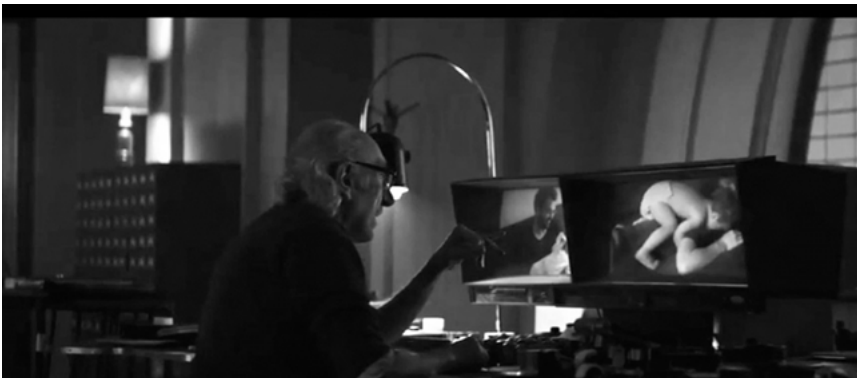
the power of predicting the user's affective memories, of making the invisible emotional connections with the images visible.

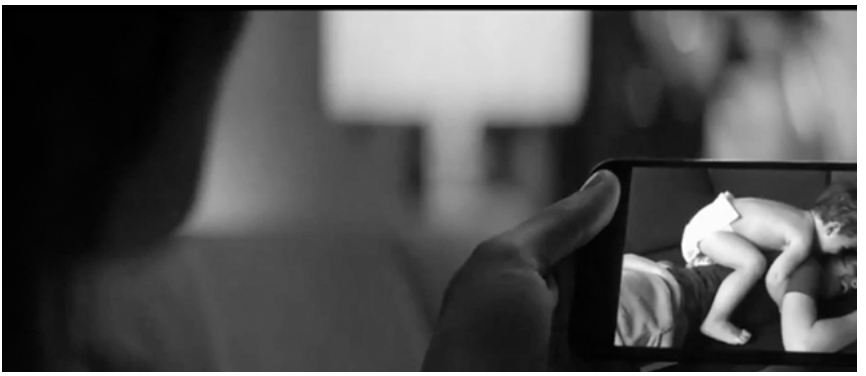
The emotive character of Memories is reiterated in Federighi's keynotes during WWDC 2017 and 2018. Incremental features are added: In 2017, the potential to "capture things like activities, like scuba diving [...], anniversaries, these really touching memories of your children growing up, and most importantly, your pets" (Federighi 2017). In WWDC 2018, a tab called "For You" is introduced to the Photos app, where all Memories are collected, but also where the algorithm highlights "a photo that you took on this day in past years" (Federighi 2018). For the 3 years it was discussed on WWDC, the Memories feature was described consistently as the careful traversal of the personal archive to automate the thoughtful, loving look to the past for your convenience ("so you don't have to").

Apple Memories' construction as an emotive actant becomes even more pronounced in the 2017 ad spot entitled "The Archives" (see Figs. 2 and 3). In the ad, we see a bespectacled elderly man as he traverses multi-storied archive rooms, selecting bits and pieces of film and moving photos. A mellow song plays as he cuts the images by hand and watches excerpts on TV screens, putting them together in a film. We then see the grey-haired man's final *oeuvre* as his eyes become watery and a soft tune is played. It shows a moving collage of special moments of a family through time. This video, as we find out, is actually being played on an iPhone that is held by a crying woman. She then presses a button on the iPhone's screen that says "Best of the Year 2016", and we see a light turn on in the man's archival room. He briefly glances at it and goes back into the archive. The texts "Memories", "Movies Made for You on iPhone 7", and "Practically Magic" come onto the screen, as we see the old man walking through the old-school setting of the archive once again.

This ad complements Apple's presentations at WWDC in that it materialises the underlying imaginary proposed by Apple Memories' corporate-speak. The ad's depiction of the archive resonates with its most popular conception: "slightly obsolete and abandoned places where usually the archivist or the caretaker is someone swallowed up in the dusty corridors of bureaucracy, information management, and organisational logic that makes the archive a system" (Ernst 2012: 1). Apple Memories, however, directly breaks with this bureaucratic conception of the archive. As rhetorically represented in the ad, we have a trove of personal data (the archive) that can be automatically edited on the push of a button (instantly, magically) by a loving, well-intentioned algorithm (the old man). Consequently, this experience will generate results that are emotive: the touching, tear-in-the-eye positive surprise of seeing the images serendipitously selected by the algorithm. The ad's depiction of film reels, old editing machines, file cabinets and other paraphernalia also connect the algorithm to old-school memory-making and its family rituals, reminding of a nostalgic past whose emotional overtones the algorithm claims to emulate.

Figs. 2 & 3: Screenshots from the ad spot "The Archives" (2107) presents an elderly man (above), carefully curating images inside of the iPhone. The result is shown in the user's hands (below): "Practically Magic".





It is important to relate this intimacy and emotive character of Apple Memories to its key selling point: the fact that the app operates on-device, as opposed to on the "cloud". This privacy aspect was frequently mentioned in Apple's WWDC keynotes, through constant reaffirmation that Apple "is out of the loop" and "won't see [your] data". In a WWDC 2016 talk show, it was even described by a commentator as a "180-degree different tactic" (Caldwell/Sargent 2016) than that used by Google and Facebook, because images do not need to be transferred outside of the user's personal space, their mobile device. The framing of Memories as an emotive technology relies on this safeguarding of privacy. "The Archives" ad relates to this: the elderly man (algorithm) works alone and carefully to manually curate memories, further sedimenting this notion of secrecy and trust, privacy and nostalgia. This representation of intimacy can be contrasted to the attempt by data centres to project safety through impersonal, "emptied, technified spaces" (Holt/Vonderau 2015: 72).

Memories is framed in Apple's marketing speak as a personalised experience that is unique to the users and their affective relations. I suggest understanding

it through its emotive character, how it "intensif[ies] the experience and expression of human feelings" (Stark 2019: 118). The app promises the automation of the emotional relation with the archive, but in a way that is actually caring and intimate. As opposed to the widely disseminated view of the algorithm as a distant, cold calculation or even as a form of uncontrolled data extraction without privacy, Apple Memories symbolises the promise of "Practically Magic". It understands your images and emotions, while operating within the privacy of your phone.

The Infrastructure of Apple Memories: Continuous and Optimised Platform Seeing

The rise of Apple Memories and its vision of emotion and privacy is enabled by a new generation of embedded hardware systems. Looking at this material aspect augments the understanding of the vision behind Apple Memories as well as indicates what lies behind it. I will now turn to how the A11 iPhone chip operates as a visible infrastructure for the private operation of applications like Apple Memories, while also building an infrastructure for "platform seeing" (Mackenzie/Munster 2018).

The story of the A11 Bionic chip goes back a decade before its 2017 launch. In 2008, just one year after the release of the first iPhone, Apple's founder Steve Jobs laid a clear strategy for the future: for the company to differentiate itself, he proposed, "you have to own your own silicon. [...] You have to control and own it" (Stone et al. 2016). He went on to develop a long-term plan: Apple needed to design the chip that would be inside its smartphones. The A4 chip became, in 2010, the first product that originated from the shift to Apple-designed chips.

By 2017, Apple released its thirteenth chip, the A11 Bionic, as part of the unveiling of the iPhone X. It was described as the "most powerful and smartest chip ever in a smartphone" (Pangambam 2017), with Phil Schiller (senior VP of Worldwide Marketing) touting its capabilities: "everything we've seen is powered in iPhone X by the amazing new A11 Bionic chip" (ibid.). Throughout the reveal, the chip was represented as an immense two-dimensional dark square, and each of its new parts was discussed. One key innovation was highlighted in particular: the Neural Engine. Promised as a game-changer, the Neural Engine would embed predictive computing into the chip's architecture itself. Phil Schiller described it as

> a specialized hardware built for a specific set of machine learning algorithms. This is another example of the incredible collaboration between the hardware and software teams that's only possible at Apple. The Neural Engine is a state-of-the-art ultrafast processing system that uses the highest density computing ever. It's a dual core design; it can perform over 600 billion operations per second. (ibid.)

Beyond the immense buzz, the Neural Engine (or NPU) can be understood as a hardware accelerator for machine learning functionalities – more specifically, deep learning. Because AI has become such an important part of the computation Apple sees as important in smartphone systems, chip design now dedicates some of the "silicon real state" to do the kinds of computation specific to deep learning (massively parallel operations) (see Mackenzie/Munster 2018: 17). In other words, rather than using the CPU or the GPU for AI, the NPU is designed to do only this specific type of computation, thus optimising speed and battery consumption.

This infrastructuring of prediction in the smartphone can be understood through the emergence of "platform seeing" (Mackenzie/Munster 2019). This concept suggests that a new mode of visuality unfolds from the fact that images today are "not simply quantified, but labelled, formatted and made 'platform-ready'" already through their "persistent processing by everyday devices" (ibid.: 8). Mackenzie & Munster assert that, in contemporary times, images exist within "*ensembles*" (large swaths of image data), a consequence of their "plat-formatting" (ibid.: 15, original emphasis). As such, visual culture is now distributed and invisible, focused much more on operational functions and Big Data ensembles than its historical goal of representation. A crucial element of this shift is its reliance on new hardware, e.g., the A11 Bionic chip, which transforms images into connected data by "the intermediating agency – at once technical, cultural, economic, and political – of the platform as ongoing operations that transform, order and circulate" (ibid.: 9).

As the NPU is embedded into the iPhone, the smartphone becomes a platform for predictive capabilities. The concept of "platform" here goes beyond the everyday understanding of social media platforms such as Facebook, connecting it instead to platform studies' focus on "computing devices" and "software environments" (see e.g., Plantin et al. 2018). Platforms are systems that allow different modular components to be installed on them (e.g., apps), although the control over the affordances and limitations of the system is up to whoever builds and maintains the platform (most often corporations such as Apple or Google) (see Bogost/Montfort 2009). By saying the iPhone becomes a platform for prediction, I am highlighting how prediction becomes infrastructural, an integral part of this platform. As seen in Apple Memories, predictions continually evolve and change based on our inputs. Algorithms experiment with images by attributing different features to them, experimenting in seeing features and patterns across the entire collection (which is why it operates better in hardware that allows for massively parallel operations). In other words, prediction does not mean simply "building a model that predicts, but trying very many predictive models in an algorithmically controlled order" (Mackenzie 2013: 398). This highlights the processuality of Apple Memories: it's always running in the background, exploring different models to understand and relate the image collection. Automated memory-making is not certain or fixed, but a continuous process across the large collection of a user's images.

In line with the "incorporation of platforms into hardware in devices" (Mackenzie/Munster 2019: 5), Apple's chip both centralises image plat-formatting within Apple's control and decentralises how it happens – away from the cloud, into our pocket. The infrastructuring of machine learning seeks not only to make predictive capabilities faster and more responsive to users; it also embeds prediction into the infrastructure so that future features and experiences may rely on it (a "platform"). This suggestion builds upon the connections traced by other scholars (e.g., Plantin et al. 2018; Plantin/Punathambekar 2019), finding that platforms are becoming infrastructural, particularly as they use their control over data and computation to expand and embed themselves "in our daily existence, taking over more and more functions formerly provided by other, less restrictive means" (Plantin et al. 2018: 12).[3]

When looked through this lens of the infrastructuring of platforms, it becomes clear how platform seeing in the device is "a hardware 'hook' for artificial intelligence to insert itself pervasively into everyday life, fostering a ubiquitous, platform-driven consumer-level deep learning" (Mackenzie/Munster 2019: 15). Operations of data extraction such as the computer vision that enables Apple Memories sink deeper into the infrastructure and make datafication a pervasive element of everyday life – with the goal of exploiting the produced data for financial gains, as indicated by both Zuboff (2018) and Couldry and Mejias (2019). Although Apple's marketing may sell the chip as belonging to the user, the chip is actually anything but. The user does not have any direct access to the chip or its capabilities, relying on what Apple (as a platform) allows to run and operate in its integrated hardware-software system. The platform for seeing, a "centrally designed and controlled system" (Plantin et al. 2018), is tightly integrated with the infrastructure of machine seeing.

However, as suggested by Holt and Vonderau, "[i]nfrastructural politics is not just about what is deliberately hidden from sight or is invisible; it is equally about the hypervisibility created around *some* of an infrastructure's component parts, all while most of the relations it engenders and the rationality embodied in its overall system sink deeply in obscurity" (2015: 80, original emphasis). The A11 Bionic chip is not only made a visible infrastructure through its presentation, but also through its performative marketing. The Bionic branding of the chip makes an ambiguous case: On the one hand, the conceptualisation of Bionic is directly

3 The concept of "infrastructure" here builds upon definitions by Star and Ruhleder (1996) as well as its extension by other researchers (e.g., Plantin et al. 2018; Plantin/Punathambekar 2019; Parks/Starosielski 2015). In sum, the concept brings attention to how information systems acquire characteristics of ubiquity, reliability and durability. The concept of infrastructure thus complexifies digital culture through understanding the sociotechnical networks that give information systems support, though they often fade into the woodwork and become banal.

related to the Neural Engine, which itself is named after neural networks and their supposed inspiration on the "McCulloch-Pitts model of the neurone" (Mackenzie 2017: 46). This use of nomenclature related to the human brain connects it with the idea that the machine itself can learn, think and understand things like a human (i.e. an emotive technology). On the other hand, the Bionic branding also implies the user becoming bionic, augmenting themselves with the "the power of the advanced silicon" (Federighi 2016) and the functionalities it enables (e.g., automated memory-making).

In the above analysis of the A11 Bionic chip, we can see the "infrastructural politics" (Parks/Starosielski 2015) of the chip: it is hidden from sight, embedding platform seeing and its predictive capabilities into our devices, while also being hypervisible and mystified. The NPU's increase of the speed and power-efficiency of predictions turns the iPhone into an infrastructure for continuous experimentation with large image collections and their connections.

The Affordances of Apple Memories: Locking the User in a Predictive Regime

The vision of Apple Memories is one of affective and emotional surfacing of connections between images, which may be understood within the wider goal to tightly integrate platform seeing into a device's hardware. But how does Apple Memories work in practice? What are the affordances and constraints it offers the user?

Upon setting up the iPhone, the Photos app (within which Memories resides) is installed and set up by default. It is also directly connected to Apple's iCloud, which serves as the most seamless way to backup photos to "the cloud". The Memories functionality automatically creates image collections and recommendations – be it through themes (e.g., "Dining", "One Year Ago"), faces recognised across the photos and places or categories (e.g., "Lakes", "Animals"). Memories can be seen as such collections or exported as a "'Memory movie', in which different related 'memories' are added to a slideshow, which can be customised by the user in terms of 'mood' (music and editing style), 'length' (short, medium, or long) and 'personalisation' (add or delete specific photos)" (Jacobsen 2020a: 7).

There is no way of opting out of the automated analysis of Photos and Apple Memories. There are only two options for influencing how such image analysis and curation work: a toggle for whether the user wants to be shown "Holiday Events" from their home country, and a button for resetting suggested memories. The sorting and ranking of images happen exclusively through the pre-made categories, which the user can't alter, add to or remove. Additionally, the system uses push notifications ("You Have a New Memory") to nudge the user into connecting with the application.

The affordances of image analysis and recommendation, as described, are all pre-set: not only are the categories pre-defined, but so are the ranking and metrics used to organise the relations between images. For example, Apple Memories creates collections from perceived events, such as "Night out in [City Name]" or "Friday Dinner". Connections may be shaped by features visible to the user, including the image contents, or the picture location metadata. However, there are also opaque interconnections the system does not ever disclose through its interface. According to Apple's Tech Brief (2019), social groups may be identified by "people who often show up in photos together" and "Calendar and Contacts [integrations are used] to understand important personal dates like birthdays and anniversaries". That means the extraction of data and its interrelations are much broader and opaque than what is ever presented to the user via the interface, with key integrations across the iPhone platform.

The user is actually able to create Memories collections by selecting photos, but this is a contrived process that only works within a particular month or day, not through the whole collection. The fact that the system is inflexible and opaque makes handing the personalisation to the machine the path of least resistance, while also inviting the user to the "Practically Magic" sensation advertised by Apple.

Apple Memories offers users the ability to share their memories as a collection of images or an automatically edited video. Moreover, Memories is also shared by default across other Apple products logged into the same account. Featured Photos from Memories are displayed in widgets in the Apple TV and the Apple Watch, for example. The system, however, does not allow the tags produced through the app, or any of the data created through the image analysis it performs to be exported (i.e., there's no interoperability).

As can be seen in this description, Apple Memories' affordances prioritise curation through the system's predictive capabilities. This means a change in the affordances of memory-making for the user: they are invited to work together with the algorithm, with few (and rather laborious) possibilities for manual intervention (cf. Reinis 2019). The algorithmic operations are, by design, made without much influence (or understanding) from the user.

Platform Seeing Beyond Privacy and Surveillance Capitalism

Apple Memories' shift of computer vision and personalised recommendation to the device is framed around notions of emotion and privacy. The iPhone chip, in turn, is positioned as a visible infrastructure, both materially and symbolically indicating the embedding of predictive capabilities within devices. Through such "platform seeing", the whole of the image collection is formatted continuously to platform operations and conditions: "large-scale patterns of associations between features" (Mackenzie/Munster 2019: 18). Finally, Apple Memories' functionality is

completely automated, operating under the surface with almost no user involvement or knowledge. The user cannot opt-out, peek into or modify these "invisual cultures" of data extraction, thus being locked into Apple's digital ecosystem.

What are the consequences of Apple Memories and its shift of image analysis and recommendation to the device? In this last section, I will argue that the concern about privacy and surveillance capitalism is insufficient when it comes to the on-device operation of "platform vision". As well described by Sadowski, the focus on privacy and security "elide[s] the systemic issues of inequity and exploitation that are endemic to the contemporary political economy of data" (2019: 9). While extracting and collecting personal data for behavioural analysis and targeted advertisements is a pressing issue, it is not the exclusive way networked images and data extraction matter.

Apple's power relies not on owning user data, but on the monopoly that it has, as a platform, to process this data and transform it into a wider, lucrative "ecosystem". Although Apple Memories promises privacy and not to spy on users, that does not mean users are not a product. Birch et al. (2021) similarly argue that the "power of Big Tech is vested in this process of assetizing users rather than from the 'ownership' of personal data" (13; cf. Zuboff 2018: 94 on the definition of "surveillance assets"). The networked image plays a key role as part of Apple's operation as a powerful platform and infrastructure for the networked image. Through on-device computer vision and personalisation, Apple Memories: 1) creates an always-on service to engage users; 2) generates more and better data about users; and 3) turns prediction into an infrastructure, with many potential future uses. As will be discussed, the value creation through Apple Memories is rather indirect and speculative, rather than the most often discussed elements of selling behavioural user data for advertisers.

The "Stickiness" of Nostalgia

First, the networked image is a rich asset for platform seeing, as it is directly related to our everyday practices of sociality, connection and memory-making. In the case of Apple, the (monopolistic) capacity to control the networked image, as well as the infrastructure of prediction, matters: it gives Apple the power to create a relation with the user by remediating their personal data (i.e. to produce "Memories"). Apple Memories seeks to "enhance product stickiness" (Jacobsen 2020b: 101), getting users involved and engaged within the Apple ecosystem. In this sense, these algorithms may be said to operate "captologically": using the analysis of user behaviour and their images to "elicit more interactions", thus keeping them "hooked" (Seaver 2018: 430). As described by Reinis, Apple Memories is an "attempt to use the affective power of nostalgia to intimately connect users with platforms and reshape subjectivity with ultimately commercial prerogatives" (2019). In sum, Apple Memories deploys its unique control over the predictive

infrastructure to both form an emotional relation with the user and hook them as an active participant in the company's ecosystem (cf. Prey/Smit 2018).

More Data

Second, Apple Memories' private operation turns the user into a willing participant in the continuous extraction and analysis of personal data. The notions of intimacy and emotion are key ways to pull the user in. Joey Tyson, Apple's Privacy Engineer, was clear about this when presenting to developers at WWDC 2018. In his words, "privacy-friendly machine learning" allows to build "a relationship of trust with your users", therefore laying "a foundation for better engagement" (Tyson 2018). He proposes that

> as users understand why you're collecting data, how it's being used, as you handle that data respectfully and thoughtfully, you're going to get better data, because they're going to be more comfortable using your apps and sharing information, and this builds loyalty over time. (ibid.)

The private operation of Apple Memories, as described by Apple's engineer, helps to get users to allow computer vision to gather and analyse intimate data on a large scale (especially on particularly intimate data). In this sense, privacy is helpful – rather than a deterrent – for platform seeing to take hold, thus increasing user engagement and information collection.

Infrastructuring Prediction, Platforming Vision

Third, and most importantly, Apple Memories is about infrastructuring Apple's platform power. Whoever controls the infrastructure can define the possibilities of how such infrastructure will (and will not) be used for data collection and analysis. The centralisation of power within Apple's "walled garden" means that, although it might not "own" the data, it builds a monopoly over its operationalisation. The focus that has been given to privacy (i.e. protecting against data mining from third-parties) ignores the power that such control over the infrastructure generates (i.e. the power to control the data extraction and analysis, including the connection of images and their categories/ranking). The users do not own the hardware and cannot modify it, or even access the data they have produced.

Apple operates as a "walled garden" platform for this specific reason: it has full control over hardware, software, and services. This arrangement benefits Apple, as it can tightly control all the different facets of user experience for its benefit (e.g., the App Store, of course, but also the seamless analysis of images through its custom-made hardware). Tech critic and scholar Evgeny Morozov similarly argues that "surveillance capitalism" is not the only form of "unequal exchange" and to

think so would "ignore all the ways in which Apple regularly pushes its customers around, even preventing them from using third-party repair services" (2019).

In this sense, Apple Memories means Apple taking indirect control of users' image collections, a form of power and value-creation that is speculative and future-oriented. This is different from using this behavioural data to directly inform advertising or improve algorithms. Instead, what it allows is for this data to remain within Apple's "walled garden", where only Apple can decide what to do with it. Although the "walled garden" may be framed as protecting user privacy, it crucially monopolises power to determine how platform seeing operates. Through platform seeing, image collections take on "a different value as future-oriented assets" (Mackenzie/Munster 2019: 10) – as opposed to "the archival logic of social media platforms" (ibid.; see also Zuboff, 2018). Controlling the infrastructure of platform seeing means control over how it (and its data assets) will be used in the future, including for surveillance or commercialisation. Function creep, broadening the data collection and sharing, could happen at any point – be it through changes in the systems' Terms of Service or by including new services and advertising for Apple's products. Data collection in the hands of (monopolistic) platforms with infrastructural power over our devices raises questions we already know the answer to: "There is no reason to assume that a corporation, unless specifically checked from doing so, won't use the personal data it collects or buys in its own interests and against an individual's interests" (Couldry/Mejias 2019: 163).

However, this is not only a concern for a faraway future: there are many signs that surveillant power can take hold in systems engineered for privacy. Metadata mining, which is often considered to be more important than actual content data, is an issue in Apple's operation, particularly because it is "exceedingly difficult to see, study, and analyze" (Cooke 2020). Moreover, techniques such as differential privacy could potentially allow the identification of not a particular individual, but a general population. For example, in discussing COVID-19 contact tracing apps, digital rights scholar Michael Veale (2020) has argued that the issue is not privacy, but "the kind of infrastructural power" that contact tracing apps enable for Apple or Google. That is, although these tools may strive for privacy, their embedding in all devices means "Apple and Google can understand and intervene in the world, while truthfully saying they never saw anybody's personal data" (ibid.).[4]

4 After this article was submitted for review, Apple announced a new functionality to scan users' images and videos being uploaded to iCloud for Child Sexual Abuse Material (CSAM). Instead of conducting such a scan on the cloud servers, which is common, Apple would leverage the computation of users' iPhones (Brodkin 2021). This move was met by criticism and outrage, with experts and organizations pointing out the potential issues of the integration of surveillance on the device. Due to this response, the functionality has been temporarily removed. However, it serves to

By pushing computer vision and predictive personalisation to the user's device, and operating it within a "walled garden" ecosystem, Apple has a monopoly over both platform seeing and its enabling infrastructure. The framing of computer vision as an intimate and personal way of remembering is part of its goal of exploiting personal data to bolster user engagement, more data and the accumulation of platform and infrastructural power within its closed-off digital ecosystem. Apple Memories is, thus, an interesting case of how the networked image today may be enabled by information architectures which, although they may not involve direct value creation through the selling of behavioural data, still rely on data extraction and analysis for the benefit of the platforms which control them.

Conclusion

Apple's shift toward on-device computer vision for automated memory-making may increase user privacy, but it also means the embedding of platform seeing into our devices. Data extraction is now embedded in our always-on smartphones. These extractive operations are framed and sold as emotive and private technologies, but they are actually key ways for infrastructuring predictive capabilities, while also creating services that "hook" users and create more data. Although much scholarship has centred its critique on the surveillant power of the "cloud", I argue that even if operating privately, computer vision allows the problematic consolidation of platform and infrastructural power. This suggests a need to rethink what "surveillance capitalism" means for the networked image: not only a question of data collection for behavioural analysis and ad targeting, but also a way of reaching into and profiting from our personal and intimate memories.

In closing, it is worth mentioning that Apple Memories' control over automated memory-making also raises important issues for our subjectivation. In Apple Memories, the algorithm becomes the curator of what is meaningful enough to be a "memory". Through its suggestions, it helps shape what gets forgotten or remembered, making it difficult to hide from or evade its logic. Following Couldry and Mejias (2019), this emergence of platform seeing could mean a break of human autonomy and the "minimal integrity of the self". Rather than being built around self-determination of individuals, the self is invaded by the automation created by Apple. As suggested by Mark Andrejevic, the "political challenge for the foreseeable future will be contesting the subsumption of subjectivity and judgment to automated media" (2020: 21). The fact that the algorithmic processing is private and operates in our pocket means that their narratives can

show how the infrastructuring of image recognition by Apple, as discussed in this article, can lead to problematic forms of control and analysis of users' images.

be more tightly interwoven with people's lives. The changes this domestication of prediction may bring to our ways of seeing and remembering images still remain to be discovered – but as I have shown, they will likely be intimately tied to the interests of those with platform and infrastructural power.

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