ABSTRACT

LEE, JEONGHYUN. Automation of Nostalgia: The Cultures of Algorithmic Memory Practices (Under the direction of Dr. Stephen B. Crofts Wiley).

Humans have long been coupled with media to exteriorize, inscribe, or store memory. However, twenty-first century media are able not only to store human inscriptions but also to generate standardized memory and nostalgia in remembering the past. Besides possessing the capacity to store the inscribed moments, contemporary media embedding Artificial Intelligence (AI) independently select, organize, and reanimate the already stored traces of the past and automatically notify us that “you have a new memory.” I call this socio-technical culture of memory practices, in which socio-technical machines automate our ways of engaging with the past, “the automation of nostalgia,” and critically analyze the new algorithmic memory practices in this project. I use the method of media archaeology to reveal or speculate about the rules of algorithmic operations that condition the new socio-technical cultures, focusing on Apple iPhone’s Memories feature, Google Photos, and Facebook’s Memories application. To make visible the technical and discursive decision rules for these technologies of automated nostalgia, I first explore, in Chapter 2, the temporal architectures of Facebook’s Memories application to show the ways in which their digital storage and algorithmic processing shape our temporal experiences and create nostalgia on the basis of stored time. Then, in Chapter 3, I trace the historical pre-conditions for the emergence of automated nostalgia, suggesting that the legacy of cybernetics has shaped the system of automation and has conceptualized a specific understanding of memory in algorithmic memory practices. In the following chapter, Chapter 4, I demonstrate how algorithmic media such as Apple, Google, and Facebook integrate our memory practices into a sophisticated form of digital archives by categorizing inaccessible digital traces stored in the archive and standardizing our subjective relationships with the past. Lastly, in Chapter 5, I

articulate the implications of becoming nostalgic subjects and explore alternative modes of engagement with algorithmically mediated memory and new ways of intervening in the process of subject formation. In the contemporary media culture, in which acts of recalling the past are increasingly becoming automated by the operations of algorithmic media, this dissertation illuminates the specificity of algorithmic media in media history, showing how the subject of remembering becomes the object of an apparatus that synthesizes human memory practices with algorithmic memory practices to create a new mode of experiencing memories.

Automation of Nostalgia: The Cultures of Algorithmic Memory Practices

by
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DEDICATION

To my family who always believes in me, from the beginning to this end.

변함없이, 나를 믿어준 가족들에게.

BIOGRAPHY

JeongHyun Lee builds her academic trajectory across South Korea and the United States. She received her Ph.D. in Communication, Rhetoric, and Digital Media at North Carolina State University, with a dissertation titled *Automation of Nostalgia: The Cultures of Algorithmic Memory Practices*. Before her Ph.D. program, she held a double major, B.A. in Journalism and B.A. in Advertising at the Catholic University of Daegu in South Korea. She received her first M.A. in Visual Communication (Cultural Studies) at Yonsei University in South Korea, with a thesis about the historical construction of "creativity" discourse in the Korean neo-liberalism. After the completion of her first master program, she continued studying in the United States with a special interest in memory, new media, and power. The second master's degree, M.A. in Communication, was received from the University of Utah, with a thesis titled *Memory Politics: Social Media Memory Practices in the Korean Ferry Sewol Memorial Website*.

JeongHyun's research areas are critical media studies, cultural studies, memory studies, and posthuman media studies. Her research focuses on digital media, algorithmic media, technology, temporal experiences, and memory practices. She is currently exploring the intersectional temporal experiences between bodies and machines in memory practices.

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I know this project is my new beginning, not the end. While I move forward after this project, all these favors I have received will never be forgotten.

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CHAPTER 1: INTRODUCTION

Memory practices have been associated with networks of different media that exteriorize and store our memory. From diary writing to photography and social media, we have documented and recorded parts of our lives in media outside of the body. Those records complement our embodied memory capacity and reactivate embodied memories. Depending on which mnemonic media we use, our memory practices—acts of remembering and forgetting, broadly defined—have operated through different historical arrangements of the body and a range of technologies. With this project, I aim to illuminate what happens to the memory practices as we develop twenty-first-century algorithmic media.

In iOS 10, Apple's photos app often provides a notification, saying "You have a new memory." The notification leads one to watch a slideshow of photos in the photo album, which is composed of photos selected from images that the user has taken in past months and years. This is a new feature of the Apple photo album after iOS 10, called Memories, which displays photos curated by algorithms that sort out significant photos from among hundreds of images and group them in terms of person, time, and location. Without any interventions from users, Apple algorithms identify who and what was in the photo, as well as where and when the photo was taken in order to classify photos by the relevant people and image. Before Apple's Memories feature, Facebook and Google offered similar functions based on their face/object-recognition systems and editing tools that analyze, curate, generate or reanimate data and/or photos. Facebook has developed several memory-evoking services that recirculate user's stored post as memories for the day, the year, and person. Similarly, assuming users' permission, Google Photos, Google's photo-storage application, provides an Assistant feature that automatically organizes a collage of photos with a certain designs and music featuring time, space, people and moods detected in the photos. Then, these services periodically display the algorithmically curated photos and posts as "memories" through their platform (see *Figure 1.1).*

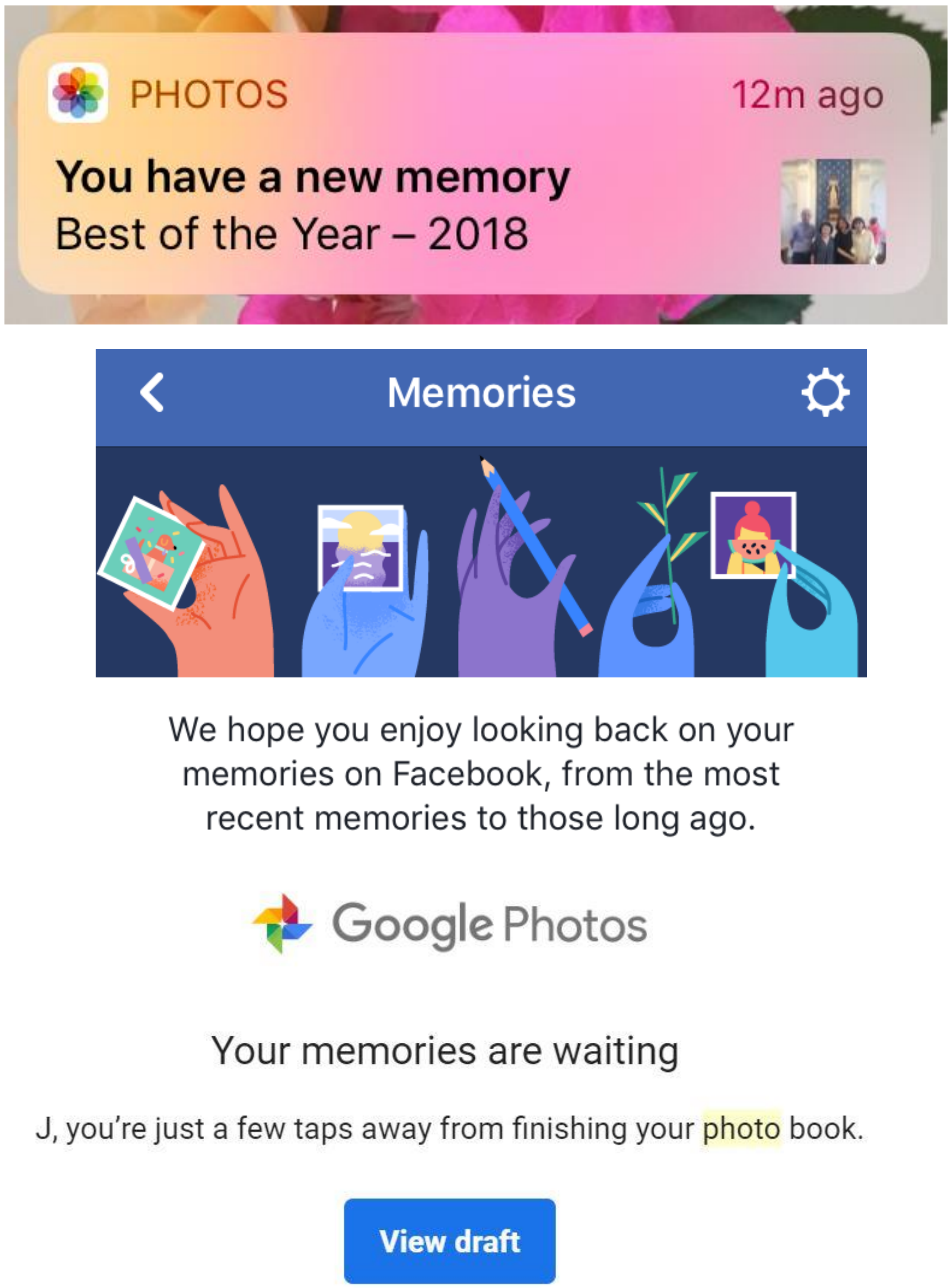

Figure 1.1: Notifications for algorithmically generated "memory" from Apple iPhone Memories (top), Facebook Memories (middle), and Google Photos (bottom)

Besides possessing the capacity to store daily life, today’s media actively intervene in the way we recall the past. Data stored in social and mobile media continuously reappear in the present, generating a standardized temporality of memory in practices of remembering the past. Artificial Intelligence (AI) embedded in contemporary digital media automatically reanimates the stored past with algorithmically selected photos that evoke memories of particular people, places, and moments. In contemporary media cultures, these techniques of remembering the past induced by algorithmic operations on stored digital records are becoming ever more pervasive.

This means that acts of recalling the past are also becoming increasingly automated. Media are able not only to store the moment but also to select, organize, reanimate, and suggest memories and additional memory practices. While humans may select certain moments in their everyday life to be photographed, video-recorded, tagged, and archived, media technics are becoming more independent in their ability to select, organize, and create what and how to remember. Socio-technical machines in twenty-first century not only shape modes of inscription, as Friedrich Kittler (1999) showed in his analysis of nineteenth-century storage media; they also *suggest* modes of remembrance, requiring further explorations beyond Kittler’s work on storage media. While Kittler’s analysis of nineteenth-century media emphasized the capacity of media to store the time, a capacity that became part of the conditions of our memory, today’s media culture goes further, creating new algorithmic media practices around the uses, activities, and conceptualizations of memory.

I call this socio-technical culture of memory practices, in which socio-technical machines automate our ways of engaging with the past, “the automation of nostalgia.” Automated nostalgia refers to the continuous production of longing for the past induced by algorithmic operations that require minimal human assistance. The concept of nostalgia has primarily been understood in terms of affective connections to the past. While the original term implied a general sense of loss and mourning, as in its use to refer to pathological symptoms among the Swiss Army fighting abroad, the modern sense of nostalgia encompasses the pleasurable contemplation of the past (Dickinson & Erben, 2006; Hofer, 1934). What the concept ultimately highlights is *a desire to return imaginatively to a specific time* of the past that is *reconstructed* in one's present condition and sensation. Algorithmic decision-making rules are designed to select images and texts that are "joyful" and memorable to users so that they can enjoy recalling the past as portrayed in their curation. In this algorithmic memory practice, my concept "automation of nostalgia" indicates the sentiment toward the reconstructed past that is automatically produced and constantly suggested by the system of automation.

My interest in the automation of nostalgia focuses on the ways in which it materializes and conceptualizes memory. It is a question about, on the one hand, how stored time is turned into memory in the algorithmic systems of reorganizing stored photos and posts; and on the other hand, how the systems of automation understand and circulate the concept of memory. When I am told by my media devices that "you have a new memory" or "your memory is waiting," the problem is that the "memory" loses its original body and its context of recall. This suggested "memory" is technically processed outside of the human sensory body and its lived temporal flow. What appears as "memory" is a systemically reorganized, static and standardized past that loses its potentials to interact with the lived temporal flow and the context of recall. Then, how is the algorithmic version of memory materialized in its operation, how has this form of memory been shaped, and what exactly is the "memory" waiting for us?

The answers to these questions require a historical exploration of discursive and technical rules embedded in algorithmic curation, processing, and reanimation. While we are habitually engaging with media to be connected with the past, invisible rules are operating to gather, analyze, select, organize, and reanimate our data to construct our memories. The way we understand these operations affects the way we use the technologies to remember. Further, the knowledge generated connects closely with knowledge of the self, so memory is an important element of subjectivity. By revealing the discursive and technical rules of automated nostalgia and its historical construction, I intervene in the new socio-technical cultures of memory to show what it means to remember through twenty-first century algorithmic media.

In sum, this project explores how the automation of nostalgia emerge in relations to the play of socio-technical forces forming discursive and technical rules that compose our understanding of memory and the self, by providing answers for the following questions:

1) What are technical and discursive decision rules of storage, processing, and reanimation that shape our temporal experiences?

2) What are the genealogical antecedents of today's techniques of automated nostalgia?

3) What are technologies for automated nostalgia creating and how do these new technologies of remembrance reshape our assumptions about memory and the subject of remembering?

4) How can we pursue alternative memory practices that critically question and intervene in the datafication and algorithmic standardization of our memory practices?

The following chapters explore answers for these questions by examining some of the most influential technologies for automated nostalgia in contemporary media cultures, such as Apple's Memories feature, Google Photos, and Facebook's Memories application. Drawing on media history and on theories of memory, time, and subjectivation, I demonstrate how “memory” is produced and circulated in algorithmic memory practices that aim to produce nostalgic subjects who engage in the temporal architectures of algorithmic archives producing identical digital objects as “memory.”

Before starting the exploration, the present chapter explains the context of this project. In what follows, I first discuss the methodological framework of the dissertation, which draws on cultural studies and posthuman media studies, and explain how I built a method to examine the socio-technical operations of automating nostalgia. Next, I discuss the methodological, theoretical, and practical contributions that I hope to make in the literature and the fields of critical/cultural studies, materialist media studies, and memory studies. Then, I present the structure of the dissertation and outline how each chapter answers the research questions. In the last section, I clarify and conceptualize key terms animating this project.

Methodological Frameworks: Toward Posthuman Cultural/Memory Studies

This project is a critical analysis of socio-technical memory practices in algorithmic media that automate nostalgia. Methodologically, this dissertation incorporates a posthumanist understanding of culture into cultural studies methods of Foucauldian discourse analysis in order to develop a media archaeology/genealogy.

As Stuart Hall has written, “[cultural studies] has never been one thing;” the scope and the methodology of cultural studies have been broadly defined (Hall, 1990). In this tradition, Nelson, Treichler and Grossberg (1992) offer a generic definition of cultural studies, which is an investigation of ways in which “culture” shapes and transforms everyday life and social relations as well as a critical analysis of ways in which power, knowledge, and politics shape “cultural” practices in everyday life. Embracing a complex definition, cultural studies defines culture as both “a way of life—encompassing ideas, attitudes, languages, practices, institutions, and structures of power—and a whole range of cultural practices: artistic forms, texts, canons, architecture, mass-produced commodities, and so forth” (p. 5). With this broad definition of culture, cultural studies has generally studied how and why popular belief and particular discursive practice are formed across “the cultural practices, languages, and logics of the people” (p. 11).

Posthuman media studies, by contrast, questions the conceptualization of “culture” and “human” in cultural studies. While the tradition of cultural studies has a long history of commitment to “the people,” most perspectives in posthuman media studies have emphasized the materiality of technologies that conditions human experience, perception, and knowledge. A materialist understanding of media explores “how that physicality matters in the determination of social relation and cultural form” (Bollmer, 2015). Technology is not independent of culture, but it shapes “culture” and/or “cultural” practices. Thus, “cultural” practices in the sense of cultural studies are always already socio-technical practices in posthuman media studies—not only practices of a human subject, social groups, and institutions, but also the materiality of technology as the infrastructural conditions of those practices.

In this posthumanist approach, a human subject is no longer privileged as the agent shaping culture but is seen as being embedded in and co-produced with technological materiality. Following this posthumanist understanding, “culture” in this project is always socio-technical, in that the social field is not independent of the technical field. Instead of “culture,” this project emphasizes a *sociotechnical field*, “populated not only by bodies, social groups, and institutions, but by sociotechnical machines, including media” (Wiley & Elam, 2018, p. 208).

My methods of studying the socio-technical culture are largely rooted in Michel Foucault’s ideas of archaeology and Marshall McLuhan’s materialist, non-content-based media analysis. In *Understanding Media*, McLuhan (2013) focuses on a broad range of media, redefining media as the extension of the human sensorium. McLuhan investigates the ways in which the human being is situated in and through different media, and how the medium extends the human sensorium. For McLuhan, “the medium is the message” because “the message of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs” (p. 1). Similarly, in *The Archaeology of Knowledge,* Foucault (2012b) develops his method of archaeology, which excavates the *a priori* conditions of existence by digging into the background reasons and historical conditions why a certain discourse, subject, object, and body have been able to be created and circulated in a specific cultural context. Foucault’s archaeology ultimately aims to reveal the system of forming and transforming statements, which is always a historically particular system that makes certain statements possible in a specific period in history.

This idea of archaeology was later expanded to *media archaeology* by Friedrich Kittler (1990; 1999). Building on Foucault’s archaeology, media archaeology emphasizes media as our conditions of existence, a technical *a priori*, which is quite undertheorized in Foucault’s discursive analysis of archaeology. Thus, media archaeology aims to reveal the historical specificity of a particular medium that makes a certain discourse, subject, object, and body possible.

In this dissertation, I employ media-archaeological methods of analysis to examine automated nostalgia. After the work of Friedrich Kittler, however, media archaeology has been characterized by a number of different interpretations, with different conceptualizations of technological agency and the role of human practices. In what follows, I review multiple interpretations of media archaeology since Kittler, discussing the ways in which they employ different understandings of technological agency, the role of human practice, and politics. I then synthesize these multiple perspectives in order to develop my own methodological approach to exploring the socio-technical conditions of contemporary memory practices.

Highlighting the role of media and technological materiality in shaping culture, several scholars in the tradition of posthuman media studies have developed new methodological frameworks or revised methodologies in cultural studies (Ernst, 2013; Geoghegan, 2013; Kittler, 1990, 1999; Parikka, 2013; Siegert, 2015; Zielinski, 2006). Following Foucault's idea of archaeology, Kittler (1990; 1999) first shows what media archaeology could look like. Throughout his work on nineteenth- and twentieth-century media, Kittler examines the technical functions of a medium to store and transmit signals and demonstrates how the technical operations of media become our conditions of existence.

In *Gramophone, Film, and Typewriter* (1999), for example, Kittler adapts Lacanian theory to an analysis of how each medium and its mode of inscription differently determine our conditions of existence. In brief, Kittler identifies the phonograph with Lacan's "Real" because it captures all sounds and noises without filtering based on human-linguistic meanings or intentions. On the other hand, Kittler links film technology to Lacan's "Imaginary" because it technologically produces an illusionary continuity of single frames and scenes. This technologically produced illusionary continuity echoes Lacan's mirror stage, which indicates the child's moment of recognizing its fragmented body through an imagined reflection in the mirror. The infant perceives this imaginary self in the mirror as more coherent than its own body of multiple and shifting selves. Lacan's "Symbolic," by contrast, is associated with the typewriter because of the materiality and technicity with which it processes linguistic signs (Kittler, 1999).

After Kittler, several scholars have conducted hardware-oriented research that allows us to rethink media as our conditions of existence and sensorial experience (Deleuze, 1992; Ernst, 2013; Kirschenbaum, 2008; Zielinski, 2006). As the term archaeology might imply in Foucault's original emphasis on historical explorations, media archaeology is a methodology of writing socio-technical media history that shows how current media-cultural situations are shaped and how media have operated on the body. Media archaeology deals with technologically given moments and techno-cultural archives by analyzing objects, discourses, and practices of media.

In the cultural studies tradition of emphasizing power relations, a slightly different interpretation of, or emphasis on, media archaeology emerges. This approach criticizes media archaeology for treating media as predetermined factors in the socio-technical field. Monea and Packer (2016) suggest that media archaeology should instead pursue a *genealogical* approach that reveals the politics of how certain formations of media, and not others, emerged and endured across time. Their media-genealogical perspective emphasizes the politics and forces of emergence that constitute rules of production, maintenance, and reproduction.

Similarly, Bernhard Siegert's idea of cultural techniques suggests ways in which we can understand the politics of sociotechnical culture. According to Siegert (2015), the cultural-techniques approach is a methodology of seeking the "recursive operative chain" that extracts the symbolic from the real (p. 13). This approach, like media archaeology, is a way of writing an alternative media history, but followers of cultural techniques assume that operations and social practices historically and logically precede the concepts generated by media. For example, the operations and practices of writing, counting, and singing precede the technics of letters, numbers, and musical scales (Macho, 2003, p. 179; cited in “Cultural techniques,” 2018). Material practices generate concepts, which enable us to make sense of the world and modify the environment in ways in which we use certain techniques and technologies. Thus, if media archaeology examines a technical a priori of our existences, cultural techniques explore “a technical and a practical *a priori*” and the mutual modification or political formation between practices, concepts, and technics (Geoghegan, 2013, p. 70). Thus, the cultural-techniques approach is a methodological way of revealing the “cultural-technical systems that produce specific forms of life, environment, and species relations” (Geoghegan, 2013, p. 78).

These concern with the political has long been a focus of cultural studies. Cultural studies has problematized ways in which power, knowledge, and politics shape cultural practices in everyday life. Both cultural techniques and media genealogy have asked the same question of cultural studies: a particular force to produce and persist cultural practices.

In this conjunction of media archaeology and cultural studies, my project explores “a technical and a practical *a priori*” (Geoghegan, 2013, p. 70) of automated nostalgia, in history. Adapting the cultural-techniques approach, I begin with a “mixture of techniques, practices, instruments, and institutional procedures” (Geoghegan, 2013, p. 70) that give rise to algorithmic processing of digital media storage in order to examine how the technological set-up produces particular concepts of memory, nostalgia, and the self.

Regarding the methods I employ in this project, Jonathan Sterne’s analysis of MP3 in *MP3: The Meaning of a Format*, which is frequently cited in explaining cultural techniques as a methodology, provides insights. When Sterne (2012) provides a historical account of audio signal compression, his methods include wide-ranging research on scientific, economic, and political documents about technical details of sound compression as well as oral-history interviews. Instead of writing a media history in a linear progression, his historical account of the MP3 is a set of connected and overlapping histories of technology, subjects, formats, and media across electrical components, the auditory nerves of hearing, and bodily techniques that collaboratively produce concepts about hearing, knowledge, and fidelity.

In my resaerch for this project, I examined a series of documents, including magazines, news articles, opinion pieces, commercials, and other scientific, economic, and political documents that can be used to explain the history and functioning of Apple's Memories feature, Facebook's Memories application, and Google Photos. More specifically, I reviewed official documents published by Apple, Facebook, and Google since 2010, which is the year these companies began to develop the technologies that would lead to automated nostalgia. Major sources were the official documents published in their digital archive—Apple's NewsRoom Archive, Facebook Research, Facebook Newsroom, Google Research – AI, and Google Developer. Additional documents, such as commercials, patent documents, user manuals, and published interviews, supported my efforts at elaborating the histories and mechanisms of these applications.

In addition, I applied Robert Gehl's (2014) concept of "reverse engineering" to analyze and supplement the archival research. Gehl (2014) theorizes reverse engineering as a methodology in software studies. Reverse engineering is originally the design analysis of the system components in the final product, taking it apart and seeking clues as "to why it was put together in the way it was and how it fits into an overall architecture" (Gehl, 2014, p. 10). Gehl

(2014) uses this term as a methodological metaphor to study coded and proprietary software systems. Drawing on a broad knowledge of software engineering, reverse engineering as a methodology takes parts of the system and speculates “which sorts of uses and requirements the software is meant to meet and how the architecture and internal implementation of it might meet those needs” (p. 10). This approach is conducted based on a broad analysis of software systems inside and outside the interface, including interface designs, white papers, user manuals, press releases, blog posts, and news stories that can give us insights to speculate what the goals and/or logic of the system may have been. Reverse engineering can be a forensic process that tracks back technologies to reveal their genealogy in prior socio-technical practices and politicizes the system in histories (Gehl, 2014). Starting from particular instances of a platform, this analysis drives toward an understanding of preceded larger socio-technical systems underneath it.

Conducting archival research and reverse engineering, I provide a media-archaeological analysis of automated nostalgia, which reveals the discursive and technical decision rules of recording, selection, organization, and reanimation and articulates how the techniques produce concepts of memory, nostalgia, and the self in contemporary media cultures. Through reverse engineering, I offer genealogical articulations of technologies for automated nostalgia to show political formations between technologies, memory practices, and concepts of memory. Using these methods, I provide a set of connected histories around automated nostalgia, including a history of social media platforms, the science of cybernetics, and the Western psychology, to show how technologies for automated nostalgia has emerged and how the new media provide new conditions of memory practices.

The Contributions of This Project

As an effort to develop a methodology of posthuman cultural studies, this project, firstly, contributes to a larger discourse of digital media history. The conception of "history" in this project, however, originates in Foucault's historical approach, in which he examines discontinuous and "specific points of rupture," instead of the linear, chronological sequence of "progress" (Foucault, 2012b [1969], p. 175). This historical approach moves away from understanding history as "the way it really was" and emphasizes a critical intervention to counter the influence of ideological selection from the victor's perspective (Benjamin, 2008, p. 391). Instead of a single narrative of progression, historical writing should be composed of various stories from various temporal points that can give a critical insight to the present situation, which is what Benjamin called "the constellation of time" (Benjamin, 2008, p. 397).

In *The Burden of History* (1966), Hayden White also suggests a new history that can provide "perspectives on the present that contribute to the solution of problems peculiar to our own time," instead of justifying the past (White, 1966, p. 125). In this understanding, a historical account should not be a single linear narrative, but always a revelation of dynamic selections in discontinuities and disruptions that show the conditions of our experiences and perceptions. Despite slightly different frameworks for conceptualizing technological agency, the human, and politics, the multiple interpretations of media archaeology I discussed apply this concept of history—looking for multiple histories of media and exploring how the present comes to be perceived as reality through phenomenological and epistemological impacts of media on the formation of human subjects.

I join the archaeological or genealogical accounts of media history that address how a specific medium in a historical context conditions a subject's capacity to sense the world. For example, Jonathan Crary (1992) investigates the nineteenth-century pre-cinema technologies, such as optical toys, the camera obscura, and the magic lantern, and shows ways in which these modern techniques of seeing shaped human subjectivity. Jonathan Sterne (2012) provides a set of connected histories around the MP3, including a history of compression, a history of hearing research, a format history, and a history of user practices, to construct a history of MP3 in conjunctures developed over last years. Orit Halpern (2015) explores the role played by technological prototypes in shaping the emergence of contemporary media technologies and human perceptions. Also, after the emergence of digital media, posthumanist scholars in the field of media archaeology, software studies, and feminist media studies, have offered historical accounts of contemporary media culture by analyzing the specificity or genealogy of digital media including the Internet, social media, and mobile media (Bollmer, 2016b; Chun, 2011, 2016; Ernst, 2013; Gehl, 2014; Gitelman, 2008, 2014; Halpern, 2015; Peters, 2015).

All these examples explore either a specific medium in a particular historical context or multiple time periods of the human world derived from media-cultural histories, analyzing the relationships between cultural histories of media and the formation of subjects. My project joins these practices of media history by exploring the emerging, twenty-first century sociotechnical culture of the algorithmic media that automates nostalgia and its formation of memory and subjectivity.

While this project focuses on the historical commitments underlying present media culture of remembering, it also bridges two fields of studies that explore memory and the subject formation: cultural memory studies and posthuman media studies. Highlighting the historical interconnections between medium and memory practice, medium, memory, and the formation of a subject have been conjoined in various fields of studies. However, cultural memory studies and posthuman media studies have separately developed their theories of memory and subjectivation, one based on humanist theories of cultural meaning and the other on anti-humanist or posthumanist theories of technological storage. As a theoretical contribution to two fields of studies, cultural memory studies and posthuman media studies, this project addresses the disjuncture between these two fields and develops a synthesized theory of posthuman memory practices.

Even though materiality and technical media are relatively new topics in the tradition of cultural memory studies, Marita Sturken (1997) emphasizes the role of the medium in memory practices earlier through her concept of “technologies of memory.” Through her analysis of memorials, photographs, and films, Sturken’s “technologies of memory” indicate objects and media in memory practices, which are not passive containers of memory but active social and technical processes through which memories are produced, shared, and given meanings. Alison Landsberg (2004) also addresses the power of objects and mass media that allow people to take on and deeply feel other people’s experiences of the past vicariously, even when they did not live through that moment. For Landsberg, object and medium become “transferential space” where the object and medium transfer memories between different subjects across different times, spaces, and identities. This is “prosthetic memory,” which is facilitated by objects and media, creates affective connections to the past and forms a subjectivity (Landsberg, 2004, p. 120).

Following Sturken and Landsberg, various scholars in memory studies reveal objects and mass media as the conditions of cultural memory practices (Hirsch, 2012; Hoskins, 2009; Kitch, 2008; Zandberg, 2010; Zelizer, 1995). Recently, more scholars have given particular attention to media in digital memory practices (Mayer-Schönberger, 2011; Schwarz, 2014; Van Dijck, 2007; Van House & Churchill, 2008). With the emergence of digital media technologies, many scholars in memory studies admit that memory becomes embedded in and highly networked with digital media technologies and suggest new visions and methods of understanding the relationship between media and memory. Gane and Beer (2008) argue that we are living through the development of digital technologies that archive, reconstruct, and remediate our memories of everyday life and identity formations. Similarly, media scholars Garde-Hansen, Hoskins, and Reading (2009) conceptualize a “new memory ecology,” indicating that memory practices are associated with new media technologies and memories are mediatized in the ecology of memories.

Just as media have become a popular topic in memory studies, memory has frequently been discussed in the field of media studies. Instead of sociological and anthropocentric perspectives on memory practices, which locate memory at the level of individual humans, media studies has addressed memory drawing on machine agency of various media that capture time through different sources of input, such as light, sound waves, and tactile inputs, and converts these signals to electrical signals or digital codes. For media studies scholars, specifically in media archaeology, memory at the level of an individual human is the product of these media operations (Ernst, 2013; Hayles, 1999; Kittler, 1999; Parikka, 2013; Stiegler, 1998; Zielinski, 2006).

As I introduced in the previous section, Friedrich Kittler has discussed how media become the conditions of our existence and memory. According to Kittler (1999), the different mode of inscription enabled by each medium allows us to experience different reality in the Lacanian sense. Specifically, his analysis of phonograph shows Kittler’s conception of memory, which relies on the technical capacity of storing the time that identifies the real by capturing all the sounds and noises without filtering out human-linguistic meanings or intents. For Kittler, the moment or duration of time itself is registered in material inscriptions of sound waves, and the technological process drags the registered past moment into a new temporality. Kittler defines this function of the phonograph as "time-axis manipulation," which is a technological engagement of storing time and manipulating the human sense of temporality (Kittler, 1999, p. 35).

Similarly, Matthew Kirschenbaum (2008) analyzes the logic of hard drives through computer forensics: contrary to the common belief of digital media's ephemerality, every contact—archiving, erasing, overwritten—leaves a trace in hard drives' magnetic film, even if the trace is not visible in the human interface. Also, Wolfgang Ernst (2013) expands Kittler's idea of machine agency on storage media to electronic and digital media. Following Kittler, Ernst emphasizes memory as material inscriptions of media in the writing of history, which are opposed to the selective, transformative, changeable, and productive mechanisms of human memory. Ernst refers to this technological inscription as the "cold gaze" of a machine, which indicates the non-discursive and technical operation of inscribing and processing the real without an active engagement to select and interpret meanings (p. 47).

Likewise, memory has been separately theorized by these two fields of studies. Even though I can find the confluence between cultural memory studies' recent interests in a new memory ecology (Gane & Beer, 2008; Hoskins, 2009; Mayer-Schönberger, 2011; Schwarz, 2014; Van Dijck, 2007; Van House & Churchill, 2008) and media studies' emphasis on the machine agency of storing time (Ernst, 2013; Kirschenbaum, 2008; Kittler, 1999; Parikka, 2013; Zielinski, 2006), these two fields of studies have not frequently intersected.

Despite its omission of nonhuman agency in memory practices, the tradition of memory studies is still valid because the memory studies approach can reveal the political dimensions of memory practices, drawing on the legacy of cultural studies work that critiques the role played by power in shaping what can be said and remembered. In cultural memory studies, memory is not static, but an unstable, set of practices, which is politicized by power relations (Choi, 2008; Connerton, 2008; Huyssen, 2003; Sturken, 1997; Zelizer, 1995, 2010). However, these authors locate memory at the level of the individual human subject and often overlook an sociotechnical field of memory, which is not necessarily linguistic. Here, posthuman media studies can bring the nonhuman into studies of memory. In the posthumanist understanding of memory practices, human memory practices are always conjoined with technics, which is why posthumanist media studies has focused on the storage capacity of media as conditions of human memory practices. As Leroi-Gourhan (1993) anthropological analysis of tools and Bernard Stiegler's (1998) concept of epiphylogenesis have shown, technics and humans are mutually constituted in history. Technology is not just tool external to the human but an essential element in the constitution of specific historical formations of "the human."

In this understanding of memory, traditional theories of cultural memory studies are limited to analyzing a collective memory in the ecology of memories. Posthuman approaches are instrumental here in incorporating various elements of memory ecology into the discussion. Without the insights of cultural memory studies, however, some perspectives from posthuman media studies omit the human body, which is also a temporal machine, and overlook dynamics and politics of memory construction in the present past and subjectivations.

Likewise, these two theories of memory, one humanist and the other anti- or posthumanist, should be conjoined to understand memory ecology. Consequently, this project addresses memory as a conjunction of the human with the technological. In that humans and nonhumans are historically always already mixed in posthuman understandings of the socio-technical culture, memory practices should be explored at the confluence between two approaches. Avoiding a dichotomy of human memory and machine memory, the last chapter of this project develops theories of posthuman memory practices that conceptualize a socio-technical memory practice and memory in the ecological operation of heterogeneous assemblages. In this context, this project contributes theoretically to communication between two fields of studies, cultural memory studies and posthuman media studies, and forms a new theoretical conversation, posthuman memory studies.

In sum, this project contributes methodologically to a discourse of media history and bridges two different theories of memory. This socio-technical account of twenty-first-century memory culture and the automation of nostalgia illuminates a specific historical moment in the development of recent digital media with a particular focus on memory practices. Throughout this process, this project demonstrates the understanding of how contemporary media generate our relations with memories and subjectivities. In addition to methodological and theoretical contributions, I expect this revelation and critique of the system contribute to reducing knowledge gaps and political imbalances between the power of encoded software systems and that of human individuals in the ecology of memory, helping individuals to understand the mechanism and explore alternative possibilities of posthuman memory practices and subjectivation.

In the following section, I give a brief overview of each chapter as a plan of this project and explain how each chapter answers my research questions. Each overview gives a summary of the chapter and articulates how the chapter develops our understanding of the contemporary socio-technical culture of remembering.

Chapter Overview

Chapter one introduces the central questions animating this project: 1) What are technical and discursive decision rules of storage, processing, and reanimation that shape our temporal experiences? 2) What are the genealogical conditions of automated nostalgia? 3) What are technologies for automated nostalgia creating and how do these new technologies of remembrance reshape our assumptions about memory and the subject of remembering? and 4) How can we pursue alternative memory practices against the datafication of our memory practices? The following chapters sequentially answer these questions by providing three interrelated histories that have shaped automated nostalgia and analyzing its implications in our memory practices.

Chapter 2, Nostalgia and The Temporal Architectures of Algorithmic Media, begins this project by exploring technical and discursive decision rules of storage, processing, and reanimation that shape our temporal experiences. This chapter examines the temporal architectures of Facebook, an early developer of algorithmic memory practices, and analyzes how they turn stored time into nostalgia in the synthesis of digital storage and algorithmic processing. By showing how Facebook reorganizes and recirculates selected posts to create nostalgia, this chapter demonstrates how algorithms dramatize the past and present idealized versions of a joyful past that aims to evoke nostalgia.

In **Chapter 3**, **Automation and the Cybernetic Imaginations**, I address genealogical pre-conditions of automated nostalgia. I trace the emergence of mathematically identifiable, measurable, processable "memory," suggesting the legacy of cybernetics as an important theoretical framework for the conceptualization of memory in algorithmic media. This chapter focuses mainly on the concept of "memory" in Norbert Wiener's theories of cybernetics, which indicates technical synthesis of storage and processing, and technical analysis of behavior patterns. At the end of this chapter, I demonstrate algorithmic uses of cybernetic memory, which we can find in the conceptualization and design of the algorithmic archive that automate nostalgia. This genealogical account explains how the legacy of cybernetics shapes the discursive and technical rules of the algorithmic archives discussed in Chapter 2.

Chapter 4, **Archive and the Universalization of Memory** explores what exactly the algorithmic archives are creating. The main argument of this chapter is that algorithmic media drew on principles of Western behaviorist psychology to universalize memory as cybernetic memory of standardized categorization of emotional expression. By showing how computational analysis of human faces are intertwined with behaviorist approaches in Western psychology, specifically Paul Ekman and Wallace Friesen's claims about "universal emotion," I theorize the rise of "universal memory" produced by the algorithmic identification and classification. The idea of "universal memory" mobilizes standardized digital objects. In closing, this chapter argues that the subject of remembering, who consumes the digital objects, becomes the object of an apparatus that synthesizes human memory practices with algorithmic memory practices to create a new mode of experiencing memories.

Chapter 5, The Automation of Nostalgia, the last chapter reviews and ties together the claims from previous chapters and addresses the implications of becoming nostalgic subjects in the nexus of three histories that shape automated nostalgia. This chapter problematizes the ways in which nostalgic subjects are caught in increasingly standardized and universal logics of subjectivation when they remember and forget through the algorithmically suggested modes of memory practices. Then, I discuss some alternative, critical memory practices that entail new engagements with memory and changes in our habits of remembering. The chapter concludes by suggesting directions for future research.

The conceptualization of key terms

This section clarifies and conceptualizes key terms animating this project: time, temporality, the past, memory, and “memory.”

I follow Bergson’s idea of *time* in this dissertation to conceptualize my idea of memory. For Bergson (1911), time is a durational flow that does not cease. Reality is a movement in the durational flow of time, and human perception can understand the world of movements only through a snapshot view of constant change. The division of past, present, and future is a tentative way for humans to understand the indivisible flow of time, which is, indeed, always the present that flows into a perception of the immediate past and a determination of the immediate future. Time can be registered in both human bodies and media—broadly defined, including objects, memorials, buildings, electronic and digital media. Then, *temporality* is different from time. According to Sharma (2014), temporality refers to continuous practices of recalibrating our own sense of time in response to particular socio-technical arrangements, environments, practices, and spaces. I define temporal experiences as human experiences and recalibrations of temporality in response to socio-technical fields that include media.

Building on this understanding of time, I conceptualize *memory* as the product of temporal experiences, which emerges in the temporal subject when a sense of the past acts through present sensation. This idea also comes from Bergson’s understanding of the past as a potentiality that acts only by borrowing the vitality from present sensation. Memory is an active commemoration happening in time—what we recall is a result of continuous recreation and regeneration in the present that always has one foot in the past and another in the future. Thus, memory practices—acts of recalling and forgetting—are not always cognitive repetition of what it was; rather, as Bergson argued, they are a living subject's response to the external stimuli and contingency in the contemporary environment. In this understanding of memory, memory is always embodied and experienced in human bodies, while media store time and provide the conditions of memory practices.

In this dissertation, however, I often mention *"memory"* (with quotation marks) to indicate what algorithmic media (Apple, Facebook, and Google) call memory in their applications. When I mention "memory" with quotation marks, it refers to algorithmically suggested images, or blocks of data, that are called memory in those applications. Similarly, I often mention the past in this dissertation. For Bergson, there is no such thing as *the past* except as a potentiality in the present that might act, and does act, by inserting itself into a present sensation from which it borrows vitality. However, I often refer to the past as a spatialized time block that is recalled in the present to articulate the rules of algorithmic memory practices.

CHAPTER 2: NOSTALGIA AND THE TEMPORAL ARCHITECTURES OF ALGORITHMIC MEDIA

As a Facebook account holder, I receive a summary of my memories every December from Facebook. The memories of 2018 on Facebook came again without exception. Along with the phrase, “Jeonghyun, let’s take a look back at the memories you made on Facebook in 2018,” a short video began with the opening of the cover of a book featuring my Facebook profile picture. With upbeat music and a different theme of moving images in the background, the video showed eleven photos of my trip to New York last Spring, followed by photos of my friend’s wedding day. The video wrapped up with the profile pictures of eight Facebook friends of mine, mentioning that “[s]ome times, looking back helps us remember what matters most.” As Facebook planned, the video made me look back some of the events I had in 2018. The photos of these two events in which my Facebook friends had tagged me were not enough to summarize a whole year, but each image did remind me of the moment, the place, and the people in the photo.

On the day after, interestingly, my phone displayed a notification from the Google Photos application, saying that “the photo book of 2018 is ready.” When I opened the application, they allowed me to edit the sample book composed of 59 photos from my Google Photos album. Since the application has access to all photos on my mobile phone, the year 2018 in Google Photos had more content than Facebook’s summary. The album chronologically organized 59 photos from the beginning of the year to the end of the year. Unlike Facebook’s summary, which was focused on photos in which I appeared, the Google Photos album included more topics and objects. Their selection had friends, family, scenes, and objects, such as my home on the first snow day, buildings I photographed in Washington, D.C., my friend on her wedding day, my parents on a family trip, and flowers on my patio. In addition to the photo book of 2018, the application offered several features such as album, movie, and collage based mostly on time and place of photos.

Most selections of Google Photos were similar to the selection of the Memories feature in Apple iPhone photos album, which also provides several collections of photos categorized by a certain space, time, and people. The timing of sending notification is less predictable than other two applications. For example, I recevied notification—that I "have a new memory" of 2018 on February 8, 2019. As did other applications, the notification led me to open "best" images in my photo albums, which include the first snow day, my trip to New York and Washington, D.C., my friend's wedding day, graduation day, and the family trip. Most of photos were overlapped with the selection of Google Photos, except the fact that Apple Memories showed more photos of food. Also, Google Photos included only one or two photos for one event—the event happened in the same place, in the close time period, or with the same people; but Apple Memories offered at least four or five photos for one event with options for me to choose images to create video. The video can be created in "short," "medium," or "long" version with nine options of background music—Dreamy, Sentimental, Gentle, Chill, Happy, Uplifting, Epic, Club, and Extreme.

Reviewing these three services—Facebook's Year in Review, Google Photos's assistant, and Apple iPhone's Memories—takes me back to times already past. The notification, "your memories are ready" breaks in the present unexpectedly and leads me to remember the joyful moments of the past, such as summer travel with family and friend's wedding day, without any personal motivations. Even if the choice of each service is slightly different, all three services portray the year 2018 as joyful and romantic enough to make me recall and wish to go back. In addition to the photograph's own capability to evoke memories, the algorithmic operations of organizing and reanimating photographs become the new mode of what Marita Sturken has called "technologies of memory," which constantly produce and mediate memory practices (Sturken, 2008, p. 75). Moreover, these algorithmic operations aim to evoke "positive" memories only, encouraging a longing for the past. Their algorithmic operations not only mediate the past time but also automation the production of nostalgia for the algorithmically created past.

As a first step to conceptualizing the socio-technical phenomenon that I call the automation of nostalgia, this chapter provides media archaeological analysis of Facebook platforms, examining how new technologies of memory *produce* nostalgia from already stored traces of the past. More specifically, I demonstrate the construction of nostalgia in digital storage and algorithmic processing, focusing on a history of major interfaces on Facebook, which is an early developer of the nostalgia algorithms.

The following section first articulates the temporal architectures of digital storage that store and juxtapose discrete time to create the new temporal experiences in Facebook. Next, I explore the algorithmic processing integrated into digital storage to show how these new services of algorithmic operations turn the stored time to new digital objects that induce nostalgia. The understanding of nostalgia in the section builds on scholarly discussions of time, memory, and nostalgia, which defines a desire to return to the spatialized, idealized version of past that is (re)constructed in the present. At the end of this chapter, I argue that the new socio-technical logics shaping memory practices induce nostalgia out of technically processed "memory," through the process of spatializing time and standardizing the temporal experiences.

Digital Storage and the Architectures of Temporality

While time has been the major focus of inquiry in philosophy over the last few decades, many different scholarly discussions have shown how our experiences of time are linked to our experiences of media technologies (Barker, 2012; Bergson, 1911; Carey, 2008; Crary, 1992; Deleuze, 1989; Ernst, 2013; Galison, 1994; Gunning, 2014; Hansen, 2004; Kittler, 1999; Lazzarato, 2007). Specifically, Stiegler (1998) argues that human experiences of time inherently rely on networks of technologies and techniques. Media technologies that mark or produce time—from clocks, calendars, schedules to photography, phonograph, film, and social media—contribute to shaping perceptions of time as they enter relationships with human bodies that are negotiating their temporal experiences. As Siegert states, "time as such does not exist independently of cultural techniques of time measurement" (Siegert, 2015, p. 57). In addition to time measurement, media hold specific temporal architectures that shape our relationships with time, which affect our understanding of memory. This section explores Facebook's development of new temporal architectures, as technical *a priori* of our memory practices, in the history of temporal media.

According to Henry Bergson, reality is a movement that continuously changes and indivisibly flows. In our visual perceptions, external objects are seemingly motionless, but, in fact, they are always changing (Bergson, 1911; Bergson, 1913). For Bergson, what a human perceives is an image or a snapshot view of the constant transition in the flux of perpetual becoming. In the Bergsonian ontology, time has no divisible moments, such as past, present, and future. Our perception of a present implies "both a perception of the immediate past and a determination of the immediate future" (Bergson, 1913, p. 81). In *duration* as the continuous flux of becoming, our perception of the present is always already the past and immediately the progress toward the future. In order to make sense of the reality in becoming, our perception measures, analyzes, and spatializes the world and time as a method of knowing the world, but every analysis of giving a form to matter is merely a fragmentation of the indivisible continuity, except the means through “intuition” of pure perception (Bergson, 1911, p. 339).

For Bergson, time is hardly measurable or perceivable with human senses. Technological engagements of media have manifested or contested this Bergsonian time in duration by capturing the instantaneity of the duration or replaying the succession of instants. In order to capture continuously flowing time without blurring, photography has evolved control over the length of exposure. By manipulating the human perceptual threshold to identify motion (one tenth of a second), nineteenth-century photography was fundamentally engaged in capturing the flow of time (Canales, 2010). Photography controls the exposure time beyond (or beneath) the human perceptual threshold and thus produces the instant, “slicing into the continual flow of time” (Gunning, 2014, p. 44). Some photographers have explored the possibility of capturing finer slices of time that show durational flows. Étienne-Jules Marey’s chronophotography, for example, utilizes a wide range of technologies from graphics technologies to inscription camera to bring us a domain of duration that humans cannot perceive, instead of reproducing human parameters of vision in the photographs (Braun, 1994).

After early photography learned to capture a snapshot of duration, the scientific and technological practices of the nineteenth century became devoted to developing new ways of perceiving time. Animation and cinematography synthesize still images beyond (or below) the human perceptual threshold to create a succession of discontinuous instants, which is, in fact, the illuson of motion and imaginary continuity. Bergson (1911) and Deleuze (1989) point out that the cinematographic method is a great metaphor showing how human perception understands the durational flow of reality: like the cinematographic method, the human perceives the world by taking snapshots of the ever-changing world and synthesizing them to perceive motion.

Likewise, nineteenth-century media technologies allowed us to experience or perceive time by capturing snapshots of duration and regenerating the sequence of instants. Even though these media operations are merely the fragmentations of the duration for Bergson, these technological engagements that capture and synthesize instants allow humans to experience time beyond human perceptual capacities. These photographic and cinematographic methods are still fundamental to the contemporary media that create our temporal experiences. The (digital) camera is pervasive and allows us to experience captured and synthesized temporal flows. However, photographic and cinematographic methods are no longer primarily tools to perceive the uniform *time* of duration; instead they become cultural techniques of creating *temporalities* that mediate and produce individual and collective memories.

Sharma (2014) distinguishes temporalities from time. She argues that, unlike a transcendent sense of time, temporalities “must be reset again and again” by the temporal subjects who experience particular socio-technical arrangements, environments, practices, and spaces that produce time (p. 8). Temporal subjects continuously recalibrate their own temporalities in order to synchronize them to the larger temporal order or system, such as the temporality of global capitalism. Contemporary photographic and cinematographic media are not only the technologies for creating time but also the cultural techniques of negotiating one’s temporalities. Unlike the use of photographic and cinematographic methods in nineteenth-century, which allowed us to perceive time, taking photos and videos today becomes a cultural technique to recalibrate one’s sense of the past, present, and future.

Specifically, the camera integrated into mobile devices allows us to take millions of photographic and cinematographic traces in daily life that can be reviewed later. According to Mary Meeker's 2016 annual Internet trends report, in 2015, worldwide users upload about 3.2 billion digital images to social media every single day. The 3.2 billion number only indicates photos uploaded online, excluding ones stored in individual digital archives. Even if not all photographs uploaded serve mnemonic functions, Meeker's report shows that a growing number of people capture moments in their daily life and leave it as digital photographs in their mobile devices, individual computers, or social media. Leaving photographic and video traces become the socio-technical norms to remember special events and everyday life. In that sense, contemporary photographic and cinematographic techniques have been popular topics for scholars who study the cultural practices of remembering (Good, 2013; Gye, 2007; Hand, 2016; Hirsch, 2012; Sturken, 1997).

In this proliferation of cultural techniques of photographic and cinematographic remembering, Facebook has developed new techniques of temporalization through its digital storage and algorithmic processing. First, Facebook develops almost unlimited digital storage space so that millions of photographic traces are archived and reactivated. To maintain the "social network" between millions of users, Facebook has created multiple mechanisms of storage, such as a pitchfork, f4, TAO, and Hadoop, for storing and organizing data on their servers (Bollmer, 2016a). As of 2010, Facebook had stored over 260 billion images, which is about 20 petabytes of data. Facebook users upload about 60 terabytes (one billion new photos) each week, and Facebook servers deliver over one million images per second at peak time (Beaver, Kumar, Li, Sobel, & Vajgel, 2010). By February 2014, the number of photos Facebook stored had increased to over 400 billion (Muralidhar et al., 2014). Developing decent servers with larger storage capacity has been a major challenge for Facebook, and the need for massive data centers has become common to other media companies such as Apple and Google. Google operates massive data centers in North America, South America, Asia, and Europe in order to provide their services (Google Cloud, 2018). This massive digital storage capacity is required to distribute data across many computers in different locations, replicate the data over multiple systems, and automatically back up critical data in case of system failure (Google Cloud, 2018).

These new technologies with storage capacity record and store the time of past so that it can be re-viewed later. As Kittler (1999) points out, the storage capacity of media makes it possible to reverse the time-axis, dragging stored time into a new temporality. Kittler states that when phonograph becomes able to store sounds of contingent time-serial events and reprocess the stored time by playing back, speeding up, or slowing down, time does not always flow linearly; the time-axis can be reversed and manipulated by media technologies. The phonograph intervenes in the flow of time and stores a slice of the flow as sound to be played back in a different time. In addition to the capacity to capture instants, the storage function of the phonograph creates new conditions of memory by allowing us to negotiate multiple temporalities between the time it is stored and the time it is played.

The massive digital storage capacity of Facebook allows us to experience the "time-axis reversal" by reviewing digital photographs as stored instants (Kittler, 1999, p. 35). Some media scholars argue that "storage" is only a metaphor in digital media, which, in fact, transmit and (re)generate information with every event of user contact (Chun, 2011; Ernst, 2013), however, the technological capacity to reverse the time-axis is still valid for digital media systems. The millions of instants captured and synthesized by digital photographic and cinematographic methods can be retrieved in different moments, and the sense of the past is experienced in the retrieval.

In addition to digital storage, Facebook has become the platform through which the millions of photos and videos are not only individually reviewed but also collectively shared. Building on their infrastructure of digital data storage, Facebook has developed new temporal interfaces that encourage each user to curate their photographic and cinematographic traces. Facebook introduced the new feature Timeline worldwide in 2012. Combining the original features of Profile and Wall Pages, Timeline is a single space that puts all the posts on Facebook with the profile picture and personal information of each user. Timeline reverse-chronologically displays all the posts belonging to a particular user, allowing it to be read as one's life story from the most recent day to the day each user was born.

Before Timeline, Facebook highlighted the networking between users. The original design of Facebook in 2006 emphasized the Profile page, which showed each user's personal information, such as job, education, current residence, and hometown, to clarify one's identity to Facebook friends and manage one's activities on Facebook (see *Figure 2.1*). If the Profile highlighted the networking between Facebook friends, Timeline provides a single space for individual archival practices. On Timeline, each user can curate and collect images, stories, and information about themselves (see *Figure 2.2*). In addition to reviewing a collection of friends' activities in News Feed, Timeline allows users to review a chronology of what one has posted on Facebook. Based on timestamps marked in each post (date, month, year, hour, minute, and second information of the post), Timeline displays all the posts in reverse-chronological order of calendar and clock.

Figure 2.1: Early design of Facebook Profile (Lessin, 2011)

Figure 2.2: Facebook Timeline (McDonald, 2011)

While one's post on the Wall page used to be ephemeral or unorganized in the previous design, Timeline reorganizes the discrete temporalities by juxtaposing separate posts in a single space. As Rushkoff (2014) describes "the now" of the digital social media, the Wall page and News Feed emphasize the eternal *now* through their temporal architectures, which display what is happening right now. However, Timeline's temporal architectures produce temporal experiences of past. Users, as temporal subjects, recalibrate a sense of past by curating their life histories and reviewing them on Timeline. Snapshots of temporal flow are stored, reorganized, and reactivated in Facebook's temporal architectures that continuously bringing the time of past to the present. The photographic, cinematographic, and archival function are woven into Facebook's platforms, creating the new temporal experiences that become the *a priori* of memory practices. Users habitually capture, curate, and review their temporal experiences to manage Timeline and synchronize their temporalities to the time of Facebook, which is the permanent and archived past.

A few years after launching Timeline, Facebook introduced new temporal applications, On This Day and Year in Review, that made reviewing the archived past no longer necessarily a user task. Facebook integrated algorithmic operations into their temporal architectures, which automate the temporal experiences of re-viewing one's past posts or remembering the inscribed past.

In the next section, I demonstrate the ways in which two of these new algorithmic applications, Facebook's On This Day and Year in Review, reset users' temporality once again by turning the stored snapshots of time into nostalgia.

Algorithmic Processing: Standardization and Nostalgia

Memory does not equal storage. Memory is not a static space but an active process of enduring and reconstructing traces in time. Memory always requires practices of holding traces, practices of recollecting or remembering, to keep it from fading. Also, memory does not equal time. Memory is an active practice of commemoration happening in time. In Bergsonian time, in which the present always has one foot in the past and another in the future, what we recall is a result of continuous recreation and regeneration in the present that is always moving into both the past and the future. Instead of deriving memories from a reservoir of pure memory, subject, in the present, *re*constructs memory each time they recall (Bergson, 1913). Memory comes from temporal experiences of time produced in the contemporary environments. Thus, memory practices are not exclusively cognitive processes. As Bergson (1913) argues, memory is a living subject's response to the external stimuli in the contemporary environments. The present subject responds to the external stimuli that evoke and filter past sensations to recall. In this Bergsonian understanding, memory does not equal time nor storage. Unlike storage as a static space, memory is continuously reconstructed by the present subjects in socio-technical environments of temporal flow.

In these tensions between time, storage, and memory, algorithmic media have evolved to suggest memories or manipulate memory by integrating algorithmic operations into the temporal architectures through which they capture, store, and organize snapshots of time. After Timeline, Facebook introduced Year in Review in 2012—a feature that seemingly produced memory rather than time. Facebook first assembled a series of trend lists, including top events, the most popular public figures, the most listened songs among the billion people around the world on who were Facebook. Facebook measures how many Facebook posts in the year mentioned a specific topic, including the term itself and related hashtags, and then ranked those topics "based on the overall number of mentions" ("2013 Year in Review | Facebook Newsroom," 2013).

Through the same measurement techniques, Facebook also introduced the personalized Year in Review to each user. The personalized Year in Review provided the 20 biggest moments from each user's year, including the most liked posts, life events posted in Facebook, the birthday messages from friends, the Facebook pages the user liked, and the number of Facebook friends the user made during the year. In the next year, Facebook revised Year in Review to show an image montage of popular posts and life events shared on Facebook. They also gave the option to review highlights and popular posts by friends (see *Figure 2.3*).

Starting from Year in Review, Facebook has increasingly been interested in becoming a mnemonic medium. In March 2015, Facebook launched On This Day, which shows content from this date in past years. Jonathan Gheller, the product manager of On This Day, described the new service as "a new way to look back at things you have shared and posts [you have] been tagged in on Facebook" to make the new practices of "look[ing] back at old photos and other memories" easier (Gheller, 2015). Users can edit, delete, and share old posts as well as choose to subscribe to the notifications of On This Day. This application was similar to the function of mobile application introduced in 2011, Timehop, which accessed to users' social media accounts and smartphone photo album to show their posts and photos on the same day of the past year with a banner telling users how many years ago the posts and photos were taken.

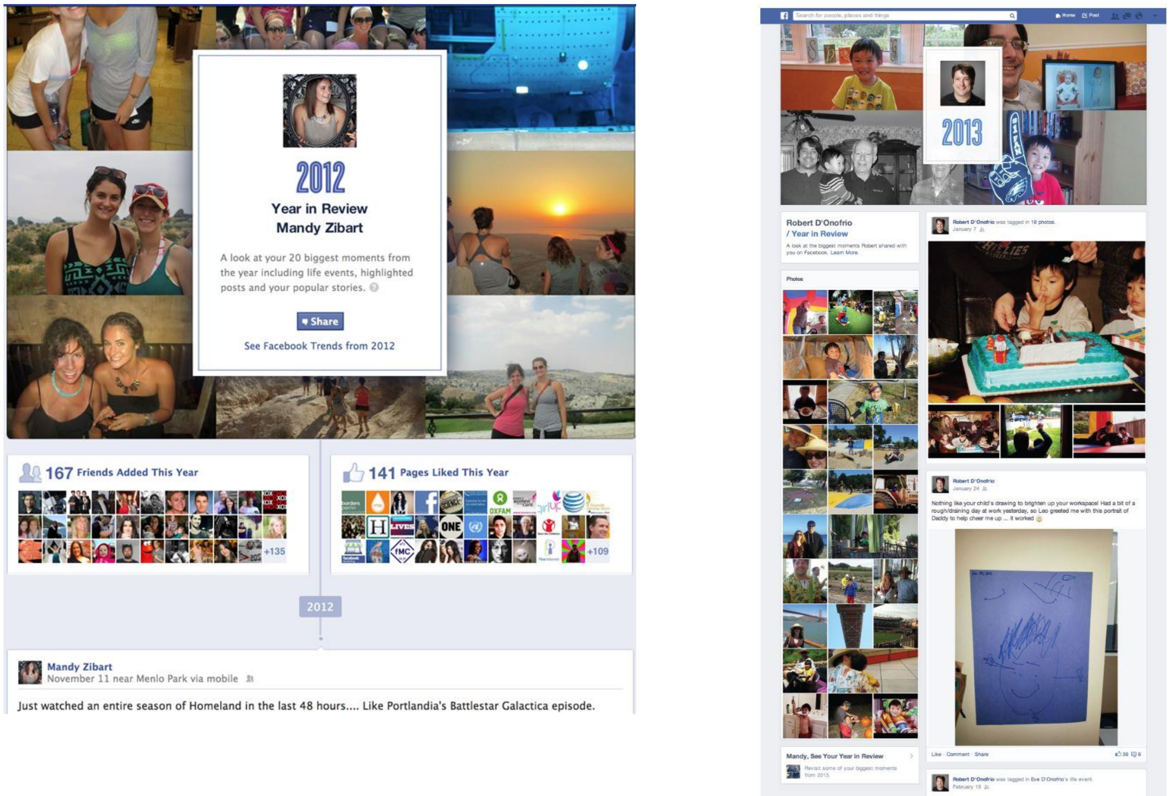

Figure 2.3: Facebook Year in Review Design 2012 (left) and 2013 (right)
("2013 Year in Review | Facebook Newsroom," 2013,
"Facebook Year in Review 2012 | Facebook Newsroom," 2012)

Through these past-oriented services, reviewing the archived past is no longer necessarily a user task. The archived past comes to users and evokes memory practices without having to make an effort to review one's post archived in social media or mobile devices. The purpose of Timehop according to the developers, is to become the application of digital memories and past connection, reinventing "reminiscing for the digital era." By curating the already archived past, Timehop aims to "build new ways of consuming, storytelling with and finding meaning in our digital histories" (Timehop, 2018). Similarly, Facebook describes On This Day as a feature that makes looking back at "memories" easier, notifying users "when [they] have memories to look back on" (Gheller, 2015). Later, Facebook also referred to these applications as memory products that “fill a need by helping people re-experience their posts without having to manually sift through their Timeline” (Konrad, 2017). As described by these social media providers, the new algorithmic services engage in the way we review the past to create and suggest “memories” in the prescribed temporal rhythms of remembering.

Halbwachs (1992) argues that memories are not only stored internally but “they are recalled to me externally” (p. 38). Additionally, Nora (1989) mentions that memory is not a spontaneous nor natural practice but requires our practices of creating traces, storing them, and engaging with them, such as creating archives, maintaining anniversaries, organizing celebrations, and pronouncing eulogies (p. 12). When memory is not a solely psychological or cognitive process but acquired, recalled, constructed, and recognized by our efforts of creating traces and reengaging with them, algorithmic processing automates our engagements with the traces of the past and recalls the algorithmically filtered and synthesized “memories” to us.

The algorithms of On This Day and Year in Review determine what types of past moments archived in the Facebook Timeline should be reviewed, by measuring, selecting, synthesizing, and recirculating snapshots of time stored in Timeline. Facebook is no longer the static storage of time and one’s digital history but becomes a digital archive in motion that actively engages us in the process of remembering. The stored past chronologically displayed in Timeline is recirculated to the present subjects. If Facebook’s Timeline embodies the photographic, cinematographic, and archival architectures that capture and store time to become the media *a priori* of remembering, the algorithmic processing of On This Day and Year in Review is devoted to sorting the stored time and creating a memory itself.

More importantly, the “memory” created by algorithmic processing reanimates one’s past, evoking nostalgia. The concept of nostalgia has primarily been understood in terms of affective connections to the past. The dictionary definition of nostalgia has shifted in the 1970s from a medical term of homesickness to a sentimental and obsessive yearning for the past (Becker, 2018, p. 237). The concept is originated from Greek roots, Nostos (returning home) and Algos (pain, grief, or suffering) to refer to pathological symptoms of the Swiss Army fighting abroad (Hofer, 1934). The original term has described a general sense of loss and mourning for the unattainable past because the return to the object of longing and the past is impossible (May, 2017, p. 404). However, the recent conceptualization of nostalgia includes the pleasurable contemplation of the past. Dickinson and Erben (2006) argue that the modern sense of nostalgia emphasizes more "the feature of concentrated pleasurable contemplation" than recalling "an ache of longing" (p. 1).

Whether a sense of loss or of pleasure, the concept of nostalgia highlights a desire to return to a specific time. As previously discussed, Bergson sees reality as a movement that continuously changes, and our measurement of time only produces a fragmented understanding of time that constantly flows without divisible moments, such as past, present, and future. In Bergsonian reality of the durational flow, the past is not a discrete entity from the present but rather a potentiality in the durational flow, a potentiality that might be powerless but also "might act and will act by inserting itself into a present sensation from which it borrows the vitality" (Bergson, 1911, p. 240). Unlike the Bergsonian idea of the past as a potentiality in the durational flow, nostalgia spatializes time and the wish to revisit the time of past as if it were a place. In *The Past is A Foreign Country* (1985), Lowenthal argues that, in nostalgia, the past becomes "foreign," which separates past from present and future and creates the sense of distance or foreignness of the past. Wilson (2005) argues that, unlike memory, nostalgia comes from separating past from present and comparing two distinct entities, which inspires a desire to return. Despite the irreversibility of the past, nostalgia takes “time out of time” and grasps “the fleeting present” (Boym, 2007, p. 14).

Additionally, nostalgia relies on the reconstructed or fantasized past. Boym (2001) defines nostalgia as a longing for the home that “no longer exists or has never existed,” implying both a sentiment of loss and a romance with one’s fantasy (p. 7). Fantasy plays an important role in differentiating nostalgia from memory. When Coontz (2016) analyzes nostalgic ideology in American television shows, she argues that the television shows depict the 1950s as the era of an ideal family structure to reaffirm the ideological images of the family. For Coontz, the nostalgic wish to return to 1950s family values builds on utopian and ideal images of a past that never existed in reality (Coontz, 2016, p. 35). Similarly, in his analysis of post-communist cities, Svetlana Boym (2007) argues that the actual past tends to be forgotten once one is possessed by nostalgia. The idealized version of mediated past replaces the way it happened in the past. The nostalgic past exists only in narrative, imagination, and fantasy. The images and narratives of the past that nostalgia evokes are not necessarily authentic, but ideological and utopian. The nostalgia creates the longing for the imagined and idealized past, which is constructed by memory and desire, not by experience (Hutcheon, 2002; Jameson, 1991; Stewart, 1993).

In case of Facebook’s On This Day and Year in Review, the idealized past is constructed by algorithmic processing of Facebook’s fantasy: to describe the archived past as joyful and emphasize users’ positive relationships with their services. The revised version of Year in Review introduced in 2014 shows the slideshow of each user’s most-liked photos organized in chronological order. The slideshow came along with the default tagline, “It’s been a great year! Thanks for being a part of it.” This tagline then leads to the cover image selected by Facebook algorithms, which is the one particularly well-engaged photo based on the number of likes and comments the photo has received, with the tagline of "Here's what your year looked like."

The Facebook algorithms thus select the user's memorable moments by quantifying attention. The system measures the number of "like" and comments the post has received from the user's friends and identifies the best moments of the year based on the quantified result. However, this quantification was not able to recognize qualitative differences, and, as a result, not-so-delightful memories often show up for certain users. Despite the Facebook's assumption that every user had a "great year," the algorithmically produced Year in Review forced some users to remember unwelcome memories or traumatic events. For example, Eric Meyer's story has been popular. Facebook's algorithms created Eric's Year in Review with his six-year-old daughter's face on the cover with an upbeat background, asking if Eric wanted to edit or share this Year in Review in public. Unfortunately, Eric had lost his daughter to brain cancer during that year, and the memories of the year were not sharable in public. Eric wrote in his blog that this automatically created video could seen as the "inadvertent algorithmic cruelty," even though it was not a deliberate assault ("Inadvertent Algorithmic Cruelty," 2014).

Other users reported similar unpleasant memories provoked by Facebook, such as a dead father's ashes, a dead dog, and one user's apartment on fire (Hern, 2014). Following Eric's post, the product manager of Facebook's Year in Review, Jonathan Gheller, apologized to Eric and promised to improve the service by taking Eric's concerns into account (Peterson, 2014). Eric's episode and other similar cases triggered a significant change in the algorithm Facebook used to decide which picture they should include and exclude. After the several complaints from users, including Eric's case, Facebook added new algorithmic layers to filter out "undelightful" memories.

According to Facebook Research in 2017, Facebook developed a more "sophisticated algorithm" to identify which memories are "good" and "bad." Facebook said that their role "should be in reminiscence" of "fun, interesting, and important life moments" (Konrad, 2017). In order to figure out the fun, interesting, and important memories, the new algorithm first sorts out someone who is blocked, dead, or has a memorialized account on Facebook to avoid reminding users of possibly painful memories or relationships. After filtering out those who may have an unpleasant history with the user, the algorithm measures and calculates all the actions given by users, such as liking, commenting, commemorating, and (un)friending. In addition to this quantified measurement, Facebook adds a new layer that may include qualitative values in it. The new algorithm prioritizes posts that include or indicate the "positive" words such as miss, face, graduation, wedding, and love, and important people, such as family; meanwhile, it filters out posts having "negative" words or less important words, such as food-related words. Then, using these criteria, Facebook categorizes users' posts using the framework of "Taxonomy of Memory Themes" to inform their ranking algorithms that select which memories to recirculate (see *Figure 2.4*). Lastly, Facebook provides options to customize what will appear in the video by allowing users to choose preferred people and timespans (see *Figure 2.5*). In this way, Facebook believes that users have been given control of their memories on Facebook.

In line with the goal of shaping positive relationships with Facebook, the algorithms calculate, categorize, and speculate on one's sense of the past to filter out items that are contrary to their desire for positivity. As West (2000) argues, memories "do not automatically produce nostalgia; they need a narrative to create an emotional connection between the viewer and the subject" (p. 175). The algorithmic synthesis of a selected past dramatizes and idealizes one's archived past. In this fantasized past, the past is seen as a place that users may wish to revisit.

The algorithmically organized past turns the stored time in the Facebook Timeline into "memory" to invoke nostalgia in us. The past recalled by Facebook to us is not necessarily authentic but ideologically utopian with the organization of the selected posts, upbeat music, captions, and bright background images. Our sense of the past become standardized by the algorithmic frameworks that undergird for the Facebook applications.

Figure 2.4: Facebook Taxonomy of Memory Themes (Konrad, 2017)

Figure 2.5: Memories preferences (Konrad, 2017)

The product manager of Facebook Memories, Oren Hod (2018), has stated that Facebook has “learned that there are many *different types of memories* and moments that people enjoy revisiting and celebrating” and has developed the application to “relive *meaningful memories*” (emphasis added). In Facebook’s effort to create sophisticated algorithms that can recognize “meaningful memories,” the past is reconstructed by algorithmic processing based on Facebook’s aim to evoke or create user desire to look back. Only particular articulations of the past that bring joy are algorithmically selected and organized to to be relived. In this algorithmic curation, the past becomes idealized to be joyful. Unlike the cinematographic synthesis of the discrete images in the nineteenth-century that created illusions of motion, algorithmic media like Facebook produce a fantasy of the past as nostalgia.

Conclusion

Facebook’s memory-oriented services have consistently triggered particular types of memory practices by recirculating the past as shared on Facebook in standardized rhythms and forms. A passage of time is experienced by one’s engagement with the temporal architectures of the algorithmic media, an engagment which generates a temporal sense of past and present. The past is not only just digitally stored but also reanimated by algorithmic processing. Specifically, the Facebook Year in Review has develped sophisticated procedures for selecting the pleasurable and joyful memories. In the process, each user’s past is reconstructed or reorganized by Facebook’s corporate desire and fantasy for positive user experiences. Algorithmic processing dramatizes the past through the curation of photos, music, backgrounds, and captions. The utopian images of the past created by the algorithmic selection, speculation, and quantification attempt to invoke nostalgia for an irreversible but "delightful" past.

By measuring all the actions taken by users, Facebook has devoted itself to providing individualized services. These memory products follow the same desire. The algorithmic processing of one's Facebook data categorizes the archived past and personalizes one's longing for the past. Previous scholarly discussion of nostalgia has tended to focus on social memory and the formation of the collective, national, and generational sense of longing, which are constructed by a collective sense of loss and longing for the same historical period (Bach, 2002; Berdahl, 1999; A. Hui, 2011; Hutcheon, 2002; Stewart, 1993). The algorithmic processing of the past introduced by twenty-first-centruy media evokes individualized experiences of nostalgia without the shared sense of loss or temporal experience.

These sophisticated algorithms that identify salient "memories" in photos become the socio-technical logics that actively engage and intervene in our memory practices. In June 2018, Facebook relocated their memory-related features to the inside a new tool called Memories, which is composed of four sections showing users' past posts and activities (Gheller, 2015; Hod, 2018). As the name indicates, the Memories application reflects on several moments in the past that have been shared on Facebook by expanding, revising, or adapting the previous memory-related services. In June 2018, Oren Hod, the Facebook product manager, announced the new Memories feature that creates the automatic notifications about the posts made on this day in the previous years (On This Day); the new Facebook friends made on the date (Friends Made On This Day and Friendversaries); and a seasonal, monthly, or yearly summary of users' past posts (Recaps of Memories); in addition to Year in Review (see *Figure 2.6*).

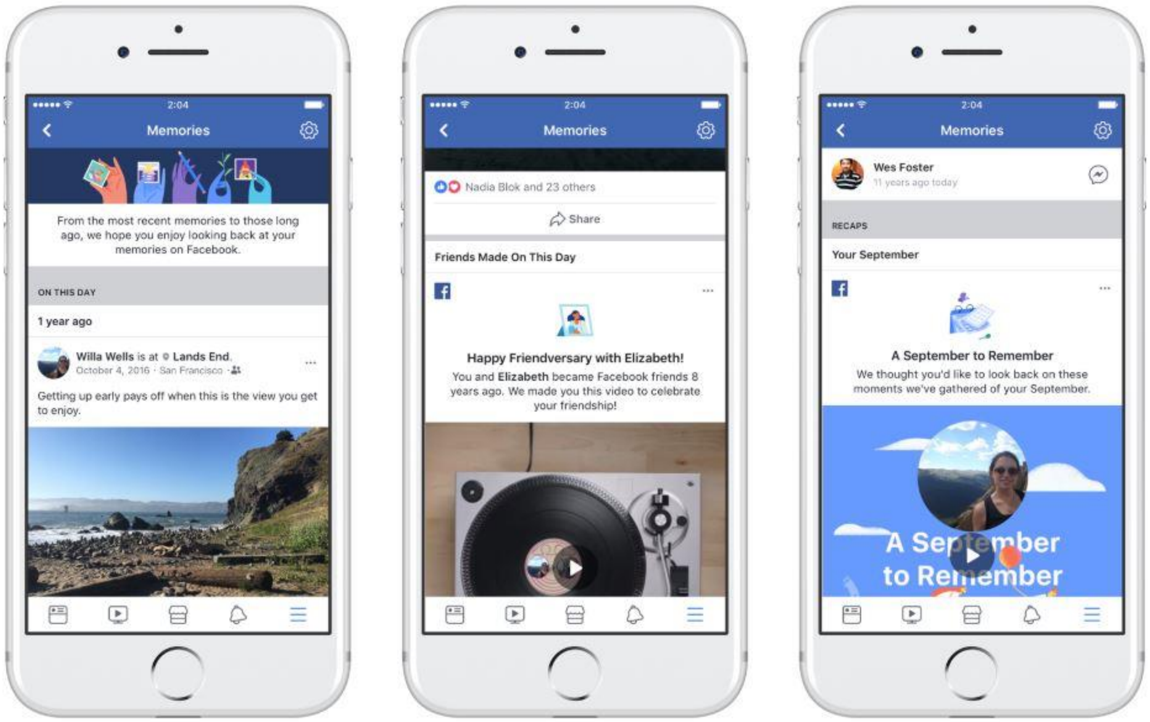

Figure 2.6: Facebook applications—On This Day (left), Friendversary (middle), Recaps of Memories (right) (Hod, 2018)

The two major memory products of Facebook discussed in this chapter, On This Day and Year in Review, have been imitated and improved upon by other social networking services and applications. Google introduced the new photo-storage service, Google Photos, in 2015. When the service was first launched, Google highlighted the free and unlimited storage capacity for 16-megapixel photo resolution and 1080-p video resolution. Later, Google Photos popularized by their Assistant feature that automatically analyzes stored photos to identify faces, geographic landmarks, special events, and other visual features, such as buildings, animals, and food. The algorithmic processing of the Google Photos Assistant curates millions of photos archived in their unlimited digital storage and displays algorithmically generated albums, videos, and montages of photos according to the subjects, people, time, and place information stored as metadata or algorithmically identified in the photos. Unlike “the algorithmic cruelty” of the early Facebook’s algorithms, Google’s memory suggestions have been much more sophisticated in selecting photos that invoke “positive” reactions.

Apple launched a similar algorithmic processing of memory in 2017. Starting with iOS 10, Apple photo album began to create nostalgic videos with algorithmically selected photos accompanied by effects, music, and cinematographic transitions. In a separate page, all photos are reorganized by time, space, and people. The Apple Memories feature also shows “featured photos,” which are several photos most reviewed by the user. In Apple’s recent update, the Memories feature also provides “sharing suggestions” by asking if the user wants to share the photos with people shown in the photos.

In Apple Memories and Google Photos, an entirely different mode of analysis emerges, which translate emotions presented in the photograph to the mathematical language, discussed in Chapter 3. The technological mode of memory practice requires techniques of automated visual interpretation. Without human additions of the textual analysis, the new algorithms treat the photographs as the visual document of human emotions, which they can mathematically model. In the 2010s, all three companies obsessively bought companies that were developing facial coding algorithms. Apple bought an artificial intelligence start-up company that reads emotions in faces, Emotient, in 2016. Earlier, in 2011, Google merged with PittPatt, a company that develops algorithms for recognizing faces in images and video, and Facebook acquired the Israeli facial recognition company Face.com in 2012 (Metz, 2016). All these facial coding companies develop machine learning for facial expression analysis in the photos and videos.

Apple, Google, and Facebook have applied the face-recognition algorithms to a wide range of services, including the archival curations for automating nostalgia.

With every update, these memory-related applications and services become more sophisticated and more accurate in recognizing information and emotion in photos. Similar approaches to identifying and constructing memories are found across the different platforms being developed by Facebook, Google, and Apple. If storage was the socio-technical obsession related to memory in the nineteenth century, the algorithmic memory practices are becoming the new socio-technical norm of remembering in twenty-first-century media.

The question becomes: How has this shift from storage media to algorithmic media shaped our understanding of memory? Even though this chapter focused primarily on Facebook's memory-related products such as Timeline, Year in Review, On This Day, and Memories as starting points of the discussion, the genealogical origins of automated nostalgia are much earlier. I suggest that the automation of nostalgia as a contemporary memory practice, is related to the cybernetic understanding of memory and communication. In the next chapter, as a genealogical effort to trace the emergence of these new cultural techniques, I review the science of cybernetics in the twentieth-century, specifically the cybernetic understanding of memory and communication. The next chapter will illuminate how the cybernetic conception of memory and communication has shaped the basic assumptions undergirding algorithmic memory practices in twenty-first-century media.

CHAPTER 3: AUTOMATION AND THE CYBERNETIC IMAGINATION

Technological engagements in memory practices have never been new. As Stiegler (1998) argues, human memory practices are inherently associated with technologies and techniques that exteriorize our memories. Starting with (or before) drawing and writing in ancient times, acts of remembering have been linked to various material aids or media. Historically, writing complements the limited capacity of human memory and becomes “an external and inferior technology of recollection” (Barnet, 2001, p. 218). Later, nineteenth- and twentieth- century electrical media provide new media *a priori* of remembering by mechanically capturing and storing acoustic and optical data outside of the human body, which become *a priori* of human memory practices.

Since the advent of electrical media, storage has been the most influential capacity of media for discussions of the role of media technologies in memory practices. When Thomas Edison invented the phonograph, he described it as a machine for “gathering up and retaining of sounds hitherto fugitive, and their [later] reproduction at will” (Edison, 1878, p. 528, cited in Gitelman, 2008, p. 25). Electrical media that have storage capacity are technical machines for remembering the past. A phonograph inscribes physical traces of the external world outside of a human body, etching acoustic vibrations onto a rotating cylinder covered with wax, tinfoil, or another inscription surface, regardless of “so-called meaning” (Kittler, 1999, p. 85). While the writing as a storage medium cannot avoid the filter of symbolic (language-based) selection and storage, the mechanical inscriptions of a phonograph store all sounds and noises that the human senses filter out, without regard to symbolic value. The stored sounds can then be replayed at a different time. Similarly, photography inscribes light, transducing optical signals into physical and chemical patterns that store and freeze time in the frame (Ernst, 2013, p. 48).

In the late nineteenth and early twenty-first century, many different forms of electronic storage media, such as memory sticks, hard drives, and the server farms that underly "cloud" computing, have shaped the everyday experience of computing, interactivity, and new media (Kirschenbaum, 2008). Moreover, contemporary mobile and wearable devices promise smaller size and larger storage capacity to capture more and store longer even with minimal human engagements.

While storage media are not new, electronic media both store and algorithmically process the data, creating the potential for new temporal experiences. In the automation of nostalgia, the nineteenth and early twentieth century interest in technologically recording an external world moves to a focus on processing and reanimating already recorded digital traces of memory. As the previous chapter showed, Facebook has become reflective and past-oriented by developing new services that recirculate already recorded traces to evoke nostalgia in us. Algorithmic memory practices of twenty-first century media are becoming pervasive in other social media sites and applications, such as Apple Memories and Google Photos, shaping the new socio-technical logics of remembering. The newness of contemporary memory practices relies on the capacity of media that algorithmically process stored data by identifying and analyzing our social media data.

This chapter offers a genealogical antecedent of the historical construction of algorithmic memory practices. I suggest that the origin of the new socio-technical culture, the automation of nostalgia, is much older than Facebook and Timehop's early attempts to recirculate the already recorded traces; it is rooted in the history of cybernetics. This chapter examines the deep and hidden legacy of cybernetics in the automation of nostalgia by investigating older phenomenological questions around "memory" in the science of cybernetics.

In what follows, I first review general theories of cybernetics, which pursue perfect communication between humans and machines. Building on the cybernetic understanding of communication, I then articulate the cybernetic understandings of memory, an understanding that has shaped the way contemporary algorithmic media conceptualize memory in their automatic operations of creating nostalgia. At the end of the chapter, I consider the legacy of cybernetics for the technical rules of automated nostalgia and the conceptions of memory circulated in it. This chapter aims to reveal the underlying rules shaping the automation of nostalgia and to illuminate how an algorithmic conception of memory has genealogical origins in the science of cybernetics.

Cybernetic Imaginations

The term "cybernetics" is rooted in the Greek verb *kybernan*, which means to steer, navigate, or govern (Rid, 2016, p. 3). The American mathematician Norbert Wiener (1965 [1948]) theorizes the term as the science of "control and communication in the animal and the machine," which emphasizes communication in/between both humans and machines to control future behaviors. With the explicit purpose of controlling and commanding the system, Wiener predicts a future in which machines in feedback loops autonomously learn, stabilize, and adapt in the same way that the human brain works in his understanding. A cybernetic system receives messages, performs the prescribed actions, and waits for feedback to adjust its next performance. In this repetitive circle of performances and feedbacks, which is communication for Wiener, the system can be governed and controlled. This system of feedback loops is Wiener's model of communication for all kinds of bodies, including living organisms and machines (Wiener, 1948; 1950).

Wiener believes that the study of communication is fundamental to understand society. However, his conception of communication is mathematically understood, which defines the message as “a form of pattern and organization” in both humans and machines (Wiener, 1988 [1950], p. 21). In his book, *The Human Use of Human Beings*, Wiener clarifies his idea of communication, stating:

> It is my thesis that the operation of the living individual and the operation of some of the newer communication machines are precisely parallel. Both of them have sensory receptors as one stage in their cycle of operation: that is, in both of them there exists a special apparatus for collecting information from the outer world at low energy levels, and for making it available in the operation of the individual or of the machine. In both cases, these external messages are not taken neat, but through the internal transforming powers of the apparatus, whether it be alive or dead. The information is then turned into a new form available for further stages of performance. In both the animal and the machine, this performance is made to be effective on the outer world. In both of them, their *performed* action on the outer world, and not merely their *intended* action, is reported back to the central regulatory apparatus (Wiener, 1988 [1950], p, 15, emphasis in original).

According to Wiener, communication emerges through “sensory receptors” of the external stimuli and “the internal transforming powers of the apparatus” to perform actions in response to the outer system. The "performed" action automatically feeds back to the original receptors and adjusts the original reaction for the next cycle. The message becomes a form of the patterns found in the repetitive performances.

Here, communication means the *transmission* of the message without considering the intended meanings of the sender. This understanding of communication is linked to Claude Shannon and Warren Weaver's mathematical theory of communication. Weaver and Shannon's (1963) model of communication emphasizes converting messages into signals and transmitting information from the sender to the receiver by minimizing noise in the process (see *Figure 3.1*). The transmission model of communication distinguishes information from meaning, paying direct attention to the maintenance of signal relays between two different points. The meaning, context, and interpretation, which were significant components of encoding/decoding-based communication model, become less important than "reproducing at one point either exactly or approximately a message selected at another point" (p. 34).

Focusing on this understanding of communication, Wiener dreams of a transmission system between humans and machines in the feedback loop—a communication systems in which signals of inputs and outputs are interchangeable between humans and machines. In this model of communication, in which patterns of signals matter more than the symbolic meanings, Wiener envisions the cybernetic system that humans and machines, or machines and machines can communicate with—transmit signals to—each other, if both sides have sensory receptors and the internal power of interpreting the received sensations in the feedback systems.

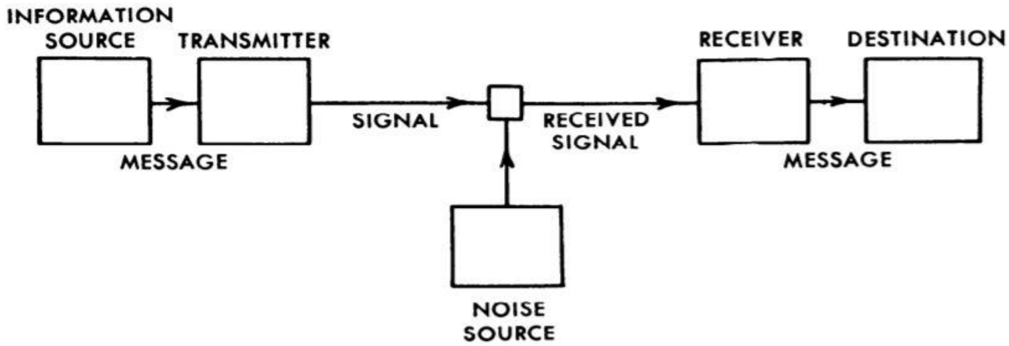

Figure 3.1: The mathematical model of Communication (Weaver & Shannon, 1963)

To achieve the ambitions, Wiener is committed to mathematically modeling human behaviors and developing automatic machines of prediction, self-referentiality, and communication that can interchanges signals with humans. During World War II, Wiener developed the "anti-aircraft predictor" to devise a better defense system that can fire a bomb to the near-future position of moving airplane, not to its current position (Galison, 1994). There are "two human elements which must be considered" to control the system, the one is the airplane pilot taking evasive action, and the other is the antiaircraft gunner following his target pilot to fire (Wiener, 1988, p. 251). Wiener believed that targeting and firing on an enemy would be more accurate if the gunner became an automatic machine that could predict the future positions of the enemy pilot and launch the bomb to the predicted positions. To achieve this communication between the human pilot and the machine gunner, Wiener considered both pilot and gunner parts of the same communication system, transmitting signals to each other in a cybernetic feedback loop.

Under the guidance of Warren Weaver, the director of the Applied Mathematics Panel at the Office of Scientific Research and Development, Weiner's team sets up experiments in war-like situations, which were designed to find the repetitive actions of pilots in flight, characterize the patterns of the movements, and anticipate the pilot's future position (Galison, 1994). During the experiments, the team documented the pilots' movements and mathematically modeled the massive data. Wiener's team discovered a remarkable repetition and redundancy in the movements, which became patterns that allowed them to predict the pilot's near-future actions. Wiener combined two human elements "as part of the semi-mechanical processes" of communication to predict, and ultimately control, the whole system (Wiener, 1988, p. 251). The core concern of cybernetics became the training of machines and humans to "communicate and anticipate the further signals" (Halpern, 2015, p. 44).

Even though the original idea of cybernetics arose in the context of Wiener's military service, Wiener's ambitions went beyond developing the defense system in the war; he wanted to apply his theory to all forms of human cognition and behavior. Wiener designed his model of prediction as a prototype of including "the vast array of human proprioceptive and electrophysiological feedback systems" (Galison, 1994, p. 229). In Wiener's (1988) view of the universe, the world is made up of patterns, which is characterized by "the order of the elements of which it is made, rather than by the intrinsic nature of these elements" (Wiener, 1988, p. 3). For Wiener, the human mind is made up of a specific arrangement, or pattern, which matters more than the physical matter and consciousness. Because Wiener emphasized the transmission of signals in communication, his interest in humans focused on the patterns of behavior that can be divorced from physical matter. The patterns emerge in repetitive behavior or "*performed* action," which is different from human consciousness or "*intended* action" (Wiener, 1988, p. 15, emphasis in original).

In this understanding of the enemy, of technology, and of the human, the science of cybernetics explores the control of the message that "effectively changes the behavior of the recipient." The ultimate goal was to develop communication facilities to transmit "message between man and machine, between machine and man, and between machine and machine" (Wiener, 1988, p. 8). Even though contemporary neuroscience rejects the technological metaphor of cybernetics projected onto the human brain and body (Bollmer, 2018), Wiener's theories of cybernetics have been influential in shaping the contemporary development of social, technological, and economic systems in Western culture. Many scholars claim that cybernetic theories and understandings of communication are still repeated in today's digital cultures (Bollmer, 2018; Dyer-Witheford, 2015; Halpern, 2015; Hayles, 1999).

My focus on the science of cybernetics is the way it defines the new conception of "memory" that is circulated in the rules of automated nostalgia. In the following sections, I trace the development of the concept of memory in cybernetics. I illuminate how the science of cybernetic conceptualizes memory, which has been influential in the conceptualizations of memory that inform the automation of nostalgia. While Wiener theorizes communication as the transmission of a message that changes and controls the behaviors of the recipient, the concept of memory is undertheorized in his work. In that, I reflect Wiener's ideas of memory across his writings on cybernetics. I specifically focus on Wiener's major argument that both human body and machine are information-processing and pattern-generating devices, articulating that cybernetic memory implies a technical synthesis of storage and recollection and a technical analysis of the inscribed behaviors.

The Technical Synthesis of Storage and Recollection

For Wiener, the human nervous system and automatic machines are fundamentally alike because both make decisions based on decisions they have made in the past. In Wiener's concept of cybernetic systems, the records of the past are essential to make decisions in the present and maintain the stability of the continuously animated communication system in feedback loops. His experiment of developing an anti-aircraft system also showed that recording is a necessary process for predicting future actions and governing the system. Recording all movements of pilots was the first step to finding the patterns and predicting future positions. Thus, recording is always connected to processing in cybernetic designs. The recorded information is continuously transmitted to perform and predict actions. The cybernetic repository of the information stores the information and facilitates the system's capacity to react and predict. Here, cybernetics understands memory in a technical way that includes the process of selecting, storing, and processing the information.

In *The Human Use of Human Beings*, Wiener argues that "sensory perceptors" and "the internal transforming powers" operate the living individual and machine of the cybernetic systems (Wiener, 1988, p. 15). A special sensory apparatus collects the information from the outer world, and the message is internally processed and turned into a new form for future actions that would be more effective in the outer world. In the dynamics between sensory perceptors and the internal transforming powers, our perception is not a representation of the outside but the negotiation of reception, recollection, and reaction. In Wiener's explanation of visual perception, for example, our visual perception comes from a series of stages that selects, transmits, and processes the flow of visual information, from the retina to the optic nerve. According to Wiener, our visual perception is an algorithmic process, which filters the visual information, outlines the external objects, and compares them with the information stored in memory to perceive and react (Wiener, 1948, p. 135). In this context, memory is connected to “the internal transforming powers” that store, process, and transform the information received by sensory perceptors.

Wiener suggests that “the uses of memory are highly various” (Wiener, 1965, p. 121). In *The Human Use of Human Beings*, Wiener (1988) explicitly mentions memory as combinations “of the data put in at the moment and of the records taken from the past stored data” (p. 11). Here, memory seems the site of storage, where the information is inscribed and preserved. In his overall theories of cybernetic systems, however, memory goes beyond the static site of storage. Wiener (1965) explains memory as a core function of both the human nervous systems and computing machines, which indicates “the ability to preserve the results of past operations *for use in the future*” (p. 121, emphasis added). In multiple uses of memory in the cybernetic systems, memory implies not only inscriptions and preservations of the records but also the processing the recorded information for future behaviors.

Wiener identifies this technical operation of memory in two separate layers in human brains: short-term memory and long-term memory. The short-term memory functions to carry out the current processes, which “should record quickly, be read quickly, and be erased quickly” (p. 121). The short-term memory temporarily stores the filtered sensation and quickly removes the information once the current process is completed. On the other hand, long-term memory is intended to be a part of the permanent record, which contributes to “the basis of all its future behavior” (p. 121).

Wiener duplicates this understanding of human brains to his ideas of the cybernetic machines. For Wiener, the perfect operation of both humans and machines means conducting a chain of operations without failing the stability of memory, where the information is inscribed, recorded, and processed. Without a short-term memory, information is only accumulated, and the excess of information in memory might negatively impact the statistical probability of prediction and the stability of the system. The system should not just accumulate all the message but rapidly erase and implant a new record. Thus, the ideal memory process should synthesize short-term and long-term memory, which would be an active process of managing, altering, and processing the stored information, rather than a static accumulation and representation. Based on this neuroscientific understanding of human brains, Wiener envisioned the machinic memory not as a static accumulation of information, but an active process of storing, adjusting, and processing the stored and incoming information for future actions. Here, memory is linked to the processual archive, rather than the storage of fixed data blocks.

This understanding of memory, which is both storage and processor, is clarified in Wiener's critiques of photography. For Wiener, the photograph is solely a storage medium that is only ideal for "the permanence and detail of its records" (Wiener, 1965, p. 123). Photography can inscribe, document, and record the information but it cannot store a process that can adjust stored elements or produce future actions. Cybernetic memory should respond, react, and adjust to the system, instead of merely repeating the stored information. In the cybernetic imagination, Wiener hopes that "the acts of recording, storing, and recalling may no longer be held separate" (Halpern, 2015, p. 71). Cybernetic memory should be both records of signals and the acts of recollection simultaneously.

The basic idea of cybernetic memory as both storage and recollection has been already suggested by Friedrich Kittler's (1990) analysis of the transition from the "discourse network 1800" to the "discourse network 1900." Kittler emphasizes that the transition explains the obsession with recording and reproducing the acoustic and optical data. In the “discourse network 1900” of various recording apparatus, such as phonograph and camera, according to Kittler, memory is determined by the network of recording media. Human senses are exteriorized and stored in media such as photographs and sound recordings, becoming technically operable memories. The memory, which belongs to the technical inscription, is transmitted and exchanged between other media. When memory belongs to the “discourse network 1900” of storage apparatus, memory is the technical operation of stored information for future transmission and operation, without considering human symbolic meanings.

This technical understanding of cybernetic memory has been analogous to the fundamental structure of computing technologies since the mid-1900s. John von Neumann, a member of the Macy Conferences[1] with Norbert Wiener, developed the “Von Neumann Architecture,” which became the prototype of the first stored-program computer, EDVAC, the predecessor of all modern computing machines (Gehl, 2011, p. 1230). The architecture stores data and programs in a memory core as well as processes and executes the stored data and programs with a processor (Von Neumann, 1993). The processor took over the mathematical task that human computing groups had performed in the 1700s and improved the speed and accuracy of processing. Processing was conditioned by the memory of the computer, which included short-term storage of equations and intermediate results and long-term storage of computer programs (Gehl, 2011, p. 1231). The synthesis of immediate and archival memory to

[1] The Macy conferences are a series of academic conferences that were held during and after the war in New York City. The Macy conferences are also known as series of research on cybernetics, initially titled “the Conference on Circular and Casual Behavior.” The conferences were sponsored by the Macy Foundation, which was an institution devoted to healthcare research with researchers in computing, wartime research, communication and systems theory, anthropology, neuroscience, mathematics, linguistics and psychology. The Macy conferences served as an important site to develop the postwar social science. The participants produced a research emphasizing on information and communication across fields and affirming interdisciplinary methodologies that can replace previous structural, historical, political economic approaches (Halpern, 2014).

process and execute future actions became known as the Random Access Memory (RAM) and the hard-drive storage system.

Likewise, the separation between transmission media and storage media, which was prominent in the nineteenth century, became obsolete after the computer revolution. In the technical synthesis of storage and processing, memory in the computing refers to storage and regeneration simultaneously. The stored information is continuously processed and came into being anew. Following the cybernetic imaginations, memory became the temporal matter of processing in the archive, instead of the spatial matter of recording data in storage. Ernst (2013) argues that the temporal understanding of processual memory updates the traditional understanding of "archive." In his theories of the digital archive, computer-memory is no longer read-only storage, but the successively generated archive. Unlike the nineteenth-century storage media that preserved time, the digital archive operates computer-memory without the intrinsic macro-temporal index. Even though what appears in the screen seems permanent, link locations of information always change in every regeneration of the information. The digital records are not stored but continuously regenerated by interventions of "enduring ephemeral—a battle of diligence between the passing and the repetitive" (Chun, 2011), which is seemingly analogous to the process of recollection in organic memory practices.

The technological understanding of memory in the contemporary technologies of computing builds on the cybernetic principles of memory programming. After cybernetics, memory is coupled with archival cybernetics that stores, process, analyze, and utilize memory toward the future, rather than the static storage of the past.

The Technical Analysis of Behaviors

Another clue to understanding the legacy of cybernetics or present-day conceptualizations of memory is related to Wiener's behaviorist perspectives. Wiener emphasized behaviors, more specifically the everchanging patterns of behaviors, which turn into information data to be transmitted and modified in the feedback systems.

In Wiener's design of cybernetic systems, the main goal of the processual memory is to creating a perfect feedback system to govern and control the communication system. The core idea of a feedback systems relies on the cybernetic analogy between humans and machines—that both can modify themselves on the basis of past experiences to act more effectively in the future and achieve specific anti-entropic[2] ends. The bodies in the cybernetic system continuously act by adjusting their behaviors in responses to the feedback. In this cycle of the feedback system, all behaviors are purposeful, aimed at achieving "a final condition in which the behaving object reaches a definite correlation in time or in space in respect to another object or event" (Rosenblueth, Wiener, & Bigelow, 1943, p. 15). Humans and machines are the systems of self-referentiality and communication that generate and modify their behaviors in response to the outer world. For Wiener (1988), the "present is unlike its past and its future unlike its present" through the continuous modification of behaviors in feedback systems (p. 48).

The modification of behaviors is observable and measurable because Wiener emphasizes the *patterns* of behavior. Wiener believes that the world is made up of patterns. For Wiener (1988), the human body is "not stuff that abides but patterns that perpetuate themselves," and the pattern is the message. That is the same as human-made machines. The physical identity of machines and living organisms is determined by the patterns, which are constituted by "the order

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[2] Entropy is a concept coming from thermodynamics, which means a quantitative measure of disorder. In cybernetic emphasis on a pattern, entropy is opposed to information, which contains an order of signals (Bollmer, 2018).

of elements of which it is made," rather than "by the intrinsic nature of these elements" (p. 3). In the feedback systems, what is transmitted and modified is the patterns of behaviors.

Reversely, the pattern is generated by something only in action and performance. The behavioristic perspective only focuses on the visible inputs and outputs that are performed. The cybernetic inquiry into bodies, including human and machine, relies on the behavioristic perspectives. Cyberneticians measure and analyze the actions and reactions to find the patterns. An internal intention and thought matter less, unless they are transmitted to others and become visible forms of actions that can be scientifically and technically observed and analyzed. In the development of the anti-aircraft gun, for example, engineers and mathematicians only focus on the behaviors of the gun(ner) and the (pilot of) plane—not their experiences, thoughts, or motivations. While the internal intentions are unseen, unverifiable, and opaque, the actions are measurable and predictable. Halpern (2014) explains that these perspectives of behaviorism make the world one of black-boxed entity "whose behaviors or signals [are] intelligible to each other, but whose internal function or structure [is] opaque, and not of interest" (p. 44). Focusing on transmitting signals between different bodies means that the way elements are arranged matter more than its intentions, meanings, and contexts. In the communication between the enemy pilot and the gunner, the mind of the pilot is unknown or not the interest of the cybernetic systems. What matters is always the actions and the patterns created by the successive performances.

As Bollmer (2018) argues, the cybernetic behaviorism can also be found in the Turing test, which is often cited as the precursor of Artificial Intelligence (AI). In his essay, *Computing Machinery and Intelligence*, the British computer scientist and mathematician Alan Turing, suggests the Turing test by asking "can machine think?" Turing proposes a game in which a human and a machine are hidden in a separate room from the human evaluator. When a human and a machine have a conversation through a text-only channel, the human evaluator should judge which one is a machine. In Turing's argument, if a machine can imitate the way humans "think" and generate "human-like" responses, the imaginable digital computers could do well in the imitation game (Turing, 2004).

Turing's idea of "think" is, in fact, generating the pattern of behaviors. The Turing test emphasizes a performative and behavioristic identity that can generate patterns, which can be imitated. In this game, the internal thought and the physical body matter less than the performed behavior. When communication is about the transmission of patterns, like Wiener's arguments, the smart machine can imitate the intelligence by performing the way the real human may act. Following the cybernetic emphasis on behavior, the Turing test gives us the possibility of communication between humans and machines "as if bodies [do] not matter" and patterns of behaviors matter (Peters, 2012, p. 236).

In this behavioristic understanding, both humans and machines are acting machines that generate and modify patterns. Identity and message are the behavioristic and informational patterns that can be observed and existed outside of the body. Moreover, the regular patterns of bodies can even be divorced from the physical body and transmitted to a different body. Wiener (1988) claims that "telegraph[ing] the pattern of a man from one place to another" is a matter of "technical difficulties" not of "any impossibility of the idea" (p. 110). These ideas lead the larger project that develops technics and technologies of measuring, extracting, and transmitting the patterns of bodies. The body becomes inessential and can be replaced by any prosthesis, such as a robot or machine.

This idea has been influential for science fiction film in Western culture. For example, the 1990 American film *Total Recall* depicts a company that can implant false memories into human brains to let people have memories without having direct experience. Also, the 2004 movie, *Eternal Sunshine of the Spotless Mind*, begins with a couple who have just extracted and erased their memories of each other after breaking up. More recently, the British television series *Black Mirror* (2016 - present) describes several dystopian images of the future when emerging technologies can intervene into human practices of remembering through the technological ability to record, implant, transfer, and manipulate everything people see, do, and hear. The cybernetic understanding of the body as a prosthesis, which is just one way of performing patterns, has shaped the scientific and cultural imaginations of memory.

In sum, the science of cybernetics examines the behaviors of bodies. The behaviors are not fixed "with respect to its surrounding" to achieve or maintain the purpose of the system (Rosenblueth et al., 1943, p. 18). The purpose cannot be deduced from one's internal intentions and properties but is "discernible only through analysis of that entity's ongoing relationships with other entities and its environments" (Behrenshausen, 2016, p. 94). For Wiener, humans and machines can learn and reproduce themselves. Through the automatic adjustments, they can modify their patterns of behaviors and improve their tactics of performances by experiences to act more effectively or purposefully. The modification of patterns matters most in the cybernetic systems, not the materiality of the body or its internal properties.

In this action-oriented understanding, cyberneticians only record and observe the actionable behaviors to find the patterns and, ultimately, adjust the behaviors. While memory is technologically understood in the cybernetic synthesis of storage and processing, memory is comprehended behaviorally here. With the technological processing of the stored data, memory means the past patterns of behaviors, which can be measured, analyzed, and then modified later. In cybernetics, the memorable means the observable patterns of behaviors that satisfy the purposes of the system. The sentimental connections or the internal meanings are inessential or worthless in cybernetic behaviorism. Both humans and machines are pattern-generating devices that continuously examine previous patterns of behavior recorded in the technical sense of memory and modify those patterns to create better outcomes. Memory becomes the source of future actions.

The Algorithmic Uses of Cybernetic Memories

The concepts of cybernetics emphasize analysis of the information-processing mechanisms that generate purposeful behaviors. In Wiener’s view of the subject, humans perform motor activities controlled by the internal information-processing mechanisms and feedback systems. Human brains, the core of the internal mechanisms, are viewed as complex communication and control systems that process and manipulate the transmitted information to maintain the stability of the systems, like an artificial control system.

Wiener’s structural analogy between human brains and automatic control systems has proliferated to theorize human behaviors and develop computing machines—the programmable electronic devices that process numbers and words to automate complex processes. Since the twentieth century, various input-output devices with different information-conversion mechanisms have been developed with the upgrading of processing speeds and memory capacities in every invention. Contemporary computing cultures reflect the cybernetic legacy, which highlights the information-processing and pattern-generating aspects of humans and machines.

This section has situated the algorithmic media of automating nostalgia within a genealogy of cybernetic imaginations. After cybernetics, memory becomes an interchangeable term between humans and machines, as if computing machines that simulate the way human brains remember. This conceptualization of memory is circulated in the way technologies for automated nostalgia generate and understand “memory.” In what follows, I demonstrate the algorithmic uses of a cybernetic approach to memory, focusing on the technical rules of Google Photos.

Cybernetic Archives

The cybernetic emphasis on processual memory shifts the discourse on memory in communication technologies. Unlike the separation between storage and transmission media in the nineteenth-century media, the new cybernetic archives synthesize storage and processing. The cybernetic archives of storage and processing process, execute, and modify the documented information to create new actions and associations to the outer world. If the nineteenth-century storage media are past-oriented media that store time, the cybernetic archives become future-oriented mechanisms that process memory to create new cycles of future behaviors. In the cybernetic archives, the acts of recording, storing, and recalling are synthesized by computational programming.

The application of cybernetic archives spread to algorithmic machines in contemporary cultures that simulate the neural organizational structures. In 2012, a group of Google scientists published a remarkable article *Building High-level Features Using Large Scale Unsupervised*

Learning, which is also known as a ‘cat paper.’ The Google research teams developed new approaches to large-scale machine learning that can distinguish objects in pictures. In the standard machine-learning approach, machines learn from “labeled data” (Dean, 2012). Humans have to collect tens of thousands of pictures that have already been labeled as the name of objects in the pictures to train the machine. Since the original approach takes much time, Google’s research on “self-taught learning” and “deep learning” suggests building artificial neural networks, an approach modeled on human brains’ neuronal learning processes[3], that might be able to detect unlabeled data. As early computing machines imitated the dual architecture of a short-term and long-term memory, the algorithmic machines simulate the way human brains learn the new information.

The Google research team developed a distributed computing infrastructure for training large-scale neural networks, then connected 16,000 computer processors of Google’s CPU cores in data centers (Dean, 2012). Their hypothesis, based on human neural networks, was that the machine networks, like human neural networks, “would learn to recognize common objects” in videos if they were exposed to YouTube videos for a week (Dean, 2012). The neural network was exposed to 10 million randomly selected video thumbnails that include a list of 20,000 distinct items over three days (see *Figure 3.2*). As they had hypothesized, the neural network were responsive to certain stimuli on the test set for the cat neuron and the human body neuron (see *Figure 3.3*) and taught itself to recognize cat faces and human bodies against random backgrounds and other detractors (see *Figure 3.4*). The results confirmed that the neural network

[3] In the neuroscientific understanding of human body, the nervous system, which consists of neurons, is an essential part of the human body. The neural network transmits signals to different parts of the body to control movement. In the human brain, there are around 100 trillion connections of neurons, which serve as a pathway for electrical signals to be transmitted between neurons. Human brains are large-scale networks that interconnect neural circuits made of neurons and synapses. The neural structure of human brains has inspired or motivated the design of artificial neural network (“Neurons & Synapses - Memory & the Brain - The Human Memory,” 2018).

learns not only the concept of faces but also the difference between cat faces and human faces without having been given the labeled images. The system showed 81.7 percent accuracy in detecting human faces, 76.7 percent accuracy in identifying the human body, and 74.8 percent accuracy in classifying cat faces, which almost doubled its accuracy in recognizing objects in a list of 20,000 distinct items (Le et al., 2011).

Figure 3.2: Some example test set images (Le et al., 2011)

Figure 3.3: Most responsive stimuli on the test set for the cat neuron (top) and for the human body neuron (bottom) (Le et al., 2011)

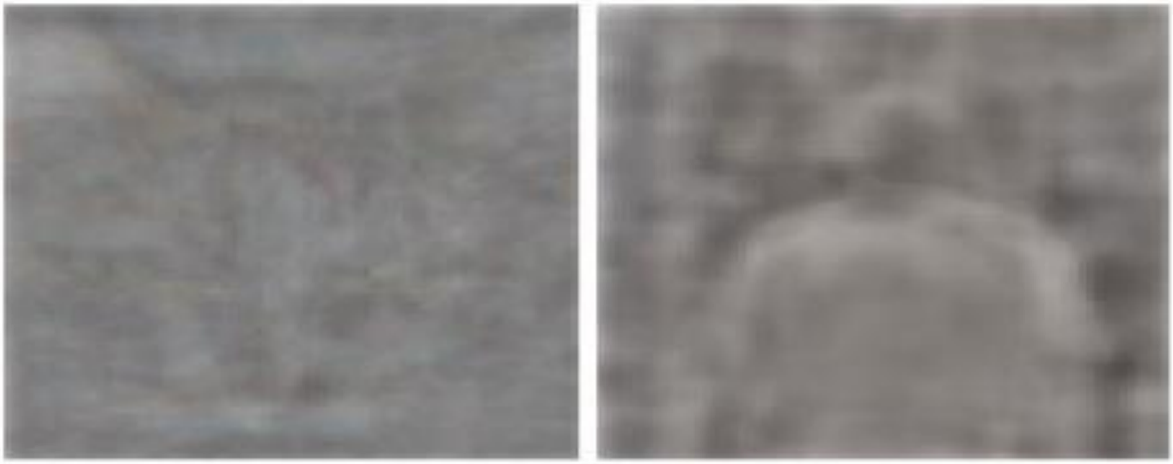

Figure 3.*4*: Visualization of the cat face neuron (left) and human body neuron (right) (Le et al., 2011)

The artificial neural network approach has been applied to a variety of Google's intelligent products, including Google Photos. In 2015, Google introduced the new application of machine learnings, Google Photos. In 2015 Google I/O[4], The Google Photos director, Anil Sabharwal highlighted three major features: free, unlimited storage capacity for the automatic back-up; an automatic photo-organization system; and an easier photo-sharing system. Digital copies of all photos that users have in their devices are automatically stored in Google Photos, which has unlimited storage capacity for digital photos up to 16 megapixels and videos up to 1080p resolution. Then, the stored photos from all devices synchronized with Google Photos are automatically displayed in a single page and organized in chronological order based on metadata of digital images. Users can re-view and search their photos across the day, week, month, and

[4] Google I/O is an annual conference for developers, which is held by Google in Mountain View, California. I/O indicates input/output and innovation in the open. The conference was started in 2008. Since then, the annual conference unveils Google's latest developer products and features hands-on learning sessions focused on building web, mobile, and enterprise application with Google and other open web technologies (Google I/O, 2018).

year. Also, any selected photos can be shared with others through the mail, text, and social media accounts.

The biggest innovation was in the organization system, which incorporated Google's object-recognition algorithms and machine-learning system. Using Google's artificial neural network, the application offers a private feature that automatically reorganizes and groups photos by people, places, and things without users' efforts to label each photo. For example, if user tabs a certain face suggested in the application, all photos having the face are separately displayed from the recent one to the oldest one. The name of places and things are automatically tagged in the group of photos based on the metadata of digital images. Additonally, user can label the name of human faces. Once Google Photos algorithm completes detecting all faces in stored images, the application sends notifcation saying that "Which face is yours?" The notification shows some faces frequently appeared in the user's photos and lets the user to choose one face to "personalize Google Photos" and "help [the user's] contacts' Google Photos apps to recognize [the] face in photos" (Google Photos, 2018). Once the user gives information of which one is his/her face, Google Photos begins tagging the user's name on every photo the user is appeared and suggesting the user's contacts to share the photo with him/her if they have photos of the user.

By detecting the people, places, and things in photos, Google Photos generates metadata, which are operated on by the algorithmic rules of categorizing and organizing all photos for future retrievals. In Google Photos, the record and its recollection become more closely synonymous, as Wiener had dreamed for cybernetic memory machines.

Long before Google Photos, Vannevar Bush, in his essay *As We May Think* (1945), had prophesized a new machine, the Memex. His idea of the Memex would be the perfect memory machine that allowed a user to access the total capture of information and utilize an automatic system of indexing the stored information. The Memex would be a desk-like machine with two projectors (see *Figure 3.5* and *Figure 3.6*). In addition to the total database of information in the massive storage space, the projectors allow users to compare and connect information to create associative trails and personal annotations on documents. The associative trails and personal annotations reorganize the information to be accessed easily in the future. Like the science of cybernetics, the design of associative trails comes from the neuroscientific structure of human brains. The design emulates the way brain cells carry an intricate web of trails and turn them into the association of thought. Memex's indexing system associates discrete documents. Bush envisioned people reacquiring "the privilege of forgetting" through the technical supplant to memory that would preserve, manage, organize, and reactivate the stored information for humans (p. 121).

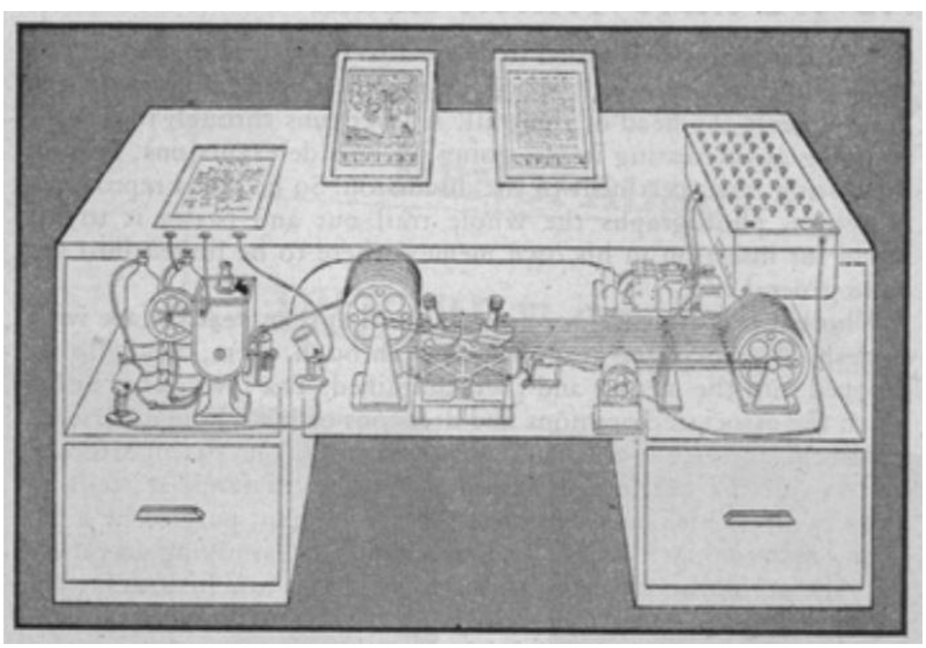

Figure 3.5: The design of the Memex (Bush, 1945, p. 123)

Figure 3.6: Memex in use[5] (Bush, 1945, p. 124)

The idea of the Memex is not only about storage but also the management and processing of the stored information. The role of associative trails is critical to managing the massive amounts of records. The records are not stored statically but continuously reorganized for easier access and retrieval in the future. The Memex envisions the future of memory, which has permanent storage capacity with automatic and novel forms of indexing. As Halpern (2014) argues, the importance of the Memex is that “the machine would break the taxonomic and stable structure of the archive” and would work as human brains may think (p. 73).

[5] Bush adds the comments on the image, saying that “[o]n one transparent screen, the operator of the future writes notes and commentary dealing with reference material which is protected on the screen at left. Insertion of the proper code symbol at the bottom of right-hand screen will tie the new item to the earlier one after notes are photographed on supermicrofilm” (Bush, 1945, p. 124).

Google Photos concretizes and updates the designs of the Memex, following the legacy of cybernetics. Like the basic structures of cybernetic designs, Google's machine-learning algorithms emulate the neural organizational structures and memory functions of the human brain. Google Photos develops novel forms of indexing systems that associate discrete photos. As Vannevar Bush had envisioned, humans can acquire the privilege of forgetting by relying on the machinic capacity of storing and managing image-information. Once users select and inscribe the moments, acts of recalling become a part of the algorithmic process that store, organize, and retrieve them. Even without human-created labels, captions, or the associative trails, the algorithms are able to generate the novel forms of the index to assemble and associate photos.

In Google Photos, there is no representational display of users' past but the algorithmic translation aimed at producing new associations and further interactions between users and Google's algorithmic machines. Despite their emphasis on the unlimited storage capacity, the main goal of Google Photos is not storing and documenting the external worlds, but becoming a cybernetic archive that integrates storage and memory.

Feedback, Behavior, and Self-learning Machines

The role of feedback systems is critical for the proper functioning of cybernetic archives. For Wiener, cybernetic archives can "modify their patterns of behavior on the basis of past experience" to act more effectively with future environments (1988, p. 48). Memory becomes a source for future actions of cybernetic archives, which belong to the cycle of feedback systems to perform differently in response to the outer world. The goal of cybernetics is self-referential machines that "improve the strategy and tactics of their performance" themselves (Wiener, 1988, p. 170).

Google Photos is a self-learning machines in feedback loops associated with human users. Compared to Memex's associative trails, Google Photos' indexing system is unique because it is automatically generated and maintained by the algorithmic operations. The automatic organization systems rely on Google's algorithmic abilities to learn and analyze patterns in photos and videos. Google Photos algorithms mathematically model photographs to analyze the patterns found in images, in addition to the metadata embedded in the digital images such as time and location information, and automate the process of organizing images in feedback loops.

As the first commercial of Google Photos (May 28, 2015) describes, Google Photos becomes the application to make "all your photos organized and easy to find" and "a home for all [the] moments in time that you never want to forget." For the last four years, Google algorithms have continuously updated their functions for producing memories out of the stored moments. The process of suggesting memories becomes automated by Google algorithms, which have taught themselves in feedback loops with users. On the first version of Google Photos in 2015, users could curate special photos through Collage and Animation features, in addition to the auto-organization of photos regarding people, places, and things. The first Google Photos commercial describes the features as the applications for turning "moments to memories" and "mak[ing] them come alive." Later, these features become a part of algorithmic operations that automatically detect, analyze, and learn the visible *patterns* of behaviors found in the images and videos.

On May 2016, Google introduced "smarter albums," which are algorithmically generated albums for users' travel photos. The algorithms assemble the best shots of travel photos and generate the separate albums for the photos and videos taken during the travel. The commercial for the smarter albums (May 22, 2016) emphasized that Google Photos finds the best moments of the travel and automatically creates an album, shows highlights of the travel, and groups photos regarding places they visited. The algorithmic operations automatically generate the memories of travel, and the only thing users need to do is to add captions to describe the images.

The automatic album implies that the algorithms can identify not only information about photos but also information *in* photos. The technical rules of the algorithmic analysis are related to the cybernetic emphasis on behavioristic patterns in the feedback system. According to Wired magazine's interviews with two Google developers involved in the smart album projects, Google Photos product manager, Francois de Halleux says that Google uses multiple layers of algorithms to create the automatic albums (Moynihan, 2016). After eliminating the duplicated images, Google algorithms detect and evaluate the elements in a photo to decide the quality of the photo.

First, Google Photos identifies the time and location information of the photos. Google's ability to track the location and time information is no longer a surprise. Based on Google location services, Google Photos first determines whether a user was travelling or not when the photo was taken. Google Photos product lead, David Lieb explains that the distances between a user's home and the location information of the photos trigger the auto-creation of an album. When photos and videos are taken far away from a user's home, Google assumes that the user is on travel. The system also pays attention to the number of photos the user has taken in a certain period. Google identifies the travel when the user takes more photos and videos than usual at a specific location or a specific time frame. Specifically, if the time is around national holidays, college break, or other significant days registered in Google, the chance of creating the automatic album goes higher.

Then, Google Photos detects additional information *in* photos. If the algorithms detect geographical landmarks in a photo, the photo can be added to the smart album. To detect national and international landmarks, Google Photos uses a combination of location services, geotags, and machine learning, according to the *Wired* megazine interviews. Even without the assistance of location services, as of 2016, Google Photos algorithms could automatically identify 255,000 landmarks through the machine learning system that have taught themselves to detect patterns of landmarks. Geotags and location information of photos given by users supplement the identification of the machine learning to minimize possible misrecognition.

The most remarkable feature of Google Photos is face detection. In addition to the elements indicating the location information of photos, Google detects human faces *in* photos. Google has been devoted to developing automatic face-detection techniques since early 2000s. Google purchased face detection software company PittPatt in 2011 and a Ukraine facial recognition company in 2012 to integrate face detection/recognition services into Google's artificial intelligence products. As one of research on face detection/recognition published in the Google AI database, Shah and Kwatra (2012) propose automatic photo enhancement through facial expression analysis. The facial analysis aims at automation, which organizes images, evaluate the "goodness" of a face by classifying facial attributes, selecting the high-scoring photos, and replacing "inferior" faces with "superior" faces from other photos without any user inputs (p. 1).

Google Photos adapts most of techniques suggested in this research to create the smart album. According to two Google Photos developers interviewed with the *Wired* megazine, Google algorithms look for faces of people that frequently appear in users' previous photos. The algorithms also detect the facial expressions of human faces. The photos where all people have their eyes open and smile are selected to be best photos in the smart album.

The detection of facial features and expressions rely on the mathematical modeling of human faces and actions. In Google Developer's[6] *Face Detection Concepts Overview* (2016), Google introduces its "face detection" technique as "the process of automatically locating human faces" in digital images or video. Google defines the following four terms used in discussing face detection techniques:

> 1) *Face recognition* automatically determines if two faces are likely to correspond to the same person. Note that at this time, the Google Face API only provides functionality for face detection and *not* face recognition.
>
> 2) *Face tracking* extends face detection to video sequences. Any face appearing in a video for any length of time can be tracked. That is, faces that are detected in consecutive video frames can be identified as being the same person. Note that this is not a form of face recognition; this mechanism just makes inferences based on the position and motion of the face(s) in a video sequence.
>
> 3) A *landmark* is a point of interest within a face. The left eye, right eye, and nose base are all examples of landmarks. The Face API provides the ability to find landmarks on a detected face.

[6] Google Developers is Google's online site that provides software development tools, application programming interfaces (APIs), and technical resources for software developers. The website offers reference information and open source code about most of Googles' popular consumer products.

4) *Classification* is determining whether a certain facial characteristic is present. For example, a face can be classified with regards to whether its eyes are open or closed. Another example is whether the face smiling or not.

("Face Detection Concepts," Google Developers, 2016, emphasis in original)

These four concepts show how Google Photos mathematically model human faces in photos to identify, measure, analyze, and classify facial traits.

The algorithms detect all the faces in given images at a range of different angles by measuring Euler Angles[7] of the human face and estimating pose angle to characterize a face's orientation (see *Figure 3.7*). Additionally, the algorithms extract the "landmarks" of the human face, which include eyes, nose, and mouth, associated with the angle (see *Figure 3.8*). Additional landmarks can be detected to identify facial features and expressions, such as two eye centers, nose tip, nose root, four eyebrow corner, and four lip corners. The technical features encode the local shape and spatial layout of human face landmarks. For smile detection, the algorithms extract features from both the mouth region and cheek and eye muscles, then calculate orientation angles between face landmarks (see *Figure 3.9*). These features also encode average intensity difference and spatial color distribution around the eyes and the mouth based on the "difference in teeth/lips color and iris/skin color respectively" (Shah & Kwatra, 2012, p. 4).

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[7] Euler Angle is a mathematical term introduced by Leonhard Euler. The term uses three angles to identify the orientation of a fixed and mobile body as regards a coordinate system.

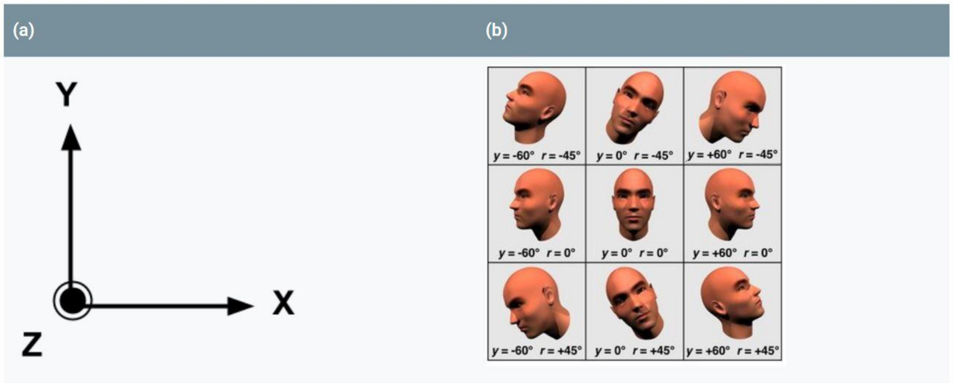


Figure 3.7: Pose angle estimation in Google Face Detection
("Face Detection Concepts Overview | Mobile Vision," 2016)

Figure 3.8: Landmarks of human face in Google Face Detection
("Face Detection Concepts Overview | Mobile Vision," 2016)

Then, the algorithms combine all the measurements and indicate a certainty value, which shows the probability that facial attributes, such as smile/no-smile and opened/closed eyes, are present in the photo (see *Figure 3.10*). When the score is higher than 0.7, the photos are added to the smart album. The higher scores ensure that the photos evoke positive emotions to users and contains a great quality of images. *The photos of the frontal face, the opened eyes, and smiling face become algorithmically chosen and processed memories for future retrievals of users*.

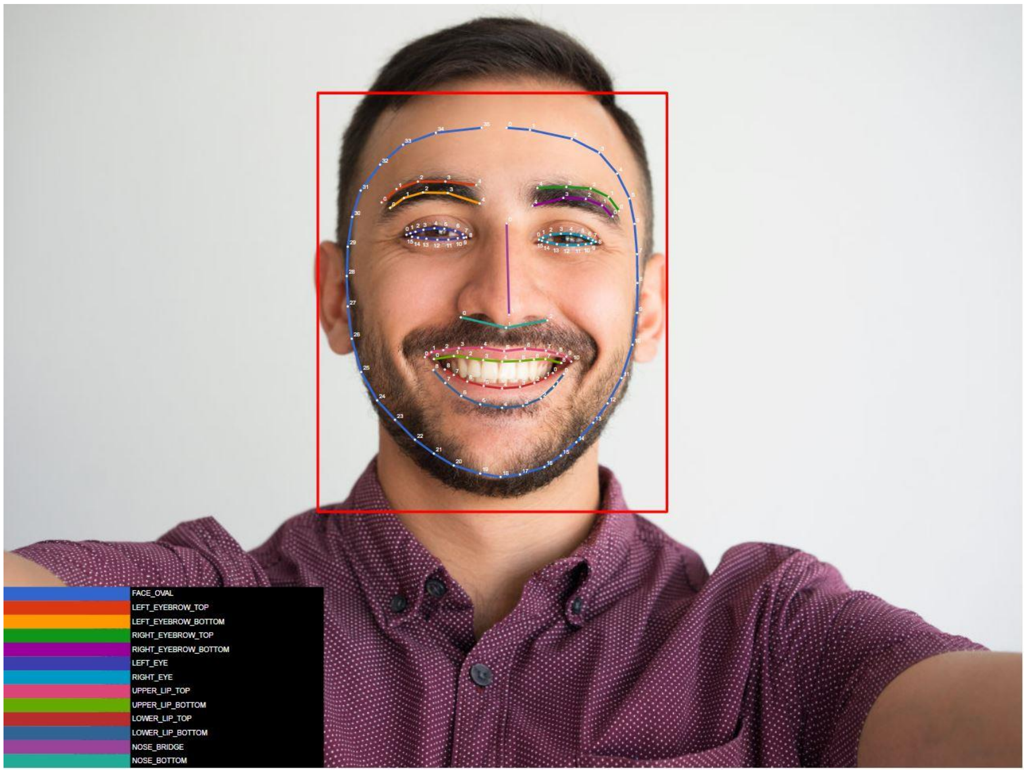


Figure 3.9: Additional Landmarks Analysis of Human Face
("Face Detection Concepts Overview," 2019)

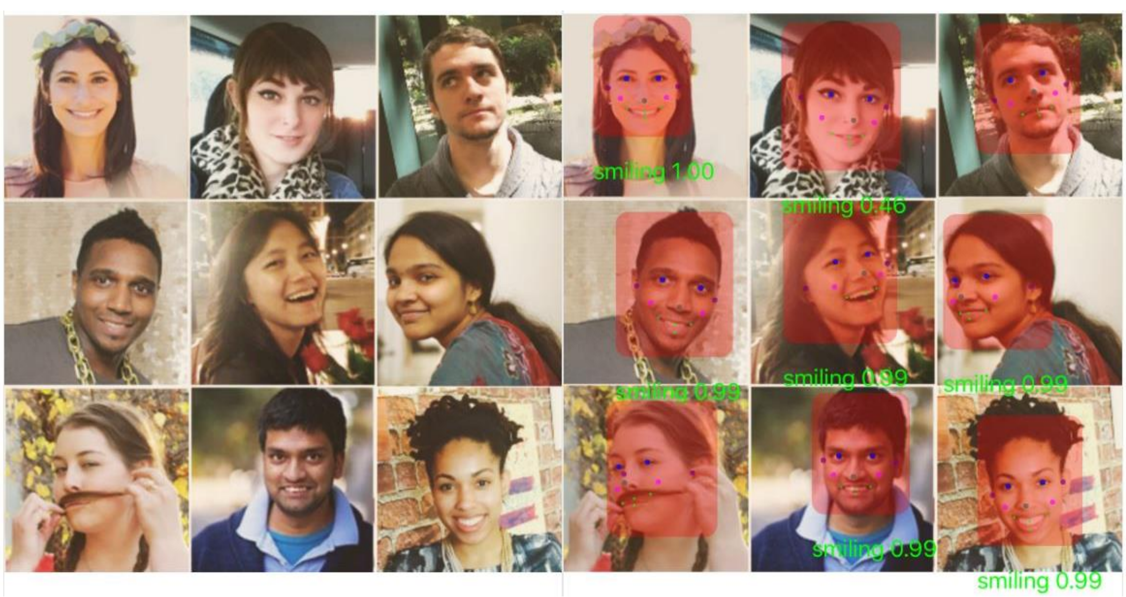


Figure 3.10: The smiling and eyes open classification in Google Face Detection
("Detect Facial Features in Photos | Mobile Vision," 2017)

Like the cybernetic emphasis on the patterns of behaviors, the algorithmic photo album follows the behaviorism traditions by documenting, measuring, and classifying facial movements. The algorithms attribute pixels to the "landmarks" of human faces to register facial reactions and emotional behaviors. Then, the algorithms track the facial muscles and movements around the eyes, nose, and mouth. Without considering the socio-cultural context, the internal intention, or the type of bodies related to the facial expressions, the automated facial expression recognition only measures the visible patterns of the human facial movements, relying on a behavioristic understanding of human emotions.

The analysis of facial expression becomes a crucial feature to identify users' emotional engagements in other algorithmic media. Facebook's August 2015 patent also proposes to use webcams and mobile phone cameras to read facial expressions, moods, and emotions of users, including both positive and negative one. Once Facebook receives photos of users, the algorithms detect "emotion characteristics" from images, which indicate the measurable signs of joy, amazement, surprise, excitement, disappointment, confusion, boredom, anger, pain, and depression (United States Patent No. US10025972B2, 2018) (see *Figure 3.11*). The signs of emotions rely on the behaviorism by focusing on movements and shapes of face, such as "smile, brow furrow, brow raise, lip corner depressor, inner brow raise, eye closure, nose wrinkle, upper lip raise, lip suck, lip pucker, lip press, mouth open, lip corner depressor, chin raise, and smirk" ("Facial Expression Analysis Solutions," n.d.).

In addition to assessing movements and shapes of the face at a pixel level, the algorithmic media also convert users' platform actions into data. For example, Facebook collects and analyzes users' actions, such as "liking" and reacting to the posts, (un)making friends, posting photos, and leaving comments. All actions are recorded and analyzed by Facebook algorithms to find and modify patterns of actions. When Facebook sorts out the negative memories, the behavioristic analysis is applied to classify users' affective relations to the posts.

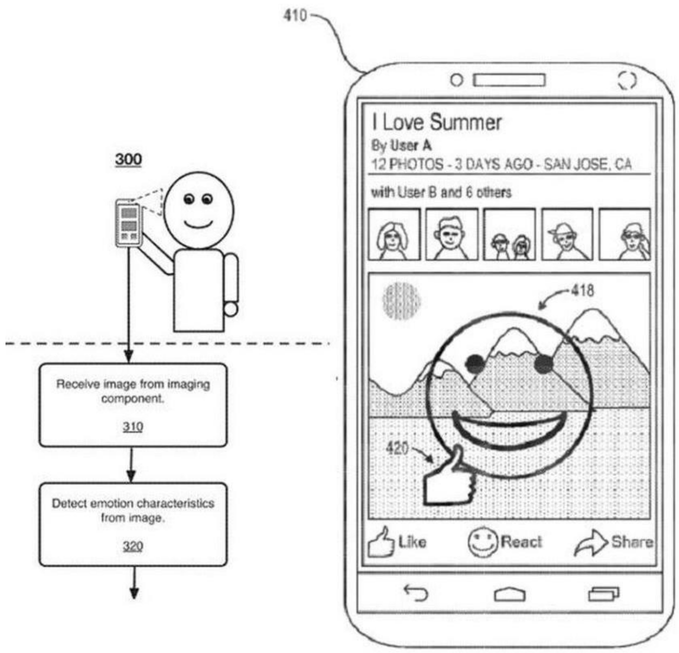


Figure 3.11: Facebook Patent Filing Images (United States Patent No. US10025972B2, 2018)

These behavioristic algorithms update the original design of automated nostalgia on Facebook and Timehop. Identifying emotions become essential to sort out the nostalgic past in the cybernetic archives. Instead of assuming that all photos posted on the platforms are happy memories, the cybernetic archives become more sophisticated, identifying human emotions and characteristics associated with the photos by analyzing patterns of facial behaviors.

The legacy of cybernetics can be found here, in the way the algorithms of Google Photos and Facebook learn, analyze, and modify observable and measurable patterns. By focusing on the transmission between different bodies, in the science of cybernetics, behavioral patterns have taken on greater significance than the physical body or the internal thoughts. Following behaviorism, cyberneticians observe, document, and analyze the visible inputs and outputs that generate modifiable patterns in feedback loops. Regardless of its physical body and internal intentions, what matters is what is visible and transferrable.

Algorithmic media for automated nostalgia such as Google Photos and Facebook becomes the cybernetic self-learning machine that detects, documents, analyzes and predicts behaviors and patterns of human users to suggest more proper and purposeful memories to users. In the genealogy of cybernetics, human users become acting machines that generate patterns of actions. The algorithmic memory practices make human emotions and memories parts of the observable actions, which can be mathematically modeled, measured, and analyzed to automate nostalgia.

Conclusion

This chapter reviews the legacy of cybernetics in algorithmic memory practices to demonstrate how contemporary socio-technical memory practices build on and modify the cybernetic heritage in the contemporary design of machines, computing, and communication. In the cybernetic imagination, signals of inputs and outputs are interchangeable between humans and machines. Cyberneticians were devoted to theorizing automatic machines of self-referentiality and self-learning that record, store, and process information to measure, observe, modify, and predict patterns of behaviors.

The theories of cybernetics understand memory technically and behaviorally. In the technical and behavioristic understanding of memory, memory becomes an interchangeable feature between humans and machines. When both humans and machines are information-processing and pattern-generating devices, memory can be measured, produced, and evaluated by the technical operations of the cybernetic archives that analyze patterns of behaviors. In Wiener's theories of cybernetics that emphasize the efficiency of information transmission between technical systems and living organisms, our memory practices become efficient through the technical synthesis of memory and recollection.

Algorithmic processing is integrated into digital storage to become the cybernetic archives that the acts of recording, storing, and recalling are synthesized. The algorithmic processing of digital storage gives concrete shape to Wiener's ambitions. The newness of the algorithmic media, such as Apple Memories, Google Photos, and Facebook Memories, is due not only to their larger storage capacity but also their algorithmic management of the stored data. What users have stored on Apple iPhones, in Facebook, and in Google Drives is not the fixed data block but re-groupable information. In addition to the larger data-storage capacity, these algorithmic media create novel rules of automatic (re)organization to process the stored data for the future. To automate nostalgia, we have drawn into a system that the algorithmic medium and the human user communicate with each other and become the integrated cybernetic system, regardless of inner thoughts, purpose, and contexts of actual memory practices. Building on the cybernetic imagination, algorithmic media are becoming sophisticated forms of archives that can store, classify, analyze, and reanimate memory.

While Wiener (1965) argued that photography is not an ideal cybernetic medium because of its inability to store processes, the photographic details and permanence of its record make the photograph the perfect site for cybernetic analysis. The contemporary cybernetic archives measure, evaluate, and classify behavioral elements as registered in photos. Photograph become a mathematical assemblage of the angle, position, orientation, characteristic, and value. Our memories and emotions become parts of the mathematical modeling in the genealogy of cybernetic documentation, analysis, and prediction.

The genealogical exploration encourages us to examine how we move forward with the contemporary socio-technical imaginations. As a cybernetic archive, algorithmic media such as Google Photos is still involved in operations of documenting, measuring, analyzing, and predicting our actions. In the endless feedback loops, the algorithms improve their strategy and tactics of performance for a "better" outcome. Our acts of inscribing, storing, and recalling are the endless sources of algorithmic predictions. While the cybernetic fantasy has defined the present understandings of memory within applications such as Google Photos, the technical legacies of algorithmic media have now become the future imagination of memory, desire, and the production of subject.

The next chapter expands this chapter's discussion of archival classification to identify emotions of photos, theorizing the rise of "universal memory." The following chapter examines how the algorithmic systems of detecting human emotions are intertwined with the systems of standardization and classification driven by Western behaviorist psychology that theorizes the existence of universal human emotions and facial expressions. The examination articulates how the cybernetic memory, discussed in this chapter, turns into a standardized digital object similar to the standardized products of mass culture of the twentieth century critiqued by Adorno and Horkheimer.

CHAPTER 4: ARCHIVE AND THE UNIVERSALIZATION MEMORY

As has been argued throughout the previous chapters, our memory practices have become linked to the technical logics of algorithmic media that archive and curate stored information. Contemporary algorithmic media such as Facebook and Google show that the capacity of these media for remembering is no longer based only on inscription and storage. The temporal architectures of Facebook, as discussed in Chapter 2, produce a perpetual loop of recalling what we stored and foster affective engagement with the algorithmically idealized version of the past. The algorithmic processing of digital storage in Google Photos gives concrete shapes to Norbert Wiener's dream of the cybernetic archive, which synthesizes acts of recording, storing and recalling, as noted in Chapter 3. Algorithmic media are directly associated with *acts* of remembering by suggesting what, when, and how to remember what we stored on the basis of algorithmic selection and organization.

To transform a stored time to a more sophisticated form of memory, algorithmic media not simply re-show the original photo and/or text; but create novel rules of automatic (re)organization, which build on a cybernetic system that transmits and processes information between the human user and the algorithmic medium. The algorithmic rules are less interested in inner thoughts than patterns of observable behaviors. The patterns of behaviors can be observed and analyzed through users' action-traces inscribed in the platform (leaving comments, (un)making friends, and liking) and the action-information registered in the photograph (time stamp and location information). In addition, all three companies—Apple, Facebook, and Google—develop automated systems for identifying information appeared *in* a photograph such as objects, landmark buildings, human faces, and facial expressions.

In these algorithmic rules of operations, the goal of detecting these patterns is not for the identification. Instead, the algorithmic operations aim to read emotion associated with an image in order to select the one that invokes joyful feelings. They emphasize affective qualities of/in the photograph as objects of analysis. To evoke positive reactions to their services, those applications need to foster a sense of joy that does more than simply transport the viewers back in the past post. As mentioned in Chapter 2, in addition to quantifying users' activities in their platform, Facebook conducted qualitative research to develop the language and theme of the ranking system that evokes positive reactions to most people, such as travel, family, food, flower, wedding, and graduation. Later, Apple and Google Photos added the automated system of facial expression analysis to their applications for automated nostalgia. With face/object-recognition algorithms, detecting human facial expressions in a photograph becomes the most crucial function to read emotion and select images that evoke nostalgia.

Reading human facial expressions has historically been associated with the ways in which "human face was categorized, investigated, and visualized in the pursuit of knowledge" (Gunning, 1997, p. 3). In a history of psychological and computational research, the human face has been treated as a site of affect that reveals emotions. More precisely speaking, psychologists studying facial expressions have explored to establishing systems of analyzing facial expressions, rather than studying emotion itself. Then, computer scientists have shared the same interest to develop technical and automatic systems of facial expression analysis. As this chapter will show, the inquiry has been associated with developing the (automatic) system of classification and standardization, which classifies units of facial movements into standardized categories of emotion.

This chapter examines the historical construction of automated facial expression analysis. Beginning with a review of the historical role of photographs in memory practices, I argue that the course of algorithmic and archival operations extends and shifts the traditional functions of the photographs and photographic memory practices. Next, this chapter critically examines how algorithmic and archival operations adopted the sciences of studying human face, specifically Western behaviorist psychology, which has been influential in detecting emotions in photographs that foster affective engagement with the algorithmically selected images. Then, I expand the historical examination to my claim of "the universalization of memory" and its consumption. In the final section, I argue that, with engagement with "universal memory" created by automated nostalgia, the automated system of archival classification influence, shape, and prescribe one's affective engagements and modes of actions, significantly altering the cultural techniques of memory practices used to understand selfhood.

Photographs and the Archive

Photographic practices have long been essential to discuss memory. Especially, the potential for photographic documentation of personal and family event has widely recognized in the 1900s. From the family photo album to the wedding photograph, photographic practices have been one of the principal tools for memorializing individuals, places, events, and achievements. In *Photography: A Middle-brow Art* (Bourdieu & Whiteside, 1996), Pierre Bourdieu observes a photographic practice as a private technique of preserving the present and reproducing moments of collective celebration in the 1900s of France, where photographs used to be an object of aesthetic judgments in the dignity of artworks. In North America, Kodak's advertising campaign in the early 1900s also emphasized photographic practices for individual memorialization. The commercials highlight the role of photographic practices in memorializing individual and family events through slogans such as “a means of keeping green the Christmas memories,” “a vacation without a Kodak is a vacation wasted,” or “in every home, there’s a story for the Kodak to record” (Walton, 2002). With photography, the past has become a collection of images, and photographic practices—taking and sharing photographs—have become primary techniques of remembering since the 1900s.

In addition to media archaeological understanding of photography as a media technique of capturing and freezing time (Braun, 1994; Canales, 2010; Ernst, 2013; Kittler, 1999), an “imaginary possession of a past” given by photographs allows many scholars to examine photography as a primary tool for remembering (Sontag, 2001). Scholars who have traced photography as a mnemonic technique also emphasize the affective force of photograph in evoking feelings about the past. In *Camera Lucida* (Barthes, 1981), Roland Barthes addresses the magical force of a photograph, which holds unique referential relations to the real, going beyond the photographic representation and identification of having-been-there. Barthes emphasizes the photograph’s “punctum,” which builds direct relationships between images and the viewing subject’s memories. Barthes finds the moment of “punctum” in his family photo album, which is the sudden but strong emotional details of wounds evoked by a photograph. By building affective relationships, the photograph communicates with viewing subject’s emotional experiences and bodily memories, in addition to the photograph serving as an index of having-been-there. The viewing subject is able not only to see the photographs but also to feel the event in the photograph, through a “process of affective contagion” between the photograph and the viewing subject’s bodily memories (Bennett, 2005, p. 36).

After the development of digital photography, photographic practices have more widely discussed in relation to memory practices. A growing body of the recent work examines how digital photographs in the networked media reshape individual and collective memories through the digitally mediated and shared memories of transnational events and everyday life (Hand, 2016; Hjorth & Moon, 2017; Van Dijck, 2007). With the integration of digital camera into mobile Internet devices, photographic documentation of everyday life becomes mundane, which leads to vast amounts of digital memories stored in different forms of digital devices. Photographic practices become routine, and the huge number of traces creates a living archive of potential memory: the scattered traces across various media can produce the unexpected emergence of data about the self (Bowker, 2005; Hand, 2016; Hoskins, 2009, 2013).

With the inherent connection between photographic practice and memory, the camera has been a crucial apparatus that determines the presence and absence of memory and produces remembering and forgetting. For example, Sturken argues that the camera, on the one hand, creates recorded images that can become material for the invocation of memories; on the other hand, the camera obliterates the unphotographed social memories in a historical discourse (Sturken, 1997, p. 688). In the algorithmic memory practice, however, a new apparatus emerges, integrating the camera into a larger system of automation: the algorithmic archive.

The photographic memory practices of everyday life feed into this archive of massive inscriptions. With pervasive digital photography, the presence or absence of photographs matters less than the management and recollection of the photographs. The archive, which synthesizes storage and processing in the legacy of cybernetics, automatically categorizes stored photographs in conjunction with a professionalized and algorithmic mode of visual analysis. Apple Memories provides curated collections of "significant people, places, and holidays" with the automatically chosen music that represents the mood of the collections (Apple, 2019). Facebook summarizes users' past year by arranging positive posts with upbeat music. Google Photos suggests the albums or videos composed of the algorithmically selected best photos. As discussed in the previous chapters, automating nostalgia begins with the algorithmic archives that sort "positive" photos out from the massive documentation of everyday life using a technological mode of visual analysis. The new apparatus operates social practices of recalling and re-viewing the stored inscriptions, rather than the inscription apparatus, the camera.

When Facebook and Timehop first launched applications for retrieving the past posts automatically, the algorithmic operation relied on the textual and behavioral analysis of users activities in the platforms. According to Facebook researcher Artie Konrad, the algorithms quantify users' activities such as liking, (un)friending, and commenting to gauging users affective connections with the posts. A linguistic analysis supports their ranking algorithms to encode what types of contents or words present and assure positive relations between the post and the user. Additionally, the Facebook research team has been devoted to finding ways to classify pictures into categories that users prefer to re-view. They first conduct qualitative research with a small sample of participants, asking them to classify their posts/pictures into major themes such as achievement, vacation, food, and family. Then, they conduct a larger quantitative survey of Facebook users who had recently seen Year in Review that asks which themes are most preferred to re-view (Konrad, 2017).

Later, as noted in chapter 2, an entirely different mode of analysis emerges in Apple Memories and Google Photos translating emotions presented in the photograph to the mathematical language. The technological mode of memory practice requires techniques of automated visual interpretation. Without human additions of the textual analysis, the new algorithms treat the photographs as the visual document of human emotions, which they can mathematically model and measure. In the 2010s, all three companies obsessively bought companies that were developing facial coding algorithms. Apple bought an artificial intelligence start-up company that reads emotions in faces, Emotient, in 2016. Earlier, in 2011, Google merged with PittPatt, a company that develops algorithms for recognizing faces in images and video, and Facebook acquired the Israeli facial recognition company Face.com in 2012 (Metz, 2016). All these facial coding companies develop machine learning for facial expression analysis in the photos and videos. Apple, Google, and Facebook have applied the algorithms to a wide range of services, including the archival curations for automating nostalgia.

The facial coding algorithms claim indexical and mathematical values of photographs, rather than textual potentials. While the previous photographic memory practices rely on the rich details of the event or the affective contagion provided by photographs, algorithmic memory practices reduce photographs to their mathematical essence. As the previous chapter showed through an analysis of Google Photos, the algorithms assign each face and facial muscle a quantitative position within the frame and measure orientation angles of the mouth region, cheek, and eye muscles to calculate the probability of the facial attributes and expressions ("Face Detection Concepts Overview | Mobile Vision," 2016). Algorithmic analysis emphasizes the instrumental potential of the photograph as a means to measure human faces and quantify emotions. The photograph promises more than its coupling with human subjects, which foster symbolic memory practices of invoking the emotional responses to the optically inscribed events; it promises the algorithmic operations, which classify facial measurements into discrete categories to speculate emotions captured in the photograph.

Between the symbolic and algorithmic memory practices, photographs become both means and objects of memory practices. Photographs are a critical means of inscribing and capturing fleeting events to remember and recall the events. In technologies for automated nostalgia, however, once human photographers upload their massive numbers of digital images of everyday life to the storage spaces, the photographs turn into the objects of algorithmic memory practices in the system of coding, analyzing, and categorizing human faces.

Algorithmic memory practices build on massive amount of digital inscriptions, transcriptions of the facial signs into mathematical data sets, and the programming of image categorizations. For the purpose of categorizing photographs and identifying ones that may invoke nostalgia, algorithmic memory practices need to define a discursive and technical standard of analyzing human facial expressions. Here, the algorithmic memory practices are entwined with the scientific branch: Western psychological research analyzing facial behaviors. The psychological experiments have developed theories of human face as a site for universal signs of embodied emotions.

In the next section, I explore a history of western psychological experiments studying human faces and theorizing "universal emotions" in traditions of physiognomy and pathognomy—(pseudo-) science of studying human faces and emotional expressions. The exploration of a history, from Guillaume Duchenne's experiments to Paul Ekman's theories, shows the psychological suppositions behind algorithmic memory practices. I argue that it is what has actually shaped facial-recognition and emotion recognition techniques, which shape a standardized structure of feelings in automated nostalgia.

Face and Psychology of Universal Public Emotions

The human face has been crucial research interest to read different characters associated with humans. In the eighteenth and nineteenth-century, various (pseudo-)scientific fields had emerged in the Western societies to read, or prescribe, individual characters of human faces. For example, pathognomy examined passions and emotions that are indicated by bodily expressions, such as gestures, voice, and facial expression. The muscular motions of the face were one of the important clues to read one's current emotional character (Bollmer, forthcoming). On the other hand, physiognomy was a pseudo-science, which claimed the relationship between face and individual character. In that it aimed to predict one's overall and long-term character, physiognomy was similar to phrenology, another pseudo-science that measured bumps on the skull to define mental traits (Sekula, 1986).

These (pseudo-)scientific interests in human faces had been prevalent in the Western culture in the eighteenth and nineteenth-century, which led to the developments of various scientific experiments and methods to studying human faces and emotions. Especially, physiognomy, became a popular "science" in nineteenth-century Paris, where the national system sorts the anonymous urban dweller into types to reassure bourgeois system, while the tradition of physiognomy is complex according to Gunning (1997). Physiognomy built the seemingly scientific system of analysis, which isolates the human face and its anatomic features and assigns a character to shapes and positions of each element. Followers of physiognomy, such as Johann Kaspar Lavater, believed facial features are "God-given signs of moral worth" (Gates, 2011, p. 157). The facial "signs" were translated into the pseudo-scientific evidence of a crime, madness, and cunning, which contributed to reinforcing the ideology of a hierarchical system mostly associated with class and race (Sekula, 1986).

The “scientific” interest in the human face had been continued with the proliferation of photography. Walter Benjamin (2008 [1935]) articulates an epistemological change that photography provides. In his well-known argument on “the deconstruction of aura,” Benjamin suggests that technological reproducibility of photography deconstructs a sense of uniqueness, authenticity, and distance that the work of art used to possess (p. 105). However, in the same essay and his earlier essay in 1931, Benjamin also identifies the “optical unconscious”—a visualization of what human-visual-conscious cannot observe—that photography discovers through its technical abilities to slow down and enlarge the original. This promise of photography fulfilled the goal of physiognomy to studying the relationship between a human face and individual character. Photography provided a still image of fleeting and ever-changing human facial expressions, which reveals visual details of human faces. The optical unconscious allowed researchers of physiognomy to deconstruct the visual signs and structures of facial expressions empirically. By capturing and recording human face and its movement, physiognomy was able not only to discover character from the face but also find likeness between the photographed faces (Gunning, 1997; Sekula, 1986).

While physiognomy was discredited by the twentieth-century, the tradition of physiognomy and its obsession with human faces lingered in many research on facial expressions, with its coupling with photography and the pathognomic interests in emotional expressions. For example, the French Neurologist, Guillaume Duchenne shared the basic idea of physiognomy by understanding facial expressions as indicators of inherent qualities. However, Duchenne was more concerned with mechanisms of facial movements than the facial typology (Gates, 2011). He explored the structures of how facial emotions are conveyed, through a series of experiments that stimulated facial muscles with electrodes and registered the movements of muscles (see *Figure 4.1*).

Figure 4.1: Duchenne's facial expression images
("Duchenne's Facial Expression Image Library » Scott Eaton," n.d.)

By using a camera and electric stimulator, Duchenne induced and recorded facial movements of his patients in order to identify the roles of the facial muscles and motor nerves playing in facial expressions. The result of the experiments was published in 1862, claiming the positivist argument that the emotional expressions, the facial muscle movements, are universal (Gunning, 1997). In his approach to dissolving human face to understand internal traits, Duchenne's work were consistent with physiognomy. However, like pathognomic traditions, Duchenne understood the face as a site of emotional expressions, rather than a site of fate and individual character that needs to remove facial emotion. In his positivist perspective, however, Duchenne also believed that emotional expressions are not culturally contingent but universal, embodied, and God-given.

The violent methods—torturing participants with a high level of pain generated by electrical stimulation—were problematic. However, his scientific work using new technologies, such as camera and electric device, to capture the facial movement had been important to psychological studies of human facial expressions as well as artistic books of suggesting effective ways to represent emotional expressions in the artwork (Gates, 2011; Gunning, 1997). Duchenne's research on human facial movement became the foundation of studying facial expression and universal emotion.

Duchenne's work was also appeared in Charles Darwin's 1872 book, *The Expression of the Emotions in Man and Animals* to explain how particular expressions of human occur through inheritance a relic of animals (Darwin & Prodger, 1998 [1872]). Darwin attempted to develop a history, or evolution, of the expressional forms and the communicative aspects. In the context of his well-known theory of natural selection, Darwin investigated historical and evolutionary construction of expressional forms and language, which derived from "the struggle for survival and various forms of adaptation to environmental or physical forces" that provides a link between men and animals (Gunning, 1997, p. 11). Darwin critiqued the idea of facial expression as a God-given trait, which was pervasive in contemporary artists. While the contemporary belief, including Duchenne, emphasized facial expression as universal and unique means of human emotional expression, Darwin demonstrated that humanity is derived from the animal through his analysis of photographed facial expressions (Darwin & Prodger, 1998). In Darwin's argument about human emotion, emotional expressions are shaped and preserved through broader evolutional descent, which cannot have discrete emotional categories.

Later, Darwin's work had multiple interpretations in American psychology, which mostly were the struggles about how to interpret his argument of emotion and expression. A misreading of Darwin, which overemphasized on his idea of the continuity and evolutionary purpose, led to a wide range of research on "universal" facial expression. Especially, Paul Ekman, the American psychologist who theorized the existence of universal emotions, explicitly noted in his 1975 book, *Unmasking the Face*: "Charles Darwin wrote that facial expressions of emotion are universal, not learned differently in each culture; that they are biologically determined, the product of man's evolution" (p. 23). This misreading became a motivation for his research on "universal" emotional expression. In 1998, Ekman wrote an afterword for a new edition of Darwin's *The Expressions of the Emotions in Man and Animals.* In his afterword, Ekman articulated how "universality of emotional expression" supports Darwin's theory of evolution, even though his tone was slightly weaken. Ekman suggested that Darwin's claim of the continuity between humans and other primates becomes weak if our expressions are culturally constructed. Also, for Ekman, the universality of facial expressions buttresses Darwin's argument that human beings had descended from a common progenitor and challenge the racist argument that one racial or ethnic group is a descendant of the more advanced progenitor. This understanding, or misreading, of Darwin was pervasive in studies on the face and emotions.

Since 1960s, Ekman had conducted cross-cultural research to theorize the universal emotions and its expressions. As a direct motivation of his research, Ekman introduced Silvan Tomkins who offered a theory about “the universality of the primary affects” with his “magical” ability to read facial expressions without any contextual clues (Leys, 2017, p. 78). Tomkins also argued the existence of primary “affective program phenomena” or “basic emotions,” which are fear, anger, distress, disgust, interest, shame, joy, and surprise. More importantly, for Tomkins, “discrete emotion was controlled by an ‘affect program’ in the brain that when activated triggered distinct physiological and behavioral responses,” especially characteristic and unintentional facial expressions (Leys, 2017, p. 82).

Building on these claims, Ekman, with his colleague Friesen, conducted cross-cultural and scientific research to test Tomkins’s idea of “basic emotions” that are appeared in the distinct facial expressions. Ekman and Friesen’s main argument with the basic emotions was that facial expressions of these emotions are the same for people, regardless of culture, language, and other backgrounds. The ambitious efforts to identify generalizable human emotions and facial expressions required vast collections of cross-cultural research.

In the first study conducted in 1966, Ekman and Friesen (2003) showed photographs of the different posed facial expressions, which built on Tomkins’s idea, to participants from the United States, Japan, Chile, Argentina, and Brazil. Participants needed to choose one of the emotion words that accurately describe the facial expression in the photograph. With the result, they argued that, in all these countries, the same emotions were linked to the same facial expressions (see *Figure 4.2*).

		Percentage Agreement in How Photograph Was Judged Across Cultures				
		UNITED STATES (J=99)	BRAZIL (J=40)	CHILE (J=119)	ARGEN-TINA (J=168)	JAPAN (J=29)
	Fear	85%	67%	68%	54%	66%
	Disgust	92%	97%	92%	92%	90%
	Happiness	97%	95%	95%	98%	100%
	Anger	67%	90%	94%	90%	90%

Figure 4.2: "Examples of the photographs utilized in a study of how emotions are judged across literate cultures" (Ekman & Friesen, 2003)

Ekman continued cross-cultural research to establish a theory of universal emotions and its expressions on the face. In 1969, Ekman chose to study how people in the Southeast Highlands of New Guinea expressed their emotions through the face, with an assumption that they would have had no opportunity to learn expressions and gestures from the outer world or the media. Participants in New Guinea were asked to choose the photograph of facial expressions that fits their emotional reaction to four stories that evoke happiness, sadness, anger, and disgust: (1) Friends had come, (2) His child had just died, (3) He was about to fight, and (4) He stepped on a smelly dead pig ("Are There Universal Facial Expressions?," n.d.). The result showed that, as did people in the previous experiment, these people selected the same photograph of face for expressing their emotion (Ekman & Friesen, 2003).

After his return from New Guinea, Ekman concluded all the experiments that emotions and facial behaviors are universal, or universally judged, even though the ways of managing and performing emotions might be culturally different. Ekman expanded this work to defining the facial expressions of seven major emotions—anger, fear, disgust, sadness, enjoyment, surprise, and contempt. The idea of basic emotions was not new, but Ekman established a model of how seven major emotions are expressed, and now, he created "online training tools" to make his argument applicable to the general public ("Are There Universal Facial Expressions?," n.d.). Regardless of its theoretical reliability, the model becomes the standard that is continuously utilized and applied to recent work that teaches how to read and respond to emotional expressions of the face across various social, cultural, economic, and political fields (see *Figure 4.3*).

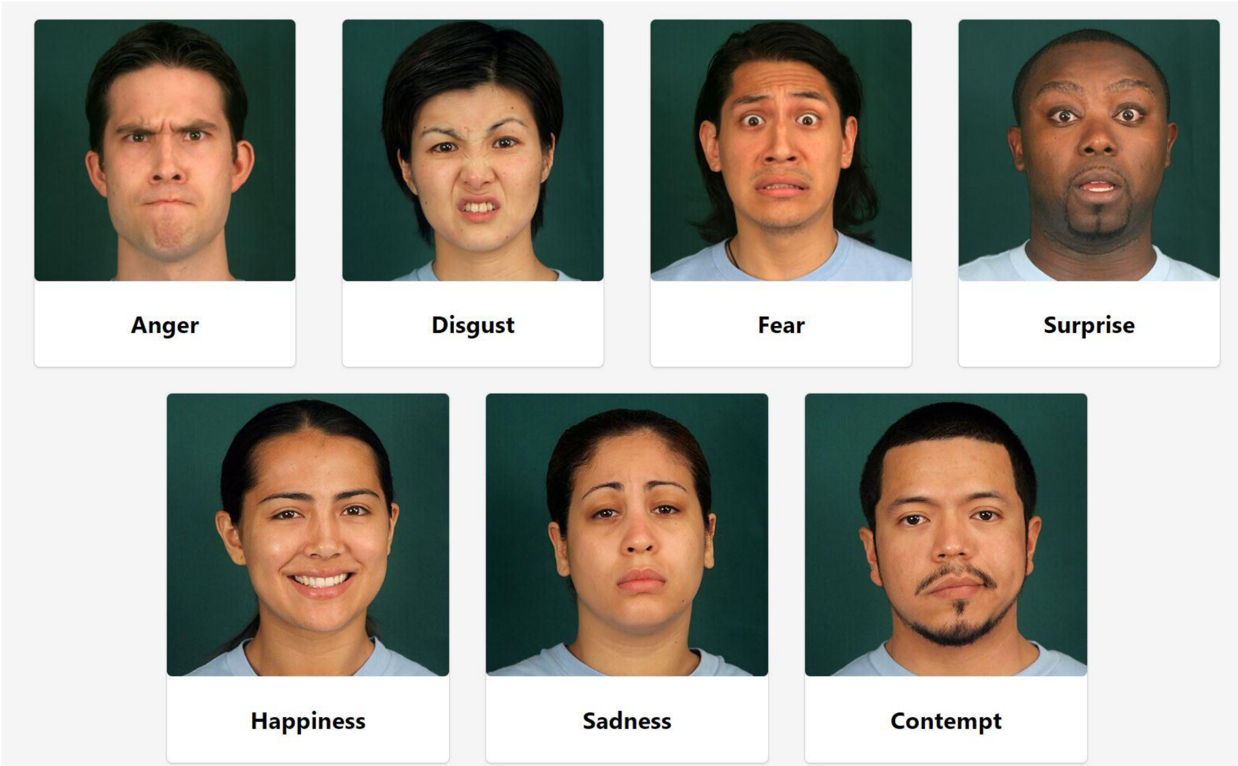


Figure 4.3: Contemporary depiction of seven universal facial expressions ("Are There Universal Facial Expressions?," n.d.)

Eventually, this research led to the revival of a general physiognomic approach of deconstructing human faces and the reinforcement of a pathognomic interests in facial emotional evidences. With an exclusive emphasis on the face, the face, which was treated as an assemblage of muscular movements that can be analytically codified, became the heart of emotional expressions analysis. With the interests in facial structures of universal emotions, Ekman's later work developed the Facial Action Coding System (FACS), which specified the anatomical analysis of facial movements and refined taxonomy of human emotions and facial expressions. The FACS expanded Duchenne's facial coding system, defining individual muscle or group of muscle movements that form many different facial expressions (see *Figure 4.4* and *Figure 4.5*).

As earlier physiognomic and pathognomic researchers and artists did, the FACS broke the human face into groups of discrete elements that can be recombined to express emotions into the face. Ekman aimed to encompass all human emotions and its facial expressions in the FACS. Through a single or combination of 19 Action Units (AUs), which refer to movements of individual muscles or groups of muscles, the FACS defined 30 AUs of facial muscles: 12 are for upper face, and 18 are for lower face that both single and combined muscle movements can occur (McStay, 2018, p. 58). This system defines not only the types of human emotions but also an intensity scale of facial expressions. The schema of FACS explains “basic” facial expressions (anger, fear, disgust, sadness, enjoyment, surprise, and contempt), “advanced” emotional expressions such as frustration and confusion, and three overall sentiments (positive, negative, and neutral).

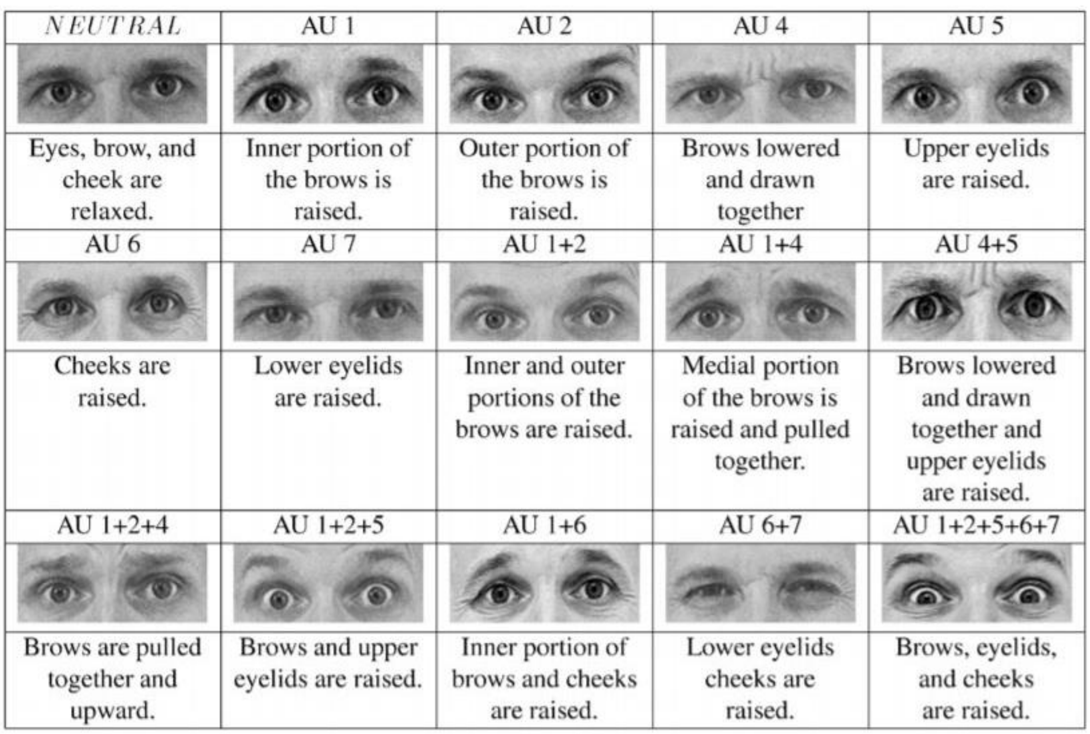
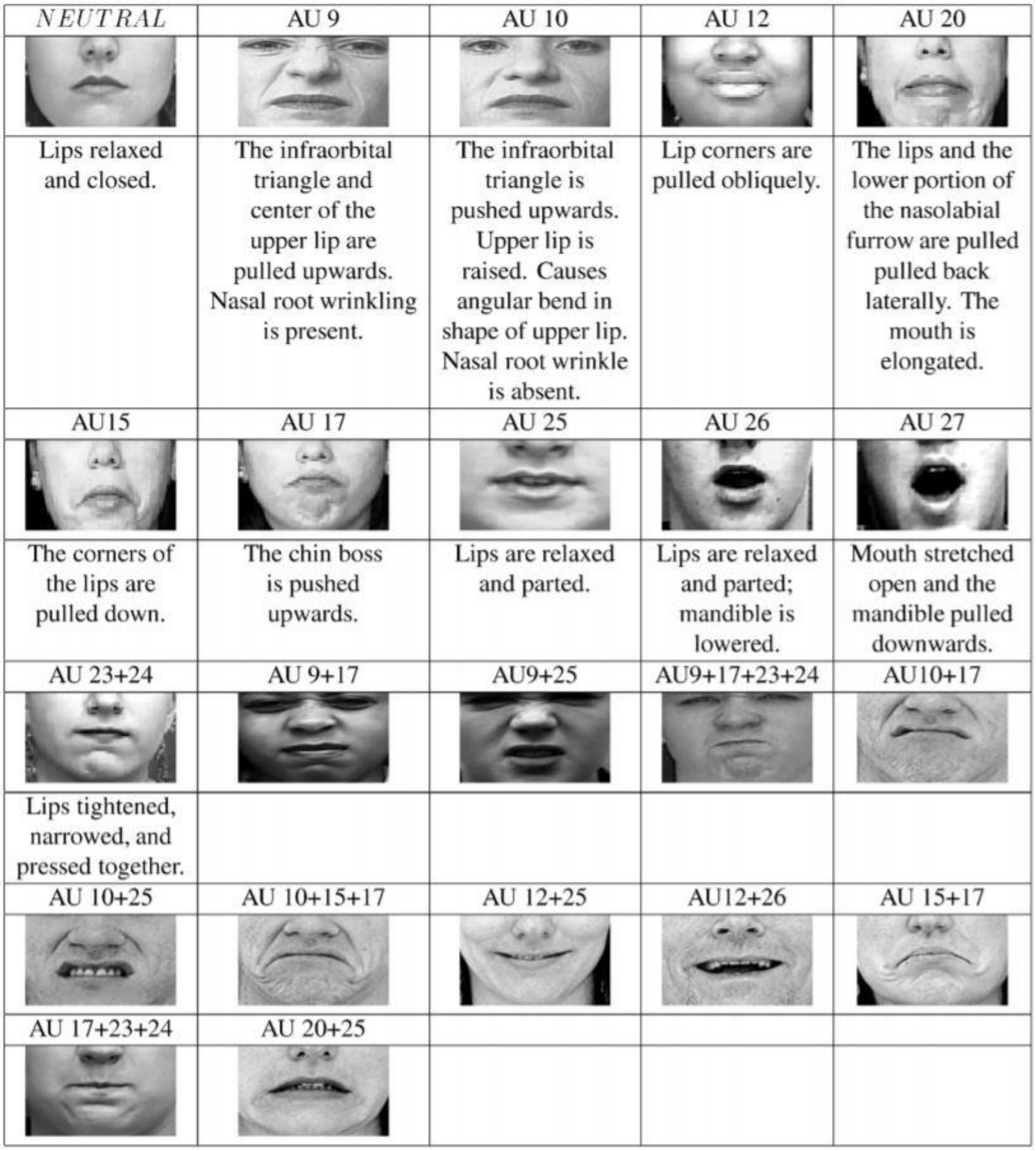


Figure 4.4: Ekman and Friesen’s upper Facial Action Units (AUs) and some combinations (Tian, Kanade, & Cohn, 2001)



NEUTRAL	AU 9	AU 10	AU 12	AU 20
Lips relaxed and closed.	The infraorbital triangle and center of the upper lip are pulled upwards. Nasal root wrinkling is present.	The infraorbital triangle is pushed upwards. Upper lip is raised. Causes angular bend in shape of upper lip. Nasal root wrinkle is absent.	Lip corners are pulled obliquely.	The lips and the lower portion of the nasolabial furrow are pulled pulled back laterally. The mouth is elongated.
AU15	AU 17	AU 25	AU 26	AU 27
The corners of the lips are pulled down.	The chin boss is pushed upwards.	Lips are relaxed and parted.	Lips are relaxed and parted; mandible is lowered.	Mouth stretched open and the mandible pulled downwards.
AU 23+24	AU 9+17	AU9+25	AU9+17+23+24	AU10+17
Lips tightened, narrowed, and pressed together.				
AU 10+25	AU 10+15+17	AU 12+25	AU12+26	AU 15+17
AU 17+23+24	AU 20+25			

Figure 4.5: Ekman and Friesen’s lower Facial Action Units (AUs)
and some combinations (Tian et al., 2001)

This system becomes a generalized standard that aims to encompass an entire sociocultural terrain of emotional expressions, positioning individual human emotions within the measurable standard. With FACS, individual facial expressions are identified by matching the muscular patterns of the face with the standard. This process of identification—identifying both individual facial patterns and its relations to the standard—generalizes not only the ways in which human emotions are expressed but also the ways in which human emotions *are read*. In addition to its influence in developing techniques of measuring emotions, Ekman and Friesen's FACS aims to provide the universal way to read, identify, and classify emotions. Ekman's efforts to verify the existence of universal emotions are expanded to the development of the taxonomic criteria for the human face and emotional expression.

Before these series of psychological experiments studying human emotions, facial expression analysis had not involved a single and straightforward theory of emotional expressions that exist universally across cultures. Instead, facial expression analysis has worked in tandem with other disciplines that define the "normal" range of emotional response to the outer world (Gates, 2011). However, the works I reviewed brought the study of emotional expression to psychological studies with the ultimate argument of "universal emotion" and its expressions. The idea of "universal emotions" was systemically theorized through a set of psychologic experiments utilizing techniques of measurement that remains the influences of physiogonomic obsession on structures of the human face and pathognomic interests in the muscular movements of emotional expressions. To establish the theories of "universal emotion," emotions were reduced to general categories that are publicly observable signals and hardly controllable patterns.

The idea of universal emotions is not a settled argument in psychology. For example, psychologist James A. Russell points out that the thesis of universality comes from the Western-centered judgment that tests Western concepts of emotions without knowing the local language, culture, and context of conceptualizing emotions and facial behaviors (McStay, 2018, p. 57).

Moreover, Ekman's foundational misreading of Darwin has been problematic, as a co-author of Ekman, Alan Fridlund criticized (Bollmer, forthcoming). Also, the use of posed expression in Ekman's and previous experiments has been widely criticized because posing for camera and researcher is inevitably influenced by sociocultural conventions (Leys, 2017, p. 104). All the psychological experiments on facial expressions were about posed and performed facial expression, rather than any natural facial expressions that can explain its universality.

Nevertheless, Ekman and Friesen's facial action coding system has widely been utilized, specifically in contemporary computer vision techniques and mass cultures. The original uses of FACS needed trained human coders to perform facial expressions and measure human facial muscles manually. However, a computational model promises more efficient and automatic coding systems, whether the original argument was cross-culturally valid or not. From animation films such as *Inside Out* (2015) to the lie detectors, Ekman and Friesen's categories of seven universal emotions and the facial muscle coding system provide a number of practical advantages for various sociotechnical fields such as computer engineers, film producers, marketers, and sales teams, who want to code and read human emotions (Gunning, 1997).

Algorithmic processes for automating nostalgia are one of many techniques that adapted these psychological studies on the facial expressions. Photography was an instrumental means to capture the fleeting effects of stimulating facial muscles or record the posed facial expressions for the future process of coding in earlier psychological studies of emotional expressions. In algorithmic operations for automated nostalgia, however, our everyday photos become an object of computational analysis for detecting human faces and interpreting emotional categories. Because contemporary techniques need to codify more complex visual information in everyday photographs, such as heads in various angles, complex backgrounds, faces of diverse genders and races, and various settings, contemporary techniques triangulate or diversify methods of identifying nostalgic photographs, for example, by analyzing time/space information of the photos and frequently appearing faces, as discussed in chapter 3. Even though the new circumstances might require additional algorithmic layers, the basic systems for detecting human faces and analyzing human facial expressions derives from the sets of psychological studies on human faces in physiognomic traditions that standardize human emotions on its facial expressions.

Following Ekman and Friesen's efforts to deconstruct human faces into anatomic units, contemporary algorithmic media detect human faces in photographs as well as reduce them to its mathematical essences in order to measure emotional states appeared in the facial movements. However, the algorithmic work is no longer creating discrete categories of facial movements. Rather, algorithms of automated nostalgia adopt the facial coding system and calculate the probability of facial emotions to judge its affective qualities. Building on the emotional categories that a set of psychological experiments provided, the algorithms treat affective dimension of the face as prior objects of measurment and automation to classify photographs inducing nostalgia in us. The structure of the photographed face is transformed into mathematical data that can be combined and calculated to mathematical probability of affective qualities, more specifically a broader sense of happiness that can invoke nostalgia. In the automated facial expression analysis, the universalization of emotions comes not simply from creating discrete categories of facial expressions but from the mathematical probability speculating whether the face represents "universal" happiness or not.

The next section explores what it means to speculate "universal" happiness to invoke nostalgia through automated facial expression analysis. In what follows, I argue that technologies for automated nostalgia, which build on the automated facial expression analysis, universalize our memory through its automatically calculated probability of "universal" happiness.

Automated Facial Expression Analysis of Happiness and "Universal" Memory

Emotient, which was the leading facial-expression analysis company that Apple acquired in 2016, began with a team of scientists and researchers at the Machine Perception Lab at the University of California, San Diego. The founding team has been devoted to developing machine learning and computer vision technology for facial behavior analysis, which it calls the Facial Action Coding System. Emotient's algorithms discern the subtle changes and expressions in the face and translate them into a "defined emotional reaction" (Emotient, 2014; cited in "Why Did Apple Acquire Facial Recognition Company RealFace?," 2017). The system processes facial detection of images/videos and automated expression analysis in real-time. Apple photo album's Memories feature is one of many services in Apple that use Emotient's algorithms of facial detection and automated expression analysis to curate memorable photos.

The cybernetic logic of turning images into mathematical language is instrumental for facial detection and its behavioristic emphasis. For automated expression analysis, the machine learning methods also build on the work of behaviorist psychologists to define universal emotions and its expressions, including Paul Ekman, who later joined Emotient's advisory board ("Why Did Apple Acquire Facial Recognition Company RealFace?," 2017). The facial coding around the eyes, nose, and mouth is crucial to identify the same people appearing in different photographs. In the process of selecting nostalgic images, facial expression analysis algorithms track and measure facial muscles and movements and classify them into emotional categories informed by Ekman and Friesen’s studies. Until Apple acquired the company in 2016, Emotient, where Ekman was a board member, was a market leader in facial coding. The members of Emotient patented the Automated Facial Action Coding System in 2009, and in 2014 Emotient obtained six additional patents for related algorithms and products that recognize, estimate, and measure facial expressions. Ekman and Friesen’s theories of universal emotions implicitly and explicitly shape contemporary algorithms of facial recognition and analysis by providing classifications and standards of human emotions that are incorporated into the archival logic of clustering and categorizing.

The new digital archive of everyday life constructs a categorical and quantifiable account of emotions based on a vast taxonomic ordering of images. In terms of constructing digital “memory,” the digital camera and photographic practices are integrated into a larger system of algorithmic memory practices that claim and facilitate the universal model of memory. The new apparatus, the algorithmic archive, engages not simply in determining the presence and absence of memory in photographs but also guiding what to remember and how to remember. Based on the psychological scales of human emotions and expressions, the algorithms classify the probability of movements into “universal” emotions. In the process of developing automatic facial expression analysis and its application to technologies for automated nostalgia, nostalgia emerges as an outcome of physical, not psychological, probability that is mathematically modeled and measured.

As algorithmic media develop, the emotion classification systems become algorithmic standards. While automatic facial coding provides more efficient and less time-consuming process, a computational analysis depends less on what the subject of expression really feels than how its expressions are seen to others and how the expression can be categorized into the algorithmic standards. Bowker and Star (2000) define classification as “a spatial, temporal, or spatiotemporal segmentation of the world” that works through mutually exclusive categories and “consistent, unique classificatory principles in operations” (p. 10). “Standard” is another significant term for Bowker and Star. Standard is “in part a way of classifying the world” as “any set of agreed-upon rules for the production of (textual and material) objects” that persist over time (p. 11). Some classifications can be standardized by going beyond the individual, local community, or limited time space. According to Bowker and Star, both are idealized in some sense by embodying “goals of practice and production that are never perfectly realized” (p. 15).

The goal of psychological experiments in physiognomic traditions were to make a “universal” classification system for all human emotions and facial expressions. By naming sets of moving facial muscles, they created segmentations of human emotions that any emotions and facial expressions can fit in. The system of classification is adapted to Apple, Facebook, and Google algorithms that speculate about the emotions revealed in photos in order to detect “happy” photographs and automate nostalgia. Here, the claim of “universal emotion” and the system of its classification become standardized by being shared between the computational algorithms.

Regardless of cultural contexts such as gender, race, class, ethnicity, national origin, or body’s ability, the universal algorithms detect the positions and movements of eyes, nose, and mouth to organize actions into the classifications at least between positive and negative emotions. The standardized classification systems, which have emerged in Western psychological studies, are used by a number of countries and communities. For example, Affectiva, an emotion measurement technology company, integrates their software into marketing to recognize global consumers’ emotions and reactions to the products and marketing messages (Affectiva, 2019). China is another leading country in the development of facial-recognition algorithms, which is used broadly, from policing practices to payment methods. Psychologists' efforts to encompass diverse populations to universalize emotions are now being realized by the algorithmic operations that apply the monolithic rules of classifications to all types of humans.

More importantly, in the automation of nostalgia, the standards of universal human facial expressions shape the ways in which human emotions are read. According to the facial action coding system, emotions can be identified by reading facial muscle movements. To read emotions, the system first identifies individual shapes and positions of facial muscles. Then, it should identify its relations with each category to classify what the face expresses. By positioning individual emotions into exclusive categories, emobided emotions, which are appeared in surface movements, are defined through its fit with the standards. Algorithmic media automate the processes of identification and shadow all photos to calculate patterns of mathematical language in the photo. Then, the algorithms compare them with coded standards to classify the moods and significance of the photo. The automated system of taxonomic ordering is operated repetitively to achieve the goal of algorithmic practices that "are never perfectly realized"—creating a new category of facial emotion: happiness that induce nostalgia (Bowker & Star, 2000, p. 15).

In this process, the automation of universal classification systems makes digital photographs into standardized digital objects that are produced under the unified scheme. Digital photographs are concretized into digital objects through algorithmic classification, organization, and definition, being placed in relation with other kinds of data. Concretization, a term theorized by Gilbert Simondon (2017), is a tendency of a technical object toward becoming stable and consistent functions. Through a process of concretization, abstract, or less specific, parts and functions of technologies become less modifiable and more individual to produce technical objects. Hui (2016) argues that digital is a contemporary mode of technical object's concretization. For Hui, digital objects are composed of "data and metadata regulated by structures or schemas" (p. 1). A process of classification, organization, and definition generated by specific metadata, data about data, places a digital object in relation with other data and concretizes the digital object.

Putting this in algorithmic memory practices, Apple, Facebook, and Google algorithms classify emotions expressed in the photographed facial expressions, organize digital photographs, and separate them into specific objects, which they call "memory." Their algorithms also classify certain objects contained within a specific image that invokes "positive" reaction, such as flowers, animals, and landmarks. Algorithms analyze photographs to create metadata that calculate the probability of emotions captured in or generated by photographs to concretize the new digital object out of an image. The digital image itself might be a digital object in relation with other data and technical objects, but algorithms make new digital objects, which are sets of images that aim to invoke nostalgia or "positive" reaction, by identifying, classifying, and organizing the images that have happy emotions.

This algorithmic operation produces a seemingly individualized digital object for each user. The new digital object shows specific photographs that contain things and people that might be special to individuals. However, the algorithmically generated "memory" is a standardized digital object that is produced under the unified scheme building on the universal classification system detecting a "happy" facial expression. Regardless of context or identity, everyone's algorithmically suggested "memory" has an identical form, a series of algorithmically curated joyful images. Human photographers' constant updates make memories seemingly fresh and new, but the nostalgic photographs and videos are nothing more than the algorithmic reproductions of identical digital objects. Even though contents might be slightly different, the forms are identical, reinforcing the typicality of emotions, especially happiness, that can fit into the algorithmic standards and the normality of life around weddings and travel, family, friends, and happiness. The products should be happy or positive to induce nostalgia and stimulate users' consistent engagement with the services or media. The algorithmically suggested "memory" is designed to satisfy the growing needs of users for the sites' profit. In the standardized classification of universal emotions, seemingly individualized memories are indeed variations of the same thing and products of algorithmic memory practices shaping identical objects and universalizing our memories.

Algorithmization of Memory Practices

The classified photographs are algorithmically assembled to become a multimedia narrative that aims to invoke nostalgia in us. When these standardized digital objects become conditions of experiences and memory practices, individuals become subordinated subjects, if they are unable to take critical insights or responsibility for their memory practices. Memory practices—acts of remembering and forgetting—have been crucial in shaping subjects. By constantly communicating between present and past, a certain type of subject is produced in relations to the techniques of remembering they are coupled with. In automation of nostalgia, however, the subject of remembering becomes the object of an apparatus that synthesizes human memory practices with algorithmic memory practices to create a new mode of experiencing memories.

Memory practices—acts of recalling, remembering, and forgetting—have been a crucial interest in memory studies focusing on the formation of autobiographical and cultural subjects. Van Dijck (2007) among many others, theorizes "mediated memories" as "the activities and objects we produce and appropriate" using media technologies "for creating and re-creating a sense of past, present, and future of ourselves in relation to others" (p. 21). Here, media technologies are not merely memory objects that statically hold or store our memories but actively shape our memories and identities. Van Dijck emphasizes mediated memories as significant sites for negotiating and shaping one's individual and collective identity across the past, present, and future. By emphasizing *acts* of producing and reviewing mnemonic objects such as photos, albums, letters, diaries, and videotapes, she argues that individual choices of what to capture, how to capture, and what to review are inherently intertwined with cultural forms and social conventions that jointly define what should be remembered. Through the sociocultural "normative discursive strategies," which explicitly and implicitly configure one's subjectivities, individuals engage in making sense of their life in relations to the others, to time, and to space (p. 7).

Humphreys (2018) expands Van Dijck's ideas of mediated memories to the contemporary context of social media, arguing that our practices of creating and re-viewing media traces construct the self. Humphreys emphasizes the practices of documenting our lives and the world around us to "remember, relive, reconcile, and reckon at future points" (p. 13). With her arguments about "the qualified self," she articulates how the practices of selecting, describing, reviewing, and interpreting our media traces convey a particular version of who we are, which allows us to interpret and understand selfhood.

In that, memory practices can be what Foucault (1997) called, “technologies of the self.” In every historical time, according to Foucault, there are unique technologies for constructing a certain version of the self. For Foucault, a subject is a product of relational forces between external forces of the social structure and the internal practices of accounting of the self (Foucault, 1997, 2012a). In the dynamics between two forces, a subject has never been an absolute position. In his theories of subjectivation, Foucault conceptualizes “technologies of the self” as the ways individuals govern and know themselves, which intersect with the external forces of power systems that discipline and/or control the subject, such as government, science, and prison.

The concept, “technologies of the self,” indicates the subject’s performance on their own bodies, thoughts, souls, and ways of being “to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality,” which is “the procedures […] suggested or prescribed to individuals [to] determine, maintain, and transform their identity through relations of self-mastery or self-knowledge” (Foucault, 1997, p. 86). Foucault argues that technologies of the self are always cultural and historical. In his essay, *Technologies of the self* (1997 [1984]), Foucault traces self-caring techniques to practices of determining, maintaining, and transforming one’s identity and state in the Stoics and in Christianity.

Among the Stoics, for example, students wrote letters about their daily life to disclose the conscientious and independent self. On the other hand, the Christian confession and the religious diary encouraged people to examine their life by reflecting on “what one has done and what one has had to do” (Foucault, 1997, p. 238). Historically, different techniques of contemplating one’s everyday life have been engaged in attaining a certain state of affect and shaping one's future behaviors. People recall what and why they acted in a certain way and reflect on their own modes of living, existence, and subjectivity in order to learn to govern their own life. In the Stoics and Christianity, the acts of writing and that which is written reflect on both the self and historical context.

Following Foucault, diary-writing has been understood as a technology of the self and an internalized discipline (Dijck, 2007; Humphreys, 2018; Hunter, 1992; Ong, 2013). Then, many scholars see the recording and re-viewing of one's digital photographs or social media posts as a contemporary version of diary-writing, which can be techniques to examine and discipline oneself, producing a socially normative and ideal self (Garde-Hansen et al., 2009; Humphreys, 2018; Pasquinelli, 2009).

As in Foucault's image of diary-writing, human users document what they have done and what they have felt by making and posting textual and photographic traces. Subsequently, they look back at the media traces of they used to be, what they have done, and what they have experienced. Humphreys (2018) argues that social media posts are strategic representations and performances of the self, constructing the "qualified self" (p. 11). Compared to Facebook posts, photos in Apple photo album and Google Photos are less public. In either case, the processing of inscribing the parts of life, like the Stoics writing, becomes the performances of the self that disclose the socially ideal self.

Today, this mode of self-examination is synthesized into algorithmic memory practices. Instead of being passive storage media, Apple, Facebook, and Google actively remediate users' inscriptions by turning them into standardized digital objects that can be algorithmically manipulated. The algorithmic media performs on one's bodies, thoughts, emotions, and memories to suggest a knowledge of one's past and a certain state of happiness. The automated process, following Kittler (1999), can transform the conditions of media infrastructure within which we develop understandings of ourselves, and ultimately shape, maintain, and transform one's understanding of the self. Even though human users might strategically select the photos and posts through its coupling with camera and social media, what they end up reviewing later is classified and standardized by the algorithmic operations, which suggest intentional organization of what one has done and what one has experienced that aims to evoke the state of happiness, joy, and nostalgia.

Thus, algorithmic memory practices, if it is without critical reflections on one's digital memory practices, resonate more with Foucault's understanding of apparatuses of subjectivation than with his concept of technologies of the self. Packer (2010) defines "apparatus" as "a strategically organized network of discursive and nondiscursive elements brought together to address problems resulting from specific formations of knowledge" (p. 89). The algorithmic archives implicitly create what memory is, how it should be remembered, and how it can be managed. Even though there are no explicit documents—user manuals telling us how to remember—the algorithmic operations themselves articulate when, what, and how to remember and standardize the memory practices. The algorithmic archives provide for the material functioning of an apparatus that synthesizes the memory practices of humans with those of algorithms to create a new mode of experiencing memories.

In Adorno and Horkheimer's (1997) theorization of the culture industry, they discuss "pseudo individuality" constructed by the consumptions of the standardized products (p. 18). By turning people into eternal consumers of predetermined values, individuation has never been achieved with passive and subordinated subjects who are unable to take autonomous and critical responsibility for their responses. In the automation of nostalgia, where memory practices become acts of recalling standardized memories selected by mathematical proabability, an individual who was once a subject of photographic practices, then becomes a nostalgic subject induced by the algorithmic analysis and curation of digital archives that follows the schema of universal emotions and facial expressions.

Conclusion

When photographs are stored in digital archives, they are not exclusively human property. Photographs become not only a means of inscribing significant moments but also objects of archival storage and algorithmic analysis, which characterizes and categorizes elements of memory—for example, time, space, and facial expressions—in the images. The inscribed photographs are continuously recalled, reworked, and reflected upon—not only by humans, as in the nineteenth and early twentieth century, but also by the algorithmic operations of Apple, Facebook, and Google. All inscriptions are categorized within the sophisticated forms of archives that reproduce the same schemes of processing. The rules of archival decision-making were historically constructed on the basis of Western psychological studies of human emotions and facial expressions. The science of human emotions created the systems and techniques of classification, and the algorithmic adoptions standardized the rules of classifications, resulting in an increasingly universal process of memory (re)production.

Algorithmic memory practices build on massive archives of digital inscriptions, the transcriptions of data about visual patterns into mathematical data, and the archival programming of categorizations. Memory has been mathematically and algorithmically produced across these three courses of socio-technical operations. Before the development of technologies for automated nostalgia, humans construct memory by narrativizing and making sense of the past. Storage media might provide new modes of experiencing time to humans; memory, which is actualized in time, has been primarily linked to the human sensory and storage capacity of remembering. Because individual memories are always incomplete and uncertain in the flow of time, memories are recalled to individuals externally and collectively through social groups (Halbwachs, 1992; Huyssen, 2003; Zelizer, 1995) and/or material and technological media (Bollmer, 2011; Kittler, 1999; Landsberg, 2004; Stiegler, 1998; Sturken, 1997). Then, humans (re)construct the recalled memory or explore plural narratives of a certain memory in relations with their temporal experiences and present conditions. The pluralism of narratives and transformativity have allowed productions of memory to resist a dominant, ideological, and singular narrative of the events (Foucault, 1980; Huyssen, 2003; Sturken, 1997; Young, 1992) and to intervene in a molar, enslaved, and fixed identity (Braidotti, 2011; Deleuze, 1987; Deleuze & Guattari, 2004; Felix Guattari, 2005).

However, in algorithmic memory practices, what appears as memory is the algorithmic standardizations of already stored images which have been classified according to standardized categories based on the science of emotions and mathematical measurements. The science of cybernetics is instrumental to the archival operations, but the rule of arrangements is linked to nineteenth-century physiognomic classifications of human faces and psychological standards of human emotions. In the new memory apparatus, subjects of remembering and memories are produced by the algorithmic detections and programming of visual and textual documents. Algorithmic media are able not only to store memory but also to construct it externally as a standardized and universal digital object.

The automation of nostalgia is pervasive in twentieth-first century media and is becoming the dominant socio-technical culture of remembering. In this new era of automated nostalgia, individuals are at once the subject of memory, then they become the object of the archive in motion that categorizes and idealizes invisible, inaccessible traces of digital memories stored in the archive. The camera is not a sole apparatus of determining what can and cannot be remembered. The algorithmic archives distinguish the past from the present, determine the memorable and the forgettable, and standardize what, when, and how we remember.

This analysis does not mean that the algorithmic curation of photos is the only way in which contemporary memory practices produce knowledge of the self. However, when we give up responsibility for careful curation of our digital memories and fail to examine our reactions to "universal memory" critically, automated nostalgia becomes more central. Increasingly, it shapes and influences our actions, our memories, and our acts of remembering and forgetting by algorithmizing procedures of understanding the self. The automation of nostalgia becomes a more and more powerful socio-technical apparatus of discipline and/or control that shapes, prescribes, and transforms the ways of being joyful nostalgic subjects.

In that, the next chapter articulates the implications of becoming nostalgic subjects and discusses possible practices to be responsible for our data and to create a new habit of digital memory practices. As a conclusion of this project, the following chapter also suggests the summary of previous chapters and directions for future research.

CHAPTER 5: THE AUTOMATION OF NOSTALGIA

Throughout this project, I have reviewed the socio-technical cultures of algorithmic memory practices, the *automation of nostalgia*. Given the active and autonomous role played by algorithmic media in acts of recalling the past, I have sought to illuminate the technical and discursive rules for technologies of automated nostalgia and to examine the specificity of algorithmic media in shaping memory and memory practices through three interrelated histories around automated nostalgia.

I began by examining, in Chapter 2, the temporal architectures of Facebook, an early developer of algorithmic memory practices, and analyzing the production of new temporal experiences of nostalgia through the algorithmic processing of stored photos and texts. In the history of Facebook's development of memory-related services, Facebook has reorganized temporal orders of stored posts to suggest new temporal experiences. I focused on the development of those services from the Facebook Timeline to the Facebook Memories feature, showing how they reorganize and recirculate selected posts to create a sense of nostalgia. Facebook's algorithms for Memories, the feature that produces a nostalgic video out of users' posts, gauges users' attention and mood by tracking and quantifying users' behaviors, such as commenting, liking, and (un)friending. The algorithmically generated videos of selected posts dramatize the past by (re)organizing photos, music, backgrounds, and captions, presenting idealized versions of a joyful past that aim to evoke nostalgia.

Since Facebook's early efforts at creating memory-related services, algorithmic memory practices have become more prevalent and sophisticated through the addition of analytic layers or technologies in an effort to avoid repeating "algorithmic cruelty"—unintentional reminders of painful memories ("Inadvertent Algorithmic Cruelty," 2014). In addition to quantifying users' attention, algorithms began to track users' behaviors in and out of the platforms and to detect emotional traits that appeared in photos. Technologies for automated nostalgia are no longer static spaces of storage, but active archives that modify what is stored under the algorithmic rules to classify, reassemble, and reanimate the textual and photographic inscriptions in order to invoke nostalgia in us. When Apple, Facebook, and Google notify us that we "have a new memory," that "memory" is shaped outside of the human body's sensory and storage capacity to hold and construct memory.

Chapter 3 traced the emergence of mathematically identifiable, measurable, processable, and transmittable "memory." I discussed the science of cybernetics as a genealogical origin where the idea of memory in algorithmic media was conceptualized. The science of cybernetics theorizes the communication systems between humans and machines, building on the transmission model of communication. The focus on the transmission of signals between humans and machines meant that human behaviors needed to be mathematically modeled and assumed that this mathematic modeling was possible. For cyberneticians, human and machine are alike in that both are self-learning and automatic entities that transmit information and generate patterns of behaviors. I suggested that the cybernetic understanding of communication conceptualizes "memory" as an interchangeable term between humans and machines by conceptualizing them in cybernetic feedback systems.

With his emphasis on self-learning machines, Norbert Wiener's idea of memory is the synthesis of storage and recollection. The automatic entities in cybernetic feedback systems do not simply store current actions; they also respond to changes in the larger system. At every retrieval of stored memories, the actions are not simply repeated but continuously adjusted and modified. The cybernetic system is not simply storage, but an archive that stores, processes, and utilizes information for future actions. Wiener envisioned the technical synthesis of storage and recollection in his idea of cybernetic memory. Also, Wiener's behaviorist perspectives provided another clue to understanding the legacy of cybernetic theory for the conceptualization of memory. By emphasizing communication between humans and machines, cybernetic systems capture only observable and measurable patterns of behaviors. The internal cognitive processes, including memory, become less important in cybernetics if they are not translated into action. Even though Wiener did not explicitly define or mention memory in his behavioristic theories, his writings show how cybernetic theory reduced memory to observable patterns, without considering the contexts or internal meanings through which memory is constructed.

These cybernetic understandings of memory are utilized in the conceptualization and design of the algorithmic archives that automate nostalgia. First, the archives technically synthesize storage and recollection by algorithmically processing data of stored photos and texts. Our photographic inscriptions are not simply stored but continuously processed to be recirculated as materials for invoking nostalgia in our memory practices. Second, the algorithms follow the rules of cybernetic analysis of behavioristic patterns. Algorithmic archives capture and analyze users' behaviors on the platform and facial behaviors detected in photographs. From Facebook to Apple and Google, algorithms track and quantify users' patterns of actions and facial expressions in order to select posts and photos that are likely to invoke nostalgia. This behavioristic analysis turns out to be nostalgic "memory," which is, indeed, mathematically modeled, processed, and analyzed patterns of bodily and facial behaviors in the legacy of cybernetics.

In Chapter 4, I argued that the algorithmic media drew on principles of Western behaviorist psychology to generate and circulate "universal memory." To evoke nostalgia through selected photographs, algorithmic media were coupled with two interrelated fields:

Western psychology of human emotions and the computational analysis of human faces. Following Facebook's efforts to add more analytic layers, facial-recognition algorithms were integrated to classify memories and create nostalgia in other memory-related features such as Apple Memories and Google Photos. In this technological transition, the photograph becomes a tool and a means of psychological and computational analysis. Algorithms treat a photograph as a site of mathematical information, which allows them to calculate values of angle, position, and orientation of the face, as they appear in the photograph.

Then, through mathematical calculation, algorithms *identify* and *classify* the emotions detected in the photos. The rules of classification build on the Western psychology, specifically sets of psychological experiments on human facial expressions and "universal" emotions. Through sets of experiments, scientists and artists claimed that emotions were universal and conceptualized categories for classifying human emotions. Their understanding of emotions was inherently behavioristic. They observed and classified facial muscle movements to categorize "universal emotions," which would later become essential to the facial-coding system of contemporary algorithmic media. Technologies for automated nostalgia conduct a computational analysis of human facial expressions, or the facial muscle movements, operationalizing and extending the categories of universal emotions. Algorithms deconstruct photographs into numerical values and pixels in order to measure facial muscle movements and classify the associated emotional traits, creating the technical conditions for detecting "universal" happiness and universalizing memory.

In this algorithmic process, memory becomes a standardized object produced under the logic of capitalist cultural production. Even though human photographers' constant updates might make the curated images seemingly fresh and new, the nostalgic photographs and videos are nothing more than algorithmic reproductions of standardized digital objects. When we consume these standardized digital objects, which appear as memory, the subject of remembering becomes the object of an apparatus that synthesizes human memory practices with algorithmic memory practices to create a new mode of experiencing memories. Reading and writing one's life used to be important "technologies of the self" as Michel Foucault argued in his examination of Stoics and Christian practices, which were efforts to transform their thoughts, souls, and ways of being to become a conscientious, wise, and moral self. By algorithmizing memory practices, however, reading and writing one's life—Foucault's technologies of the self—become incorporated into algorithmic operations that implicitly suggest when, what, and how to remember, exerting more and more technical influence on our practices remembering and forgetting.

In these processes, discussed throughout previous chapters, memory is reconceptualized and circulated in new ways. When algorithmic media consistently and regularly call on us to re-view "memories" they have generated, "memory" comes to mean standardized digital objects created outside of human bodies. These new digital objects are results of the standardized reproduction processes operated by cybernetic archives: 1) identifying emotions appearing in a photograph and/or a post, and 2) classifying the photographs into algorithmic standards of human emotions, and 3) algorithmically assembling those digital objects into multimedia narrative. The aim of these processes is to create digital objects that portray an idealized past and produce a nostalgic subject who constantly revisits the past through technologies for automated memory. When we become a nostalgic subject by consuming algorithmically created digital objects, algorithmic operations circulate a newly conceptualized form of memory and promote new modes of memory practices that manage one's experiences, emotions, and modes of engaging with one's past.

Nostalgic Subjects

Becoming nostalgic subjects is problematic not simply because memory is constructed by algorithmic operations outside of human bodies, but because these nostalgic subjects are caught in increasingly standardized and universal logics of subjectivation. By examining the technological and discursive rules of this process, this media-archaeological analysis ultimately problematizes the way nostalgic subjects are produced in semiocapitalist processes of subjectivation, where memory practices are turned into forms of labor and capitalist value in cybernetic feedback loops.

In memory practices of automated nostalgia, our memories are disassembled into sets of data and then reassembled into patterns—patterns of behavior, usage, update, and reaction. Especially after the development of social media, digital memory practice became a means of collecting data about the self, including personal taste, time/space information, emotions, actions, and faces. The collected data are analyzed to find patterns and are connected to other data for future uses. Actions we undertake with social media and algorithmic media to record and remember moments of our lives—inscribing, updating, revisiting, rating, and deleting—turn into data that generate patterns. In the automation of nostalgia, "memory" is algorithmically created by reassembling data of our bodily and facial behaviors into new digital objects such as Facebook Memories compilation videos. Acts of viewing these digital objects, including our reactions to their algorithmic curation, are also converted into data in order to modify future operations, just as in cybernetic feedback systems. The more digital traces we leave, the more "accurate" digital objects are produced.

In these algorithmic operations, subjects of memory practices become *dividual* elements, which will be reassembled into observable patterns through algorithmic arrangements. Lazzarato (2014), building on Deleuze and Guattari (2004), articulates a new process of capitalist dividuation, "machinic enslavement." While Foucault's theory of subjectivation emphasizes the way subjects *produce* themselves as actors who exercise disciplinary actions assigned by discursive rules over their bodies, which Lazzarato calls "social subjection," machnic enslavement occurs through *control* and *management* of socio-technical machines such as media. In machnic enslavement, the individual is no longer an individuated subject or actor but "a component part" in assemblages (Lazzarato, 2014, p. 25). Our actions are converted to data and fed into circuits of capital—selling data to advertisers and data surveillance for the site's profit—regardless of whether the subject is produced or not in the process.

This mode of dividuation precisely resonates with what Deleuze (1992) describes as control society, and the database/dividual pair as distinguished from the mass/individual pair in the discipline society or social subjection: "[i]ndividuals have become 'dividuals,' and masses, samples, data, markets, or 'banks'" (p. 5). Control society or its system disassembles our bodies into data "which in no way attests to individuation—as they say—but substitutes for the individual or numerical body the code of a 'dividual' material to be controlled" (p. 7). The dividuals are contiguous with machines, constituting assemblages in which humans and machines are "recurrent and interchangeable parts of a production, communications, [and] consumptions" (Lazzarato, 2014, p. 26). We no longer act and individual subjects but function as points of “connection, junction, and disjunction” of flows in the assemblage (Deleuze, 1987; Lazzarato, 2014).

In the automation of nostalgia, on the one hand, we act and exercise modes of remembering induced by technologies for automated nostalgia, as I discussed in Chapter 4; on the other hand, we become dividuals and components of algorithmic memory practices that are later synthesized to be the digital objects, which they call “memory.” This machinic enslavement modulates techniques of human memory practices and assigns them algorithmic modes of memory practices. Nostalgic subjects are constructed in between these two modes of subjectivations. As human components of algorithmic memory assemblages, we produce moments of synthetic subjectivation through embodied memory practices. Then, the memory practices are integrated into the behaviorist patterns that appear and are captured in the contents, which are later transferred to a “semio-capitalist” (Genosko, 2012; Lazzarato, 2014) digital object that produces psychic stimulation, nostalgia for their past and, more importantly, positive responses for their sites and services. Our memory practices are caught in machinic enslavement induced by standardized, universal, and semiocapitalist digital objects, dividuating into digitally enslaved bodies.

With capitalist logics, memory practices become “immaterial labor” that produces “immaterial products, such as knowledge, information, communication, a relationship, or an emotional response” (Hardt & Negri, 2005, p. 108). Our memory practices with technologies for automated nostalgia have creative and affective dimenions, which must be captured by capital and turned into capitalist value as media sites. With the economy of immaterial labor, all actions for remembering are fused to the production of capital. The digital objects, which appeared as nostalgic on purpose, trigger automated memory practices that must be later transferred to semiocapitalist values by algorithmic operations. Memory practices are machinically enslaved.

Technologies of memory practices and that of control become inseparable or integral. When we update a certain aspect of everyday life and react to the algorithmically curated past, institutional and entrepreneurial logics capture the desire for remembering and turn it into data for capitalist profits. As cybernetic feedback systems, these systems work continuously and extensively. As I addressed in Chapter 3, cybernetic systems continuously repeat processes of documenting behaviors, analyzing patterns, and predicting future actions. In Chapter 3, I argued that cybernetic archives of automating nostalgia document, analyze, and predict human bodily and facial behaviors to produce algorithmically generated memory. However, those technologies for automated nostalgia belong to larger systems of cybernetic documentation, analysis, and prediction, which are governed by capitalist logics.

Technologies for automated nostalgia that utilize photos of individual faces may turn out to be new technologies of control in the future. While we engage in algorithmic memory practices, inscribing and reviewing memories in our media platforms, we are "voluntarily" but unintentionally joining new sets of cybernetic documentation that gather and analyze new data of the self for different usage in the future. Once we "consent" to the terms and policies and document some moment of our life, the digital memories, or digital traces of memory practices, begin circulating forever, to be used for additional purposes. Even though Apple, Facebook, and Google claim that the algorithmically generated memory is their gift to users who have used their services, we will not know how they may be turned into new products or new modes of control until the new technologies and technics are settled. Memory practices, which used to be significant technologies of the self for Michel Foucault, become capitalist techniques of creating a standardized and profitable self in contemporary and future media.

Then, what can we do in response to this machinic enslavement of memory? This project calls for us to explore alternative memory practices, rather than accept and consume memory that is conceptualized, processed, and suggested by algorithmic operations of socio-technical norms. When the nostalgic subjects reproduce and reinforce data surveillance and memory practices driven by capitalist logics, we need a new politics that intervenes in the contemporary socio-technical production of memory as a quantified pattern, a byproduct of recorded actions, and a universal digital object automating nostalgia and capturing desire for remembering. What could be modes of technologies of the self that examine "distributed cognition" (Hayles, 1999), "synthetic subjects" (Wiley & Elam, 2018), or "para-selves" (Rotman, 2008) in human-technical assemblages? The new politics should entail new engagements with memory that change our habits of remembering and open potential ways to take control of caring for "para-selves." To that end, this final chapter suggests self-tracking as an alternative practice that can discover new habits, practices, and interventions, moving toward new modes of subjectivation in/through memory practices.

Toward Posthuman Memory Practices

Posthuman subjects are always synthetic. Posthumanism does not argue that we are no longer human, but reconceives "who we are as human beings in relation to the other-than-human world" that we have inhabited (Adams & Thompson, 2016, p. 5). With an emphasis on a fluctuating and unsettled production of selves operating between our organic bodies and our material surroundings, posthumanist theories prefer to discuss hybrid and heterogeneous becoming, rather than anthropocentric and autonomous human being (Bennett, 2009; Deleuze, 1987; Deleuze & Guattari, 2004; Hayles, 1999; Hui, 2016). Thus, posthuman theories understand a subject as a historical becoming, which is intertwined with technologies that exteriorize our memory and condition our experience, as Stiegler (1998) argues through his term "technogenesis" and "epiphylogenesis."

Following a posthumanist understanding, I argued that the nostalgic subject is a subject grounded in mixtures of embodied memory practices and heterogeneous elements, such as temporal architectures, the science of cybernetics, computational and psychological analysis of human emotions, and algorithmic manipulation of desire. By revisiting traditional or previous technologies of the self, such as writing and reading, and linking these to the technical process of automation and algorithmic standardization of memory, this section suggests self-tracking as a practice generating conditions for new modes of subjectivation, which might shift agential power in heterogeneous assemblage and contribute to the active agency in the assemblage.

The concept of self-tracking has recently emerged in discussions of digital technologies and mobile devices that collect, measure, and display one's body and everyday life. In June 2009, Wired magazine published a special issue with five articles on new technologies that quantify and track people. By illustrating new technologies that monitor one's running, health, and nutrition, the issue emphasizes how the contemporary self is observed through and understood as an assemblage of quantifiable data. Starting from the special interest of Wired magazine, a growing number of literature has focused on novel self-tracking technologies and individual or collective practices of tracking quantified data (Bentley et al., 2013; Khot, Mueller,

& Hjorth, 2013; Li, Dey, & Forlizzi, 2011; Lupton, 2014, 2016; Pantzar & Ruckenstein, 2017; Ruckenstein & Pantzar, 2017; Schüll, 2016; Selke, 2016).

Self-tracking refers to “the practice of gathering data about oneself on a regular basis and then recording and analyzing the data to produce statistics and other data (such as images) relating to regular habits, behaviors, and feelings” (Lupton, 2014, p. 1). The concepts build on an increasing number of devices and apps that constantly read body metrics and automatically collect data on bodily functions such as physical movement, heart rate, pulse, body temperature, and neural activity. Some people actively track the quantified data of the self to understand and maintain a certain level of mental and physical condition.

Despite their focus on technologies and data practices for health and fitness, the research on self-tracking provides significant insights for theorizing how one’s practices of producing and reviewing data assemblages can be new modes of self-care and self-examination. With mobile and digital devices that collect detailed and continuous data about everyday interactions, behaviors, and bodily functions, the knowledge of the self is constructed beyond one’s organic memory and manual inscriptions. Lupton defines self-tracking more broadly, which indicates not only “quantifying aspects of one’s lives using digital technologies” but also “using pen-and-paper to record such details” as their reflections, plans, appointments, and body metrics over time (Lupton, 2016, p. 8). In addition, Lupton’s self-tracking practice integrates further actions to make sense of the numeric data of the self. In addition to tracking and collecting data of the self, Lupton emphasizes interpreting and using data in various ways to discern patterns in the data.

Applying Lupton’s idea of self-tracking, I suggest self-tracking practices of one’s distributed, synthetic, and para-memories as new modes of technologies of the self that examine the principles of action that govern one’s life. As part of my pedagogical practice, I have facilitated in-class workshops in college classrooms at North Carolina State University in which I encourage students to find ways of taking control of their digital data and using it to discover what their habits and create new habits. The workshop encourages participants to gather and discover digital traces about themselves regularly and then to examine how the self is datafied within capitalist logics. Participants first learn the process of machinic enslavement, the way we are disassembled into data and then reassembled into patterns captured by capital, such as advertising or data surveillence of users' habits. Participants in this process request a copy of their data from applications and social media sites such as Apple, Facebook, Fitbit, Google, and Snapchat. Despite the inherent power gap of accessing to data infrastructure between corporate and user, many sources of data are now available to download for users[8]. Upon request, the media company sends a collection of the data file for individual users. I suggest that this long process of downloading, reviewing, and examining inscribed and collected data can operate as a contemporary version of Foucault's "care of the self."

The quantitative and qualitative analysis of and reflection of our digital traces helps us to understand both the objectives these sites pursue and the objectives we want to pursue as caring

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[8] Most of social media sites currently allow us to download the data about us that they gathered and preserved. All the users can request and download the data file though following procedures:

1) Facebook: We can request downloading data at "Facebook Settings," which is in "Facebook Information" of one's account. User can add or remove which categories of data they want to download. Depending on the volume of data stored in Facebook server, it may take several days for Facebook to finish preparing the download. For Facebook, people who don't have Facebook account also can request data about them that Facebook might hold through their Friends network.
2) Google: Google provide "Download your data page" (https://takeout.google.com/settings/takeout) that allows users to download their data stored in all Google products. As Facebook does, users can select which categories of data they want to download in the page.
3) Apple: User can find "Privacy Contact Form" link under "Access to Personal Information" at Apple's Privacy Policy page (https://www.apple.com/legal/privacy/en-ww/). After selecting "I have a question about privacy issues" in its drop-down box, user can leave note in the comments box that s/he requests a copy of personal information.
4) Snapchat: After logging into personal account, user can see "My Data" and "Submit Request" button at the bottom of "My Data" page.

for the datafied self. By examining what one has done and what the sites have done with our data, we can generate knowledge about hybrid and heterogenous becoming. Data provide material, technical modes of sensation and memory that are not unified in the human "I" but located in disparate parts. Deleuze and Guattari (2004) articulate a dispersed subjectivity distributed across diverse desiring machines, suggesting a tendency toward changes by making different connections in the assemblage to transform the encoded flow. Self-tracking practices allow us to discover existing habits and create new connections, new practices, and new habits.

For example, the data examination might entail an analysis of new habits of memory practice. Chun (2016) argues that "our media matter most when they seem not to matter at all, that is, when they have moved from the new to the habitual" (p. 1). When certain media become overly familiar to us, users become objects of media operations and analysis that stream, update, inscribe, and share information about the actions. Habits become important elements of subjectivity because it creates and maintains the tendency and mode of living. Without understanding the way we appear as data and patterns, we habitually update, share, rate, and revisit to remember. By contrast, a new mode of caring for the self can lead users to develop new habits of pushing back against the ubiquity of datafication. For example, they might disconnect social media, delete contents in social media, or reduce the importance of social media in their life. These new habits fight not only for "the right to be forgotten" but also for "the right not to be stored in the first place" (Chun, 2016, p. 172).

The creation of new habits can extend to activism against datafication. For example, *Our Data Our Selves*[9] is a web page introducing and sharing projects about how personal data become an asset and capital in a digital society for different stakeholders, and how these

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[9] Our Data Our Selves: https://ourdataourselves.tacticaltech.org/

stakeholders are exerting control over citizens and civil society. This initiative is conducted by Tactical Tech Project, a non-profit organization in Berlin. By providing three interrelated sub-projects (Data and Activism; Data and Politics; Data and You), they explore technologies, actors and strategies behind the data collection, as well as the political and social impact of the use of personal data worldwide. These individual and/or social practices produce the new “line of flight” that connect different points in an assemblage to transform the encoded flow (Guattari, 2015). By changing habits or creating an intervention in practices of habitual updating, new subjectivations can be possible, which may lead to creating the new line of flight that intervenes in the flow of capitalist logic.

Techniques from the critical-making movement can also be coupled with self-tracking practices. Ratto (2014) frames critical making as “materially productive, hands-on work intended to uncover and explore conceptual uncertainties, parse the world in ways that *language cannot*, and disseminate the results of these explorations through embodied, material forms” (Ratto, 2014, p. 227; emphasis added). Critical making emphasizes the importance of “making” as a way of intervening in the dominant modes of living and social life. These material and embodied practices trigger creativity. As Guattari (2005) suggests, certain aesthetic regimes of subjectivation can liberate us from the singularity that is repressed by a dominant and dominating media subjectivity. Thus, self-tracking practices can be extended to activities of critical making that explore and construct the self in more liberatory ways. In Lupton’s original idea of self-tracking, Lupton also introduces critical-making projects as process of materializing and grasping quantified data. For example, Exertion Games Lab uses 3D printing to produce material artifacts that represent individual data tracked by wearable digital devices (Khot, Hjorth, & Mueller, 2014; Khot et al., 2013). This process of making can increase the power of bodies involved in an assemblage, allowing us to move from passive and reactive to active and powerful bodies "whose resulting joy and power are greater and, simultaneously, whose *knowledge* of that shift adequately incorporated its causes" (Wiley & Elam, 2018).

When our memory practices are increasingly integrated into algorithmic operations, these self-tracking practices can be new modes of caring for the self by reflecting on one's digital traces, examining individual and corporate goals, and producing alternative practices or new habits for future. When human subjects or human memory practices are no longer an extractable entity in the assemblage, this project suggests to begin with understanding the role of technologies in the subject. The examination provides knowledge about hybrid and heterogenous self that is caught in capitalist logics while we habitually and voluntarily leave data as a part of memory practices. The new mode of self-examination can open new possibilities by creating responsible data practices and new habits for their life.

Directions for future research

In this section, I conclude by suggesting some directions for future research. This project builds on the posthumanist understanding that the human subject is no longer an extractable entity in the assemblage of organic, technical, and social elements—if it ever was (Stiegler, 1998). When subjects are made in relation to the sociotechnical assemblage, posthumanist theories begin with understanding the roles of technologies in subject formation (Kittler, 1999, 2014; Lazzarato, 2014; Peters, 2015; Stiegler, 1998). Starting from Kittler (1999) who argues that the technical milieu inherently determines the media situation in which subject's capacity for memory is defined, this project examines the technical and discursive decision rules of algorithmic media as the conditions of contemporary memory practices. With Stiegler (1998), I explore the constructions of nostalgic subjects in relations with algorithmic archives that construct a collective memory of the assemblage. Also, this project has not only explored, archaeologically, the specific affordances and capacities of algorithmic media in capturing, processing, storing, and reanimating information; it has also genealogically traced the socio-technical conditions for the development of algorithmic memory practices.

This project's genealogical account of the conceptual emergence of algorithmic memory can be extended in future research examining "the clashes of power that resulted as multiple technologies were (counter)posed as potential solutions within a problematic field" (Monea & Packer, 2016, p. 3145). While I have focused on the genealogical conditions of algorithmic memory practices that mathematically measure and process memory, I have noticed a long and conflicted history of different services, applications, and technologies that predeate the stabilization of contemporary forms of algorithmic memory practices. The automation of nostalgia is a radical shift in attitudes to recording, displaying, and reanimating memory. By examining multiple technological initiatives in the history of technologies and techniques for recording, displaying, and reanimating, this research can be expanded to more fully trace the genealogy of automated nostalgia.

Second, this project is focused on the archaeology and genealogy of three global media companies —Apple, Facebook, and Google— and their services as they have been developed and popularized in the United States. As one of the key arguments and contributions of this project, I articulated the legacy of cybernetics and the Western behavioristic psychology as important influences that shaped the development of algorithmic memory practices. During my research, I have observed that the discursive and technical rules of algorithmic memory practices are increasingly internationalized. Facebook is a worldwide service except for a few countries that have banned access, including Bangladesh, China, Iran, and North Korea. As of November 2018, Apple offers its products to 24 countries and Google offers the Google Photos service in 27 countries worldwide. With the globalization of media platforms and services, their technical and discursive rules are duplicated or adapted internationally. The international adaptation and application of these services should be further examined. Specifically, the Western-based behaviorist psychological classification of human emotions has become the socio-technical standard in global adaptations. Drawing on theoretical frameworks of cultural studies, further research should explore the clashes of race, gender, class, and body's ability in the algorithmic operations as well as cultural differences in the bodily expression of emotion. Recent research has started to focus on how the algorithms produce or reinforce discrimination based on class, gender, and race in North America (Eubanks, 2018; Noble, 2018; Pasquale, 2015). However, the scope of algorithmic operations is not always local or national. Examining those issues of power in the international context would help illuminte the ways in which how algorithmic operations are reinforcing or transforming inqualities of gender, class, race, and ability in the context of globalization, issues that were central to previous discussions in cultural studies.

Lastly, I suggest that we need new empirical practices of remembering, as well as new research on critical posthuman memory practices. Posthuman theories give insights to understand humans, or human memory practices, as only one possible mode of analysis. By understanding the subject as the product of an assemblage, the process of becoming a certain subject and caring the self needs to be understood in the larger and smaller scales that include media and technics of memory practices. Experimental practices and empirical research at individual, social, and institutional levels will help us discover alternative subjectivations and ways of becoming active and joyful subjects. When we are caught in processes of algorithmic becoming-nostalgic, we must examine how our memory practices are caught in the larger logics of capitalism and surveillance and develop new ways to reengage with our memory practices that entail a change in our habits of updating, using, reacting, and remembering.

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