

Preface

Creditors have better memories than debtors. (Benjamin Franklin, January 17, 1706–April 17, 1790, one of the Founding Fathers of the United States)

Mnemosyne (Greek Μνημοσύνη), the personification of memory in Greek mythology, was the daughter of Gaia and Uranus and the mother of the Muses by Zeus. Zeus and Mnemosyne lay together for nine consecutive nights during which the nine Muses were conceived. Mnemosyne ruled over a pool in Hades, a counterpart to the river Lethe.¹ One of the five rivers of Hades, the Lethe, which flowed around the cave of Hypnos and through the underworld, was the river from which the souls of the dead drank so they would not remember their past lives when they were reincarnated. Initiates were encouraged to drink from Mnemosyne's pool when they died, rather than from Lethe which induced to oblivion, in order to learn from their past so as to achieve a higher level of wisdom.

This is a book about technologies that allow us to store large quantities of data and provide reliable storage devices. We describe the techniques and methodologies that allow us to store data, large quantities of data, just (or precisely (choose the better word)) called mass memories storage.

However, memory is not an issue that concerns only technicians, engineers, and physicists, but is also very important in the philosophical tradition.

Just think of Plato and Aristotle: when Plato said that all knowledge is reminiscence, his concept was related to memory or, better still, closely linked to memory. That is, he thought that everything that we know is the memory of what we learned in another life, in another world, before falling into this world. On the other hand, in Aristotle's philosophy, the perspective is entirely different. Aristotle carefully distinguishes between memory and reminiscence. Memory is that phenomenon by which we remember things of the past, whereas reminiscence is the attempt to recapture a missing piece of the past. Thus, reminiscence has an aspect of consciousness that is somehow absent in memory. In contemporary culture there is great interest in regard to memory, an interest that is not exclusively the realm of philosophers, but

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¹The term comes from a Greek root, *leth*, “forget,” from which derives *alètheia*, “truth” with the alpha privative, thus indicating “that you never forget.”

is of interest to neurologists, psychologists, psychiatrists, scholars of the brain in general, and of course technicians.

However, memory is not confined simply to the acts of storing and subsequent recall, but is deeply rooted in the mind of man, who is terrified of being forgotten. Our desire for immortality, whether or not we believe in the immortality of the soul, is still strong. The idea of not being forgotten is so vast that it reflects a peculiar expression: we are full of objects that bring to mind something; limited to the people. Cemeteries are places that bring to mind people who are missing, as well as monuments, steles, tombstones; in short they provide a way to idealize a presence that no longer exists, in a physical image, to recall something.

In the film *Blade Runner*, there are characters called “replicants,” artificial beings identical to the humans among whom they live, who do not know that they themselves are not human. And that is their problem. When one of these androids realizes that he or she is not a real human being, but a replicant (a creature who has a memory that has been inserted in his or her brain as in a machine and is not a real memory), there is a crisis. The concern that the memories are false causes terrible anguish because the replicant has no memory or nostalgia for the past. The absence of nostalgia, the absence of memory, is a loss of identity. If we did not have our memories we would not know who we are.

Personal identity is based on memory, on one’s autobiography. I know that I am the same person that I was when I was 3 years old, and this is an absolute certainty, Hume would say, even if that knowledge is not confirmed in any way it is nonetheless an absolute certainty that comes from memory and from the use I make of that memory. How my identity is defined by my personal memory. Thus in the same way, within certain limits, I can say that the identity of a group is defined by its memory, so much so that every group, every party, or any human community, e.g., a group of people who gather to play cards, create symbols that recall the aim or purpose that its members somehow found for themselves.

Modern techniques tend toward retaining all data. Teenagers keep text messages that have been exchanged by phone, pictures, virtually everything possible, and then never look at them again.

However, a person who could remember everything would be in a frightening, pathological, situation. In Borges’ story *Funes el memorioso*, Funes is a man who cannot forget anything, and since he cannot forget, he has no memories, but only a huge crowd of things that kill the mind and brain. He not only recalls a glass on a table, but also sees all the clusters of grapes that make up the pergola is over the table and remembers all the fabrics that he has ever seen in the same way as he remembers that specific glass. That is, he remembers individual things, moment by moment. He has no memories because if there were no oblivion, there would be no memory. There would only be a frightening awareness of remembering everything.

In ancient times there were arts of memory and there were people who used these art or claimed to use them, saying that by way of these arts they achieved quite fantastic effects. We find this in Cicero, in Quintilian, in the ancient rhetoric, in Thomas Aquinas, and in the great mnemonists of the fifteenth and sixteenth centuries. The technique was to take a physical place, such as a church or a house with

many windows, many columns, in short, a place that could be easily represented geometrically, and store it in the mind in a complete and absolute way, being certain not to miss the “loci,” the so-called “places” of memory. Images are located in these places much like images on paper. That is, the places are fixed and I cannot change them, for if I change them, I have built another system—the images are movable, like writing on paper. In this case the art of memory is to place the pictures in their proper places. Then, if the environment is very familiar to me, as I review sites, I again see one image after another. These images are such that by association or contrast I recall the thing that I have to remember.

A rather complicated affair if we think about it, because it is more involved than what we commonly do when we remember. What features those images must have? Pietro di Ravenna, who was one of the most famous theologians of the “*ars memorativa*” of the Renaissance, said they must be images that excite the imagination, so much so that one should hesitate before turning to an audience that is obviously chaste and not sinful, for it must not have sinful images. But his best piece is to think of nude women in particular places, because, he says, men remember the image of a naked girl better than any other image!

“And when they ask us what we’re doing, you can say, WE’RE REMEMBERING. That’s where we’ll win out in the long run. And someday we’ll remember so much that we’ll build the biggest goddamn steamshovel in history and dig the biggest grave of all time and shove war in it and cover it up.” (Ray Bradbury, *Fahrenheit 451*, born on August 22, 1920, American fantasy, horror, science fiction, and mystery writer).

In the painting *The Persistence of Memory* (more commonly known as the *Flabby Watches*, 1931), Salvador Dali deforms watches (the time-measuring instrument par excellence) to invite the viewer to consider the temporal dimension with new eyes. Some vague shapes are included the dream space of the canvas, suggesting that our minds record our memories in an unconventional way. The deformation of the objects corresponds to doubt that what is ordinarily considered the rational is real, and that same doubt is the means by which we are able to elicit one more meaning.

Art critics have debated whether Dali would have imagined the new space-time metric of general relativity. Actually, it almost seems as though the painter was thinking about the softness of Camembert, a typical cheese that he had eaten the evening that he completed the picture by adding the “flabby watches” to the background.

Memory is one of the most complex and important ‘worlds’ in the life of our consciousness and thought. For St. Augustine memory is the space of subjective interiority, where in addition to images of objects there are the memory of numbers, the first principles of knowledge, the deep tensions that drive us to seek happiness, as we do not find it in the fleeting pleasures of everyday life and so invoke it with all our being. Happiness is real ownership of good, and we call this truth, which means we are happy only when we happen to be in a state that is really good. So we find the answer to the primary question posed in Book X of *Confessions* “I am absolutely certain to love God, but I always have a question about what I really love when I love God. I love something that is in the depths of my memory, where I

also remember exploring paths to oblivion, and that (it) structures my throbbing (or pulsating or beating please choose the best) alive (or living) as a great love, and in the same time an acute nostalgia.”

According to the Augustinian conception, remnants of an idea create a permanent trace that can be recovered, perhaps through some sort of “involuntary memory,” which can, in some irrational way, bring back episodes from the past that we thought were lost forever: a sight, a scent, or a taste might be enough to resurrect a memory of that perception in order to revive “as faithfully as possible what we were at that time; this fragment of time cannot be relived except through our sense of the person we were at that time” (Proust 1913).

On the other hand, according to Bergson, memory is not the faculty by which we classify memories and put them in a drawer or write them on a register. There is no record; there is no drawer. Indeed, strictly speaking, we cannot speak of it as a ‘faculty,’ as a faculty works intermittently, when it wants to or when it can, whereas the accumulation of the past continues day in and day out. In fact, the past preserves itself automatically. It follows us, whole, all the time: what we have heard, thought, wanted from an early age is there, hovering over the present that it is going to absorb, pressing on the door of consciousness, which would to leave it out.” (Bergson 1907).

A man tells his stories so many times that he becomes the stories. They live on after him, and in that way he becomes immortal (Tim Burton, *Big Fish*, 2003). The world is not an external object to us, given and immutable. It does no matter (or it isn’t very important) to live things (or events); it is much important to remember them, and if memory can change events by making them more adventurous, so much better, if that can help us to live or die.

“*Once Upon a Time in America*” is a backward journey in memory, an epic effort based on the autobiographical novel of a small-time gangster. The constant swinging between the present and the past, between the present life and the life relived, is the forward and backward path in the memory of the protagonist, Noodles wanted to create an emotional continuum extending over a period of 50 years. The time does not flow; rather it swings in jumps from 1933 to 1968, then again back to the 1920s, and so forth and so on.

It is the ‘magic feeling’ mentioned by Proust in *Recherche du temps perdu* (1913), a sensation “common to the past and the present, and very essential to both them: [...] it had allowed him to seize, isolate, halt—for the duration of a flash—what he usually does not capture ever: a piece of pure time.” It is the feeling (or sensation) that allow to “escape from the present” and “to enjoy the essence of things, that is out of the time.”

Memory. A bag full of junk that rolls out at random and ends up surprising you, as if it had not been you that had collected it, transforming the pieces into precious objects. (Wu Ming, stage name of a group of Italian writers, 1994–1999)

Zen, which developed from Buddhist philosophy, soon spread among the samurai; “In a society dominated by them, death was always present and destroying the fear of death was just one of the tasks of the followers of Zen. Zen awakened

the innate aesthetic sense of the Japanese by creating close links with the national characteristics of Japan and gave great impetus not only to architecture, painting, calligraphy, and ceramics, but also to poetry and music.

Zen considers man to be an integral part of the things around him: there is no purpose since there is no victory to be gained and no end to be achieved. According to this principle, then, there is no hurry because the world proceeds to a destination, but does not move toward any goal. We must achieve this purpose without effort; we must be free and detached from our “selves” and ensure that everything flows from the unconscious. However, this condition of unawareness is reached only if one is perfectly free from any technical difficulty and has an absolute mastery of form.

Here the importance of repetition, of veneration for the teacher whose patience to wait and observe the rhythms of the pupil will ensure that the technical ability becomes a spiritual one. Thus Zen requires physical relaxation, which is gained by focusing on breathing, a concentration of all physical and psychological strengths. Hence the importance of memory, which becomes “the instrument through which you can automate and internalize the experience” so that learned art becomes art that is going to be learned.

The experience of a martial arts gymnasium makes the sense of memory concrete. Memory is the means by which we internalize the movement, the breath at the right time, the balance, and the dynamics with an infinite repetition of the action to get to the end, to forget everything and reach a vacuous state.

“A man’s real possession is his memory. In nothing else is he rich, in nothing else is he poor.” (Alexander Smith, 1830–1867, Scottish poet)

The chapters of the present book describe various technological approaches.

- Chapter 1, *What Is a Memory, That It May Comprehend Itself?*, by Ernesto Bussola, is an epistemological reflection on the phenomenon of memory, taking into account some formal models related to the potential self-reflexivity of the remembering process.
- Chapter 2, *Mass Storage Memory Market Biography*, D. Caraccio, Nicola Guida, Manuela Scognamiglio, Cristina Tiziani, and Federico Tiziani, traces the history of the development of devices used to remember, a journey through the millennia.
- Chapter 3, *Probe Storage*, Marcellino Gemelli, Leon Abelmann, Johan B. C. Engelen, Mohammed G. Khatib, Wabe W. Koelmans, and Oleg Zaboronski discusses a combination of electronics and micromachines that achieves very promising storage density.
- Chapter 4, *Modern Hard Disk Drive Systems: Fundamentals and Future Trends*, Tong Zhang, George Mathew, Hao Zhong, and Rino Micheloni, describes the techniques and future prospects of what might be today’s most common mass storage media.
- Chapter 5, *Introduction to SSD*, Massimo Iaculo, Francesco Falanga, and Ornella Vitale, proposes an alternative to the hard disk for portable applications.

- Chapter 6, *Packaging Trends and Technology in Wireless and SSD Applications*, A. Losavio, D. Codegoni, M. L. Polignano, F. Zanderigo, and L. Zanotti, discusses the technology that enables the assembly devices to keep Moore's law alive.
- Chapter 7, *High Capacity NAND Flash Memories: XLC Storage and Single-Die 3D*, R. Micheloni, L. Crippa, A. Grossi, and P. Tessariol, deals with NAND memories and new technology to increase storage capacity.
- Chapter 8, *Optical Data Storage*, Yang Wang, Yiqun Wu, Haifeng Wang, Mingju Huang, and Yan Wang, is an overview of the latest storage techniques that exploit the properties of light.
- Chapter 9, a nice contamination, *Biological Memory in Animals and in Man*, Raffaele d'Isa, Nicola Solari, and Riccardo Brambilla, is an exposition of the best-known mass storage device—the human brain.
- Chapter 10, *Memories for Everybody* by G. Campardo, is a popular exposition about techniques of solid-state storage.

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 31 March 2010

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Memory Mass Storage

Campardo, G.; Tiziani, F.; Iaculo, M. (Eds.)

2011, XXVII, 479 p., Hardcover

ISBN: 978-3-642-14751-7