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Memory Between Bio-cell and Semiconductors: An Introduction to Hybrid Artificial Intelligence

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1. Introduction

During my time as a theoretical researcher at the quantum laboratories of the University of Paris-Sud in Orsay / Paris - France, in the late 1980s, I had the opportunity to meet one of the most prominent writers on simplifying quantum cybernetics and machine language, Mr. Viktor Davidovich Pekelis, a writer, specializing in quantum cybernetics who was visiting at the time for the Orsay Research Center (University of Paris-Sud).

It was at this exact stage that the idea for this article began, but it did not take its current final form until 2023 / passing through a draft that was published in the TRONIX Magazine in Arabic in 2005.

The series of lectures he gave at that time remained in my memory, and in 1996 I was lucky enough to meet him again in Minsk (a few months before his death), and I told him how much I was influenced by the ideas he instilled in us - we who consider ourselves his old students.

Then the conversation developed towards quantum computers, and how his old ideas about giant quantum memories might see the light of day within the next decade, (perhaps some remember the series of research papers that we cracked their heads with during the years 2003-2004 on this subject in TRONIX Magazine).

Mr. Pickles' ideas, which date back (as I understood them) to the early fifties, especially those based on Electro-Biology, were one of the foundations that later contributed to the creation and development of what became known as artificial intelligence [1].

Despite his being ignored and not being famous compared to the fathers of artificial intelligence, as he was more of a scientific writer than a scientist, it is rare today to find a reference in this regard that does not contain, directly or indirectly, some of his ideas, as we'll see later.

2. Trail on a Waxy Surface

2.1 Memory Capacity

It is the amount of information that can be stored at one time inside a storage device.

The Greek philosopher Socrates (and the story here is according to Professor Pickles) compared the process of imprinting ideas in the mind to a copper seal when it leaves it trail on a wax surface, but what is the depth of this mark, and how strong and spacious is the memory, and can it accommodate a lot or is it limited? ... In general, what is memory originally?

There are many amazing stories about the power of memory:

For example, the accountant of the Polish football club "Gornik", Leopold Held, remembered in detail all the results and details of the club's matches since its foundation.

Once, a television commentator asked him about the result of his team's match against the "Odra" team that took place in the city of Opole four years ago.

Held immediately answered: "The match took place on August 18 and we won it 4-0. It was watched by 18,000 spectators.

The total revenue was 235,000 zlotys.
I remember that Paul scored three goals, and the fourth goal was scored by Zoltitch.

As for the prominent scientist Chaplykhin, he could remember without error any telephone number he used once when he was a teenager.

However, these almost amazing examples of memory are not all thing.

We know the case of the journalist Shereshevsky, who worked as a correspondent for one of the Moscow newspapers and then as a correspondent for the prestigious British Daily Telegraph.

Specialists studied his case for the first time in 1926.

In fact, this man's unique memory has not known Limits, where he could remember numbers up to a hundred digits long "One Google" in addition to huge combinations of words from a language unknown to him.

And, even an arbitrary series of indefinite length of sequences "0, 1", and he was able to recite a table of numbers of five digits, fifty pages long, A4 size.

So where this amazing store is (named the memory) and what is the mechanism of its work.... Unfortunately, we do not have precise knowledge.

2.2 Brain Capacity

If we define memory as the brain's ability to store information collected in the past and present it as soon as it is requested, the following assumption would immediately appear to us: "Memory is a set of pulses that flow in a circuit like an electric current" [2].

Unfortunately, we have not yet been able to obtain memory currents inside the brain in a definitive manner.
It is natural that researchers are interested in how the brain retains this enormous amount of information that a person receives throughout the day, and this interest continues until the possibility of knowing the mechanism through which memory is achieved.

In general, Electron Biology experts believe that the brain consists of about 100 billion neurons "molecular neurons", and it is difficult to believe that each neuron retains a mark or one piece of information, and it is also difficult to believe that a neuron can exist in dozens or hundreds of cases to adapt to recording new information, and even if this is the case, it is also difficult to believe that it is possible for the brain to absorb this enormous amount of information in this manner.

2.3 Storage at the Molecular Level

A respectable proposition is that memories are recorded at the molecular level, in other words: there are memory molecules in the brain, a "scientific fact", but we do not know the mechanism by which recollection takes place within the structure of the molecule itself, which are very complex, huge molecules that resemble an infinitely long ladder of ropes, with beams of two different types, where these molecules follow each other like dots and dashes in Morse code signals, forming a molecular-atomic alphabet [3].

The question now is: Can we record a lot according to this alphabet? ... Let us calculate together.

Each molecule contains about 25,000 human genes distributed across 23-paired chromosomes (of two types).

Therefore, the number of primary markers in a living cell becomes nearly of 25-30 billion markers.

Microbiologists have noticed for some time now the presence of slight changes in the structure of molecules, which means other special markers, in other words: these slight changes that allow writing an infinite number of tags makes the capacity of human memory to store data virtually unlimited.

2.4 Types of Memory

You all know that a person does not always remember everything for a long time, and usually retains the information literally for a short period "according to its importance to him", which makes us decide simply that human memory has several types.

In general, the mechanism can be explained according to Quantum Chemistry as when information reaches the brain, inductive electrical circuits are created in it as bridges in parallel between two or more neurons depending on the length of the information and begin to rotate in it.... This is the temporary memory.

The currents of the neuronal circuits affect the molecules of the neuron itself, which leads to the formation of the albumin within it.

If a repeated signal arrives, the albumin maintains its special structure associated with this specific display, so its quantum structure is stored in long-term memory.

However, if a repeated signal does not come, it decomposes, the inductive circuits are disconnected, and the temporary memory is separated.

Many researchers tend to believe in the existence of operational memory, in addition to temporary and long-term memories.

Notice with me the professional secretary who is busy typing a text on a typewriter. She keeps short paragraphs of text in her memory for very short periods, to be replaced in her memory by other paragraphs that she types... and so on... until she finishes typing the text.

Humans have realized since the dawn of history that any absolute preservation of the past does not last long, and that only a very few have a super memory, which means that it is necessary to resort to artificial means to strengthen memory.

The oldest practical method that appeared is drawing on rocks and cave walls, which later developed into graphic writing "hieroglyphics, for example" and finally the letters of the alphabet.

The invention of printing expanded human memory and the invention of photography and audio recording led to remembering the moment in great detail.

In the eighteenth century, the monotonous and boring memorization of information from bright drawings on a cloth fabric was done by holes on the perforated drum of textile machines.

Then in the 20th century, mechanical recording devices were replaced by electromechanical devices (now obsolete) which

were replaced in the 1950s by magnetism, then paramagnets and diamagnets on semiconductors since the 1970s, and finally spintronics.

3. Memory of the Machine

The mechanism of retrieving information in the structure of computers did not differ much between the oldest and most modern computers, as numbers and commands are stored in the machine's memory, just like shopping malls.

From this store, information is transferred to processing.

The data is processed in the processor, which is like a kitchen, and then the results are returned to memory again, regardless of the type of this memory.

The computer, like the human being, has a multi-type memory.

Each of us still performs the multiplication process of 37 * 45 and says: five times seven equals thirty-five, we put five on the hand three... etc.

The computer does the same thing, but with non-decimal counting systems and in general it writes the five and keeps the three in its memory.

Just as a person needs to use a phone number once, so he records it on any paper within his reach to throw it away later, or he thinks that he may need it many times, so he records it in his private notebook, which is a long-term basic memory, the computer does the same thing, so you find it has the temporary operational memory and the basic and long-term operational memory.

The waste paper here is temporary memory, while the well-indexed notebook or "agenda" record is long-term major memory.

The classic hard disk here is long-term permanent memory.

The capacity of the computer's memory and its response speed depend on its design characteristics, the response speed of the hard disk and its capacity - processing speed, short wavelength of the temporary memory with the huge capacity of its instantaneous storage, etc [4].

It is interesting that capacity and speed are inversely proportional, which means that the typical machine is the machine that can overcome one of the two problems in favor of the other (the situation can be represented mathematically by Kronecker's delta), and in the quantum sense: the machine is typical when its speed and capacity increase at the same time without affecting each other's performance, and in a way that supports each other (the inverse formula of Heisenberg's principle).

One of the simplest forms of permanent memory is that written on magnetic tape. This type of memory has become extinct and has becomes folklore.

At that time, it was sufficient for increase its capacity: to increase the length of the tape.

But the time required extracting information also increased as we had to decode and analyze hundreds of meters of magnetic tape to obtain information, and so this type of memory was abandoned without regret, as research moved towards increasing capacity while shortening the time to extract information (handling time).

Closed magnetic rings that are recorded in several tracks were replaced by increasing the mechanical speed of rotation and increasing the number of reading heads, shortening the handling time.
Researchers realized that placing a mark between the tracks, in other words dividing them into sectors, shortens the handling time by 35% without the need to increase the rotation speed.

This is one form of correct use of good indexing, and the type and number of sensitive head devices play an important role in the speed of extraction.

This is what polymer chemistry provides, along with the physics of mixtures and optical engineering, in terms of services for classic hard drives or for compact disc copiers and readers [5].

It is no exaggeration to say that the development of computers is actually limited to increasing their storage capacity (“permanent memory”) while shortening the processing time (“processor speed and temporary memories”) regardless of how it is done.

And we can easily realize this if we follow the development of computer memories and processors.

A little more than sixty years ago, processor memories based on cathode ray tubes (“tube memories and processors are considered very fast in those days gone by”) were replaced by ferrite cores and memories with large capacity and relatively small size with the highest degree of reliability during operation, which quickly gave way to memories and processors based on the latest achievements of applied physics: tunneling diodes, crystalline semiconductors, ultra-thin dia-paramagnetic devices, in other words, Microminiaturization Accouterment.

Then later: giant magnetic memories, and after that modern electro-spin memories and electro-spin processors.

However, despite the impressive properties of machine memory, with all the expectations of its expected evolutionary leap in the foreseeable future, it is still far behind human memory [6].

3.1 Between Human Memory and Memory of Machine

Figure 1: Imaginary Photo Comparing Human Memory and Memory of Machine

Our memory capacity is enormous, and we have calculated this from the beginning by relying on the research of Professors: Pekelis from Moscow State University and Professor John McCarthy from Stanford University, in addition to the pioneering work of Professor Marvin Minsky from the Massachusetts Institute of Technology, but we can add another example that Professor Pekelis always liked to put forward for further clarification, which is that the sum of all semiconductors and integrated logic and analog circuits manufactured in the whole world does not exceed the number of neurons in one human brain, as a human has a practical memory capacity of up to a quadrillion "million billion" units of information, and human memory is far superior to machine memory in terms of reliability and guarantee of operation, as the more elements in the machine's memory, the greater the possibility of its failure, so if we assume a complex device for machine memory that contains what only one pair of neurons contains of elements, it will never work due to the large number of malfunctions, while the human brain works without fatigue despite the billions of neurons it contains, which contain in their structure billions of combinations as well, and human memory does not stop Practically no repair required.

A quick comparison between the size of the human brain and the memory of an imaginary machine that has the same number of data and elements of semiconductors, we find an amazing paradox:

The size of the brain of an adult human is approximately 1200 cubic centimeters, but if such a machine were found from semiconductors using the finest achievements of miniaturization, it would require a volumetric mass roughly equal to the Burj Khalifa in Dubai.

Also, the energy used by the brain to operate (which is here the simple sugars, is equivalent according to the most accurate electrochemical conversion tables to 9 watts, while the memory of the machine would require eight nuclear reactors the size of the Chernobyl reactor.

In addition to another very important factor, which is that our memory is compatible in the way it retrieves data, where memories associated with that data are recalled one after the other to provide the brain with the necessary information and at the same time give it a tremendous ability to create, invent and deal with the momentary emergency variables.

Compared to this miracle, the machine's memory seems trivial, as its limited capacity compared to human memory is not its only flaw, but also in the dynamics of its connection to the processor, which is still very similar to a failed warehouse keeper who turns over all the things in his warehouse to reach something lost [7].

4. Conclusion

I completely agree that current artificial intelligence has greatly shortened the handling time, but it is still very far from the dynamics of the human brain.

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