Impact of Volume of Information on Human Behavior

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Abstract. *The paper is dedicated to problems, emerging with human behavior in digital society and the ever increasing volume of information, which he has to perceive. An attempt has been made to draw an analogy human mind-computer on the basis of information processing. Some issues concerning educational features and the link human – environment in the digital society are discussed.*

Introduction

As each day passes, the volume of information received from various sources increases. Some studies show that it currently exceeds several exabytes, representing an enormous amount of accumulated data, information, historical events, music, etc. Assuming that there is a common definition, to treat this data, we can use, $V=V_0 f(kt)$ where V is the volume of information, k is a proportionality coefficient, and V_0 is the volume of accumulated information up to the point where we start a countdown of the time t.

The increasing volume of information is related to the growth of technological advancements for its preservation. One can also easily recognise the fact that the information[1] (data) which is not preserved is of no value, as it cannot be put in effective use. Let us define the effective volume of information used as $V_{eff.}$, and the ratio $\frac{Veff}{V}$ will be defined as a coefficient of applicability $K_{APP,}$ with a maximum value of 1, depending on a human's ability to apply the information[2]. This leads to a constant growth in the human's potential ability to understand and process the information, which in turn establishes the progress in modern society. As the information of today should be available on a global aspect, we can derive two major necessities. One is that it should be easily accessed and should find no barriers for its growth. Second, people are in need to increase their capacity of knowledge, so that we can store and apply it.

The problems that must be solved arise from several aspects, two of which are of particular importance.

The first is related to the transfer, processing and storage of information in terms of technology. Currently, the technological capabilities evolve towards an increase of speed and performance of computer systems (Moor's Law), as the capacity of memory devices also increases. Although the speed of transfer of information has not reached its theoretical limit, the time t_V for which information is transferred is still considerably less than the time for information processing t_O, ($t_v < t_0$), especially in the case of "Multi-task problems". This tendency is well researched in literature where more and more rational solutions are being offered.

The second aspect is related to the requirement for a continuous increase in the quality of education. For this purpose we focus on education's modernization, which is delayed in respect to the technological development, as well as the improvement of people's skills through the creation of supporting technology. With this we associate any devices and instruments that support people with disabilities, so that they can continue developing their work performance.

Improving education and people's skills and improving the technological bases so that individuals can rationalize and process information leads to the solution of problems. In term, these problems related to the research of speed limit of information transfer, as well as the minimum technological time limit for its processing [1]. At the technological limits, the human's abilities for perceiving and processing information will assume introducing a coefficient for the effective employment of useful information $\hat{E}_{em} < \hat{E}_{app.}$

Man and the Digital World

There are several problems that need solving in order for a person to enhance his/her mental skills and abilities so that processed information becomes useful.

On the one hand we explore the person's cultural and intellectual development in an environment where the volume of information and the methods for its implementation are constantly increasing. On the other, people are still dependent on their local environment and should therefore continue their physical development in order to gain the necessary survival skills. A man should therefore develop not only his/her physical strength but also a particular set of knowledge and mental skills. It should moreover be noticed, that a man's survival efforts are not the only physical activities required by our day-to-day life. People should also put in physical efforts to improve the environment, so that we can, for instance, obtain our necessary quantity of food.

Two scenarios are distinguished:

• Birth of a class (group) of people who intellectually developed;

• Birth of a class (group) of people involved in the immediate work processes.

[1] According to definition, information can be viewed as structured data. For the purpose of this paper, we only approach volume of information and measure it in bits. Information and data can therefore be used as synonyms.

[2] According to [6] data and symbols that cannot make sense are not recognized as information.

These two groups are dependent on each other, as the one side is in need of food, and the other is in demand of technology and services. We can divide society in one class of people who stand well in a physical aspect and another class where people's mental abilities are better developed. Nevertheless, one can easily make a calculation for the production of food sufficient for humanity, on the basis of what our land produces up to and after a certain point of time. This is not the case of studying the development of mental skills, which would involve a precise measurement of the marginal amount of information that a certain intellect can receive. A major problem here is the intellect's ability to capture this volume of information and whether or not technology can help the intellect to further develop.

As far as human's intellect is related to the brain's capacity, the relationship between its development and the introduction of new technology stands as a question of high importance. Some papers already describe technical approaches that allow faster introduction of information and also ways to use it more rational when managing real systems [2,3,4,5].

This is obviously a process that is limited in the long run, a question that can now be left for a solution. It is associated with certain paradoxes – is there a limit to the knowledge one can gain and can one reach this limit. If there is no limit to a person's potential knowledge then this knowledge will constantly grow up to a level, providing human's consciousness a new way of being. How will this development affect the group of people who are directly involved with physical labour and cannot reach the minimum intelligence level? Will we reach to a rift between the two groups or will we search for a mutually beneficial solution – a matter of research under certain assumptions, which is both technological as well as philosophical. The more likely scenario is that conflicts will arise, since earth's resources will be depleted, and people with higher intellectual standing will be able to deal with certain diseases, the cures of which will be out of grasp for the other group. But without this other group the food issue should be viewed in a whole different perspective. What will this society be – one of highly developed intellectuals who will use modern technology to supply their basic necessities, or will we inevitably pass through a global conflict leading to an uncertain outcome about the preservation of our civilization? This once again raises the philosophical question of the existence of global intelligence and its level of involvement in these information processes.

Processing information. Computer-Man

If we assume that there is a given connection between a human's and a computer's methods of processing information, we can roughly derive the following parallels. Durring the administration of the different activities in the computer systems, a certain part of the RAM is kept for the preservation of the base supervising program (SP).

Looking into the development of the computer systems, the supervising program has taken from 10% to 20% of the RAM. What is more, in order to use the full capacity of the computer, there is a continuous exchange between the RAM and the external memory.

For example, in the case of a RAM of 6K words in MINSK 32, the dispecher (SP) is roughly 10K words, whereas the 256 KB RAM of IBM 360/30, the SP is around 30 KB and the 16 GB RAM of Windows 2007 the SP is 1 GB and so on. A paralel could also be made between the the size of the memory of the whole Operational system (OS) and the general memory of the computer.

One would be correct to assume that roughly 20% of the memory preserved for administration provides for the use of the rest of the RAM in a wide variety of tasks.

It should be noted that an increasing complexity of tasks corresponds to an increasing need for a larger quantity of SP and RAM. A parallel with the human brain can be made. According to research papers [7], the number of neurons is around 10^{11}, and the number of connections is around 10^{14} (synopsis). According to research [8,9], out of approximately 86 billion neurons, 69 billion are located in the brain and 16.3 billion find place in the cortex. It is possible that these 16.3 billion perform functions similar to the SP.

We will focus with more detail into the supervising program which usually takes place in a protected part of the RAM.

The SP aims to ensure functionality of the computer system by using RAM and external memory. The RAM hosts the data that is to be processed. Whether it will be hosted it pages intended to solve certain task in a multiprogram mode, or whether batch-processing will be performed is an issue related to the performance of the computer system, and naturally its organization and architecture. In any case, however, SP aims to ensure completion of the programs and their interactions with the environment (peripherals). It is possible that parts of the SP are transferred between the external memory and the RAM so that functionality of the computer system is ensured when taking care of the solution of certain tasks. We also consider error messages, management of the peripheral devices, and all processes linked to the requirements of the users or the creators of the corresponding program. We take it clear that the SP cannot pro-create new features within itself, but rather the system programmer or designer will add any amendments if needed. I.e. once confined, the SP cannot be modified during the execution of a specific task. Corrections can only be made in a certain time intervals depending on the requirements and functionality set by the designer. Figuratively speaking, the SP cannot cultivate and acquire new skills.

In the human brain, things look way more different. A fixed portion of the brain cells have a task of managing operations of the other cells, whilst constantly introducing them with new information subject to storage and processing.

The work process in the brain differs from the relationship SP-RAM (in the computer system CS) as a certain minimum of initial functions should be introduced which would serve to accumulate information in the brain cells. This process begins its development with the birth of a human being when he/she starts to percept and sense. Part of the information is stored, but at the same time is processed by those brain cells responsible for carrying out the connections. It is thus that we start accumulating a certain volume of information in our brain which can be perceived through sight, hearing, touch, smell, and any other form of sensing known to the human body. This is a volume of information that constantly increases but managing the links between this information is carried out by the corresponding CPB (Control Program of the brain), which occupies part of the brain cells. An interesting fact [7] is that each neuron can carry out 7,000 connections (synopsis). Within time, the data accumulated from the external environment grows more and more, resulting in a need for an improved supervising system so that better processing of this information can be achieved. This respectively leads to improving a human's organism actions in his/her environment. In such respect we can establish similarities with a computer system carrying out tasks for real-time processes.

In the same way that these actions can be associated with food gathering, they can also be associated with obtaining new knowledge about the surrounding environment. Such knowledge may improve a human's survival skills and/or may contribute for acquiring useful information in respect to his/her activities. In other words, we derive at a process where the volume of information is increased and at the same time the CPB is improved. Unlike a computer system, however, this improvement in the CPB is obtained thanks to training and self-training due to the contact between different personalities, and also thanks to the accumulated volume of information which allows management capabilities to grow. I.e. an interesting feature is that the more information the human brain acquires, the more complicated it becomes to manage this information in respect to survival related activities or development of the human's skills and intelligence. Moreover, giving progress to the CPB by the creation of new neuron cells will further improve the functionality of the whole brain system.

Here it is natural to outlay the following hypothesis: the more information the human brain stores, and the better this information is processed – the more improved our skills and abilities become. This provides new opportunities for life to be extended, since conditions for our being are improved accordingly.

That is to periphrases the hypothesis as follows: the larger the volume of accumulated information and the improved quality and speed of its processing should lead to an extended life expectancy.

There is another interesting feature in the case of computer systems. In this case, the SP and volume of memory for a certain generation is fixed and cannot be substantially altered, and only a next generation can be designed with better functionality, increased memory, increased volume of the SP, etc. However, in the case of a human being this is all performed through an internally-dependent process. I.e., improving CPB is related to the increased volume of information which a person must perceive. As observed – this volume increases over time, which leased to an even increased number of connections between the separate brain cells.

One of the typical characteristics is that this development is related to time. In other words we observe the accumulation of information since a person's birth, an improvement of the way it is processed and an improvement of management of the brain cells. This continues up to a certain age after which we observe a gradual fall in the ability of the human organism to accumulate more information. The reasons are in certain biological factors such as reduced abilities of the senses leading to a reduced quantity of received information. This in turn corresponds to reduced brain capability to create memory connections that should come in accordance the human's new situation and environment. We observe a slow process leading to a reduced capability of the brain to make new perceptions and to acquire new skills and abilities. From a certain point on, the organism's functional capacity decreases until the biological clock stops. It is typical for the CPB that even though memory loss is observed, certain biological essentials such as the abilities to see, eat etc. are taken care of.

As the human race develops, so does the management of the brain cells as this is related to the increased number of connections between the cells. And having in mind that there are 100 billion cells with 86 billion neurons and around 16 billion connections all of which responsible for the brain's functionality, there will yet be portions of the memory, which could be utilized, i.e. we should be able to continue adopting new information. When considering a rough estimate of around 10 GB RAM in the human brain and several GB of CPB, the human's potential is far from exhausted.

Since it is estimated that the total volume of the world's information is around several exabytes, then it is logical that the information used by one individual is considerably smaller, i.e. $K_{app.} << 1$.

An issue that we should raise is to what extend will the human senses and skills continue improving. More and more individuals will have the opportunity to process the received information in a faster, higher-quality manner. Is there a limit to the possibilities of extending life via improving all our senses of obtaining information and via technical advancements? Is there a maximum value lower than 1 which limits $\hat{E}_{app}$, and if we can use technology and biological instruments to stimulate the growth of new neurons, can we extend life expectancy? The extent to which such improvement can take place depends on the potential limits of the human brain and on the degree of technological advancement that can be reached. Only after having these answers may the problem be approached with precision.

It is obvious that there are certain limits to peoples' individual abilities, i.e. some people will be able to develop faster than others, which in the long run will lead to a gap

between peoples' intellectual levels. This will cause the separation in society which was earlier discussed. In order to find solutions to the issues described we also need long-term statistical data so that we can paint a more accurate picture of a human's standing. In any case, the accumulation of new knowledge will be of high importance for the next stem of mankind's development.

Man and Education

The availability of information allowing a constant increase of an individual's knowledge suggests changes in the educational system. We can already witness research that focus on introducing new methods of learning. Even without capturing the entire educational field one can point out some interesting examples. Substantial progress is observed in the field of computer systems, due to its vast applicability. It is even suggested [10] that a larger number of both lecturers and research in the methods of teaching are essential in order for all ongoing developments to be reflected.

The introduction of more advanced computing innovations requires serious study of their positive and negative effects on society [11]. It is known that in some advanced countries, training of the so called "smart commandos" already takes place. Their task is to acquire skills of complying and reacting quickly to crisis situations. Quick decision making related to the proper management of complex instruments is essential in such events.

It is important to discover new approaches to learning, which would allow accurate retrieval of the data needed to solve a problem. Since technology constantly changes, the fundamental methods of retrieving important information from data also change. It is not easy for one to navigate in the vast volume of the current data bases, and even harder to extract all the information concerning a specific subject. The ability to set the necessary initial conditions for extracting all relevant data requires two things. On the one hand this requires detailed knowledge of the problem being investigated, and on the other – relevant knowledge enabling effective use of the search engines.

Relation to the Environment

The continually increasing volume of data is not only related to people's ability to store it, but also to the surrounding environment. Today, the development of the environment largely determines the behaviour of human society and the individuals themselves. Even our task of construction accommodating instruments is related to environmental changes. The fact is that we constantly forget that we do not have the ability to assess reality. Human's nature and behaviour are way more unpredictable than the physical laws of nature. We constantly hope that the pioneers in various areas of studies will not repeat one too many of the mistakes already made.

Naturally, the construction of a device or computer system is a practical example of human's desire to create something that will exist, work, and not die. It may be interesting to point out that a number of objects created centuries ago are still working [6]. It is a whole different matter that such objects are not used, and it is related to the fact that more effective ones are developed. There is, however, no doubt that some of the machines which are created 100-200 years ago can yet be put in use. The development of human's capabilities including our creative skills is without precedent related to the increased volume of information that we receive and process. A similar analogy can be made in the case of animals, where the different species improve their ways of living, adapt to the environment, create new generations in changing conditions – all of which is linked to the fact that they have improved their abilities to receive and process information.

On the one hand this is mainly due to the adaptability of living organisms, which has undoubtedly been achieved through an evolutionary path. On the other, however, it is also related to a change of behaviour based on the manner of processing information. There are numerous examples of animal families where one can find clear indications of a structured organisation for communication in situations such as danger, necessity of food, etc. This is undeniably a result of gathered information and a developed ability to process it.

Some of the migration processes take place due to the emergence of new species. A main influence for this to happen is that they have namely expanded the abilities to capture and process information. The fact that a number of species are able to anticipate the behaviour of man and nature when it comes to down to survival can be found in numerous examples, and is described by many authors.

In this case we do not focus on the animals' change of behaviour, but rather on how the volume of received and processed information has influenced on preservation of the species. This matter is without doubt quite controversial, as it is very difficult to measure this volume of information. Moreover, observations should be made on a really long time-span, in order to determine the effects of the different types of information. Nevertheless, a certain amount of influence is present. The extent to which this influence affects the existing species is a matter that should be investigated by the relevant specialists.

The question of how human's actions reflect in the environment and accordingly impact the behaviour of animal species and the way they capture and process information is not to be discussed in this paper. However, just as humans strive to develop and improve both our physical and mental strengths, we inevitably affect, at least to some extent, the animal world.

When will human's actions reflect globally, and will they reflect at all are questions subject to uncertain predictions. Nonetheless, we do have impact on the changing qualities of the animal species – for example, we do so when fighting pesticides. The result of our actions do allow animals to capture and process information, which changes their qualities either in a predefined by humans way, or by enhancing their abilities to survive.

Conclusion

The examined issues give ground to believe that attempts of finding the volume of transmitted and processed information, and identifying some of its parameters, are of crucial importance. Finding answers will provide us with new opportunities to decide on how and in what direction to act as in terms of both humans' and the world's development.

Determining the limits of the volume of information that humans can perceive and process suggests that the potential of the human brain is far from exhausted. The commonly adopted approach of using the "bit" as a measurement of assessment should not be considered as the only method. Other approaches should give us a more accurate picture of the processes related to the evolution of human behaviour.

By setting a point for further research, it can be concluded that the faster we perceive and process larger volumes of information, the more we improve our lives.

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