

On the Measurement of Quantity of Information on Speech, Sound and Image and their Link with the Information Processing*

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The speed of information transfer and processing becomes more and more important. One of the main tasks, following the information proceeding is the rationalization of the results or acceptance of decisions and conclusions.

The research so far shows that the possibility of existence of civilization, similar to ours is minimal. This means that the chances for information exchange, so important for mankind actions are also minimal.

This implies that new serious research can be carried out on the issues of maximum speed on information transfer, minimal time for its processing and the correlation between them.

Today there are many articles dedicated to these problems [4,5].

Ways to transfer information (speech, sound, image)

1. Speech transfer

If we consider one of the ways of information transfer - the speech - some rough calculation can be made. Each character is coded with 6 bits (binary). If we assume that in average, a word consists of 5 characters, one needs 60 bits for two words. Man can talk no faster than 3-4 words per second, which means that we can assume the upper boundary of 200 bit/sec as the one used by humans for information exchange (having 8 bits for coding and 4 words - 160 bits/sec, with compression - up to 4 bits and 4 words - 80 bits/sec).

The possibilities of the human brain for immediate use of character information, is huge. Let assume that a talented actor can memorize about 200 pages text, which he can repeat, after learning it by heart. According the standards, 1 page has 66 characters in a line and 30 lines per page - all together - 1980 characters. When coding 1 character with 8 bits we got $1980 \times 8 \approx 16 \text{ Kb}$ per page.

With maximum speed of reading of 200 bits/sec, the time for reading of those 200 pages is:

$$(200 \times 16 \times 10^3) / 200 = 16 \times 10^3 \approx 16 \times 10^3 \text{ sec} \approx 4.44 \text{ hours.}$$

The volume of transferred information is about 400 KB. In fact (actually) a man reads a page for some 90 sec, i.e. with coding of 8 bits per character $\approx 176 \text{ bits/sec}$, when we have 6 bits per character $\approx 132 \text{ bits/sec}$. Approximately it could be accept an upper boundary of 200 bits/sec.

2. Sound transfer

Let us consider a piece of music. I suggest (for simplicity) the Minute Waltz of Chopin, which is played by good pianists for 1 minute.

The piano has 85 keys and for the coding of each one, we assign 1 bit (on, off). For the strength of the sound, from the weakest (pianissimo) to the strongest (fortissimo), we assign 10 bits. This scale has 1024 grades, enough for a good master.

For Chopin's waltz if we use 50 keys (out of 85), 50 bits

* Author wants to provoke discussion about problems for measuring of information and correlation with its processing. The paper reflects his personal view.

will be needed in addition to the 10 bits for the volume, which comes altogether to 60 bits.

In the musical score, one can count 730 notes (in general, in case we regard the chords as one position). In such case, the speed of transfer will be

$$(730 \times 60) / 60 \approx 730 \text{ bits/sec.}$$

Or a bit more, in case we include notes with longer duration.

We can make the conclusion that there is 3 to 4 times bigger speed for transferring information, in case we use sound (tune). If we compare a good musician to an actor, the former has to memorize several time bigger information than the latter (for some 3-6 hours), maybe even more, when regarding the musical score of big musical compositions like symphonies, requiems, etc. It is not our task or intention to compare the brain abilities of the actor and the musician. The conclusion is linked to the fact, that using more musical tunes leads to transfer of more information.

The volume of the transferred information for 4.4 hours is $4.4 \times 3600 \times 730 = 11\,563\,200 \text{ b}$, which is approximately 1.43 MB - 4 times bigger volume.

We can think that a thunderstorm or sea waves will be „described“ with higher information speed (bits/sec) and correctness if using sound than speech.

If we look at some Eastern languages (Japanese, Chinese), we shall notice that some words express concepts and we can conclude that for the time, that European languages transfer some 200 bits/sec, the ancient languages transfer bigger quantity bits (i.e. more information if we measure the quantity). It is curious to know whether the ancient languages, preceding in terms of history the European, are more perfect in terms of information transfer. Or the elaboration of those languages was aimed at transferring more information for a shorter period of time.

For example the speed of communication can be improved more by overloading the words with several meanings. Chinese language is a good example on this: ma = mother, horse and question. Also notation of words can be improved by using reduced instruction set, also like in Chinese: <mother> = <woman> + <horse> <house> = <roof> + <pig>

A natural obstruction is that using more tunes leads to more possibilities for errors (i.e. wrong understanding of the expressions).

In this aspect, the decrease of speed increases the authenticity of information, which leads to the creation of more reliable languages, like the Europeans.

This area is object of serious linguistic research and further discussion is out of the scope of this paper.

3. Image transfer

Transferring information by image is faster and more effective. Watching modern monitors, our eye accepts for 1 second several hundred thousand bits (in a quality image, there are several mega pixels and not all shades are being percept). This imposed the cinema, TV and other image devices as the faster source

of big volume of information. They are also the most informative, in terms of acceptance and processing by the human brain.

For several minutes of concentrated perception, this volume of information can not be processed and some of the information remains as a background one.

Until the present moment, the education and acceptance of new facts and knowledge was linked to oral explanation and visual materials. Knowledge was gained also from books. In both cases, the sent and available information lets human brain to process it. Depending on the intellectual abilities of the person, the processing and rationalization of the information was quicker or slower, but there was the option of explanations, the visual materials or the written information was available to the learner. Modern tools allow even better quality of visualization by image projection but this approach also allows control of time, so that the percept information can be realized. One can state that the process of information transfer was faster than the process of its processing and man had enough time to grasp and realize the presented information. With the mass introduction of TV, computers with significant abilities for visualization, the flow of information has increased significantly and the need for faster processing and realization of that information is evident. The resurrection of interactive methods for education allows the process of transfer of information to go in parallel with the one of its realization.

The continuous information flow sometimes requires swift reaction by a person, depending on the situation - as in emergencies or when fast and effective decisions are required in areas, still controlled by man - transport, emergency operations, industrial processes, etc. This implies that modern man has to increase his abilities not only for faster understanding and grasping of information but also for its faster processing. Both requirements assume getting more abilities and skills through new approaches.

The development or perfection of human senses - can be achieved by proper training and education: quick image recognition, effective filtering of background information, increased ability for sight and hearing. It is clear that individual abilities of each person should be taken into account. The fact, that abilities are ever improved by system training and using various approaches shows that using that regular work can lead to improved individual qualities in accordance to the demanded particular requirements.

One can see two scenarios here: creation of abilities by purposeful education of people - i.e. creation of „intelligent commandos“. The other scenario is using gene engineering - creating „cultivated modern societies“. Both approaches do not provide good forecasts. Even now, Internet divides society to those, seeking fun and strong emotions and the ones seeking knowledge. The first group will soon form not very well educated class or group, which we can call „user“. The second group we can place at the so called „educated elite“ (or intelligent society). This will lead inevitably to division of society and a future destructible conflict can be expected in either near future or later on, taking into consideration national characteristics. In short - one might expect a digital division of society and the question „When destructible social conflicts will begin?“ remains. They will get bigger and stronger also due to the increasing gap between rich and poor.

The second scenario of improving the qualities and skills of people, by changing the gene material does not lead to good forecast either. Human senses can not improve endlessly and there will be a moment, when a deformation of organs will occur, having unforeseen consequences. Whatever improvement is carried out on a particular organism, there is a limit - it is clear that 100 meters can not be run for 1 second. Maybe some more precise forecasts can be made here - not only for the characteristics at this end point but also for the consequences and the expected time of the event.

The faster processing of information supposes the progress of abstract thinking and the potential for physiological and social generalization of the processes. Undoubtedly for people with various tendencies in certain societies, using certain approaches can lead to solving complex abstract or practical tasks. For others, there can be significant success in summarizing real humanitarian situations or the creation of pieces of art. The first group can work well in the field of technology in the name of mankind's prosperity, while the second will be leading for their spiritual enlightening.

An important conclusion is that the flow of information becomes more and more important for the future development of society, if not the most important. The previous advance of mankind was mainly in the area of satisfying the physiological needs of man. Modern society will have other priorities.

One can present the hypothesis that the human organism was and will be developing in the direction of increasing its abilities for maximal perception and fastest processing of information.

Acceleration in the last decades is hardly due only to better nutrition.

The growth of people supposes wider opportunities for their senses to grasp the surrounding information and also sight and hearing. This determines in large extend its public behavior.

Certain classes in the past had enough food but there has been no record during the century for rapid growth. Other qualities were more important for them for their survival and growth that receiving a vast volume of information, the fast processing of which was not required (with the exception of few instances). Analyzing the works of the writers 1-2 centuries ago, we can notice some details linked to the way of life (household, clothes, etc) - something which is of little interest for the present reader, who can get these details in a matter of minutes from TV or Internet. If we analyse the evolution of other organisms, maybe we shall conclude the development of their senses on the basis of how they get better information for the environment, linked to their survival and maximal possibilities for its rapid processing. It is well known that some animals can not process the information they receive and put into action their surviving skills. For this reason, there are many cases of injured and killed animals on the roads. It is in the process of evolution in some animal species that the mental processing has been transferred in certain reflexes. Those are also linked to certain time reaction.

Let us consider the possible boundaries for speed of transferred information. According to some examples from university classes[3], during the use of light in the micron scope (1.3 microns), where the attenuation is almost a constant, for example for $\Delta\lambda * 0.17 * 10^{-6}$, we have

$$\lambda \cdot f = c; \frac{df}{d\lambda} = -\frac{c}{\lambda^2}; \Delta f = \frac{c\Delta\lambda}{\lambda^2}$$

$$m.e.\Delta f = \frac{3 \cdot 10^8 \cdot 0,17 \cdot 10^{-6}}{(1,3 \cdot 10^{-6})^2} = 30 \cdot 3 \cdot 10^4 \text{ or } 30 \text{ THz}$$

Using Shannon's formula for the speed of information transfer [2] we get:

$$S = \Delta f \ln \left(1 + \frac{S}{N}\right) \approx 30 \cdot 10^{12} \ln(1 + 10^6) \approx 30 \cdot 10^{12} \cdot 200 \approx 600 \cdot 10^{12} \approx 0,6 \text{ Pb/s,}$$

Having a ratio signal/noise = 1 000 000 = 10^6

Even if we consider electromagnetic radiation with shorter waves, the speed of transmission will be limited to tens Pb/s. Is there a limit of the speed theoretically? As S/N is limited, the increase of Δf is also limited; c is constant, so theoretically it is hardly possible to achieve speed of several Exab/s.

Processing of information

Let us consider the possibilities of computer processing. Modern speeds of processing are in the range of PFlops/s with the tendency of achieving ExaFlops/s. Reaching the next order will be difficult due to technological and power problems. Energy losses (power consumption + cooling) can be unsuitable from environmental point of view.

The problem can be solved by the introduction of new principles of computing - for example - quantum computing, molecular computers using other principles of computing, though some restrictions can arise.

It is possible that the time for processing of certain quantity of information can be less than the time for transfer of the received or send off results.

This raises the question of perceiving of the results of the processed information and its use in terms of expedience. In certain cases, human brain can be used to take decisions in real time, even when using computer systems, which he must get going. This means that his reaction won't be in time - i.e. there won't be the necessary result, hence it is not expedient.

The question for the relation between the speed of transferring of information and its processing is most likely well developed by military strategists. Reaching enemy's goal is linked to carrying an explosive with certain parameters: weight, distance to the goal, time for flight, etc. From the relativity theory we can conclude that the time can not incline to small values, as the speed of the carried explosive (its mass) is limited by the speed of light. This means that finding the object is far earlier than the moment of reaching the goal. Possible options depend on a number of parameters, linked to the corresponding enemy objects, initial positions of fired explosive, weight, etc. Without going into details, it is clear that the information sent on the parameters of the carried explosive allows a minimum of several tens of seconds (or several minutes) time for processing of information and even time for taking political decision on highest level and also - time for retaliation. Hence, one can not expect that the first to strike will get substantial advantage without threatening the existence of mankind. This problem has been discussed in literature for decade. The conclusion is trivial - if a country is aimed at military domination, it has to block the information flow and the means of information processing and only then to strike. In [1] we read „The National Security Agency (NSA) is looking for a few good cybersecurity experts. They're hoping to hire as many as 3,000 people over the next two years - so the agency can be fully staffed for a „cyber Cold War.“

We come back to the question of perfection of technology for receiving signal information either via biological changes or through finding new forms of artificial intelligence (robots that are fast learners or robots for quick solutions).

The first approach on training the senses (hearing, improving the capabilities of the brain for quick perception with possibility for associative processing) of children after their birth has been discussed.

This will inevitably lead to biological changes after some time for the human being and his organs. But the training must start now.

The second approach will lead to artificial creatures, capable to process and transfer amongst themselves big volume of information with high speed. We shall receive final solutions or conclusions from the tasks, they have been given.

During the assumptions we made, some of which need detailed investigations, some questions arise. They are linked not only with formal proof but also with the necessity of changes of some fundamental issues in philosophy and religion.

Some Thoughts

Following the statements above, a priori a question arises: Does mankind has a limit of knowledge and its application and can it control this process?

One reaches the paradox that if we can control knowledge, it does not have an upper boundary. The assumption that there is an upper boundary leads to the theological question of the existence of God or Universal intelligence. If this is so, there are two possible scenarios: The first one is that mankind is an experiment of Universal intelligence. For the one, who made the experiment, may be there is no sense whether we exist or not. The second scenario is that after reaching a certain limit of knowledge, we can expect to become part of the Universal intelligence.

Probably for that reason, if there is information, which is transferred by high speed, and we can not process it, we are still cut off the Universe.

Thinking about

In line with the presented, let us consider a hypothetical possibility, that there is an information filed which spreads with speed, not limited by the speed of light.

Having such setting, our notion for the evolution of mankind might change dramatically. In addition to the matter, of which we are made of, we are carriers of information elements. The proof or refutation of this hypothesis will lead to partial answer of the suggested assumptions above.

But then each of us will ask himself „Where are we now?“

References

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