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INFORMATION PRODUCTION AND DEVELOPMENT OF SOCIETY: CAUSAL RELATIONSHIPS

The article analyzes the causal relationship between the volume of the produced information and the level of development of society and civilization. It explores the causes of information abundance occurred over the last few decades and its impact on the society. Furthermore, it studies the emergence, current status and prospects of the transition from classic processing technologies to Big Data technologies.

Keywords: *information volume, abrupt production of information, information revolution, development rate of society, Big Data.*

Introduction

People are performing their labor activity using the techniques and information tools gained as a result of the knowledge and experience. The development of these tools causes the transition of the society to the new development stages and the drastic changes in the material and spiritual values. Socio-cultural and political-economic evolution of society takes place in the context of the rapid development of the information acquisition and use in the same periods. Today, information society is emerging as meeting the necessary needs of the people to acquire and use the information.

In the past few decades, the abundance of information produced by the technical and information tools has led to the rapid development of the society, and this development, in turn, has caused the development of a new generation of technical tools and information processing systems.

The fifth information revolution is related to the rapid growth of information abundance with the production and consumption of IBM-branded PC and to the transition from the corporate use of the Internet to mass production, while the consequences of the sixth information revolution may include a sharp increase in information generated by the Web-technologies, social networks, mobile phones, new generation digital sensors, new audio-video information systems and other techniques and technologies.

At present, civilization has reached such a level of development that it is in a predicament to process generated the large-scale information. The need for the solution of such problems has given the rise to a new area of computer science - so-called Big Data.

The article explores cause-and-effect relationships between the volume of information produced and used by the society and its development level. It also studies the need for the emergence of Big Data technology and its role in the development of the society.

The volume of produced information as a criterion for the development level of the society

Prominent Russian Soviet scientist Moiseev N., who studied the philosophy of the society's informatization, and the relationship between the abundance of information and the development, writes [1]: "The study of the history of the society can be referred to the study of history as an information process, since, one of the key factors that influence the development of the economic, cultural and other fields of each society is the information composition of the history of the society." Another Russian scientist Negodaev N.A. mentions the existence of a relationship between the development level of the civilization and the capacity of the information produced in the society [2]. According to him, the less the information the lower the development level of the society is and vice versa, the society develops in case of the abundance of information. The

development of the society - its past, present and future, is closely connected to the technical facilities, in particular, to the processes of acquisition and use of information. From this perspective, the information has become an important driving force of the socio-cultural, political and economic development of society. In other words, the amount of information produced and used by the society has the characteristics of benchmark for the development of this society.

Proceeding from this postulate, Negodaev N.A. defines the following levels of civilization according to the volume of produced information:

- Level 0 - information capacity of the brain of the first human - 1.0 Kb;
- Level 1 - information capacity of the oral speech within the community, tribe or village - 10.0 Mb;
- Level 2 –existence of the culture of writing. The volume of information of the Library of Alexandria, which consists of 532800 manuscripts, is 1.0 Gb, as the size of the Information Society;
- Level 3 - existence of the culture of book. During this period, the total information capacity of published books and journals is estimated at the extent of0.1 Tb;
- Level 4 –emergence of electronic information processing technologies. During this period, the information production capacity is approximately 10.0 Pb.

The abundance of information stipulates the development of all sectors of society, while the development of science, engineering and technology, in turn, results in the formation of means (services, relationships etc.) producing or using large amounts of information, and this process periodically repeats. Compared to the previous means, the emerging ones are more efficient and powerful generator of information, in other words, they cause more dynamic growth. Therefore, they accelerate the emergence of the following means and shorten the lifecycle of the previous ones. Considering the chronology of the information revolution known to mankind, we can reinforce the validity of this thesis. It is factual that:

- the period between the emergence of human being and the first information revolution (emergence of speech) - 1.5 million years;
- the period between the I and II information revolutions (emergence of writing) - about 35-37 thousand years;
- the period between the II and III information revolution (invention of printing the book - 1497) - 4.5 thousand years;
- the period between the III and IV information revolution (invention of telegraph (1844), the telephone (1876), radio (1868), television (1932) as a result of the invention of electrical current) - 400 years;
- the period between the IV and V information revolution (massive use of personal computers -1971-1981 and the Internet -1969-1989) - 100 years.

The studies show that there is a correlation between the capacity of information and its processing quality, and it remains constant for a certain period of time: the processing techniques are used in accordance with the growing dynamics of the volume of the generated information. This process is more or less true for clearly distinguishable periods, i.e., the correlation coefficient can be adopted within a fixed period. However, the volume of information goes beyond the linear growth trend after a while within a certain period and a rapid growth occurs in a very short time. This process, as a rule, is related to the emergence of innovations of global significance in the field of techniques and technologies (except the first revolution, i.e. emergence of speech). As a result, volume (processing) adequacy breaks, correlation coefficient sharply reduces, and existing methods cannot process the dramatically increased volume of information as before. To eliminate the inaccuracies, new methods and technologies need to be developed. In our opinion, relating the recent rapid increase in the volume of information with the mass production(consumption) of *IBM PCs* (1971-1981) and to the transition from the corporate use of the Internet to the massive use (1969-1989), which is called the Fifth Information Revolution, the process of the rapid generation

of information during the last 20-25 years, accordingly, can be called the Sixth Information Revolution.

Table 1.
Information revolutions and the volume of generated information

Conventional development level	**Development factor**	**Revolution/Renewal Period/Date**						
		0	I	II	III	IV	V	**VI**
			1,5 mln years	36 thsnd years	4,5 thsnd years (1497)	400 years (1844-1868)	100 years (1971-1989)	**20 years (2010-2020**)
0	Emergence of human	1 Kb						
1	Emergence of speech		10 Mb					
2	Emergence of writing			1 Qb				
3	Invention of book printing				0,1 Tb			
4	Invention of Electric current (telegraph, telephone, radio)					0,1 Pb		
5	Massive use of PC, Emergence of the Internet						10 Pb	
6	**Big Data**							**45 Eb**

Indeed, today, civilization has reached such a level of development that it is forced to process produced extremely large-scaled information (whether input data flow in online mode or archived database in offline mode). The need to solve such problems has given rise to a new field of computer science so-called Big Data technology.

Large-scale information processing technology - *Big Data*

As mentioned above, in the last few decades, the dynamics of the growth of structured and unstructured information generated by various sources has reached such a level that this huge information cannot be handled in accordance with the quality indicators (time, accuracy, etc.). The term "processing" includes not only mathematical and logical operations through the direct calculation tools, but also the processes of data collecting, recording, analysis, archiving and transmission.

In recent years, the term Big Data technologies include architectural systems and etc., so that the data processing is carried out in accordance with 5V features. Here, 5V means quality indicators associated with the features as Volume, Velocity, Variety, Veracity and Value. In other words, Big

Data is a technology discovering knowledge and true and valuable (significant) results by providing high-speed processing of extremely large-scaled data received from various sources (streams or databases in online and offline modes), which are interpretable for certain decisions [3] .

The above mentioned is especially refers to the online processing of unstructured data stream (audio-video traffic, social networks, web texts, e-mail data, technological sensors' streams, etc.)that do not meet the structuring formats of the modern data bases. Traditional relational databases cannot effectively perform the functions as deployment, structuring and management of extremely large-scale information by a number of indicators. Therefore, new non-relational, distributed structured, open-source, horizontally scalable database management systems (such as *NoSQL, New SQL* etc.) that principally distinguishes from the classic databases are developed for currently emerging *Big Data* technologies. Similarly, *Hadoop* platform is widely used for the large-scaled data storage, parallel and cluster processing, and database management.

Large volume of data is considered to be a major problem for Big Data technologies. The essence of the problem can be characterized by numerical values. Technical literature contains different opinions about the data volume of related to *BigData*. In terms of the growth dynamics of the data volume and the functionality (capabilities) of processing methods, in chronological order, the following classification can be more accurate.

a) classic methods of data processing:

- large-scaled data –up to hundreds of gigabytes;
- extremely large-scaled data - up to hundreds of terabytes.

b) Big Data methods of data processing –up to tens of petabytes.

A number of researchers forecast the development of the next generation technology for larger scale data (measured in exabytes) in the near future and call them as "Post Big Data", "Extremely Big Data" and etc. [4].

Statistical analysis, Data Mining, Text Mining, Machine Learning, imitation models, optimization, visualization, Aggregation and other methods are used for Big Data processing. Some authors state that predictive analysis (analytics) methods are also effective in this regard[5].

The causes emerging Big Data

We have studied the causes paving the way to the emergence of *Big Data* information revolution during the last 25-30 years.

The foremost reason for the surge of information during this period is the completion of the process of the digitalization of all description types of information and the development of the effective coding methods. For instance, modern sensors are constructively equipped with the sampling and quantum operations (including radio-transition sensors); audio-video equipment is digitalized. These technological capabilities enable to produce more digital information easily [6] (Figure 1).

The second reason is the change of objectives of the use of data processing. Indeed, affordable prices of personal computers, including computer-based mobile phones, computerization, networking achievements and so on are sharply raising the use of these tools and turning computing techniques from corporate processing tools into mass processing tools [6] (Figure 2).

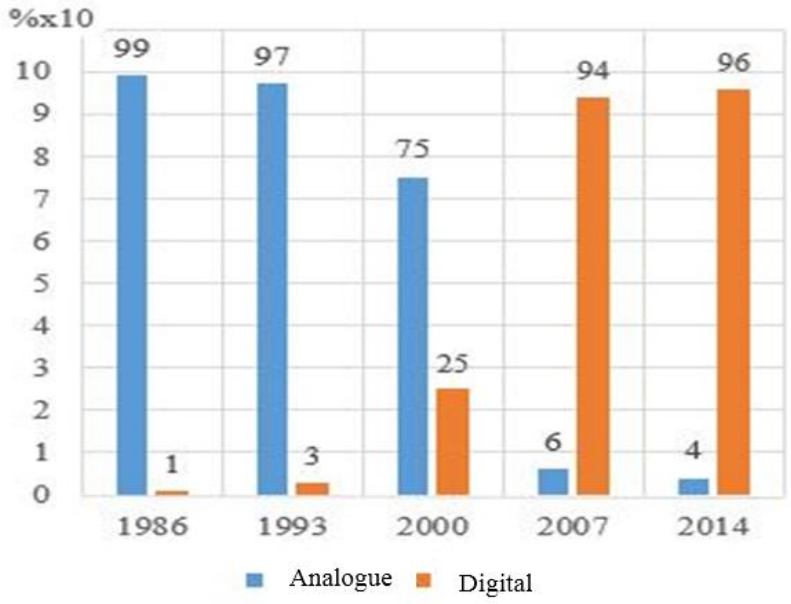

Figure 1. Analog-code Transformation of Data description

The third reason is an increase in the computing efficiency (rate) in the given period. As can be seen from Figure 3, the total production capacity of these devices, the product of which is information, has risen dramatically [7, 8].

As a result of use of a number of new technologies, including the latest generation sensors, social networks, the Internet and mobile phone applications, major search engines and etc., at present, the volume of produced information has reached Exabyte (Eb). For example, according to some estimates, in 2012, the number of e-mails sent per second throughout the world was 2.9 million, the volume of the video uploaded on *Youtube* per minute - 7 Tb, the volume of data processed a day in Google - 24 Pb, on Facebook - 10 Tb, on Twitter - 7 Tb, the volume of information exchanged through mobile phones a year - 1.3 Eb [9], in 2020, the volume of information to be produced in the world is projected to grow up to 44 Eb [10] (Figure 4).

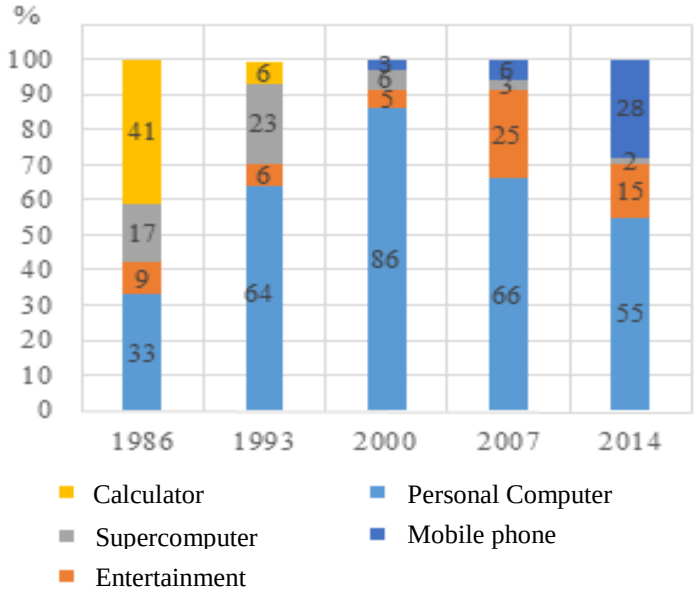

Figure 2. Destination transformation of data processing devices

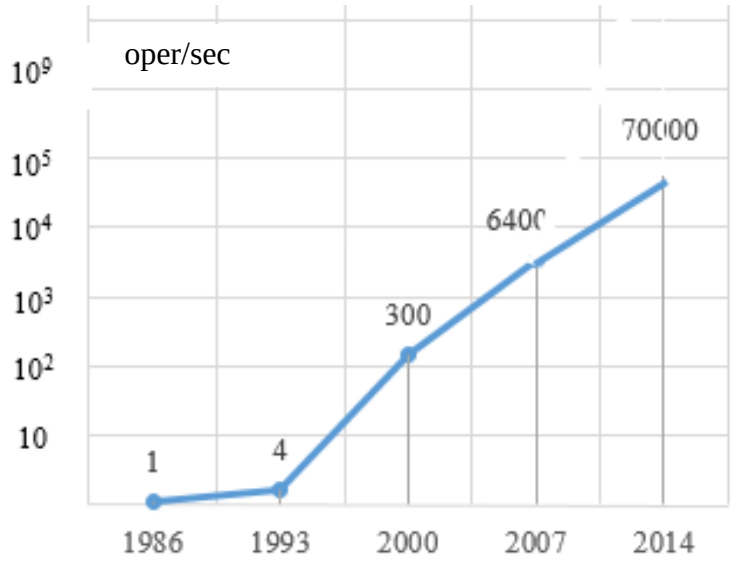

Figure 3. Dynamics of the performance of computing techniques

Currently, since the key information carriers are the electronic devices, their functionality, first of all, its capacity (volume) has been increased adequately to the growth of information. This, primarily, refers to the magnetic, magnetic-optic, optic and electrical principled external storage devices of computing tools and to the electronic archive storage facilities. For example, capacity of modern PC's hard disk (Winchester) is 3-5 Tb, whereas this capacity is8-10 Tb in the storages of petabytes of capacity. According to some sources, by the end of 2016,the capacity of HAMR (Heat-assisted magnetic recording) hard drives is estimated to be more than 10 TB [11]. The capacity of hard drives has averagely increased by 10 million times during last 35 years [12] (Figure 5).

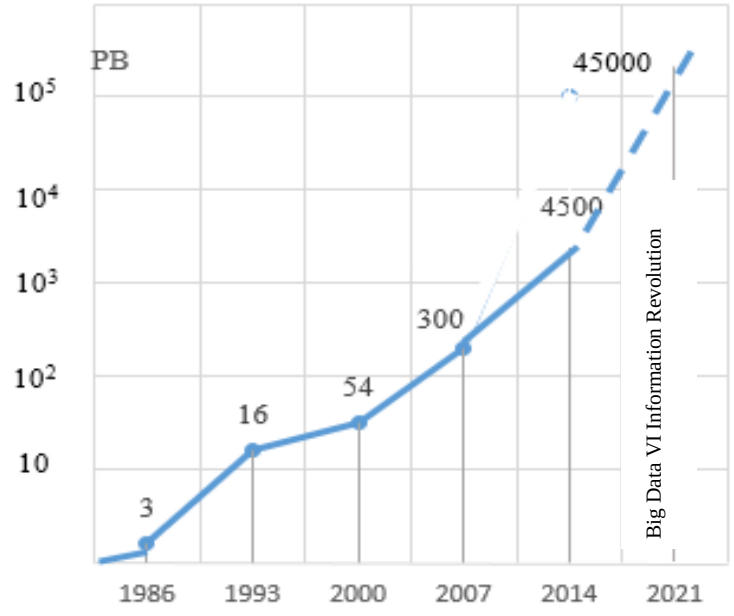

Figure 4. Dynamics of data volume growth

Summarizing all abovementioned, we can say that the main objective of the emerging Big Data is to develop new processing methods and technologies sufficient for the excessive amount of information produced by the human activities in recent years.

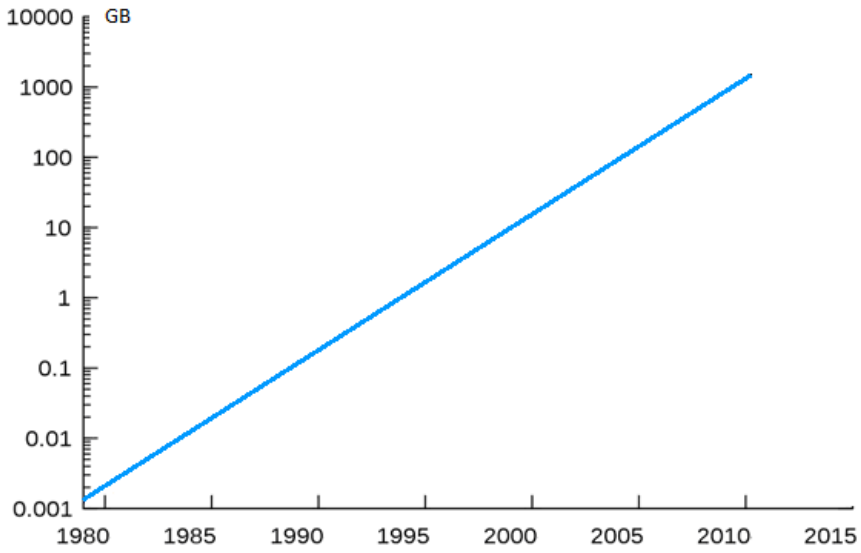

Figure 5. Dynamics of growth of external hard drive volume

Exploring the civilization history as the history of the information production process allows us to conclude that Big Data, which is the product of the latest information revolution, will be replaced by a new information revolution in a short period of time with greater raise of information than before.

Conclusion

The article explored the development level of society, the cause-effect relationship between the volume of produced information and the capacity of information carriers. It displayed that the greater the volume of information generated in the civilization and societies, the higher the level of development. Nevertheless, the proportion of the information volume and the development level has remained stable for a particular period of history, and development of new technological inventions in certain period violates this stability: the rapid growth of information arises and a new, higher stage of development begins. This periodicity is repeated throughout the history. The rapid growth of information, during last 25-30 years. is also defined as the information revolution. This article associated the chronological growth rate of the volume of the data carriers with the need for storage of growing information, and presented the table of time-volume dependence for this period. It also analyzed the process of transition from classical information processing technologies to *BigData*, and justified this transition with the necessity of solving the problems of information processing in recent years. It is stated that solution of these problems requires the development of new approaches and methods based on the principles distinct from the classical ones. And therefore, scientists and experts of a number of scientific centers are conducting research on the large-scaled data collection, storage, transmission and processing. We can conclude that the latest information revolution - *Big Data*, will be followed by a new information revolution in a shorter period of time than the previous one.

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