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ONTOLOGICAL MEANING OF STATISTICAL STRUCTURES

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Abstract: Several turning points occurred during the process of cognition, which had fundamental meaning for the development of mankind. After mastering the language, which enables the communication of people, the further step was the invention of numbers and consequently measures. We can call them as the first quantification. If we concentrate on the Western culture because of its relative success, then the antique thinking with the Aristotle's distinction of first and second philosophy was very important. The theology developed from the first philosophy with the concentration on mathematics, logic and ethics and the second philosophy was suppressed. The modern times started with the refusal of medieval scholastics and with the invention of Bacon's natural philosophy. It was immediately related to the invention of statistics as a second quantification, which significance was not yet fully recognized. It initiated the development of a new branch of mathematics – mathematical statistics and the theory of probability, which has found the use in all scientific disciplines. The statistical regularities could be found everywhere and they support also the new societal

dynamics or the start of global revolution of modern era (modernization). This wide process consists of partial revolutions in all processes, where the people are involved, and e.g. in industry, agriculture, settlement systems, medicine and hygiene, education, science and technologies, secularization, emancipation of women and many others. The demography was very close to the invention of statistics, because of its founder John Graunt as a Bacon's follower was the cofounder of statistics, too. The demographic revolution is also very important part of this wide process, as the revolutionary change from unplanned parenthood to family planning has enormous significance for the success of the whole process. In the middle of 19th century Adolf Quetelet tried to find ontological meaning of statistical structures, but he over evaluated the symmetrical statistical distribution. One century later Jaromír Korčák completed this idea that there exist two extreme statistical distributions in the reality: the symmetrical and the asymmetrical ones. This idea was fully developed in works of Martin Hampl in the theory of complexity.

Keywords: quantification, natural philosophy, statistics, global revolution of modern era, demographic revolution, statistical structures, integrated order of reality

Introduction

This contribution aims to discuss the differences between methodological (formal) disciplines and disciplines studying parts of reality, which could be objective or virtual. Formal disciplines such as mathematics, logic, and statistics can be applied in any non-formal ones, their use is universal. Non-formal disciplines reflect a part of the existing reality in our cognizance (they deal with objective reality) or they are results of our thinking (they deal with virtual reality). Sometimes we cannot distinguish between them, they are often interconnected. We have to accept the existence of two truths. Aristotle was the first who tried to solve this problem by creating the first and second philosophy. The truth in the science is rather difficult question and many authors have expressed their meaning in this context (e.g. T.G. Masaryk). The formal disciplines create also mental paradigms, but they are not confronted with the truth; their truth is based on formal correspondence with advance accepted axioms. Limits of such knowledge stressed e.g. Albert Einstein.

The process of quantification as a basis for mathematics started when a notion of number was invented many ths years ago. The invention of measures later on was another important step. The use of quantification helps significantly in the development of knowledge in all non-formal disciplines. The theology as dealing with the virtual reality was a continuation of Aristotle's first philosophy organizationally safeguarded by emerging Judaic and Christian churches. It plays the leading role among all disciplines and was supported by

the emperor (e.g. our last emperor governed out of God's mercy). The new findings which emerge from other disciplines (as a continuation of the second philosophy) were occasionally not in agreement with the Scripture and so exposed to suppression. The writings of Greek philosophers were also banned up to the middle of second millennium and the scholastic based on deductive reasoning was the main content of then science. Francis Bacon refused scholastic and with his empirical approach to reality was the representative of changes in the 16th century. The founder of demography John Graunt acknowledges Bacon's natural philosophy and used his inductive method in the study of mass phenomena (e.g. numbers of deaths). Thus along with William Petty he was also a co-founder of statistics as one of the quantitative methods. Statistical regularities were found everywhere and they were explained in very different ways. They initiated also special branches of mathematics as mathematical statistics and theory of probability. The significance of this second step of quantification was not yet fully understood.

Only 200 years later in the middle of 19th century Adolf Quetelet tried to explain statistical structures as those existing in reality and gave them not only methodological but also ontological meaning; they reflect the differentiation of reality. However, he overvalued the symmetrical statistical distribution and especially the average, which had for him similar importance as ideas for Plato. One hundred years later Jaromír Korčák had completed this approach and showed that two equally important extreme statistical distributions exist in reality: the symmetrical and the extremely asymmetrical one. His disciple Martin Hampl developed this idea further and tried to find on its basis the integrated order of reality.

The origin of critical thinking

Ancient Greece has been considered as a cradle of scientific thinking. Its cultural rise started during the first millennium BC. There are many different explanations, why at that time and why in Greece. I would like to refer to one, which is not usually mentioned. It is the geomorphologic situation of the territory. Greece is not a country where large civilizations based on agriculture with millions of people could have been developed, such as in the valleys of Tigris and Euphrates, the Yangtze and the Nile. As a result many independent states emerged on the contemporary Greek territory and Greek population achieved an unprecedented high level of individual, cultural and societal development. Also first features of democracy emerged at that time, although with the unequal status of slaves and women. Gods and myth were still everywhere, but philosophers started looking for reasonable explanation of events around them; they were not satisfied with myths and magic and they assumed that gods behave also according to certain logic and regularities.

The development of critical thinking was rather very slow. An important step forward was made by Aristotle (384-322) and his school by dividing philosophy into two: the first and the second one (O'Connor 1964, p.38). The first philosophy deals with the existence as such and events, e.g. with the metaphysics, which is beyond the sensual perception (its subject is transcendental) and the second one incorporates all other disciplines. Aristotle did not distinguish between these two philosophies clearly and such a situation exists up to now; the

question is how we can evaluate the good, justice or the demands of social policy in the ontological order of thinking.

The elaboration of logic and moral philosophy (ethics) have been considered as the main contribution of Aristotle which influence the scientific thinking up to now; his results in other disciplines were insufficient or even wrong from the point of view of contemporary science (O'Connor 1964, p. 60). He was looking more for the purpose than for explanation of events. It is difficult to understand his posture towards myths, because he did not deal with them. His attitude towards God was similar; he was not for him the creator and God's providence. Aristotle's world did not need the creator and his God was not preoccupied with human affairs. It is not easy to understand how the God functions, because he was immaterial and living out of time and space.

Besides logic and moral philosophy Aristotle gave important attention also to mathematics, which is in principle close to logic. In the process of cognition mathematics was based on numbers and thereby the process of quantification was developed. However, many Greek scientists were known especially as mathematicians' relatively long time before Aristotle (e.g. Pythagoras living almost two centuries before Aristotle considered the number as a basis of everything; at the same time he also believed in reincarnation). The notion of quantity as such is also a quality: something is too much or too little, the distance (territorially, socially) could be large or small. The quality as such cannot be compared with another one because of its unique character. There are not exactly two identical qualities in

the reality. This can clearly be seen especially in complex notions as culture, democracy or individual's IQ. It is not possible to say that e.g. one culture is superior to the other one. We have to find an operational system to formulate different features, which can be quantified. The quantification has two possibilities: calculation and measuring. The calculation is based on the numbers and measuring on measures. Both are mental paradigms which do not exist in reality, but they can be separated from the quality and so compared. Nobody can see number 2 (only as a written symbol, but not in reality) or meter. In fact any abstract notion (in comparison with a concrete one, e.g. Mr. Smith) cannot be seen in reality as such, e.g. a tree. However, all trees can be defined on the basis of common features which exist in reality, i.e. in the way of abstraction. The situation concerning numbers is different.

Any quality has an infinite number of features which cannot be separated because they form its internal substance. The selected features for quantification should express aspects of our interest, but they never cover the whole quality. The quantification is always an enormous simplification. The population size of Benin, Bolivia, Burundi, the Czech Republic, Dominican Republic, and Portugal is very similar (around 10, 4 mil inhabitants in 2014). This is quite important information, but unless we know more about these countries from other sources, this is really a very simple piece of knowledge.

The mathematics is a product of human thought which is independent of experience and reality. In spite of this fact it is very important for all scientific disciplines. The measurement of time existed in ancient civilizations in astronomy and astrology. The

numbers play also great roles in the human mythology, some of them were related to different myths, today we would say to prejudices. The number 7 was important in ancient Greek and Roma as well as in Judaism and Christianity. Plato (427-347 B.C.) wrote about the favorable number of 5040 (Novotný 1948, II, p.284; 1949, III, p.111). As we can see, it is factorial of 7. The number 4 is unfavorable in the Japanese culture. Some people do not like number 13; the 13 floor is omitted in certain towns and the line 13 does not exist in the network of street lines in some cities (in Prague it was introduced only recently).

The mathematics is developing on the basis of axiomatic. It is a formal discipline which creates limits to its contribution in the process of cognition. Albert Einstein (1879-1955) formulated this fact clearly: "How can it be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality? Is human reason, then, without experience, merely by taking thought, able to fathom the properties of real things? … the answer … is, briefly, this: as far as the propositions refer to reality, they are not certain; and as far as they are certain they do not refer to reality." (Einstein, 1954, p. 233).

Two orders of thought

Without going too deeply into philosophical thoughts, it is possible to distinguish in the process of cognition two approaches to objective reality. We can get to know what exists without trying to understand what is the purpose, role, function or use of certain thing or behavior as a part of reality. The answer of the question "why does this exist" is the aim of this approach and we call it ontological or also casual-ontological (Engliš 1947, p. 41). This approach is also called positive in economy (Sojka, Konečný 2004, p. 13). It is also possible to study the items of reality as desired or unwanted, useful or pernicious, etc. Thus here we are trying to understand why it is useful or what we should do to reach desiderative purpose. We call these approach teleological and corresponding findings or statements belong to virtual reality. Following this approach we have to create criteria, which do not exist in the reality but they are results of our thinking, assessments or desires. They reflect our interests which arose from our education, personal character, social and family posture, etc. In economy this approach is called normative (Sojka, Konečný 2004, p. 14). In the process of noesis Karel Engliš (1880-1962) also defines a normological approach. "If we look in ontology at the reality as simply existing, if we look in teleology at the reality as desired, we look in normology at something what (for somebody) has to be" (Engliš 1947, p. 47). Although this explanation of normological order seems to be logical, its teleological background is evident. The access of obedient subject towards norms (moral, juridical or orders of parents) cannot hide their original purpose, even though this aim need not be

evident. The obedient subject is usually interested mainly in the legacy, force and validity of the norms and not in their purpose.

The existence of two truths

The theology has the same origin as Aristotle's first philosophy. It uses all accessible pieces of knowledge of the second philosophy and uses also scientific methodology. It incorporated all this knowledge into scriptures (e.g. Talmud, Bible and Koran) and fixated them as revealed truths, the dogmatically unchangeable truth. The theology became an important discipline in ancient and medieval science. It was always the first faculty in then universities since their gradual foundation starting in 12th century in Europe, with important influence on other faculties.

Simultaneously with the development of theology various churches originated, among Christians the oldest and dominant in Western world is the catholic one. Its constitution lasted several centuries and completion of this process is assigned to Aurelius Augustus (354-430). His looking for truth is based on the inquiry of the man himself. According to him the knowledge is the ability of human soul to recognize and evaluate surrounding world, the ability given by God and mediated by Apostles. The Catholic Church became an influential organization in the 8th century with the large support of population. The emperor Charles the Great (742-814) recognized this situation and concluded the concordat with the Catholic

Church with the advantage on both sides. The Church assumed the responsibility for some public functions in the field of education, health, social and charitable services. The emperor protected the Church instead of its persecution in previous centuries. On the other side the church sanctified the emperor's government as the rule from mercy of God.

Achievements of the Church were indisputable and the scholastic doctrine connected with Dominican priest Thomas Aquinas (doctor angelicus, 1225-1274) dominated then science. Theologians supported other formal disciplines as mathematics and logic, but they were suspicious to other disciplines which originated from the Aristotle's second philosophy. When the new knowledge was not in agreement with the dogmatically revealed truth, it was branded as heresy and believers of this knowledge were persecuted very hard. Giordano Bruno was one of the last victims; he was burn to death on February 17, 1600.

The contemporary of Giordano Bruno was Lord Chancellor and Viscount St. Albans Francis Bacon (1551-1620), who at that time lived in England. He opposed then predominant scholastic, introduced the inductive method in the cognizance of objective reality and clearly distinguished natural philosophy from theology. He was against premature generalization, but at the same time against random experiments. He stressed the pragmatically oriented and purpose-built cognizance of the nature, which could bring along the knowledge of natural laws. He was aware that man limiting himself to empirical cognizance could be affected by idols; he recognized four of them: they originated in

misunderstanding of objective reality, from contacts with people, from various dogmas and myths and from generally accepted prejudices (Hesse 1964, p. 141-152).

The influence of scholastic was diminishing but the Church did not give up. The truth can be found in the ontological order of thinking only, we are coming to it gradually and we should never be sure about it; it is subjugated to changes and the process of cognition is endless similarly as the discussion about it; we should never believe in it. The theologians do not distinguish between the ontological and teleological orders of thinking. Propositions found in these two orders are similarly truthful, irrespective of the fact, where they were found, in the nature or in our thoughts. All originate in the will of God, they are always indisputable and it depends on us if we believe in them or not.

The well-known Czech writer Karel Čapek (1890-1938) wrote a book based on discussions with the president of the then Czechoslovakia: Talks with Tomáš Garrigue Masaryk (1850-1937); Čapek asked Masaryk what was the truth and he answered: "Please, what are, those birds over there in the park? The magpies, Mister President. You have better eyes, said Masaryk. Are they not pigeons? No there are magpies. Are you certain? Yes, I was studying them closely for a while. The pigeons fly differently. So you see you expressed yourself the features of truth: that you know it certainly because you were looking attentively and I verified my knowledge according to you. If you insist on defining the truth, I would say: The truth is what we securely know, what is the conscious reality" (Čapek 1937, p.351).

In the teleological order of thinking we are looking for the origin of various propositions (e.g. ethical norms), or we can take them as communicated by somebody, as unchangeable revealed truth. Immanuel Kant (1724-1804) influenced very much philosophical thinking and in his famous saying we can see the acceptance of two truths. He had to abolish the knowledge to make place for the belief. "Kant himself insists that the moral law is autonomous, self-sufficient and in particular independent of religious belief….he seeks to derive it not from God, as legislator and judge, but from a man himself as a rational being.... he is attempting to expound a Christian view of morality while explicitly repudiating its religious foundations. He is attempting to set forth the idea of God's law without reference to God" (Warnock 1964, p. 308).

Many other authors distinguish the ontological and teleological order of thinking and consequently two truths. The well-known sociologist Max Weber (1864-1920) was one of them. He "stressed the necessity of careful disseverment of the knowledge and evaluation. Surely not because he would like to evade the expression of his own ethical, political, economic or social persuasion. Just on the contrary, he considered himself a university teacher … who stressed factual study of some social conflict and who was not trying to bring about to students certain solution, but who wanted every student to know what is going on in individual situations … as ethically more worthful" than lectures of professors, "who presented political speeches from university chairs" (Musil 1966, p. 577).

Another example is T. G. Masaryk, who wrote: "Usually one speaks about the antagonism between the science and the religion and the antagonism is seen in both of them. I do not see any necessary conflict between the science and religion. That is when the piousness – religion in the subjective sense – is declared as an emotion, which follows up every world view, and when the theology is considered to be the world view … then it is evident that the issue is whether we want to arrange our life according to theological or philosophical point of view….. As far as the theology considers the revelation as the main source of the knowledge, the science has confidence in experience and in reasonable explanation. The theology has therefore mysteries, the science riddles and problems; the theology is infallible, the science accepts only to a very small extent evident propositions and their contents with more or less probable precepts" (Masaryk 2001, p. 204); and he continues onwards: "The theological verdicts head towards practical style of life, whereas the scientific ones lead first of all to theoretical interpretation of life. Therefore, the first more than the second ones contributed in time to existing organization of society" (ibid., p. 205).

Many authors in the history of science accepted explicitly the existence of two truths, or this conclusion can be derived from their writings. I would like to mention only two examples as representatives from different scientific disciplines. Adam Smith (1723-1790) was interested not only in economy but also in ethical laws, especially in his first writings. He was the coeval of Immanuel Kant (born the same year and died fourteen years sooner). They probably did not know each other, but their approach to this problem was similar. Two generations younger August Comte (1797-1857) is considered as a founder of sociology. At

first he completely rejected religion. In his three stadia mankind's history: theological or fictive, metaphysical or abstract and positive or scientific; there was no place for religion in the third one. He refused to deal with metaphysics in his writings Lectures from positive philosophy (1830-1842), but in reality he dealt with it. He realized in the second phase of his life that something is lacking in the society (especially for its stability) and he created the Positivistic Association and later the Positivistic Church (1849) as a religion of humanity with relevant rituals, priests, holidays and saints. He himself made pertinent proposals, designed the complicated liturgy, composed prayers and put together church calendar. Instead of God the object of the cult should be the Great Being; he named himself the Hierarch (Guru) of this church (Diderot 2000, III, pp. 251-2; Neff 1948, pp. 64-66).

From the Aristotle's first philosophy originated the theology and the scientific philosophy. Every discipline has its own philosophy, i.e. problems, which are trying to explain but in the process of cognizance are limited only to formulating hypotheses. We accept any hypothesis as truthful unless we find something that is not in agreement with it. In this case we formulate new one or it is not the shame to confess that we do not know the answer. "The science is the power of man, but it also convinced him about his impotence; because there is a little what we know, much more that we know incompletely, we are mistaking in many cases and there are very many things we do not know completely" (Masaryk 2001, p. 25).

The origin of statistics

The previous paragraphs should serve as an outline of the history of critical thinking and the background of thoughts on the basis of which the statistical method emerged in 17th century. The co-founder of statistic John Graunt (1620-1674) was born in the same year when Francis Bacon died. The process of quantification is very old one, it started in the moment, when numbers were invented, but the statistical method as a specific type of quantification arose only relatively recently. John Graunt was not academically educated, he was autodidact, but he had friends among many prominent persons in London's society. One of them, William Petty (1623-1687) is considered the founder of statistics with his publication Politicall arithmetick, which was published in 1776. Graunt published his book Political ad Natural observations already in 1662.

John Graunt visited London's vicarage and found out there the bills of mortality for last 20 years. Checking the bills an idea came to him that he should classify them. He realized that the numbers of deceased men and women were almost identical. He logically concluded their numbers in the population must also be the same. This was a new information, because of the then prevailing opinion that the number of women is higher (the doctors had among their patients more women, the polygamy among Muslims, etc.). He classified the bills also according to the cause of death and he estimated the age structure of deceased persons (because the age was not noted on the bills, he reckoned the age on the basis of the causes of deaths). He realized that the probability of dying is not equal in all ages and so he came to the

idea of life tables. He opened the way for searching statistical regularities by the method of incomplete induction in all fields of reality. It is only necessary to define population units and their aggregate called also population. We do not need to define human population units and individual deaths. If we define the unit, at the same time the population is defined. If the reality is continuous (as the territory), we have to delimitate the unit first. It is evident that using the natural units (such as man or death) in statistical way suggests itself; so the beginning of statistics started with them.

John Graunt was influenced by Bacon's natural philosophy. He was very modest and in the introduction to his work stated that his results were a small contribution to natural philosophy based on mercantile calculations. He did not realize his phenomenal contribution to the whole science; statistical regularities emerge everywhere. He himself found beside different intensity of mortality according to age also statistically significant difference between the number of born boys and girls in the proportion of 14 boys to 13 girls. It lapsed 350 years from the release of John Graunt's book and the regularity has not still been explained, but only refined to the proportion 106 to 100. The first explanation one century later was theological. Johann Süssmilch (1707-1767) in accordance with the then predominant ideology interpreted this regularity as a manifestation of God's will (he gave even the reason for it: the celibate of priests). It shows one important thing, valid for all similar regularities based on incomplete inductive method: statistical method cannot explain the found regularities; it never deals with a substance of a given matter, it sees the reality

from the phenomenal view, the explanation must be searched in the corresponding empirical discipline (in this case in biology, resp. in genetics).

The ontological meaning of statistical regularities and structures was invented a century later by Adolph Quetelet (1796-1874). According to him, statistical regularities have a deeper implication. By studying individual phenomena using the statistical method, a special collective entity appears with an existence of its own and governed by laws of its own. This requires, however, for the entity to be formed from similar elementary phenomena. "There exist a general law governing our world, which appears to be designed for the expansion of life; it gives to all that is breathing an infinite variety, without changing the principle of constancy…..that law, unknown to science for a long time and remaining unused for practical purposes until this day, I shall call the Law of Incidental Causes" (Quetelet, 1848, p.16). A logical consequence of the overestimation of the principle of constancy is Quetelet´s interest of the average – his attempts to define the average man are well known – and the concept of evolutionary trend to lessen deviations from the average as fundamental. It seems to him that there is an increasing equality among people, that wealth and wages are leveling out the more civilized the country becomes, that everything progresses towards a certain harmony and a stationary condition. He fails to see that in such a state of calm the development would cease altogether.

Adolph Quetelet deliberately confined his interest to elementary phenomena of one and the same kind, where he always found a distribution reminiscent of the Laplace-Gauss

error curve (unimodal symmetrical distribution) with a typical average and deviations compensating each other. If he encountered phenomena which do not corresponded with such a distribution, he failed to investigate the causes of this event but found a simpler, though incorrect explanation. Thus, asked what the typical size of a country was, he replied that this could not be determined as countries have various borders according to their geographical position, but above all "they are not frequent and their incidental causes are too frequent for mutual compensation" (Quetelet, 1848, p. 156). It is not difficult to refute his contention of small frequency as in another instance he states that it suffices to investigate a small number of phenomena to determine their type. Obviously, a country is a different type of phenomena than a man, animal or plant. When investigating the distribution of countries according to their territorial area or population size, it will always be found that it is very far away from unimodal symmetric distribution: there will always be a majority of small countries and a small number of very large ones. With regard to the set of countries, their average size is a wholly untypical value.

Jaromír Korčák and two fundamental types of statistical structures

The first and most important feature of any collective entity is, apart from its size, its internal structure. Each section of reality has a certain pattern of quantities, which correspond with its qualitative structure. Every empirical discipline is concerned with the study of structures of reality as a means of discerning the internal differentiation and

simultaneous integration of its subject; in the structure, the combination of a whole and a part is contained. Contemporary science is characterized by the distinct predominance of analytical findings on the nature of reality; this, and the concurrent development of mostly methodological aspects in the study of structures, leads to vagaries in the basic orientation of their evaluation. This is illustrated the best by the fact, that the most important classification of structures, characterized by means of the classification of scientific disciplines, has hardly changed over past two centuries, though it is in essence based only on the evolutionary principle. Because of this approach the position of many structures are very difficult to be included in such classification. In particular, this is the case of the structures of systems of phenomena of different kind and a set of complex phenomena.

In spite of growing interest to study the differentiation of complex systems, especially of uneven structures of various real systems, neither generalization nor systematization was reached, let alone their explanation. Such structures are common in geography or ecology. Studying these phenomena, even quantification or statistical methods were often refused and the singularity of such phenomena was stressed. However, for a more universal assessment of the differentiation and integration of reality, it is necessary to establish the classification of structures not only from the aspect of evolutionary principle, but also from the principle of their coexistence, and to try and find the hierarchy of those structures. On the basis of their features, the statistical distributions can be used for inclusion to the classification of structures.

The works of Jaromír Korčák (1895-1989), a geographer and statistician, represent a fundamental contribution in this direction. Although he expressed this idea already in 1936, his principal work was published in 1941, based on extensive study of literature and rich set of empirical examples. According to him, "statistical distribution is not a term specific to statistics….it shows a certain and general regularity in the structure of external world and thus contributes to the cognition of the world order, i.e. the clarification of a concept which belongs to the oldest in philosophic thought" (1941, p. 174).

The structure of the homogenous collective entity, characterized by the error frequency curve has been recognized and described countless times on biological and demographic phenomena of similar kind; at the same time it is a base for the development of formal mathematical branch of theory of probability and mathematical statistics. The structure of the heterogeneous collective entity, characterized by the left-sided statistical distribution, was practically neglected, or efforts were made to transform it formally into symmetrical one. It is obvious that the majority of geographical phenomena form very heterogeneous sets, where the typical unit cannot be determined. For a long time, statistical distribution was used also in geography for the verification of average values and no regularity was found in asymmetrical distribution.

Jaromír Korčák then developed his fundamental idea about the structure of objective reality further: "…symmetrical statistical distribution governs phenomena the less, the more their nature is geographical" (1941, p. 200) and he continued: "In the world of external

reality, there exist two statistical structures, two statistical orders which essentially differ from each other: statistical distribution of the hyperbolic type and of Gauss curve type. The first is the statistical image of the inanimate base of organic nature, the second shows the quantitative variety of animate individuals distinguished into species. E.g. if we observe the size of such individuals, we find a symmetrical distribution, which thus actually proves the similarity of the species; here, variability is merely a manifestation of inessential deviations. However, if we could observe in a similar manner the biosphere as a whole, as a single set covering the surface of the Globe, then we would doubtlessly find an extremely asymmetrical distribution, as the smallest plants and animals are by far the most numerous, and their number declines with increasing size. Hence, the statistical distribution is the image of the wide variety of the Earth as a whole" (1941, pp. 221-2).

One century after Quetelet Korčák affirmed that the statistics has also an ontological value, that it reflects existing regularities in the objective reality, their integrated order. This does not lessen its use as one important method which can be applied in any part of reality; nevertheless, the ontological meaning of statistical structures is philosophically of primary importance because it gives a true picture of the differentiation of reality.

Jaromír Korčák was a geographer with a large understanding of problems of many other both natural and social disciplines, incl. philosophy; the statistical methods were traditionally refused in geography and the ideographic method was forced. Despite the importance of Korcák´s idea, the response of scientists of that time was practically non-

existent. This could partly be due to the Second World War, to the limitedness of Czech language (only short information was published in French in 1938), and last but not least to the marginal position of geographic knowledge in the whole science. It is necessary to bear in mind that there is only one science because the objective reality is also only one (if we speak about different sciences, we have in mind specific disciplines); the disintegration of contemporary science during last two centuries led to enormous and still growing unevenness in acquired knowledge in specific disciplines with the absence of comprehensive and integrated objective picture of reality. These facts make difficult both the internal development of science and its external application. So far science has been unable to provide a solution to complex problems. Many efforts from this sphere have led to failures or to unfair identification of the technocratic instead of scientific approach. The process of learning partial and simple phenomena is relatively simple; the cognition of complex phenomena and holistic structures is difficult.

Further elaboration of Korčák´s idea

According to the Korcák´s idea expressed for the first time in 1936, the geographical or regional systems (or elements of these systems) have always internal statistical structure of hyperbolic type. The hyperbola has a pure and simple mathematical formula known already in antiquity, but of no use in contemporary statistics. The mean is atypical value for majority of geographical structures and so the central limit theorem cannot be used for the expression

of hyperbolic structures. On the other side there are biological systems, the homogenous collective entity, characterized by the error frequency curve, which have been recognized and statistically described countless times since Quetelet´s looking for the average man.

To make it more complicated, we will introduce the evolutionary view of V. S. Nyemtchinov (1894-1964): "Mass processes and individual phenomena in social life are of a considerably more complicated qualitative nature than analogous processes and phenomena in inorganic and organic nature. The transition from phenomena of the inanimate world to phenomena of animate nature and from those to the sphere of social phenomena is accompanied by the constantly increasing complicacy of the processes occurring in reality. The following law should be noted thereby: in the transition from the lower forms of the motion of matter to higher ones, growing variety is observed on the one hand, and also an increased complicacy of the qualitative nature of events and processes, and on the other hand, a declining number of homogeneous and inhomogeneous objects which form part of the respective mass processes. Social phenomena are incomparably more varied and qualitatively complicated than biological phenomena, and those in turn are considerably more complicated than phenomena of inanimate nature; however, the number of individuals gradually decreases in the transition from inanimate nature to biological and social phenomena. Thus e.g. the number of protons and electrons of the atomic world gigantically outnumbers the molecules, not to speak of the macro-bodies forming the world of inanimate and animate nature. The number of elementary units forming social phenomena (people,

families, nations, economies, factories) is incomparably smaller than the number of molecules, atoms, and their elementary particles" (1955, p.22).

In every part of reality (we can consider it as a system) reproduction occurs (evolution, development) due to internal and external causes and the hierarchical position among other systems. The internal causes (e.g. heritage of genes) tend to the reproduction of the homogeneity and the external causes (such as environmental causes) reproduce the heterogeneity. In reality not only these two extreme types exist, but also many intermediate types due to the various combinations of internal and external causes and their respective weight. The interaction of different systems is a primary source of the development of reality. At the same time, the essence of the contrast between heterogeneous and homogeneous systems represents the contrast between the whole and the part. Thus reality appears as heterogeneous set of partial homogeneous sets. The basic characteristic of the development of reality is its increasing evolutionary complexity and variety, the origin of new homogeneous sets and the increasing resultant heterogeneity of the structure of reality as a whole.

The most general view confirm the left sided extremely asymmetrical distribution of the matter in the world, reflecting the relation of the quantity of matter and the level of its qualitative differentiation (evolutionary level: inorganic matter– flora – fauna - people), which 0is a manifestation of the selectivity of the evolution of reality.

Classification of real systems

The classification of real systems was developed by Martin Hampl (born 1941). Originally he defined four basic systems coming out from the combination of two main principles: evolutionary and structural complexity. Following systems can be so defined:

1) **System of natural elements**, with relatively low complexity, evolutionary relatively simple and passive with low level of internal variability, certain stability and low integrity – e.g. atoms, molecules, individuals of the same biological species, biological features of plants and animals, IQ etc. The structure of these systems has high homogeneity and can be characterized by unimodal symmetrical distribution (table 1).

Table 1: Distribution of cuckoo eggs according to their length

Variation groups	1	2	3	4	5	6	7	8	9	Total
Frequency of provinces	125	60	18	11	5	2	1	1	2	255

Source: (V. Fabian, 1963); Hampl, 2000, p. 41

2) **System of social elements**, with relatively low complexity, evolutionary developed and active with progressively oriented variability; these systems have various level of integrity and low stability. The statistical structure is similar to the preceding one, unimodal symmetrical distribution with oriented motion along the axis of quality – e.g. – similarity of biological features of people affected by various social conditions (see table 2).

Table 2: Distribution of countries (territorial units) according to life expectancy of men[1)]

Variation groups /Year		1	2	3	4	5	6	7	8	9	10	11	12	Total
Frequency of countries	1950	8	31	32	27	20	26	20	24	8	4	-	-	200
	1960	1	16	29	23	18	27	19	33	28	6	-	-	200
	1970	-	1	23	25	18	21	25	32	53	13	-	-	200
	1980	-	2	9	17	22	17	17	42	52	22	-	-	200
	1990	-	-	1	15	19	18	10	35	58	40	4	-	200
	2000	-	-	4	10	21	12	14	19	50	50	20	-	200
	2010	-	-	-	1	9	18	11	23	29	64	39	7	200

Source: World Population Data Sheet, Population Reference Bureau, New York

[1)] To reach the same number of territorial units the smallest population units were omitted. The life expectancy in the first group is below 30 years, the countries in the last group over 80 years, the size of every group is the same (5 years); (Pavlík, 1998).

3) **Systems of natural complexes**, e.g. physical geographic regions and the whole of natural reality. These systems are relatively complex with various kinds of qualities in mutual coexistence; they manifest low level of evolutionary activity and integrity, are stable and passive. These systems are internally heterogeneous and their statistical expression is an extremely asymmetrical distribution, which characterizes the extreme lack of uniformity in the incidence of qualitatively different phenomena and extreme differences in their quantity (see table 3).

Table 3: Distribution of main tributaries of 12 selected rivers according to their length

Variation groups	1	2	3	4	5	6	7	Total
Frequency of units	835	277	60	8	5	1	1	1 187

Source: (J. Korčák, 1950); M. Hampl, 2000, p. 41

4) **Systems of complete complexes**, e.g. geographical regions comprising all kind of forms of the motion of matter in mutual coexistence (incl. social phenomena). Such systems can be characterized as highly heterogeneous and dynamic, which is ensured mainly by the development of society and its impact on nature. The statistical structure is again the

extremely asymmetrical unstable distribution with the extension of hypothetical curve along the axis of quality. This corresponds with the qualitative withdrawal of society from nature and the increasing disproportions in the territorial distribution of social phenomena (see table 4).

Table 4: Distribution of population density in European provinces around the year 1960

Variation groups	1	2	3	4	5	6	7	8	9	Total
Frequency of provinces	125	60	18	11	5	2	1	1	2	225

Source: J. Korčák, 1973, p. 109-111

The delimitation of four basic distributions is only the first step in the searching for the integrated order of reality, although the most important. However, in reality the pure (balanced) distributions of either basic type are rare; usually transitional (intermediary) distributions are found which represent a combination of the system of elementary

phenomena with complete complex phenomena, corresponding with the multi-leveled nature of the coexistence of phenomena in reality. The regularities do exist not only in the distribution of homogenous systems, but also in the heterogeneous ones. The underlying causes for the reproduction of homogeneous systems are of internal character and for heterogeneous of external character. The combination of both types of causes leads to intermediate distribution, what is the situation in majority of cases in reality.

The distribution of incomes could be a good illustration of such intermediate distribution, which is typical for all societies irrespective of their economic, social and political system. It was named the Pareto distribution. The human beings as one the biological species have similar abilities in the normal variation (physical force, IQ etc.). On the other side their social position, wealth, position in hierarchy of power are rather uneven. If we include also a regional dimension, the differences among people increase considerably. Such a distribution is even more heterogeneous (see table 5).

Table 5: Distribution if average wages of employees in Czech districts in the year 1996

Variation groups	1	2	3	4	5	6	7	8	9	10	Total
Frequency of districts	24	26	9	7	6	2	1	1	0	1	77

Source: M. Hampl, 2000, p.40

The transition of homogenous distribution can be represented by changes in the life expectancy during the demographic revolution. The process of demographic revolution can be described as revolutionary changes in the demographic behavior of people during which the level of both fertility and mortality is decreasing; the decreasing level of mortality can be described by the growth of life expectancy. The demographic revolution started at the end of 18th century in France, and then it gradually diffused to other European countries and in countries with population of European origin. The process ended in the middle of 20th century and simultaneously started in the developing countries, when the differences among countries were the biggest. Since that time, the differences are gradually decreasing with the expected homogenization during the second half of 21st century (see the table 2). Systems containing social phenomena may be called active systems, in view of their progressive nature and the intensity of their variability.

Formal expressions of statistical distributions

A few efforts were made to express known statistical distributions in a formal way. Most of them are based on general statistical principles, i.e. on methodological approach without taking into consideration the specific content of the given part of reality. The permanent movement occurred in the objective reality as well as in all of its parts (i.e. their

reproductions), only the length of time differs extremely according to the substance of reality. The system of rivers and their tributaries might change in mils of years and so does the length of eggs of a biological species in hundredths ths of years (those are the passive systems); on the other side the reproduction of population or urbanization are changing relatively quickly during hundreds of years (those are the active systems).

One specific case could be mentioned as an example that is the reproduction of demographic system. The changes in the level of mortality in 200 world countries (territorial units) characterized by their life expectancy (see table 2) express the progress of demographic revolution in the world. It occurred in two periods: in the European countries and in other countries with formerly European population it occurred in 19th and in the first half of 20th century; it is occurring in the rest of the world after WW II. The life expectancy was very similar in all countries around the end of 18th century, the distribution is bi-modal around 1950 and the trend to new homogenization could be clearly seen afterwards. The length of life is basically a biological phenomenon and all people have similar internal predispositions for it. The changes in the length of life during the demographic revolution are due to the external factors (e.g. social) which have only transitional effect.

On the other side due to external factors, the urbanization and the system of territorial distribution of population tend to the steady growing of concentration. This is typical for the development of geographic, ecological or complex systems. There also exist regularities in the coexistence of different kind of phenomena contained in complex systems.

The territorial physical concentration of people can be added to or replaced by concentration of their activities, especially by qualified working places, higher level of education, information or power etc. The statistical method should be ready to divide the effect (the weight) of internal and external factors.

J. Novotný and V. Nosek (2009) tried to find out models based on general statistical principles. They started with the Gauss unimodal distribution and followed by a study how different authors deal with these problems. The literature collected is rather rich in number. In 1879 already Galton criticized the "law of arithmetic mean", which was so important for Quetelet. After quoting a series of authors and describing their effort to transform variable into log-normal distribution, Novotný and Nosek came to the conclusion that further investigation was required. In my opinion the contemporary statistical methods based on mean and variability measured related to this mean is not adequate for extremely asymmetrical distributions. The average sizes of cities or average length of rivers (tributaries) are very problematic pieces of knowledge, which do not give any adequate information. Therefore also the measures of variability related to the mean are equally problematic. The statistical moments of higher degree (skewed or concentrate distribution) have similar meaning for extremely asymmetrical distribution.

However, for slightly skewed distributions authors tested and recommended six measures, which could effectively be used. The Coefficient of variation is the first, which does not need any explication. Two others are based on the logarithmic transformation of

variable, the Theil coefficient and Mean logarithmic deviation. The variables of the two other measures were not transformed and often used: Gini coefficient and Robin Hood (or Hoover) index. Gini coefficient stems from Lorenz curve; these both measures are based on all values of variable, but also related to the mean. The last measure named by authors as the Rate of heterogeneity quantifies value at the 50^{th} percentile of the Lorenz curve. It was first suggested by Martin Hampl and therefore should be called the Hampl´s index (H). In contrast with the other measure H is insensitive to other values of the set and so to the shape of the distribution; on the other side it is not related to mean and this is its advantage. The H should be supplemented by the range of variability or by some measure of differences among units of the set.

Conclusions

The discussion started rather broadly, with the origin of contemporary science, the distinction between the ontological and teleological approaches in the study of reality, the problems of quantification, the problem of two truths, the importance of Bacon's natural philosophy for the origin of statistics, and the significance of Quetelet´s and Korčák´s approaches for understanding of the ontological meaning of statistical structures. Finally the initial effort of Martin Hampl with the elaboration of principles of integrated order of reality has been shown. It was not possible to deal with all problems connected with this idea as explained in Hampl´s work (Hampl, 2000). He deals with integrated approaches in science

and geography: holistic vagueness versus biased clarity of reductionism, types of hierarchies and the classification of real systems, hierarchical levels and the organization of reality, integrated structure and evolution of reality, society in environment: structures, interactions and development mechanisms, physical geographic and sociogeographical organization: rank/scale differentiation of the environment, types, evolution and problems of assessing hierarchical organizations.

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