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(IN)APPLICABILITY OF STATISTICAL METHODS TO THE STUDIES ON LIVING SYSTEMS: THEORETICAL LENS

Abstract: *The paper theoretically explores the limitations of the statistical method. Specifically, we point to the inapplicability of statistics in the studies on living systems. Western interdisciplinary sciences, natural sciences and humanities, often analyze data and develop the lines of argumentation as endorsed by the statistical analysis. In the present study, we select several theoretical, applicational problems which question this methodological in the studies on living systems. Paradigmatic/philosophical considerations, the improbability principle, or the correlation between the variables in the research are among the themes we focus on in our paper. The underlying idea is that life processes and the living world operate in a reality which is both linear and nonlinear, local and nonlocal. Hence, the methodology of research into these living realms needs to bypass the computational approaches and algorithmic modelling. We argue that statistics (as a branch of mathematics) cannot be decisive as regards research and applicational programs on living systems.*

Keywords: *Living Systems; Statistics.*

1. Introduction

Medical topics have been hitting the international headlines for the last year. Facing the epidemic crisis of Covid-19, humans more intensely then ever before realize their identity as the inhabitants of the global village. International collective attention is now focused on effective regulatory and preventive programs to deal with the virus and its mutations (Walach et al. 2021; Boldrini et al. 2020). Scholars of the medical and biological specializations are mobilized not only to find effective and safe vaccines, but primarily to build up preventive models which will lead new generations out of the Covid-weary society into the newparadigmatic lifestyle model and quality living.

In this theoretical analysis, we claim that to build post-Covid models of quality life, the focus of the transdisciplinary international research needs to go deep to the level of the paradigmatic framework and re-address the core intellectual, common sense and scientific assumptions scholars hold about reality, and specifically about the ways to scientifically access the nature of reality. As we argue in this concise analysis, the methodological approach of the statistical analysis is not applicable in the research on life and life processes. It is mathematical tools of statistics which are mainly used in the scientific process of the western sciences which do the research on living systems. Also, verification of social, health-related, psychological, technological models to be applied in practice is done through statistical argumentation, regarded as the most reliable

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method of scientific/formal evaluation. The main argumentation we develop here against this scientific/methodological approach are as follows:

(i) living systems are not mathematical systems; are not closed systems (von Bertalanffy, 1968; Vitiello, 2001; Penrose on noncomputational nature of life processes, 1995: 26-27; 2005);

(ii) tools of statistical research have not been designed to study life systems; and do not apply to this type of analysis. We summarise our line of argumentation into **three applicational problems** enumerated in the section 3 of this concise presentation.

2. Paradigms and thinking styles in the scientific process

When we activate our cognitive processing, be it basic perceptual or thought processes, or more complex cognitive operations like formulating assessments, expectations, problem-solving, or the complexity of the scientific process, these cognitions are always embedded in a framework of pressumptions about the context in which they unfold. This framework of assumptions about reality usually is conceptualised by us as the basic truths of life, or the obvious facts and unquestionable data about the reality around (cf. Fleck, 2007 a, 2007 b, 2007 c). As such, these undisputable truths we live by, build up paradigms (Kuhn, 1970). So, paradigms are not only the theoretical, abstract ramifications scholars use in the research; but primarily these are non-conscious and basal sets of truths humans use as their cognitive filters to understand the reality around them.

A self-directed reflection about the paradigm one operates within when indulged in any cognitive activity is a recent scientific/methodological strategy on a larger-of-scale among scholars and intellectuals (Walach & von Stillfried, 2011). Untill recently, western sciences and both individual and collective minds (cultures) were by force of inertia functioning in the materialist, classical paradigm, installed by proposals of Descartes, Newton, and Darwin, to name but these recognisable intellectuals who, for several centuries to come, shaped the western cognitive systems of representation. Implementing statistical models to the studies on living systems - humans, animals, the plant world, etc. – reflects the Cartesian life model, in which living systems are conceptualised as living machines, engines constructed out of parts and operating within the Newtonian laws. This purely materialistic and mechanistic view on life substance on the planet Earth has to date been the dominant scientific paradigm of the western cultural zone (Walach, 2005; Walach & Schmidt, 2005; Walleczek, 2000).

With the rise of 20th century physics western scholars have been presented with a paradigmatic alternative to the classical paradigm; today, we can discriminate between the classical framework and the post-classical paradigmatic framework (Bogusławska-Tafelska, 2016; 2019). In other words, in our intellectual or scientific pursuit, we have an alternative of two starting-point referential planes. Modern holism, being the alternative to reductionist materialism, is no longer a generalized, unspecified philosophical vision, but a serious interdisciplinary theory on life systems (cf. Galileo Commission Report by H. Walach, 2019).

3. Statistical research: the inaplicability in the studies on living systems

We arrange our selected argumentation in three applicational problems identified below.

Applicational problem no 1: the error of 'the improbability principle'

Let us focus on the obvious basic facts. Mathematical statistics is a branch of mathematics, which means that it contains definitions and theorems proved by the rule of inference based on the *modus ponendo ponens* tautology (as in all areas of mathematics) and on this basis, research methods are constructed and made available to practitioners. Thus, the precision of results in statistics are analogous to those of theorems in algebra, or mathematical analysis. This needs to be emphasised, since there are opinions of practitioners that problems using statistical methods result from a certain imprecise flaw in the theory of statistics. However, this is not so, and is due to a confusion of concepts. The limitations and ambiguities that the practitioner encounters in the application of statistical schemes appear at the interface between a theory which is precise, and the phenomena studied. The statement that the estimated parameter θ lies within the confidence interval 1 – α is a precise statement, since it is a consequence of an appropriate theorem. The fact that a researcher constructing a confidence interval in a specific experiment is not able to decide whether θ really is in this confidence interval is due to the limitations of the statistical method, not to its imprecision.

This connection between theory and practice is a significant and sensitive problem for both sides. A mathematician who, understanding the proof of Kolmogorov's theorem, may have a problem transferring it to an engineering setting, but on the other hand, a researcher who uses the Kolmogorov test needs to properly and thoroughly check the assumptions of the theorem needed to be met in order to be able to apply this test. An example of this is the well-known history of an attempt to predict the presidential election in 1936 in the USA, when the magazine Literary Digest based its forecast of a definite victory for Landon (32 out of 48 states) on a sample size of 2.3 million, but Roosevelt won in 46 states. A similar situation was repeated in 2016, when most opinion polls the day before the elections predicted a clear victory for Clinton, giving the country-wide Democrat candidate an 11-percentage point advantage over Trump. However, Trump won 304 seats against Clinton 's 227. One of the few who predicted the Republican candidate would win was Georgia's Trafalgar Centre. The obvious error of the polls in both elections was due to a lack of randomness in the sample, and so failed to meet the assumptions required by the procedure.

One of the most widespread research techniques used in statistics are significance tests. In these tests, the researcher has control over only the type I error, i.e., the error rejecting the null hypothesis H0 when it is true (false positive) but does not control the type II error (false negative), which seems to be lost from sight, or even the unconscious question of making the mistake of not rejecting a null hypothesis that is false. Ascribing more importance to the type I error however, results from the nature of the significance test itself, the aim of which should be to try to reject the hypothesis H0. In this case the predetermined error level for rejecting the null hypothesis, (when it is true), allows the null hypothesis to be meaningfully rejected, which is sometimes called a strong conclusion. In turn, not rejecting the null hypothesis is not the same as accepting it, due to the lack of control over type II error. Inference based on an attempt to reject the presumed null hypothesis is a transfer to the statistical ground of the principle *reductio ad absurdum* from classical logic. It seems that the strategy of rejecting the null hypothesis is not fully thought out by practitioners, who may expect the significance tests to confirm the hypothesis H0. Such an expected justification can be obtained in cases when the null hypothesis is not rejected, but the value of such a conclusion is scientifically questionable, which in turn may have serious research implications. On the other hand, the principle of *reductio ad absurdum* in its pure form cannot be used in statistical conclusions. Hence it is referred to as 'the improbability principle'. By this is meant that if a random event has a very small probability, then it can practically be assumed that in a single trial this event does not occur. Clearly this is not true. In fact, no statistical test will ever solve a given problem with certainty, which sets the limits for the applicability of statistic methods. For this reason, understanding and proper interpretation of statistical tests is a serious challenge for theorists. Commonly used is the computation of the p-value, due to Fisher, and comparing the p-value with the significance level α, or the meta-analysis (Glass, 1976) is a standard procedure. However, neither of these methods satisfies theorists or practitioners, which has led in the last decade to severe, even excessive criticism of significance tests, including the rejection of scientific results using these tests.

Applicational problem no 2: statistics as a starting point in building the cause-effect relation in a given research

Each effect has a cause, which in statistical language can be described by two features X and Y, one of which is a variable dependent on the other independent variable. If the researcher thoroughly recognizes the nature of the phenomenon, either based on theory, or as a result of experiments, then before starting statistical research, he/she can determine the nature of both X and Y. Then the construction of a statistical model describing the relationship between X and Y, which in statistics is called regression, is justified. Particular attention, and therefore doubts, are raised by scientific research in which the researcher tries to find cause-and-effect relationships relying solely on statistical techniques. Knowing the effect of Y and looking for the cause of X for it, one can repeat the test of independence multiple times between the variable Y and subsequent variables X until the null hypothesis is rejected in one approach. Hence it can be concluded that there is some significant relationship between the found X and the fixed Y. This practice, although formally correct, makes no sense, which results in the practice of pseudo-science.

The use of statistical tests requires some skill which is not necessary to compute the correlation coefficient between two features X and Y, commonly used in statistical research because calculations are easy. Due to symmetry, this parameter does not distinguish between dependent and independent variables; it is interpreted as a measure of the relationship between the X and Y. Given any two features X and Y, the correlation coefficient can always be computed to give a non-negative number not greater than one. Thus, using the contractual interpretation of the magnitude of the relationship between X and Y assigned to the value of the correlation coefficient, it is possible to illegally determine the existence of such a relationship which does not actually exist. This means that before computing the correlation coefficient, one must know the relationship between the variables which results from the nature of the phenomenon, so that the value of the correlation coefficient carries meaningful information. The belief of some practitioners that the correlation coefficient contains information about the real strength of the relationship between the variables is inaccurate, since the measure of the relationship between the variables assigned to the correlation coefficient, interpreted to what extent the change of one variable affects the change of the other variable, is purely arbitrary.

Applicational problem no 3: statistics is not designed to study open systems

In this present concise analysis, we also would like to point out that statistics as a tool of research can only be applied to studies on closed systems. In itself, statistics belongs to the symbolic systems (von Bertalanffy, 1968:29). While today interdisciplinary scholars agree that living systems – organisms, cells, etc. - are essentially open systems, which remain in constant communication and exchange not only with each other but also with the ecosystem outside them. Regarding them as the elements of the closed, atomistic model of the classical Newtonian reality is a methodological error (von Bertalanffy, 1968; Couto, 2014).

4. Towards conclusions

To repeat the organising thesis of this paper, statistical analysis, being a branch of mathematical science (both theoretical and applicational), cannot be used to accredit applicational programs in domains where *living systems* are under scientific scrutiny. This inapplicability is not founded on the idea of statistics being imprecise; rather it pertains to its limited analytical capability. It is a cliché to say that statistics and its methods have mastered or are in the process of being expanded into new scientific areas. If the application of mathematical statistical methods in science such as physics or chemistry is understandable and natural, then criticism in applying statistics to the social sciences, sociology in particular, psychology, pedagogy and the humanities, should not be understated, since there would be lack of reason and painful imprudence, completely removing from consideration the truth. Knowledge about humanity or its selected subsets offered by statistics is not the same as the knowledge about man as an individual. At the same time, the consequences of this knowledge about the community transferred to individuals through political decisions can have dramatic consequences. Especially if the decisions concerning society were made based on incorrectly conducted statistical research. Philosophy and theology offering speculative idea over all things and each individual being, have been replaced by science, technology and politics. Statistical methods, inherently relating to mass processes, applied in science, used in technology and political decisions, removes in part or even completely, the second conjunction in the simplified definition of philosophy and theology, i.e., contemplation of the individual being and its goodness.

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