Article

On Interrelation of Time and Entropy

Leonid M. Martyushev[1,2]*

[1] Ural Federal University, 19 Mira St., Ekaterinburg, 620002 Russia
[2] Institute of Industrial Ecology, 20 S. Kovalevskaya St., Ekaterinburg, 620219 Russia
* Correspondence: LeonidMartyushev@gmail.com; Tel.: +7-922-22-77425

Abstract: A measure of time is related to the number of ways by which the human correlates the past and the future for some process. On this basis, a connection between time and entropy (information, Boltzmann–Gibbs, and thermodynamic one) is established. This measure gives time such properties as universality, relativity, directionality, and non-uniformity. A number of issues of the modern science related to the finding of laws describing changes in nature are discussed. A special emphasis is made on the role of evolutionary adaptation of an observer to the surrounding world.

Keywords: measure of time; entropy; evolutionary adaptation

1. Introduction

The development of science and our understanding of the world demonstrates a gradual transition from static and absolute concepts to evolutionary and relative ones. The Earth is no longer a firm center of the Cosmos but only one of the planets formed approximately 4.5 billion years ago travelling, similarly to an infinite multitude of other celestial bodies, around the Universe. Living beings are not unique creatures; they are but a result of the evolutionary adaptation to a changing environment. The human as well as the human brain, societies, languages, notion of beauty, etc. evolve. We widely apply the concept of time in order to describe observed changes. However, every man-made branch of science associates its own understanding and properties with this concept. Biological time, psychological time, historical time... Even physics has different times: time in mechanics (classical and quantum) and electrodynamics is reversible and is included in equations as an independent variable (parameter); in contrast, thermodynamics employs irreversible time, while the classical cosmology of the expanding Universe uses irreversible time and additionally considers that it is influenced, for instance, by massive bodies. Such a diversity of times has appeared historically as scientific knowledge grew. Some branches of science have been developing without any considerable interaction with one another. However, such an interaction starts sooner or later. In this case, a difference in basic concepts may cause problems, contradictions, and paradoxes. Particularly, this is observed in physics when attempting to correlate the description of phenomena from the perspectives of quantum physics and the general relativity theory as well as using mechanics and thermodynamics. If dynamic phenomena described by time in these sciences have fundamentally different properties (specifically, reversibility and irreversibility), can we apply one time even within the framework of physics? Can it be that there are several times and we erroneously identify them with one variable in equations? Such questions have arisen in physics before (see, for example, [1]) but they fail to attract great attention. Nevertheless, this problem seems to be fundamental and crucial. In this regard, a measure of time needs to be determined (introduced) in a uniform and universal manner and, on this basis, every individual branch of science and, subsequently, their interrelations should be reviewed.

Let us emphasize another important point related to time. By studying the variability of some properties of the surrounding world, scientists try to mathematically formalize the developments in the form of laws using, among other things, the concept of time. In a number of cases, mostly in

physics, this is successfully implemented. Such laws are the results of creative insights, generalizations and the like of the great scientists of the past: I. Newton, J. Maxwell, A. Einstein, E. Schrödinger, etc. Can the same be obtained using a measure of time as the basis? Can a deductive analysis of a measure of time introduced in a uniform manner together with some model of the surrounding reality lead to equations similar to the laws of mechanics, electromagnetism, etc.? This may prove to be especially important in the fields where generally-acknowledged laws are missing – for example, in biology, ecology, psychology, economics, linguistics, or history.

The issues raised above are crucial for the successful development of science. Certainly, it is not the purpose hereof to solve them. The purpose of this study is to introduce a measure of time in such a manner that these questions could potentially be answered in the future. Universality (i.e., the possibility to consider and apply it within the existing concepts of natural and human sciences), measurability, and, finally, fruitfulness (i.e., it should enable, if necessary, to deductively obtain dynamic laws of the surrounding world) should be the most important properties of such a measure. This investigation considerably expands on our ideas that have been previously set forth in [2,3]. In addition, we adopt a somewhat risky (from physicists' point of view) plan for introducing a measure of time: by relying on psychology. Here, considering that we work with such a concept as time and present our ideas in the *multidisciplinary* journal, this decision seems to be the most natural one.

2. A measure of time and its prerequisites

Different aspects of the concept of time, from philosophical to engineering, are presented in an enormous number of works that have been published throughout many centuries. It will take more than one volume just to provide a list of these books. Let us very briefly formulate a number of ideas that play an important role for the purposes hereof and can only be partially considered original and generally represent rewordings and interpretations of some part of the works dedicated to time and related issues. The ideas (and facts) listed below, which can be regarded either as axioms or more or less rough assumptions, are prerequisites forming a basis of the definition of a measure of time proposed at the end of this section.

A measure of time is needed to describe a change. If our world remained unchanged, there would be no need for this concept. Here, we do not go deep into philosophical questions such as: Why do changes occur? We also categorically reject the metaphysical idea that time causes (drives) changes.

A measure of time is a property (manifestation) of the consciousness (cognition and the like) and surroundings of an observer, i.e. it is related to one and the other. Without changes in either the consciousness or the surroundings, the concept of time would not have appeared. There is no time both in a world without an observer and for an observer without a changing surrounding world. There is no point in referring to an abstract observer for the purposes of this article; instead, a human, people, should be taken into consideration.

The human brain is an open dynamic system representing a product of evolution and adjustment to the evolving surrounding world. Therefore, the concept of a measure of time cannot be absolute, static but is relative, dynamic. Here, we agree with the corresponding ideas of, specifically, K. Lorenz (rather than I. Kant) that a priori forms of cognition (specifically, the understanding of time) should be regarded as adaptation because they are connected with the brain that has acquired its reasonable species-preserving form thanks to interactions with the reality during evolution. In this respect, it is important to mention the results of the investigations conducted by J. Piaget, upon an initiative of A. Einstein, that children have no understanding of time in infancy and they adopt this concept at later stages of development.

The understanding of time is related to such brain functions as memory, sensation, perception, and thinking. We have no special receptors for sensing time (as, for instance, for smells). As a consequence, the understanding of time represents a very complex process of the brain, connecting the past (related, for the most part, to memory) with the future (related to imagination, thinking). It is an important feature of this process that the brain does not function unmistakably; hence, the

correlation between duration of a change and a measure of time cannot be unambiguous. Indeed, when recollecting, we always perform some work on a recollection and transform it; data are not simply retrieved from a storage and then returned in their original form but are recreated every time. It is also important that our memories as well as imagination are controlled by the same parts of the brain. That is why memory and imagination can mix because all the necessary information is not wholly contained in the memory but is reconstructed when accessing it on the basis, for instance, of some semantic information (see, for example, [4]).

Thus, the brain's measurement of the duration of some phenomenon (change) is associated with some process that links the past with the future (let us call it the τ-process). The brain is neuroplastic and uses for this process multiple structural elements distributed over the entire brain and connected both in series and, what is important, in parallel. The past and the future of some phenomenon in the brain are in a way imaginary and to a large extent ambiguous. As a consequence, in the case of the τ-process in the brain, there should obviously be more than one way of correlating the past to the future for one phenomenon. Let us designate the number of such ways as Ω. It is logical to assume that the longer a change subjected to the τ-process in the brain, the more ambiguous its past/future and the greater Ω (see Fig. 1).
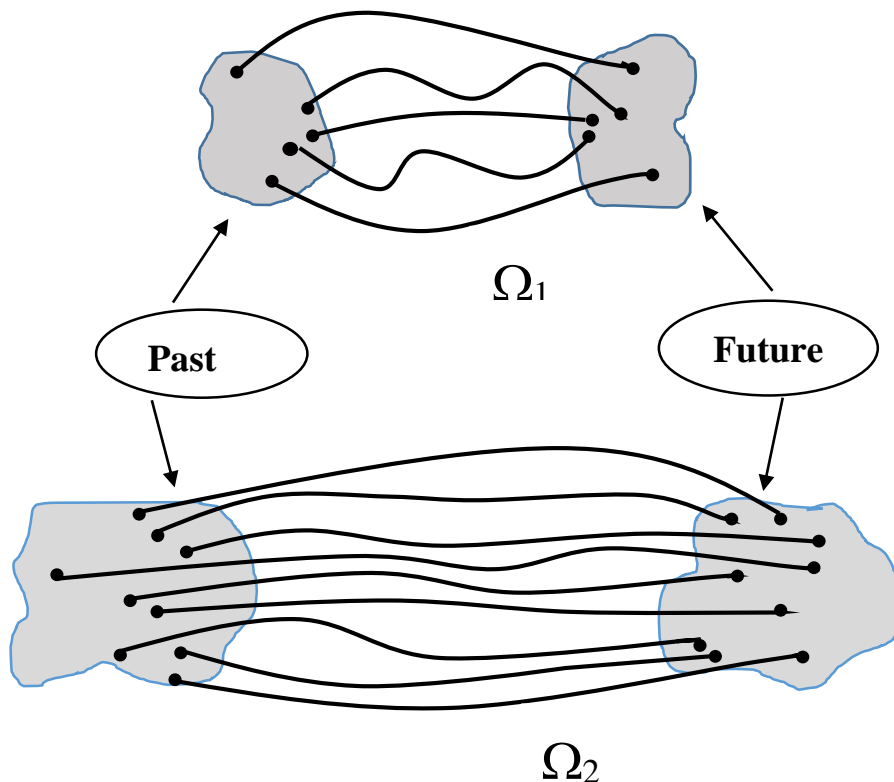

Figure 1. Schematic illustration of different ways of linking the past with the future for some phenomenon. The longer the time interval, the more uncertain the past and the future and the more ways, Ω, by which they are linked.

In spite of the above tendency to mistakes, measurement of the duration of a changing process must be a crucial property of the brain from the standpoint of evolution. As a consequence, the brain must demonstrate reliability while implementing the τ-process (immunity to interferences of both external and intrinsic processes). It is obvious that the longer the process, the harder it is to ensure such reliability. Each of Ω ways is different and can employ a different number and types of structural elements. Consequently, the correlation of quantities associated with structural elements (or their statistical moments) with the duration (measure of time) will not ensure reliability of the τ-process. Therefore, it is Ω that seems to be the brain's simplest robust scalar estimation of time.

We shall postulate that the duration (time) τ of some change represents a single-valued monotone function of Ω only, i.e. τ=F(Ω), and the larger Ω, the greater τ.

Let there be two phenomena with the durations τ_1 and τ_2 following each other (Fig. 2). We shall assume that the phenomena are independent (both objectively and from an observer's perspective). Then, if the number of ways assumed for the τ-process equals Ω_1 and Ω_2 for the first and the second phenomenon respectively, the number of ways in the τ-process for the total duration process $\tau_1+\tau_2$ will be equal to $\Omega_1\Omega_2$. As a result, we have $\tau_1+\tau_2 = F(\Omega_1)+F(\Omega_2)$ and $\tau_1+\tau_2 = F(\Omega_1\Omega_2)$, i.e. $F(\Omega_1\Omega_2) = F(\Omega_1)+F(\Omega_2)$. As is well known (see, for example, [5]), a logarithmic function is the only function satisfying such a property. (Here, $F(1)=0$ is an important additional requirement. It can be considered within the framework of the interpretation assumed herein that the only way of correlating the past and the future in the brain may be implemented just for hypothetical zero-duration processes.)
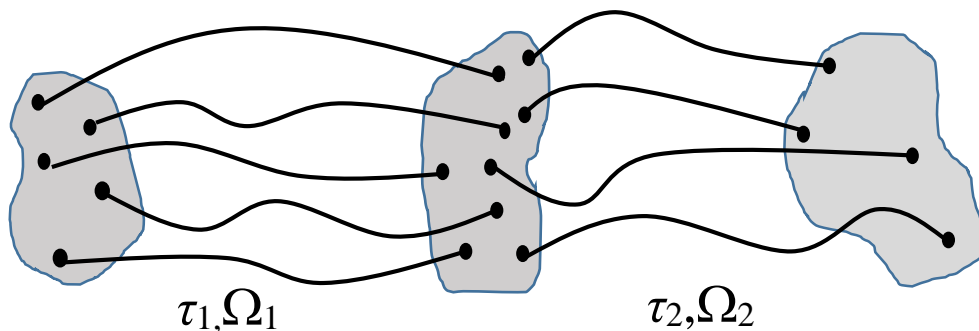

$$\tau_1, \Omega_1 \qquad\qquad \tau_2, \Omega_2$$

Figure 2. Two consecutive independent processes with the time durations τ_1 and τ_2 having respectively Ω_1 and Ω_2 different ways of linking the past with the future.

Thus, we arrive at the following relation between the measure of time of some phenomenon and the number of ways of its representation during the τ-process in the brain.

$$\tau = k\,\ln\Omega, \tag{2.1}$$

where k is some coefficient related to the used measurement units of time.

So, the duration (measure of time) is linked with the number of ways by which the brain represents some occurring change. Due to the currently insufficient level of knowledge about conscious and unconscious processes occurring in the brain, because of the astronomical number of structural elements involved in the τ-process, and considering the existing experimental techniques and methods, it is now impossible to *directly* determine Ω. However, Ω can be estimated *indirectly*. Measurement of the total amount of energy consumed by the brain during the τ-process can be one of such estimations. It is obvious that the larger Ω, the greater the value of the consumed energy, which, as is known, is connected with oxygen consumption and can be presently measured with a sufficient accuracy. We shall call this experimental method the E-method. Mathematic modeling can be another indirect method of estimating Ω. So, using one model of a phenomenon (with supposed or known restrictions) or another, we calculate the number Ω_m of ways by which the change at hand can be represented. Then it is assumed that, since both quantities, Ω and Ω_m, correspond to the number of ways for representing the duration of the same process using the same observer (brain), Ω_m can serve as a good indirect estimation (an estimation with an accuracy to some arbitrary constant multiplier) of Ω. We shall call this theoretical method the T-method. Let us remark on the T-method. As a rule, created models are based on some provisions of the modern science, which, in their turn, represent a product of the collective adaptation of people to a changing, evolving environment. Similarly to the brain that has been 'learning' to register changes in its surroundings with the help of time, science has also been evolving in order to correctly reflect the changing world. For this reason,

in a number of cases, the T-method can provide a value of Ω_m that describes change in the world better than a more individual characteristic, Ω.

3. Time and entropy

If entropy is determined as a measure of uncertainty in a rather general form as proposed by C. Shannon (following L Boltzmann) [5,6], then, according to (2.1), time and entropy will be almost identical concepts (with an accuracy to some positive dimensional multiplier). Entropy as a logarithm of the number of temporal trajectories linking some past and future is also referred to as the trajectory entropy S_{tr}:

$$S_{tr} \propto \ln\Omega \ . \tag{3.1}$$

We shall use the T-method for estimating Ω. Let there be a model of some process. We shall assume that there can be several values of Ω_{mi} for given restrictions within the selected model. According to (2.1), $\tau_i \propto \ln\Omega_{mi}$. As a result, the larger Ω_{mi}, the greater τ_i. The greater τ_i of the process corresponds to its longer duration (i.e., observability for a longer time period), whereas the longer duration corresponds to the higher probability that this process will be registered by an observer who becomes interested in the process within some random short (relative to the duration of the process involved) time interval. Therefore, according to (3.1), a process corresponding to the maximum trajectory entropy will be observed with the highest probability.
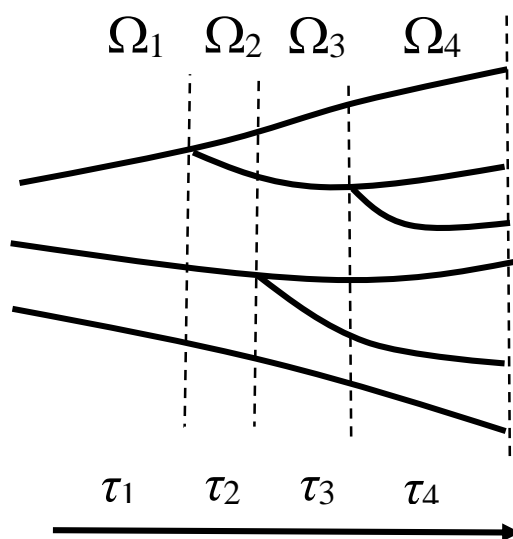

Figure 3. Time variation of trajectories linking the past with the future for some process. Trajectories can only branch out in the course of time.

An example of a system's evolution from the past to the future is presented in Fig. 3 (some set of Figures can be provided if not only the most probable process is considered). Since an increased duration of a process (elapsed time) is directly connected with the number of trajectories (ways), then, in such a presentation, trajectories can only 'branch out' (forming two or more trajectories) but they cannot group together, discontinue, or form loops. So, it is natural to suppose that the number Γ of possible ways (microstates) corresponding to the system's state at some moment of time can be characterized by the number Ω_m of trajectories linking the past with this state. In view of the above peculiarity of the topology of trajectories, there should be a one-to-one correspondence between Γ and Ω_m (see, for example, Fig. 4). The entropy S_S as a logarithm of the number of possible microstates for representing some state (macrostate) is often used in the literature: $S_S = \ln\Gamma$. Since $\Gamma = \Omega_m$ and (2.1), we have:

$$\tau \propto S_S. \tag{3.2}$$

Here and above, it is assumed that the initial state corresponds to the zero time; if we drop this assumption, then, for the differences of the quantities at hand, we will obviously have the following:
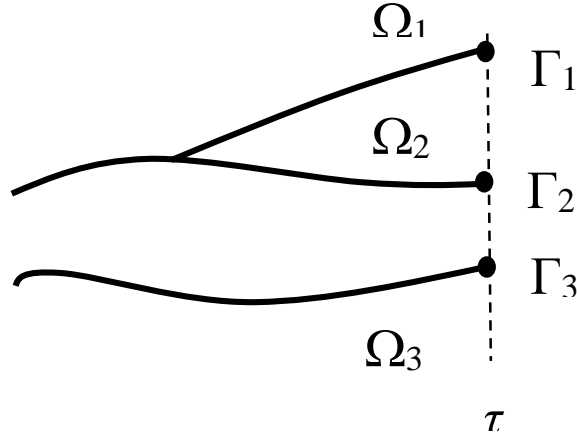
$$\Delta\tau \propto \Delta S_S. \tag{3.3}$$

Figure 4. One-to-one correspondence between the number Γ of microstates (representing some state (macrostate) at some moment of time τ) and the number Ω of trajectories (ways) linking the past with these microstates.

Let us consider some isolated system transiting from one thermodynamic equilibrium state to another thermodynamic equilibrium state during the time τ. Such a state is traditionally described in statistical physics by the Boltzmann–Gibbs entropy S_{BG} that is connected with the number of a system's microstates Γ_{BG} (for instance, for the given energy of the system) as $S_{BG} \propto \ln\Gamma_{BG}$ [6,7]. Obviously, S_{BG} is a particular case of S_S. As a result, based on Eqs. (3.2), (3.3), we write:

$$\tau \propto S_{BG}, \tag{3.4}$$

$$\Delta\tau \propto \Delta S_{BG}. \tag{3.5}$$

Thus, it is shown that, for a number of important cases, time (duration of a process) can be calculated by a variation in the Boltzmann–Gibbs entropy. Since this entropy is traditionally regarded as the statistic interpretation of the thermodynamic entropy S [6,7], we come to an important theoretical and practical result: time (interval of time) equals, with an accuracy to the positive constant, to a change of the thermodynamic entropy ΔS (the entropy production Σ for a process in an isolated system).

$$\Delta\tau \propto \Sigma. \tag{3.6}$$

The formula (3.6) makes it possible to calculate the time of an evolving system based on the calculations of entropy production. Local non-equilibrium thermodynamics provides a convenient method for calculating entropy production as a sum of products of thermodynamic forces and fluxes. Despite the fact that the possibility of introducing time for arbitrary systems (specifically, *not* physical-and-chemical ones) becomes smaller as we gradually move from Eq.(2.1) to Eq.(3.6), the thermodynamic formulation, without a doubt, is convenient. At the same time, the scope of applicability of Eq. (3.6) remains sufficient and covers a very wide class of problems for which local non-equilibrium thermodynamics is applicable: from stars to living organisms. It is interesting to note that, using Eq.(3.6) and arguments similar to those mentioned above (see the discussion of the

maximum trajectory entropy), one can obtain the maximum thermodynamic entropy and maximum entropy production principles well known in the literature [6-10].

In conclusion of this section, we would like to show how understanding of the relation of time and entropy production makes it possible to look at well-known results from a new perspective. So, it is often said that the Sun is a source of life for the Earth. Indeed, the Sun is a giant thermonuclear 'machine' producing entropy (see, for example, [11]) and sending it in the form of an entropy flux to our planet. According to (3.6), it can be metaphorically considered as a flux of time which is sent by the nearest star to our planet and in which the Earth exists from its origin.

4. Discussion

Let us list and briefly discuss the main features of the measure of time introduced herein.

1. *Measurability and universality.* The introduced measure of time does not require certain periodical or non-equilibrium processes for consideration, local equilibrium, and the like. Instead, it is necessary to have an arbitrary change and an observer who judges about time based on the number of possible ways of describing this change (its duration). Here, this number can be either indirectly measured (E-method) or theoretically calculated (T-method) by finding entropy at any specific level of the consideration of a system. As a result, time is introduced using the method enabling to determine it for a very wide range of problems in various branches of science. It is important that the time defined here from rather general perspectives is consistent with a number of other papers addressing a similar problem. Let us give three examples. (1) The expression of a process's time through thermodynamic entropy can be found in a number of physical studies (see, for example, [2,12-14]). The following quotation of E. Mach demonstrates this very clearly (quoting from [14], p. 145: *"If the entropy of the world could be determined, it would be an absolute measure of time and it would be, at best, nothing but a tautology to say that the entropy of the world increases with time. Time, and the fact that certain changes take place in a definite sense, are one and the same thing".* (2) In biology, time (biological time) related to the metabolic rate and entropy production during life activities (see [3] and its references) is used to consider the time of living and growth of living beings. (3) In psychology, the perception of the duration of time is associated with an amount of energy consumed by neurons (and with other metabolic processes in the brain) as well as the intensity of cognitive processes and the amount of information stored in the memory [15,16]. The mentioned examples can be regarded as an independent evidence corroborating the ideas developed herein.

2. *Time is relative and subjective.* Indeed, this quantity is often considered in physics as something absolute and objective, independent of anything else. Einstein's relativity theory has shaken confidence in these ideas only to some extent. We base our reasoning here totally independently of the mentioned traditional ideas. This is connected with the fact that time, while reflecting objective changes in the world, is inseparable from an observer. The observer cannot be abstract (metaphysical). Basic properties of the observer can be presently connected only with characteristics of the human brain, which has been evolving together with the world. Hence, the relativity and subjectivity of time. At the same time, it is the brain that 'strives' to reflect changes in the surrounding world with minimum distortions. This is what prevents us from drawing a conclusion that the human is unable to formulate laws describing and predicting changes in the world. The 'sense of time' arises because the human represents a part of the evolving world where everything interacts directly or indirectly to a certain extent. This sense (understanding of time) is gradually adjusted in the course of evolution through individual and collective experience (including, for instance, by science). As a result of such an adjustment (synchronization), the brain's understanding of changes in the world using time (for instance, with the help of the T-model) allows reflecting the real surrounding world. Synchronization of an observer and a process (as well as synchronization of different processes with each other) suggests that the time introduced herein as an individual characteristic of every evolving process can describe, in some cases, a number of interacted processes, i.e. be a system characteristic.

3. *Directionality of time (arrow of time).* The introduced time is directional by its definition. The farther the past and future horizons of some change, the more the possible ways of connecting these horizons and, consequently, the longer the time. The human brain is the source of these observations and predictions; as was mentioned above, it represents an open, ever-changing (among other things, due to memory-related processes) and adaptive system. These properties of the brain prevent any reversibility from occurring in the results of its work. The described interrelation of time and entropy also indicates the irreversibility of time. However, there is a widely-spread opinion well expressed in the book [17]: "*It's very possible that this mysterious irreversibility is of precisely the same character as the mysterious irreversibility in thermodynamics, as codified in the Second Law: It's a consequence of making approximations and throwing away information, even though the deep underlying processes are all individually reversible.*" The opinion defended herein is totally opposite to this statement: nature is in principle irreversible, while equations (laws) traditionally considered as 'fundamental' are approximate, which is the only reason of their reversibility. The case is that the fundamentality of a law of nature is as historically anachronistic as the absoluteness of space and time. It is well known from the times of K. Popper that any absoluteness and firmness presuppose unscientific (pseudoscientific) laws (theories) rather than scientific ones. Indeed, any scientific theory represents a continuous chain of improvements, conjectures, and refutations. Examples from mechanics are the most well-known: the Kepler laws were replaced with the Newton laws that were replaced with the laws of quantum mechanics and the relativity theory. Yes, all of the above are the examples of reversible equations. However, it does not prove the reversibility of the world. These equations are only brilliant guesses that described some changes in nature *within the accuracy required for their times*. These laws are not divinely conferred or, at least, rigorously obtained from the standpoint of mathematics. These laws are fruits of our brain that observed the surrounding world and, under the influence of a number of purely 'human' qualities such as the principles of simplicity, beauty, correspondence, and the like, *approximately* formulated these laws by discarding details and taking the essence. The understanding of time is related to the human; however, any human-related science (biology, psychology, history, archaeology, linguistics, etc.) demonstrates the arrow of time and, therefore, the true nature of time cannot be reversible. For this reason, the majority of time measures used in physics are logically (not practically) invalid because they are based on time-reversible concepts of the modern quantum and electromagnetic theories and, hence, contradict the crucial property of time.

4. *Non-uniformity of time.* According to the introduced definition as well as the relation of time and entropy (entropy production) under discussion, time is obviously non-uniform. Although it absolutely contradicts the understanding of time that has appeared in science thanks to I. Newton, one cannot claim that this statement is original today. For instance, there is a well-known quotation of H. Poincaré [18]: *"We have not a direct intuition of the equality of two intervals of time. The persons who believe they possess this intuition are dupes of an illusion. When I say, from noon to one the same time passes as from two to three, what meaning has this affirmation? The least reflection shows that by itself it has none at all. It will only have that which I choose to give it, by a definition which will certainly possess a certain degree of arbitrariness".* It is important to note that the understanding of time being non-uniform (non-linearly connected with the "time" hypothetically considered uniform) turns out to be a crucial, necessary, and commonly-accepted provision for a very wide range of problems solved by theoretical biology and psychology, specifically when addressing the issues of ontogenesis and development (see, for example, [3]). Non-uniform time scales are also sometimes used in physics. This is especially true for cosmological questions. There are well-known, now classical, works by E. Milne [1,19], where he obtains two logarithmically-interrelated measures of time while building his cosmology. Nowadays, these works of the last mid-century have become especially topical in connection with the dark energy problem. A number of contemporary cosmologists involve the idea of non-uniformity of time by either developing the ideas of Milne or arriving at them independently [20-23].

5. Conclusion and prospects

The present study introduces the measure of time as a number of ways by which our brain links the past with the future. The interrelation of this measure of time with entropy and energy is discussed. Obviously, the formulated approach to the problem (specifically, the T-model) allows using the introduced measure of time in different sciences, both natural and human. Using the single measure of time, one can attempt to solve the fundamental problems and issues mentioned in Introduction.

There may be an impression that the questions discussed herein have nothing new to physics and may be interesting only to other, not so much 'developed, advanced and successful' sciences. This viewpoint may be valid for applied physics but not for theoretical one, its foundation. We shall reason this viewpoint. Laws of physics concisely generalize the known and predict the unknown. They are only approximated to the 'truth' and are formulated by people based on the existing experience, using some adopted model (a simplified picture) of the world. There is no confidence therefore that these laws could be valid for another model of the world that significantly differs from the previous one. Different models are used to describe mechanical, quantum and electromagnetic phenomena. Considerably different models are employed in different areas of cosmology, etc. Laws cannot be separated from the system: a model of the world and their creator (human), i.e. laws are products (corollaries) of the system. However, there is often a temptation to consider a law outside its system by ascribing it such properties as fundamentality and absoluteness. As a result, the law becomes detached from the model and attempts are made to apply it to other models. For instance, there are endeavors to apply the second law of thermodynamics to the evolution of the Universe, to explain the irreversibility of diffusion processes by laws of mechanics, or to employ the quantum theory to problems solved by the general relativity theory. Such an approach is very risky from the methodical perspective (especially, if models are considerably different) and one cannot predict whether it becomes promising for the development of science. This is a roulette of some kind: a scientist can unexpectedly discover/explain something or arrive at paradoxes and waste their scientific life (and scientific lives of other people too) on solving them. Can it be that a number of famous physical paradoxes existing in quantum mechanics, statistical physics, cosmology, etc. are among them? A law can contradict the world's model if this model is rather different from the model on the basis of which the law has been previously formulated. Such thoughts were expressed before, specifically, by E. Milne [19]: "*To begin with laws of nature and then add an arbitrary content on which the laws are to act is logically self-stultifying; for we have no guarantee that the laws assumed are compatible with the content assumed.*" The idea defended herein can be illustrated by another example. Let us have a three-dimensional world and propose a model based on the axioms of the Euclidian geometry in order to describe it. Within this model, we derive some theorem (for example, the triangle sum theorem). This theorem (law) is applicable only within the framework of our model. If we now replace the world's model, for instance, by the Lobachevsky model, then the use of the obtained law of angles will be absurd and lead to paradoxes.

It is especially dangerous when basic concepts such as, for example, time represent an integral part of a specific model forming a law, and then this law claims to be universal (i.e., is applied to other models and fields of science). Classical mechanics with its understanding of the absolute time represents a vivid example.

What methodological solution can be used to address the above problem? Firstly, basic concepts (like time) should be formulated in such a manner that they could be introduced (and calculated) at different levels and for the maximum number of models used in the modern science. Then these concepts should be defined more precisely for some model at hand intended to describe some phenomenon of the surrounding world. Afterwards, using the introduced concepts and model (some set of axioms and hypotheses), laws should be deductively obtained. These laws and their corollaries should be compared with the phenomena of the surrounding world. In case some deviations and problems are found, the world's model should be adjusted and the cycle should repeat. Such a process of tests and corrections will be an endless movement towards the truth: the evolution of science. At the same time, basic concepts should be treated extremely conservatively. These concepts

concern and link the entire framework of science with its multiple models, i.e. form the basis of our scientific worldview. Basic concepts (like time) should be kept outside changes (adjustments) until the overwhelming majority of modern natural and human sciences 'call' for their revision. With this approach, we seem to have no fundamental laws claiming to explain anything and everything. However, we would have basic (fundamental) concepts representing a scientific reference point in the surrounding world not divided by various sciences into areas of interest. One can hope that the ideas concerning time and its properties considered herein will be beneficial in this regard.

Conflicts of Interest: The authors declare no conflict of interest.

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