Scienatics

The science of science

Naiyf Saud

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Preface

The nature of science is an elusive concept, so any attempt to define science did not succeed in stipulating the extension of that concept such that all of its members are included. The common practice of defining science by its activities is not appropriate, since the activities involving different sciences are different and hence the members, which constitute the class of reference of science, are distributed in several extensions that appear to have different nature while all of them refer to the same concept. Also this type of definitions is, in fact, a definition of the practice and intellectual activities of science rather than an exact definition of science. On the other hand, defining science as a collection of principles related to a particular subject produces a huge confusion since, according to this definition, any collection of concepts, without any prescribed plausible justification, can be regarded as a science. These aspects have the signature of the lack of understanding of the true nature of science which was produced by our unconscious ignorance of key factors that have important clues about the nature of this concept. For instance, if we try to study the relation between the pressure of a gas and its volume, we have to pay attention to its temperature. Otherwise, the variable temperature would produce a chaotic pattern for that relation. This character of science arises from its interference with other concepts that appear to have no connection with it. These concepts increase our appreciation of the nature of existence and their relation to science and reality. This book is an attempt to develop a theory that treats science more precisely and hence reveals its genuine aspects and constitutional structure. This theory will enhance our instinct to distinguish between science, pseudoscience and fantasy and explain the scienatic phenomena that we encounter every time we deal with definitions, equations and numbers. In the first chapter, we discuss the nature of existence since it is a central idea for our understanding of science as one of the five features of any concept. The seven types of concepts and their three aspects for the orthodox observers are also investigated in this chapter. In chapter two, we are investigating the Adamic sciences, their constituents and the constitutional structure of science. The essential and accidental contents of science are also investigated in this chapter. We end this book by discussing the distinction between science, pseudoscience and fantasy and the relations between mind, science and logic which constitute the intellectual system.

Naiyf S. Alsaud
March 2018

1 Introduction

1.1 The nature of existence

One of the most speculative and perplexing inquiries is the quest to reveal the essences of entities. Questions like: What are the ultimate natures of light, sound, scents, tastes and tangibles or the absolute essences of brightness, colors, voice, smell, flavors and warmness? What are the inherent natures of time and space? What are the essences of virtues and vices? have caught the attentions of humankind fancy along the development of their civilization. However, the products of human intellectual activities have revealed counter-intuitive answers to those questions. The intellectual heritage accumulated in many disciplines provides a strong evidence for these unexpected results. What we see as a light depends on the sensitivity of our photoreceptor cells in the retina which was developed as a ramification of the peak radiation of the sun. So it is not a coincidence that we see in the electromagnetic waves that have wavelengths in the visible light. This sensitivity could be developed, in principle, for any wavelength range of the electromagnetic radiation if the environment in which the organism has evolved was dominated by radiations in that range. This well-established result indicates that what we call light and darkness does, in fact, depend on the structure of our optical detectors and brains. We could perform a thought experiment to appreciate the relativistic character of this phenomenon. Suppose that there were two organisms - one of them was evolved in an environment that acquired him the sensitivity of the electromagnetic waves in the range $\sim 10 - 380$ nm, which lies in the ultraviolet radiation, and the other evolved in Earth, so its photoreceptor cells are sensitive to the spectrum in the range $\sim 390 - 700$ nm. Further suppose that they were setting in a room which has two light bulbs, one emits ultraviolet radiation and the other visible light. Now if we turn on the former light bulb, the organism whose optical detectors are sensitive to the ultraviolet light would see everything in the room and perceive the aspects of lightness after darkness while the situation remains unchanged for the terrestrial organism. The situation would be exactly the opposite if we instead have turned on the latter light bulb which radiates in the visible range. On the other hand, the acuteness of their sensitivity to light will govern their judgment about the brightness of their respective bulbs. Hence if the acuteness of the sensitivity to the visible light of the terrestrial was more than that of the other organism, he would see his bulb brighter than the brightness of the ultraviolet bulb that was experienced by the alien, even if both of them have the same brightness. The identities of the colors which they describe are determined by the structures of their brains which were shaped by the different environments in which they have evolved. So there are no absolute natures of the primary colors (red, yellow and blue) and their mixtures but rather relativistic aspects which were created by their inherently different brains. In the case that there were sources of sounds, scents and tastes in that room, the essential natures of them depend on the structures of the creatures senses and the interpretation of their brains which is a reflection of the conditions in which they have developed. The differences in the essences of these observables between the two organisms could, hypothetically, be enormous such that some or all of the observables for one organism perform different functionalities for the other. For instance, the longitudinal waves that carry the vibration through a medium as a sound for one organism could be used as a mean of vision (the standard role of light) for another and the same proposition is true for the other observables. Moreover, their descriptions and feelings of the temperature of the room depend on their respective normal body temperatures. So if the temperature of the room was 15° C and the alien creature and the terrestrial organism had a normal body temperature of 10° C and 37° C respectively, the alien would describe the room as a warm place while it would be a cold place for the terrestrial. This demonstrates that what we call a nice cool summer evening would be a harsh condition for another organism and vice versa.

The essence of time has puzzled the ordinary people as well as the intellectual communities through ages. The impenetrable comprehension of time emerges from its duality of existence and intangible character. Its characteristic of being measured produces the feeling of its existence and its intangible aspect conceals its nature. We use days, hours, minutes and seconds to measure time which are, traditionally, defined by letting the day be the period of a complete rotation of Earth about its axis and define the hour as one part of 24 parts of that period and define minute as one part of 60 parts of an hour and so on or, recently and more accurately, by using the transition of the electrons between the two hyperfine levels of the ground state of the cesium-133 atom, we defined the second as 9192631770 periods of that transition and define the minute as 60 seconds and so on. However, in both definitions or in any possible inherently similar definitions, we are, actually, measuring "changes" which is a measurand that is ordered by nature, so there are changes with low levels of intensity and changes with high levels of intensity and infinitely many levels of changes between them. The apparent proper motion of a star as a result of a complete spin of Earth is a change by 360° and the transition of an electron between two hyperfine levels is a change in its position. Moreover, the intensity of the former is much greater than the intensity of the latter which characterizes change as a measurand. However, the possibility of estimating the entirety of a given level of intensity by its parts is a property of any measurand. To estimate any length, we use standard units of length (e.g., meter, foot or yard) which themselves are lengths. Also, to measure mass we utilize standard units of mass (gram, pound, ounce, etc.) as standard units which themselves constitute masses. This reasoning could be carried to any measurand which leads, correctly, to the conclusion that the standard units which we use to measure change should themselves constitute kinds of changes!! So if we would like to measure the speed of an object, which is a change in position, we could use the step of a person walking on the pavement, which is also a change in position, and say: for each step of that person the object moves 5 km. Also we could compare the intensities of the movements of that object and other objects if we use a unique standard change as a unit (e.g., the step of that person) to measure their movements and, hence time in its essential nature is change and its units (e.g., hour, minute and second) are standard units of change. However, for the historical development within the orthodox line of thought, we coined the concept "time" to indicate that standard change which we use to measure and compare changes. If we consider any dynamical phenomenon such as growth, heating or even painting, we find that its essential nature is movement. Growth occurs when the living cells undergo subsequent changes which are results of the movements of their ultimate constituents. The increase in the temperature of a body by heating is a reflection of the increase of the average translational velocity of its molecules which is in its essence a movement. Painting a picture involves the transformation of the paints from the palette to the portrait and producing artistic patterns by distributing them rationally in the portrait using the brush and so all of the subsequent changes to completely draw a picture are, in their essences, movements. This sample of dynamical phenomena, which certainly involve changes, can be expanded to include more and more types of change and hence inductively supports the conclusion that any type of change is essentially a movement.

The deduced universal upper limit of movement as a ramification of the constancy of the speed of light, which is confirmed experimentally by Michelson-Morley, should have effects on any type of change including time since the essential nature of the latter is a movement. To deduce the nature of the influence of this phenomenon on the movement and hence on any change, we begin with Lorentz transformations which are the logical consequences of the constancy of the speed of light, the relativistic principle (the laws of physics are the same in all inertial frames of reference) and the isotropy and homogeneity of space. We state these transformations below: (They can be easily deduced based on the previously mentioned three assumptions.)

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad y' = y, \quad z' = z \qquad (1.1)$$

where c is the speed of light and x, y, z and t are the respective space and time coordinates of the subsequent events in space-time for the stationary frame of reference S, and x', y', z' and t' are the corresponding coordinates of the same sequence of events for a frame of reference S$'$ which have, with respect to S, a relative velocity v along the x direction. (We have assumed that $t = t'$ when $x = x'$ which does not produce any loss of generality.) Now by differentiating these equations with respect to t we get:

$$\frac{dt'}{dt} = \frac{1 - \frac{v\frac{dx}{dt}}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad \frac{dx'}{dt} = \frac{\frac{dx}{dt} - v}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{1.2}$$

and

$$\frac{dy'}{dt} = \frac{dy}{dt}, \quad \frac{dz'}{dt} = \frac{dz}{dt} \tag{1.3}$$

so by dividing the latter derivatives of each spatial coordinate of S$'$ by its derivative of time and using the definition of velocity we have:

$$u'_x = \frac{u_x - v}{1 - \frac{vu_x}{c^2}}, \quad u'_y = u_y\frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{vu_x}{c^2}}, \quad u'_z = u_z\frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{vu_x}{c^2}} \tag{1.4}$$

It is obvious from these equations that any movement in the direction of the relative velocity of the two frames (along the x-axis) or in the directions perpendicular to it (along the y or z axes), will be continuously reduced to lower intensities as the relative velocity between them reaches the speed of light. In fact this proposition is true for the movement in any direction, since, in the three dimensional space, this movement can be analyzed into three components along the Cartesian-axes and the orientation of these coordinates can be set arbitrarily. So if we choose the orientation of the coordinates to coincide with those used in our frame of references, each of these components would be reduced as we have shown and hence their resultant (the movement) will be reduced as the relativistic velocity of the frames approaches the speed of light. This effect emphasizes that, relative to a stationary frame of reference, any movement and hence any change will be diminished to lower and lower intensities as the velocity of its frame of reference increases to more and more values. However, this phenomenon will not be pronounced until the relativistic velocity becomes sufficiently close to the upper intensity of movement (the speed of light). Hence, if we imagine an astronaut traveling in a spacecraft with a speed very close to the speed of light such that the effects of the previous phenomenon are significant, the intensity of any change in the spacecraft will be diminished by the same rate (relative to an observer in Earth). The movements of the oscillating elements in his clocks on which the seconds and hence minutes and hours are based will be reduced, so time (the standard change) will dilate. This rate of reduction will be experienced by the movements of the nervous signals that carry the information to and from his brain, along with the movements of the atoms and the electrons binding them in molecules which constitute the ultimate microscopic bases that produce the biochemical reactions which manifest themselves as his growth and metabolism. The same arguments are applied to his movements or any other type of movements (changes) in his spacecraft. As a result, any change in the spacecraft (time, growth, reaction, etc.) will appear to be slower than its counterpart in Earth by the same rate. This line of reasoning can be carried to the observer on Earth relative to the astronauts since the former has the same relativistic velocity with respect to the latter. However, the reasoning of the observer on Earth is genuine and that of the astronaut is an illusion which is a reflection of the first. This is true because, before the astronaut left the Earth, the physical situations of the observer and the astronaut universally (relative to any thing in the universe) were the same, but after the astronaut has left the Earth, the universal physical situation of the astronaut diverged from its initial state while the observer's universal physical situation remained unchanged in the same state and so if we claimed that the astronaut's reasoning was genuine, the observer's initial condition should reach a new condition without any change in its universal initial physical situation which is imposable. (We always get nothing from nothing.) However, the astronaut's universal physical situation has changed to a new situation and this "genuine new change" leads to a universally new genuine condition, so the astronaut's reasoning is an illusion which is a reflection of the genuine reasoning of the observer on Earth. Therefore, any deduction based on the illusive argument would lead to false conclusions and any deduction based on the genuine argument would lead to real conclusions. As a consequence of that, the astronaut would reach the real conditions if he assumed that his observations are illusions and in reality the Earth is stationary while he is moving with a relativistic velocity with respect to it and performed his reasoning and calculations using the relativistic formulas on this basis. On the other hand, the observer on Earth can assume the reality of his observations and deduce his relativistic real conclusions based on that assumption. Therefore, the criterion of distinction between the illusive and real conditions is the nature of the universal difference between the initial and final physical states of the frame of references. As we have mentioned the upper bound existence of the intensity of movements leads to the reduction of the intensity of any change and hence stretches the intervals of time in a phenomenon called "time dilation". We could deduce the latter effect mathematically as follows:

$$\Delta t' = \int_{t_1'}^{t_2'} dt' = \int_{t_1}^{t_2} \frac{dt}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1.5}$$

where $\Delta t'$ is the time internal in the stationary frame of reference and Δt is the corresponding interval with respect to the moving frame. This effect entails logically the well know phenomenon of "twin paradox". According to which two twins would grow and respond to stimulation with different rates if each one of them lived in a different inertial frame of reference with non-zero relativistic velocity between them. However, this phenomenon, as mentioned, will not be pronounced except if their relative velocity contributes a significant portion of the speed of light. Now if we assumed that this effect of the relativistic velocity on time appreciation was produced by the natural structure of one or both of the observers, the two observers would acquire different senses of time, even if they were on the same frame of reference. These arguments strongly support the conclusion that even the essential nature of time depends on the natural structure of the observer.

In mathematics any set of elements (called points) for which the mathematical concepts of continuity, connectedness and convergence can be defined is called a "topological space". This most abstract notion of space constitutes the ultimate resemblance of the Euclidean space and so these aspects are the least properties that a set of points (which could be any type of elements) should have to be described mathematically as a space. The topological space is called a metric space if the distances between its points can be defined and, in the case that this metric processes the properties of the Euclidean metric, it is considered a normed vector space. Finally it is called an inner product space if it, above that, has the notions of the vectors lengths and the angles between them which is a ramification of having an inner product. It is obvious that the concept of space was originally created to describe the set of points which constitute the Euclidean space, so the latter has the definitional aspects of any space and hence it is a normed vector space. We will consider the possible normed vector spaces that consist of "geometrical points" including the Euclidean space. The distance from an arbitrary point to another, in any geometrical space, can be described quantitatively by constructing a coordinate system based on any arbitrary path connecting them and so there are infinitely many possible coordinate systems that could be utilized to accomplish this task. The metric tensor is a mathematical concept that describes the relation between the coordinate system and the distance. So, for a given geometrical space, the elements of the metric tensor will change as a consequence of changing the coordinate system while the distance which is an intrinsic geometrical property will remain unchanged. If we were using the Cartesian coordinate system, the metric tensor of the Euclidean space would have the form:

$$g_{ij} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{1.6}$$

however, based on the related definitions, it can be shown that the square of the distance in any coordinate system is given by:

$$ds^2 = g_{ij} dx^i dx^j \tag{1.7}$$

and hence, in the Cartesian coordinates, we would have:

$$\begin{aligned} ds^2 &= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} dx \\ dy \\ dz \end{bmatrix} \times \begin{bmatrix} dx \\ dy \\ dz \end{bmatrix} \\ &= dx^2 + dy^2 + dz^2 \end{aligned} \tag{1.8}$$

Now since the distance is invariant for a given geometrical space, we would have for any two coordinate systems:

$$g'_{\alpha\beta} dx^\alpha dx^\beta = ds^2 = g_{ij} dx^i dx^j \Rightarrow g'_{\alpha\beta} = \frac{dx^i}{dx^\alpha} \frac{dx^j}{dx^\beta} g_{ij} \tag{1.9}$$

This formula can be used to calculate the metric tensor for a geometrical space in a coordinate system given the tensor in another coordinate system and the relations between them. We know by definition that the relations between the spherical and Cartesian coordinates are:

$$x = r \sin\theta \cos\phi, \quad y = r \sin\theta \sin\phi, \quad z = r \cos\theta \tag{1.10}$$

so using these relations and the metric tensor in Cartesian coordinates along with the previous formula, the fundamental tensor in the spherical coordinates would be:

$$g'_{\alpha\beta} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & r^2 & 0 \\ 0 & 0 & r^2 \sin^2\theta \end{bmatrix} \tag{1.11}$$

therefore, based on this tensor, the distance in the Euclidean space described by the spherical coordinates will be given by:

$$ds^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2 \tag{1.12}$$

The last equation constitutes the metric in a continuous flat three-dimensional space which has a number of aspects that are consequences of its fundamental properties and hence there are hypothetically infinity possible spaces (discrete or continuous) each of them could be created, based on, some fundamental properties. However, we will restrict our analysis to spaces that are closely related to the Euclidean space which could be introduced by utilizing the concept of curvature. One manifestation of this concept is the intrinsic geometrical difference between curves and straight lines. These geometrical differences, captured by that concept, can be generalized to spaces with higher dimensions (two, three, four, etc.). However, for simplicity, a constant curvature is assumed (i.e., homogenous and isotropic spaces). It can be shown that in this case the curvature of a space is given by "Theorema Egregium" which was deduced by the mathematician Carl Gauss. We will state below this theorem without proof for the special case of two dimensional space:

$$k = \frac{1}{2g_{11}g_{22}} \left\{ \frac{1}{2g_{11}} \left[\frac{\partial g_{11}}{\partial x^1} \frac{\partial g_{22}}{\partial x^1} + \left(\frac{\partial g_{11}}{\partial x^2} \right)^2 \right] \right.$$

$$+\frac{1}{2g_{22}}\left[\frac{\partial g_{11}}{\partial x^2}\frac{\partial g_{22}}{\partial x^2}+\left(\frac{\partial g_{22}}{\partial x^1}\right)^2\right]$$
$$\left.-\left[\frac{\partial^2 g_{11}}{\partial (x^2)^2}+\frac{\partial^2 g_{22}}{\partial (x^1)^2}\right]\right\} \quad (1.13)$$

As an application of this theorem to two-dimensional space, we notice that since the sphere is a two-dimensional surface embedded in the Euclidean space, its metric is given by the previously deduced metric as a special case, namely:

$$ds^2 = R^2 d\theta^2 + R^2 \sin^2\theta d\phi^2 \quad (1.14)$$

and hence the metric tensor that describes the intrinsic geometry of its surface is:

$$g_{ij} = \begin{bmatrix} R^2 & 0 \\ 0 & R^2\sin^2\theta \end{bmatrix} \quad (1.15)$$

so we have:

$$g_{11} = R^2, \quad g_{22} = R^2\sin^2\theta, \quad x^1 = \theta, \quad x^2 = \phi$$

from that it follows:

$$\frac{\partial g_{11}}{\partial x^1} = \frac{\partial g_{11}}{\partial x^2} = \frac{\partial g_{22}}{\partial x^2} = 0$$

so

$$k = \frac{1}{2g_{11}g_{22}}\left[-\frac{\partial^2 g_{22}}{\partial (x^1)^2}+\frac{1}{2g_{22}}\left(\frac{\partial g_{22}}{\partial x^1}\right)^2\right]$$

and hence:

$$\begin{aligned} k &= \frac{1}{2R^4 \sin^2 \theta}\left[2R^2(\sin^2\theta - \cos^2\theta) + \frac{4R^4 \sin^2\theta \cos^2\theta}{2R^2 \sin^2\theta}\right] \\ &= \frac{1}{R^2}\left[1 - \frac{\cos^2\theta}{\sin^2\theta} + \frac{\cos^2\theta}{\sin^2\theta}\right] \\ &= \frac{1}{R^2} \end{aligned} \tag{1.16}$$

This shows that the curvature of a spherical surface is the reciprocal of the square of its radius, so as the size of the sphere and its radius approach infinity, its geometry approaches the geometry of the flat plane that has a zero curvature which is in a perfect consistence with observation. This space is an example of a two-dimensional Riemann space with a positive constant curvature. To describe this space in a more convenient way, we will introduce the following coordinate system (see Figure 1.1 below):

$$x = ar\cos\phi, \quad y = ar\sin\phi, \quad z = a\sqrt{1-r^2} \tag{1.17}$$

where r is a dimensionless parameter defined by $r = \sin\theta$ and so its values are contained in the interval [0,1]. Therefore by noticing that:

$$r = \sin\theta \Rightarrow \sin^{-1} r = \theta \Rightarrow d\theta = \frac{1}{\sqrt{1-r^2}} \tag{1.18}$$

it follows from the above derived metric of the sphere that it has in this new coordinate system the following form:

$$ds^2 = a^2\frac{dr^2}{1-r^2} + a^2r^2d\phi^2 \Rightarrow g_{ij} = \begin{bmatrix} \frac{a^2}{1-r^2} & 0 \\ 0 & a^2r^2 \end{bmatrix} \tag{1.19}$$

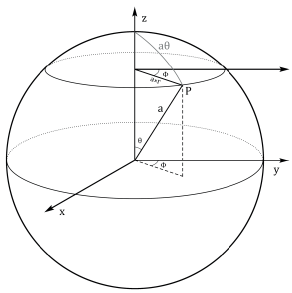

Figure 1.1: The spherical plane embedded in the Euclidean space along with the adopted modified spherical coordinates.

Another example of non-Euclidean two-dimensional surface is the hyperbolic plane (Figure 1.2). This plane is embedded in the pseudo-Euclidean space which has the metric tensor:

$$g_{ij} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \tag{1.20}$$

and hence the metric:

$$ds^2 = dx^2 + dy^2 - dz^2 \tag{1.21}$$

so, using equation (2.8), it is a straightforward to derive the metric tensor of this space in another disguise based on the following coordinate system:

$$x = a \sinh\theta \cos\phi, \quad y = a \sinh\theta \sin\phi, \quad z = a \cosh\theta \tag{1.22}$$

if we let $r = \sinh\theta$ to produce a new coordinate system and use the definition of the hyperbolic plane as the set of points in a pseudo-Euclidean space which has a fixed distance (according to its metric) from a specific point, we would derive the following metric and fundamental tensor of that surface:

$$ds^2 = a^2 \frac{dr^2}{1+r^2} + a^2 r^2 d\phi^2 \Rightarrow g_{ij} = \begin{bmatrix} \frac{a^2}{1+r^2} & 0 \\ 0 & a^2 r^2 \end{bmatrix} \quad (1.23)$$

now since the Euclidean plane has in polar coordinates the metric tensor:

$$g_{ij} = \begin{bmatrix} 1 & 0 \\ 0 & r^2 \end{bmatrix} \quad (1.24)$$

we could combine the preceding results and have the spherical, hyperbolic and Euclidean planes as special cases of a general tensor by letting K=(-1,0,+1) in the following metric tensor:

$$g_{ij} = \begin{bmatrix} \frac{a^2}{1-Kr^2} & 0 \\ 0 & a^2 r^2 \end{bmatrix} \quad (1.25)$$

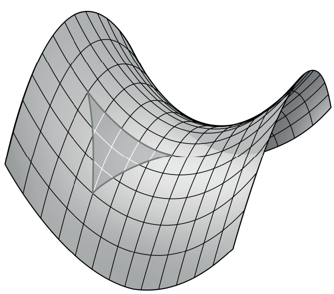

Figure 1.2: A simplified depiction of the hyperbolic plane.

the constant K which is defined in the preceding way is actually the curvature of the surface in each case. This result can be proven using equation (2.12) as follows:

$$g_{11} = \frac{a^2}{1-Kr^2}, \quad g_{22} = a^2 r^2, \quad x^1 = r, \quad x^2 = \phi$$

which entails that

$$\frac{\partial g_{11}}{\partial x^2} = \frac{\partial g_{22}}{\partial x^2} = 0$$

so we have:

$$k = \frac{1}{2g_{11}g_{22}} \left[\frac{1}{2g_{11}} \left(\frac{\partial g_{11}}{\partial x^1} \frac{\partial g_{22}}{\partial x^1} \right) + \frac{1}{2g_{22}} \left(\frac{\partial g_{22}}{\partial x^1} \right)^2 - \frac{\partial^2 g_{22}}{\partial (x^1)^2} \right]$$

and hence:

$$\begin{aligned} k &= \frac{1 - Kr^2}{2a^4 r^2} \left[\frac{1 - Kr^2}{2a^2} \times \frac{2a^2 r K}{(1 - Kr^2)^2} \right. \\ &\qquad \left. \times 2a^2 r + \frac{1}{2a^2 r^2} \times 4a^4 r^2 - 2a^2 \right] \qquad (1.26) \\ &= \frac{1 - Kr^2}{2a^4 r^2} \times \left[\frac{2a^2 r^2 K}{1 - Kr^2} + 2a^2 - 2a^2 \right] \\ &= \frac{K}{a^2} \end{aligned}$$

which is the curvature of the surface in each case. Following a similar reasoning, we could generalize these concepts to three-dimensional space leading to the following metric tensor:

$$g_{ij} = \begin{bmatrix} \frac{a^2}{1-Kr^2} & 0 & 0 \\ 0 & a^2 r^2 & 0 \\ 0 & 0 & a^2 r^2 \sin^2 \theta \end{bmatrix} \qquad (1.27)$$

However, the relativistic phenomena that arose as logical consequences of experimentally confirmed assumptions behave as if our three-dimensional space, which is the scene of the observable events, embedded and moved with speed of light in a four-dimensional pseudo-Euclidean space called "Minkowski space". This space has, in Cartesian coordinates, the metric tensor:

$$g_{ij} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \tag{1.28}$$

the events in this space are 4-tuples $x^{\mu} = (ct, x, y, z)$ and hence its metric, given in that coordinate system, has the form:

$$ds^s = c^2dt^2 - dx^2 - dy^2 - dz^2 \tag{1.29}$$

if we adopt this experimentally supported view, the metric tensor of our pseudo-Riemannian space (the space-time continuum) would have, in our amended spherical coordinates, the form:

$$g_{ij} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -\frac{a^2}{1-Kr^2} & 0 & 0 \\ 0 & 0 & -a^2r^2 & 0 \\ 0 & 0 & 0 & -a^2r^2\sin^2\theta \end{bmatrix} \tag{1.30}$$

and hence the following metric:

$$ds^2 = c^2dt^2 - a^2(t)\left[\frac{dr^2}{1-Kr^2} + r^2(d\theta^2 + \sin^2\theta d\phi^2)\right] \tag{1.31}$$

This metric is called “Robertson-Walker metric” and it predicts and explains many cosmological phenomena which have been proven to be consistent with observations. Three types of hypothetical universes can be conceived through this metric depending on the density of matter in the universe. Those types are the closed, flat and open universes, and each of these universes has its own geometry. The closed universe has positive curvature and hence spherical geometry so that in this type, the parallel lines converge to a point, the sum of the angles in a geodesic triangle is more than 180°, the circumference of a circle divided by its diameter is less than π and the surface area of a sphere as a function of its radius is periodic. The flat universe, which has zero curvature, is supplied with Euclidean geometry, so the parallel lines have a fixed vertical distance between them, the geodesic triangles have a total sum of their interior angles of $180°$, the ratio of the circumference of a circle to its diameter is equal to π and the surface area of a sphere is proportional to its radius. Finally, the open universe with a negative curvature has a hyperbolic geometry in which the parallel lines diverge, the sum of the interior angles of a geodesic triangle is less than $180°$, the circle circumference and its diameter have a ratio greater that π and the surface area of the sphere and its radius vary exponentially. The previous geometrical differences between these types of universes are just examples of some aspects of the differences between their geometries. As a result of that, the relations and aspects of the geometrical elements in each universe differ widely, leading to the requirement of different capability to appreciate them. Therefore, the inherent faculty of the creatures, in this universe, to conceive the geometrical objects, their symmetrical aspects and relations and hence to appreciate the relative distances, sizes and motions was a reflection of their development in the Euclidean space which would be different if they were developed in other geometrical environments. This fact emphasizes the relativistic nature of space and its dependence on the constitutional structure of the observer. However, to appreciate the extent of this dependence, we notice that those three types of universes can be treated as special cases of a more general space that has infinitely many other special cases of discrete and continuous spaces with any variety of geometrical aspects that can be conceived. This assumption opens the door to infinitely many possibilities in which a space could be perceived depending on the parent geometrical environment of the observer.

Order and chaos are two faces of the same coin. In fact, one of the main functions of science is to organize chaos. If we have two sets of points A and B (see Figure 1.3) and we want to derive the set of rules which describe, quantitatively, their distances from an arbitrary line, the points of the set A will be described by a single rule, but each point in the set B will be described by a special rule. We consider the system A as a well organized system and the system B as a very chaotic system, so the increase of the degree of chaos in a given system is a reflection of the increase of the order of the set of rules required to describe that system. However, the fuzzy boundary line between the systems which are designated as chaotic systems and those described as ordered systems depends on the constitutional structure of the observer. (That boundary line is not the same for chimpanzees and human being.)

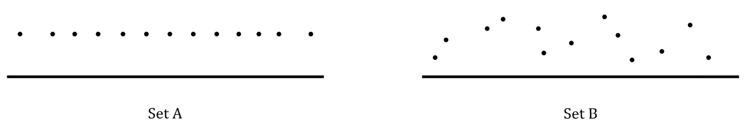

Figure 1.3: An organized system (set A) and a chaotic system (set B).

Our intellectual judgment of whether a particular behavior is right or wrong depends on our principles, customs, values and traditions, so these constituents compose the intellectual frame of reference that determines the natures of the correct and wrong actions. As a consequence of this fact and if we allow each of these constituents to have any possible form, the virtues and vices would be relativistic phenomena that depend on the experience of the observer, and hence there are no absolute rightness and wrongness. However, the existence of common universal virtues and vices in our world is a reflection of the similarities in the constituents of our intellectual frame of references, so we agree on the correctness of the behaviors that are based on these similarities and disagree elsewhere. This observation entails the dependence of the nature of any behavior on the experimental constitutional structure of the observer that is shaped by the intellectual environment in which he has developed.

The previous arguments inductively support the relativistic natures of what we receive by our senses and judge in our thoughts. The natures of the physical world around us and the intellectual thoughts in our brains were created by our constitutional structures which are mirrors of the physical and intellectual environments in which we have evolved. The metric of the four-dimensional pseudo-Reimannian space, which its spatial part is the scene of the observable events, emphasizes the relativistic natures of past, present, future and the essence and appreciation of time. The dimensions of the ultimate constituents (the elementary particles) of our bodies and our environmentally shaped senses determined the identity of the physical world around us. Our similarities in the intellectual experience and psychological structure produce a common sense of virtues and vices. These support the proposition that the identity of any concept depends on the constitutional structure of the observer and if we relate that concept to a suitable static or dynamic constitutional structure, it "theoretically" would have any prescribed entity. This line of thought emphasizes that the constituents of these entities have relativistic properties that depend on the structure of the observer. This phenomenon is not restricted to the preceding examples. Actually, careful reasoning based on the accumulated human endeavors to explore the living reality inductively supports the existence of this phenomenon as a ubiquitous aspect of the characters of any entity.

The only intrinsic nature of any meaning is that it is a meaning, so we will use the word "concept" to refer to any abstract or concrete meaning. The constituents of any concept are again concepts which in turn consist of concepts, so any concept is a fractal by its nature. On the other hand, any set of concepts has intimately real or imaginary extension. We call this set of concepts a "reality" and its extension a "science". For instance, the previous sentence is a set of graphs (concepts) and it has a set of geometrical spacing, symmetries and shapes as an extension, so this set of graphs constitutes a reality and its geometrical aspects (its extension) constitutes a science. In fact, this relation is reversible, that is, each of the previous set of concepts is an extension of the other and hence a reality and science of each other. We call any set of concepts and its extension (any reality and its science) an "existence". However, since any group of concepts, which may be considered a reality or science, form collectively a new concept, any concept is a reality and science. Moreover, since any set of concepts, which form collectively a concept, can be divided into two subsets each of them is an extension of the other, from real or imaginary respects, any concept is also an existence. However, the concept can be treated as a property of another concept, from some respects, hence any concept is, also, an attribute. For example, if we have a red box, the red color is a concept, reality, science and existence, but it also is an attribute of the box. This treatment can be generalized to any abstract or concrete meaning that can be conceived.

1.2 Concepts

Aristotle has talked about the upper ten classes of meanings (known as the ten categories) in what is called today the material logic. This classification was apparently based on the assumption that any class of meaning has an absolute essence which is independent from the constitutional structure of the observer. However, as we have shown, the accumulated knowledge in many disciplines strongly supports that the essence of any meaning is a relativistic phenomenon which depends on the observer. This entails that the ten categories do, in fact, describe the essences of meanings with respect to the constitutional structure of humans. In this monograph, we intend to develop a new conceptual system to treat these concepts more abstractly, so we classify meanings according to their receptive entities rather than their absolute essences which, actually, do not exist. If we define "intelligence" to be the ability of processing data and producing knowledge, we could distinguish between the insulated and non-insulated intelligence. The first type has no connections with its exterior world and hence can not be considered as an observer, while the second type is connected to the outside world, so any observer is, by nature, a non-insulated intelligence. To achieve communication with the exterior world, the observer must have a probe to detect the mediator of the data, we call this probe a "sense". Theoretically, the observer can have as many senses as his structure allows him to differentiate different meanings. As a result of the conditions in our terrestrial developing environment, we have earned five senses that enable us to classify sensible meanings into five types (image, sound, feel, smell and taste). However, the sensation of these different meanings and the interaction with the surrounding environments, in the existence of the intellectual activity, create two internal domains that produce conscious and emotion. As a consequence of that, two more types, essentially different from the five sensational concepts, originate. We call these two types "thought" and "affection", respectively. These meanings constitute the "orthodox meanings" and the general observer, that has developed those five senses and their ramifications to distinguish between the latter seven types of meaning, is called the "orthodox observer".

Each of the orthodox meanings has genuine, intermediate and mental aspects. We may use the concept of representation to distinguish between them. The genuine aspect of a meaning depicts the representation of the concept by itself while the intermediate aspect describes its representation by another concept and the mental aspect is the observer's intellectual representation of the concept. If we take the tree as an example, the tree itself is a genuine aspect of itself, the word of tree is an intermediate aspect of it and the intellectual idea of the tree, with respect to an observer, is its mental aspect. There is just one genuine aspect for any orthodox meaning, but infinitely many intermediate and mental aspects for it. However, the type of any intermediate aspect of a concept is one of the seven types of the orthodox meanings, so there are visual, audible, tactile, gustatory, smelled, affective and mental intermediate aspects. For instance, the written word of the sun is a visual intermediate aspect of the actual sun while its pronunciation is an audible intermediate aspect of it. The first two types (visual and audible) of the intermediate aspects are widely used, while the third type (tactile) is rarely utilized (braille language), but the rest of these intermediate types are obsolete. The word "name" is the common word for the intermediate or the middle aspect. Compactness and pureness are properties of the middle aspects (names), so some middle aspects are more elaborated than others and some of them purer than others. The equation of a straight line, for example, is more compact than its graph, and both of them are indirect visual middle aspects (names) of the relation which is genuinely a mental concept. However, the figure "2" is a direct (pure) visual intermediate aspect of a mental concept of a quantity. This discussion and distinctions are observed in any instance where we encounter intermediate aspects or names. It should be emphasized that there are no absolute essences of these three aspects, but their essences are relativistic phenomena that depend on the constitutional structure of the orthodox observer.

2 Sciences

As we have mentioned, any science is an extension of a reality and one of the five natures of any concept is a science. The commutative natures of science and reality, such that one of them is an extension of the other, lead to the fact that science and reality are two faces of the same coin. For instance, medicine, in its genuine aspect, is a science of human body and human body is a science of medicine, and each of them is a reality of the other. Therefore, the assertion that a particular set of concepts is a science of a real or imaginary extension, which constitutes its reality, is a matter of definition that reflects our scientific objects. This means that the environments of the scientific objects determine the sets of concepts which form the extensions of the realities and hence are considered as sciences. The natures of human interests produce objective environments that coincide with the sensibles, so the latter are taken as realities and their extensions as "human sciences". As a result, human sciences can be defined as the extensions of the sensibles. If we return to the previous example of medicine and human body, we found that the concepts which constitute the human body are sensibles, so they are taken as a reality and their extension (medicine) as a human science. The relative "stability" of the concepts that collectively compose a reality has a transitive effect on the stability of the concepts that constitute its science, so the "real" science mimics the instability of its reality. However, if science is developed without allowing for this property of its reality, the phenomenon of accurate and inaccurate sciences would be produced as a reflection of different degrees of instability. For example, psychology (the science of affective structure) is less accurate than physics (the science of nature) because the properties of the four physical constituents of the universe (matter, energy, space and time) and their relations are much more stable than the constituents of the human psychological structure, which varies widely between humans. (This also explains why medicine is more accurate than psychology.) Another property of the reality which is related to the stability and has a reflection on its extension or science is "uniformity". This property of a reality determines the degree of "complexity" of its science, so the more uniform a reality, the more simple its science. Theoretically, any reality with any degrees of stability and uniformity has a science. However, for the limited capacity at a given time, the realities with high degrees of instability and non-uniformity are considered as random systems and treated by inferential statistics and other methods involving uncertainty principles such as quantum mechanics and quantum field theory. For a given reality, the "rational data", obtained by observations and experiments, determine its extension or science. The rational data can be defined as the collection of data that realizes or facilitates the realization of the scientific objects. Therefore, we may accurately define the science as a set of correlated and isolated concepts that are connected to the rational data and arise from the relative stability of the environment of the scientific objects. It follows from this definition of science that "any" object has a science, so if someone would like to drive a car, there is a science to accomplish this task. The reality of this science is the structure of the car and the conditions in its environment. On the other hand, if a nation would like to build a colony on the moon, there are sciences for these realities to achieve this object (physics, space sciences, engineering and architecture). Even for the aim to win a backgammon game, in which its structure and rules constitute a reality, there is an extension of this reality that constitutes its science to accomplish this objective. The definition of science as a particular set of concepts and the existence of genuine, intermediate and mental aspects of any concept lead to the corresponding three aspects of the science. We call its middle aspect (name) the "Adamic science".

2.1 Adamic sciences

Based on its previous definition as an intermediate aspect, there are an infinitely many possible Adamic sciences or names for the extension of given sensibles as a reality. However, for simplicity, sufficiency and historical reasons, only a few of them were utilized. Henceforth, we will drop the word "Adamic" and refer to those intermediate aspects just as sciences. We may distinguish between "perfect" and "imperfect" sciences according to the degree of the assignment of their realities. If the reality of a science was completely assigned, then the science is perfect. Otherwise it is considered imperfect, so chemistry or any natural science is imperfect, while the science of chess or any game is a perfect science. Also, for educational reasons, the realities of sciences are simplified with different degrees of simplifications which produces sciences of different complexity for a given reality. This kind of simplification is pronounced when comparing the sciences taught in the fundamental education with the same sciences taught at the university level and the latter with them in the postgraduate level. It is obvious that the simplicity of the same reality decreases with the educational level and, as a consequence, the science complexity increases. Another property of science, that arises from the limited capacity of the observer, is the scientific branching. This phenomenon occurs when a huge accumulated data, that outlines the science, revolves about two or more distinguishable scientific areas, so this problem is mitigated by splitting them, based on these areas, into several sciences. For instance, statistics was the branch of mathematics that deals with the description of data and the scientific principles of taking decisions evolving in-deterministic experiments. However, for the stated reason, they have been split into two distinct sciences.

2.2 The constituents of science

Science, as any concept, arises from the relative stability of a set of constitutional concepts, so its nature and behavior depend on these concepts. Language and definitions are constituents of any science. However, quantitative sciences have the relations, measurand systems and unit systems as three additional constitutional concepts. We thoroughly analyze these constituents below.

2.2.1 Language

The human brain, as an example of the intellectual processor of the orthodox observer, is made of nervous cells that create intellectual domains by sending nervous signals to each other. The genuine aspects of these domains are physical by nature and very complicated, so the simplifying and organizing method that was acquired through the natural development of the human race was the language. However, since the nervous signals are the responses of the mental cells to the stimulation from the surrounding environment, the intellectual domains have developed in such a way to reflect a relative essential nature of this environment, so the physical aspects of the intellectual domains mirror the chronological feature and the distinction between different meaning that exist in their surroundings. As a ramification, the language, as a simplifying and organizing medium to the intellectual domains, should have these features. In language, the temporal feature is captured by the concept of "tenses", and the sense of three tenses (past, present and future) naturally appeared in the human language. However, there are some meanings that have chronological aspects while others do not essentially have the temporal tincture and still others do not have "stand-alone" meanings, so the concepts of verb, noun and preposition have developed. The language is the collection of these concepts and their rational constructions (syntax) that produce logic and sensible reasoning. Technically, there are infinitely many possibilities of the middle aspects (names) of the linguistic concepts and their syntaxes. (This fact manifests itself in the thousands of languages that exist in the world.) However, in general, the only used of the seven types of the middle aspect in any human language are the visual and the audible aspects (except some cases in which tactile aspect is used for blinds). Therefore language provides science with the visual and audible aspects of the linguistic concepts and their rational structure (syntax) that contains the logical and sensible reasoning. Any tool that has been developed by an orthodox observer to perform the preceding functions is called an "orthodox language" or in short a language if there is no confusion.

2.2.2 Definitions

Concept is one of the five faces of any meaning, and the constitutional structure of the meaning as a concept is created by definition, so the existence and the nature of a concept depend on the existence and the features of its definition. This ontological relation between concepts and their definitions necessitates the existence of the structural concepts in the suitable correlations and configurations that set up the definitions and hence collectively create the concepts. The prior existence of the definition to its concept is a privileged property of the genuine aspect of the definition, so its middle (name) and mental aspects succeed the existence of the concept. For example, the genuine aspect of the definition of the horse or its constructing concepts (flesh, bones, organs, etc.) and their relations occur before the existence of the genuine aspect of the concept of horse, since they are the constitutional structure of that concept. However, the intermediate aspect (in the dictionary) and the mental aspect (in human mind) succeed its existence. The mental concept as one of the seven types of the orthodox meanings has, by its nature, the distinctive character that the creation of any possible middle aspect of its definition entails the existence of its genuine aspect. As one manifestation of this phenomenon, the linguistic definition (name) of the cross product of vectors produces the genuine mental aspect of its definition. However, the rest of the orthodox meanings do not have this privilege. For instance, the creation of an intermediate aspect of the definition of the Phoenix in a particular language does not lead to the existence of its genuine aspect in reality. In the latter case the concept is called "fictitious". This property of the mental aspect arises from the capability of the orthodox observer to construct the intellectual concept according to a prescribed intermediate aspect of its definition, so the other orthodox meanings would have the same privilege if the orthodox observer was endowed with the capability to construct the genuine aspects of the created "names" of their definitions. This effect is demonstrated by the construction of a car based on its artistic depiction and engineering design which constitute the intermediate aspect of its definition. In principle, there are countless possibilities of definitions that can be used to perform a particular function which leads to the creation of a distinctive intellectual structure. However, for simplicity and uniformity, only limited flavors of them are employed.

However, the constitutional structure created by the genuine aspect of a definition may exist in more than one entity. This produces a class of entities with the characteristics created by that definition. We call this class the "extension" of the definition. The uncertainty in determining the extension of a given definition produces a confusion about the exact entities that are included in the extension. This confusion is called the "vagueness" of the definition. Another important phenomenon, inherent in any language, is the use of the same middle aspect (name) to represent different meanings. This effect creates the so called the "ambiguity" of the definition. To overcome these problems, we always use "stipulated definitions" for the linguistic intermediate aspects used in science which should be partially descriptive (have related meanings to their meanings in the language). The latter requirement is essential since it reduces the insanity results from the confliction between the stipulated and descriptive meanings. We call any possible collection of partially stipulated definitions that can be used in a particular science a "nomenclature".

There are, in general, two main types of definitions the "intentional definition" and the "extensional definition". The former type defines the concept by its constituents and hence the existence of the genuine aspect of that definition creates the constitutional structure of that concept. However, the extensional definition defines a concept by determining its extension, so the existence of its genuine aspect entails the existence of the genuine aspect of its extension. The vagueness associated with the uncertainty in determining the extension in the second type of definition can be eliminated by naming that extension if its members are finite and few. Otherwise the extension can be determined recursively or operationally. For instance, we may define, recursively, a set of "parallel lines" in the Euclidean plane as the set parallel to a particular line, so we could use this line or any other line (parallel to it) to construct that set. On the other hand,