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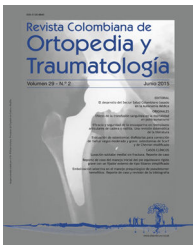

EDITORIAL

What's up with the Poincarè conjecture, Entropy and Artificial intelligence (AI)

La conjetura de Poincaré, la Entropía y La inteligencia Artificial

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''Science is built up of facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house''.

Jules Henry Poincarè.

Since late 2010s, we have been often hearing about the concept of artificial intelligence: the human being will soon be able to create intelligent machines that could displace him academically and professionally. A surprisingly frightening idea, even apocalyptic, as in the Terminator movie shows. The truth is that although it is true that machines can replace us, artificial intelligence will not be more than that, smart machines, they will not have the ability to have feelings or empathy, at least for now.

The Poincaré conjecture is a mathematical problem of multidimensional geometry and therefore of set theory and statistics, which was raised in 1904 by the French philosopher and mathematician Jules Henry Poincaré, the renowned author of Hypothesis and Science. The Poincaré conjecture textually states: ''Every simply connected, closed 3-manifold is homeomorphic to the 3-sphere''. The Poincaré conjecture was stated as one of the 7 mathematical problems of the millennium and was finally resolved in 2003 by Russian mathematician Grigori Perelman who drew upon Richard Hamilton's previous work. Its resolution opened the way to the famous algorithms with which the technological platforms of social networks and artificial intelligence work on.

Far from the conspiracy theories among which it is said that Amazon already knew that I was writing this editorial even before I started to write it, and that Trump was elected president by the surgical intervention of Facebook and some occasional Russian helpers, social networks and artificial intelligence have a scientific and mathematical support, I will try to explain here. Personally, I think we all need to learn math, especially Physicians, that have chosen biology because neither they like math nor succeeded in it along high school life time. Through time, I have understood that the problem of health sciences professionals with mathematics has to do much more with the mediocre training they received in mathematics, an issue that seems not to have changed much in three or four decades. The bad results that our Colombian graduates received today in international tests resembles the situation.

Recalling that the machines speak in binary language (zeros and ones, where zero is without electric current and one is with electric current) in combinations to activate different sectors or functions within a processor, memory, etc., according to programming languages made by man, artificial intelligence needs to be able to discern the geometry of the data that has been stored in it as zeros and ones and have the ability to differentiate between ''simply connected or unconnected'' geometries. In other words, connected or unconnected geometries should be understood in an even simpler way as complete plane geometries or hole geometries. A machine should be able to respond to a simple order:

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''mind the gap'', then it has to locate the gap and dodge it to avoid falling into it. From the point of view of intelligence, receiving the verbal command ''mind the gap'' is to receive a specific alert, and requires multiple actions to identify a specific gap and avoid it. The differentiation of the gap or hole in a rational way implies for a machine to create a ''de novo'' concept that is that of the gap or hole, to delimit it geometrically, and according to this, take the pertinent actions to avoid it. Identifying a gap or hole and defining it geometrically implies constructing an image of an abstract concept (the gap) and making decisions to avoid falling into it. In artificial intelligence this corresponds to creating a ''de novo'' sequence of zeros and ones corresponding to the gap and inserting them as code into its own programming code libraries to later remember where the gap is. However, once the gap is covered or full filled, the machine must discern that the gap has indeed been covered and will have to rewrite a ''de novo'' code fragment with the information referring to the gap since it was covered and will have to rethink the action to take: instead of taking a detour, it must pass over the covered gap; but it must remember where the gap was located before it was covered.

Mathematics is a formal science (systematic set of rational and coherent knowledge), which from axioms (verbal approaches to problems) and logical reasoning, is responsible for studying the relationships and properties between abstract entities (numbers, geometric figures, symbols, etc) to pose problems unambiguously in specific contexts, which has been widely defined as the language that should be used in science. As mathematics defines geometry and geometry to statistics, to physics, to the universe itself among others, and proves it, Poincaré's conjecture was at the center of human knowledge to discover, remaining unsolved for almost a century.

The Poincaré conjecture is a geometry problem that the topology handles. Topology is a part of mathematics that is responsible for studying the properties of geometric bodies that remain unchanged by continuous transformations. A simplistic but easy way to illustrate the concept is to say that is the science that studies the geometric properties of a plasticine in the hands of a child. As long as the plasticine is not separated, stuck or punctured, its two-dimensional geometry may change by compression or tension, but since it is the same geometric set, therefore the mathematical resolution of the geometry of that plasticine set will be essentially the same. As a joke, it is often said that a topologist is not able to discern the difference between a cup and a donut, because from a topological point of view, actually they both have the same geometry. By having a cup and a donut a hole, one could be transformed into the other if both were made of plasticine by compressing and stretching the plasticine around the hole. According to this a plasticine ball could become a frisbee when compressed and stretched, but it could not become a donut because the ball has no hole. Having no hole means that the ball is ''simply connected''. The only simply connected 2-variety structure that exists is the sphere. The sphere we see and perceive has been defined as a 2-sphere or 2-variety sphere. The 1-variety sphere or 1-sphere would be a circle without volume drawn on paper. However mathematically there are n-spheres. That is, spheres that our eyes cannot see but that our mathematical knowledge can infer. So far we have defined the concepts necessary to understand the first part of the Poincaré conjecture; ''Every simply connected, closed 3-manifold''. For the second part of the conjecture: ''is homeomorphic to the 3-sphere'', it is necessary to understand the mathematical concept of homeomorphism.

In mathematics, homeomorphism is defined by continuous bijective functions with continuous inverses. A function is bijective, only if it is injective and surjective at the same time. The link that develops between two sets is known as an injective function, through which each element of a set is assigned an element of the other set or none. A set of ordered pairs in which the first element of each pair is not repeated is known as an surjective function. In other words, this occurs when all the elements of the output set have a different representation in the arrival set and each of the elements of the arrival set corresponds to one of the elements of the output set. When this occurs in geometric or spatial terms on a continuous basis and with continuous inverses, homeomorphism is discussed. Imagine for a moment that in set A we found the riddles and in set B there are the answers to the riddles. Then, in set A we will have the element 1: What has a head and a tail, but no body?; and element 2: Forward I am heavy, but backward I am not. What am I? In set B we will have element 1: coin; and element 2: Ton & Not. Each of the elements of each set (A and B) are represented by a homeomorphic element in the other set. They are homeomorphic because the conceptual representations are injective and surjective at the same time and will always be continuous with continuous inverses.

A ball is an example of a of 2-dimension sphere (a 2-sphere) or a 2-variety sphere. If we think of the 2 sphere as a set, its content will have elements with specific characteristics to have been grouped within the set. An example of this is the famous Latin American Facebook group ''I also fractured my calcaneus''. From 2006 to date in this group there are 915 patients who had a calcaneus fracture referring fair and poor result after receiving their treatment, whether it was surgical or non-surgical. By definition this is a group of people with a characteristic that defines them (calcaneus fracture), which has a geometry that according to the probability defines us that after the treatment the result was fair or poor. On the other hand, at the same time about 700 patients have been published in Latin America included in several studies reporting calcaneus fractures that were also managed surgically or non-surgically with acceptable and good results. This is a group of people with a characteristic that defines them (calcaneus fracture), which has a geometry that according to the probability defines us that after the treatment the result was good or excellent. The million dollar question is whether these two sets of people with the same characteristic that defines them (calcaneus fracture) actually have the same or different geometry. It could happen that they are two geometric representations of the same plasticine that has been deformed in the case of the Facebook group by the expectation of the patients and the visual analog scale of pain, while in the case of those reported in the scientific articles the geometric deformation could have occurred at the expense of the value of the result of the AOFAS hind-foot scale. That would mean that having the same geometry this has been deformed by the form or

manner of clinical assessment. In the case of patients on Facebook group the geometry could be that of a ball (subjective but real assessment), and in the case of researchers that of a frisbee (objective but unreal assessment). But it could also happen that the group on Facebook is not simply connected and corresponds to a geometry with a hole while the group of scientifically reported patients is a sphere (without hole) and therefore both groups would have a different geometry and therefore They would be different. To solve this, one would have to appeal to the 2 law of thermodynamics described by Albert Einstein in 1907: ''Entropy'' also known as ''statistical mechanics'', as originally described by Ludwig Boltzmann between 1890 and 1900, without practical application. Entropy is the statistic of disorder, it defines in a simple way the greatest probability of equilibrium within a system (thermo-dynamic according to the applicability that Einstein gave it) that a priori seems like chaos or disorder.

The most frequently used example to explain Entropy is that of the dice: when throwing a dice, if no trap is made, the probability of hitting the result is the same for each of the numbers marked on each of its six faces (16, 66%); however, if two dice are thrown, the probability of obtaining a result is not reduced to 8.33% because there are two dice. Actually 11 possible number results can be obtained (numbers of the 2 to 12), but we also has to consider the possible combinations that each result could have in order to establish a proper probability for each number result. For example, to obtain a 2 only the combination of 1 + 1 would be possible, to obtain a three one could combine 1 + 2 and 2 + 1, to obtain a four one could combine 1 + 3, 2 + 2, and 3 + 1, and so on. Therefore, the result with the greatest possibility of combinations would be 7, so by entropy, we could say that the greatest probability of result when rolling two dice would be 7. This probability system understanding, is the reason why some casino players must visit orthopedists after rigging the game, and explains why the casino usually changes the dice on the game table on a regular basis. According to the entropy, everything in the universe, although it seems messy, actually has an order.

Therefore, artificial intelligence will necessarily have to identify probabilistic patterns in simply connected geometries and differentiate them from those in non-connected geometries. That ultimately is what our brain does with a large margin of error through the process we call experience. With our experience, we are able to fill knowledge holes by turning unrelated geometries into simply connected ones, motivated by our emotions, which is a huge mistake because we deduce badly. By entropy we can sometimes deduce well, but as our brain perceives but does not record mathematically, we are at a disadvantage compared to a machine that manages to think mathematically. That is what terrifies us. Of course, as the dice player, we can bet everything on an idea that eventually solves something but not necessarily in the right way. The machine will instead methodically generate small resolutions to specific problems and will continue to analyze its data over and over and over again, perfecting itself.

The problem with artificial intelligence is not the machine itself, it's us the creators, and administrators when we do not properly build a system of values, rules or limits that must or should not be crossed. If artificial intelligence is fed with values, rules and limits, it will surely contribute to the progress of the human being as a species. If the rules, limits and values are not clearly defined for the machine, then we will be creating a monster. It will be the educational process of human beings the on the will modeled the Artificial intelligence with its values, rules and limits. The math is already solved the programming is on going, but the limits and the lack of them are from the last century. Tricky, ah, the AI experiment in Scandinavia certainly will differ from the one performed in Colombia. In the meantime, at least we have to use this knowledge to be a bit critical on daily Uber worldwide discussion.