Creative Artificial Intelligence: Generation of New Objects

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***Abstract*—** This paper presents an introduction to Artificial Intelligence and creativity. Creativity is analyzed from a biological point of view based on the concept of neuroplasticity of the human brain. It seeks to understand the process associated with the creative act to formalize it. He analyzes biological neural networks not from the point of view of their topology, but from the process, they carry out during the creative process.

The focus of attention is placed on the generation of new objects. It seeks to formalize the creative act to propose a model of creativity with the ultimate goal of building a Creative Artificial Intelligence. To understand this process, well-documented examples from real life were studied. From them, the creativity process is analyzed and deconstructed into basic elements to later formalize it.

Throughout history, various authors have studied the creative act and this has given rise to different theories. The proposed model is analyzed taking into account traditional approaches, constituting a tool for technological improvement that will complement human creativity.

***Keywords*—**Creativity, Artificial Intelligence, Model, Intelligent Computing

I. INTRODUCTION

Although Artificial Intelligence has advanced by leaps and bounds since its inception, even today we do not have algorithms that can be said to be creative.

In this paper, human creativity is analyzed trying to understand the process from a biological point of view.

The creative act needs motivation, to be able to access knowledge, to be able to formulate problems to investigate. In general, it must be able to comprehensively define the problem space to be solved.

In order to realize the creative act, skills are needed to reduce the search and it is also necessary to use the knowledge in a methodological way [1].

It can be said that it is possible to work with conventional scientific methods, but on some occasions, this is not possible.

Nevertheless, creative ideas can often remain just that, an idea. This can happen because it is simply not possible to specify it, it is not possible to make it a reality; or although it is possible to make it real, it remains only an idea because society does not adopt it.

Another aspect to take into account is when the creative act generates new objects or discovers others from experiments that were carried out with objectives that did not seek to generate or discover the object that was finally created.

Various authors have studied creativity and this has given rise to various theories [2] among which we can find factorial, associative, stage and miscellaneous theories.

Factorial theories take into account various factors, among which we can find intellectual factors and those that take into account different personality traits. The associative theory [3] considers the creative process as an association of elements that the more distant they are, the more creative the result will be. Stage theories usually consider 4, 5 or 6 stages. In [4], Wallas

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proposes the following: preparation, incubation, illumination and verification/implementation. On the other hand, from the physiological point of view, some authors [5], [8] show that creativity is typical of human beings, everyone can develop it and the neuroplasticity of the human brain can develop it beyond time or geographical region. This creative process, therefore, is supported by the neuronal topology of the human brain and in this work, its deconstruction is presented to find its basic elements.

II. Artificial Intelligence and Creativity

Although there is no agreement among various authors regarding the definition of Artificial Intelligence, according to [6], the different approaches can be found within the following classification:

1) Systems that think like humans
2) Systems that act like humans
3) Systems that think rationally
4) Systems that act rationally

Unlike an agent that thinks or acts like a human, an ideal rational agent should do whatever action is expected to maximize its measure of performance. That is, based on the evidence provided by the perception sequence and whatever knowledge you have.

In this work, we will put the focus of attention on the classification that considers it as a system that thinks like a human.

If the creative process, as previously stated, is latent in all human beings and the neuroplasticity of their brain can develop it, our objective is to find the basic elements that constitute it.

The first thing we will do then is focus on the creative process to generate objects. These are objects that did not exist before but their creation helps to solve a problem or can even improve the quality of life of people or animals.

If we can understand how the creative process occurs in the human brain, finding its basic elements, we will be able to deconstruct that process and implement a creative Artificial Intelligence.

To understand the creative process from a biological point of view, we turn to neuroplasticity. Neuroplasticity explains how through the connection of neurons, known as synapses, new concepts can be learned and how these neurons are grouped to carry out processes that are more complex. These biological processes contribute to the creative act and we will focus our attention on them, which aims to understand how this act develops.

At this point, we can say that the creative act then depends on the neuroplasticity of the human brain and the information available. Therefore, depending on the triviality or not of the creative process, it will take more or less time to find the connection paths within the brain.

III. Creativity and Neuroplasticity

From the point of view of Artificial Intelligence [7], it seeks to represent the interconnection of neurons through mathematical functions that can be implemented through simple arithmetic computational elements. These neural networks can learn to recognize patterns from examples.

In this work and from a biological point of view, a mathematical model that represents the process carried out by neural networks during the creative act is sought. It seeks to understand the phenomenon from the point of view of neuroplasticity rather than the representation of the topology of the interconnection of neurons.

So far, we cannot say that neural networks such as Artificial Intelligence Algorithm are creative and that is why the authors propose to analyze a little more the process of human creativity. Therefore, the focus will be strictly on the brain and the neurons that allow us to remember, learn, reason and be creative.

We have this ability to remember, learn, reason and be creative because as we grow the connections between the billions of neurons that we have do not remain connected to each other in the same way for life [8]. This dynamic means that at the beginning, there are neurons that are not connected but then they are connected as the brain is exposed to new information and different experiences.

Neuroplasticity constitutes this possibility of creating new connections and gives us the possibility of understanding the creative process in order to translate it into a Creative Artificial Intelligence. Enriched environments [8] rapidly creating new neural networks benefit this plasticity of the brain.

The authors in [5] conducted a review of creativity processes from prehistory to the present. In this review, we observe the advances of the human being with simple creative acts at the beginning until performing complex creative acts when immersed in increasingly enriched contexts.

The plasticity of the brain allows us to continue learning and creating. In the human brain, there are billions of neurons with interconnection capacity and with the capacity to modify themselves if there was a learning error or new knowledge.

IV. Some Aspects to Consider

It is convenient at this point, and before proposing a model of creativity, to make some aspects clear [5].

A. Interaction of Known Objects

The creation of new objects requires the intellectual manipulation of those objects or others.

B. Answer to a problem

Faced with the same problem, one or several people can respond with a creative act. For this, it is essential that they all have training and enriched environments for the intellectual manipulation of objects.

C. Neuroplasticity

The plasticity of the brain allows relating objects. For this, it is necessary to correctly characterize the objects, have logical thinking skills and be able to see the new object in reality. Training and enriched contexts increase the capacity for connections to achieve the objective.

D. The Subject and the Context

Several people can perform the same creative act at the same time. The educational level will influence, which may be similar or complementary, and a context of similar cultural availability.

E. Cultural Availablity

Cultural availability implies that all people can access the same information from their time and before. The lack of information constitutes a strong restriction for the creative act [5], [14].

F. Similar training

People can be equally creative but to get the same results they need to be able to access similar training systems.

G. Curiosity

Curiosity is the desire to know something that is not known and therefore leads people to learn, investigate and all this can lead them to innovate. In this desire to search for something that is not known, the possibility of creating and innovating is generated.

H.Proactive and Persevering People

Although to be creative one must also be curious, curiosity would not be enough if the person does not have the impulse to act quickly, that is, if they are not proactive. At the same time, perseverance is also required because on many occasions, the answers sought are not easily obtained or it is not so simple to put that creative idea into practice [9].

I. Language

A person's language influences the way they see and analyze the things around them. Therefore, those people who can speak several languages benefit from being able to compensate for the limitations of one language with another, especially when those languages have different roots. This influence can be observed during the 20th century in relation to the development of thought and technology through various examples [11]. Language is a system of symbols that can facilitate or hinder the description and characterization of the objects that surround us and the ability to solve problems related to them [12]. It should also be noted that language changes as society evolves. Language is not static. Although it should also be noted that there are languages that are more open to change and others that are not. As a consequence of this, different languages have different capacities for analysis, classification and memorization of objects. And the limitations of some could be compensated with the learning of others.

Under these considerations, creativity [5] can be defined as “the ability to generate objects or concepts that did not exist before to solve a problem or generate an improvement in the life skills of people or animals”.

In this work, the creative process involved will be analyzed from the point of view of what happens in the brain. The focus of attention is placed on the process from which a procedure is proposed.

Neuroplasticity [8] provides an explanation of how the process involved in the creative act can happen in the human brain. How a new concept can be learned, how the connection between neurons contributes to this, and how simple networks of neurons can be connected to each other to form more complex neural networks.

V. Traditional Approaches

The creative act requires information and we have seen that it is closely linked to the neuroplasticity of the human brain.

Some models of creativity [10] with traditional approaches are:

1) Boden's model distinguishes creativity between impossible (when knowledge is restricted) and improbable (from the combination of familiar ideas).

2) The Finke, Ward and Smith model is divided into two phases. A generative phase (construction of mental representations with their own characteristics) and another exploratory phase (characteristics are analyzed).

3) Koestler's model proposes the juxtaposition of two sets of ideas to produce the creative act.

4) The Wallas model divides the creative act into 4 stages: preparation, incubation, illumination, and verification

We seek the answer to how the creative act develops by analyzing the case of Darwin and Wallace [15]. Both were able to access the same information that, even though they were not connected at the beginning, it can be thought that complex concepts were stored in independent neural networks that evolved making new connections to conclude in a more complex neural network that would lead both to the same act creative.

The creative act requires information and we have seen that it is closely linked to the neuroplasticity of the human brain.

At the same time, it is important to highlight that the creative act will involve a greater or lesser amount of time in relation to the triviality or not of the response sought. It will depend on the number of connections that must be established to complete the neural network that is necessary to build to carry out the creative act.

This time will then be affected by the number of neural connections involved in the representation of concepts learned and developed as well as the experiences lived. In turn, the latter depends on the neuroplasticity of people's brain and the information available to them.

The proposed case study responds to the creativity model of Wallas [10] and its 4 stages: preparation, incubation, illumination, and verification. The first stage is to dedicate yourself to studying the problem. The second stage consists of temporarily stopping thinking about the problem, occupying the mind with another activity. The third stage is to deal with the problem again and then find the solution. The fourth and final stage consists of verifying the solution found and formalizing the creative act.

VI. A Model of Creativity

In the following, a model of creativity is proposed that allows reflecting the process that occurs in the human brain during a creative act of real-life objects.

The generation of tangible things has a strong restriction and that is that the object can be an impossible idea to materialize.

The human brain can characterize real-world objects in a way that helps define them [13]. These features must have a one-to-one relationship with the object and must be tagged.

An example of characterization is presented in Fig. 1. The human being used his own hands as a liquid container object. Fig. 1 shows how, by joining the two hands, they can be used to contain, among other things, water. Thanks to the concavity they create when they are together. The characterization in this case is precisely the concavity.

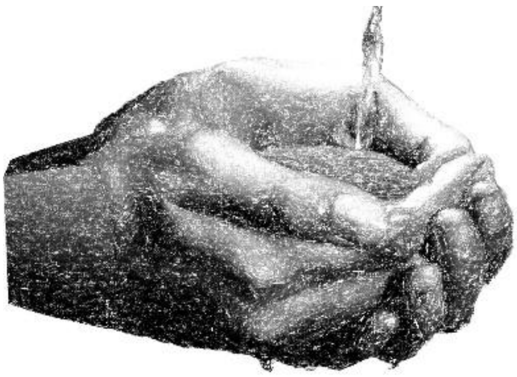

Fig. 1. Two hands together whose characterization is concavity.

The more complex the object, the greater the number of features needed.

During the creative act, the solution can be found as the simple modification of an existing object, giving rise to a new object with new functions and characteristics similar to the modified one; or through modification of many features and objects that increase its complexity

The next step is to characterize the problem in a similar way to characterizing objects. That is, it is proposed to characterize the problem from the characterization of its solution. This will allow obtaining the necessary characteristics to describe the functions of the new object to be created.

The process then consists of matching the characteristics of the problem with the characteristics of those objects that can be linked to the problem. If the problem does not exist, the creative act arises from the reflection on known objects.

In both cases it must be taken into account that:

1) The more complex the creative act is, the set of objects and therefore the number of features will grow to incorporate more information into the solution.

2) The pairing of several objects can be direct or not, depending on the need to make adaptations, such as rotating an axis.

A. *Order of complexity of creativity*

The number of necessary adaptations on each characteristic to achieve its pairing determines the order of complexity of the creative act.

1) Reference is made to Creativity of Order 0 (CO0) when the creative act does not need adaptation of characteristics. An example is presented in Fig. 2, where a skull can be characterized by its concavity.

Fig. 2. Skull whose characterization is concavity.

Using a skull for the first time as a bowl to hold water is an example of CO0. From the observation of Figs. 1 and 2, it can be clearly seen that the pairing of the characteristic concavity in both figures gives rise to the creative act of using the skull as a water-containing bowl.

2) Reference is made to Creativity of Order n (COn) when the creative act needs a number of adaptations n of the characteristics to achieve matching. Where n is a natural number.

An example of CO1 is found when the first potters, who worked with the craftsman's wheel and a stake converted into a fixed axis. One of the most important creations in the history of humanity.

The primitive potter worked daily with his wheel and a stake that formed a vertical axis so that the wheel would not slip. From this knowledge arises the first example of a wheel. The creation of the wheel arose from a toy like the one shown in Fig. 3 that copied the potter's wheel. We have reconstructed in a 3D image the toy that appears sketched in [16]. On the toy, the wheel did not work because it did not have a thru-axle. It was not functional until it was put into practice and it was found that it was necessary to have a thru-axle so the wheel would not fall off.

Fig. 3. Reconstruction of an old toy.

This example shows that it was necessary to transform the vertical axis into a horizontal axis. In other words, it was necessary to adapt a characteristic (the vertical axis became horizontal) and therefore it is a Creativity of Order 1 as it is shown in Fig. 4.

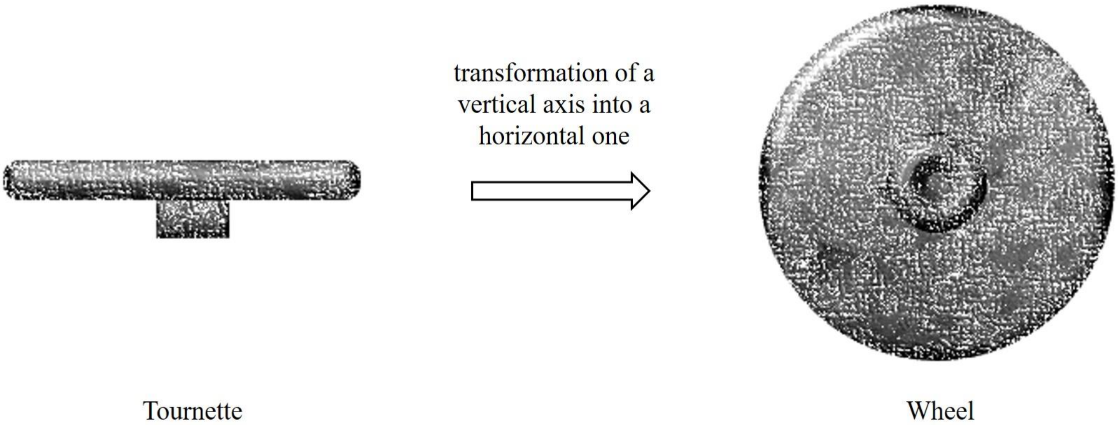

Fig. 4. Transforming one object into another by adapting a feature

Whenever a feature pairing is performed it is possible that more than one adaptation is needed.

All adaptations must be made at the time of creation. On many occasions, all the necessary adaptations are found after carrying out several experiments.

The greater the complexity of the build, the greater the amount of feature pairing and customization required.

As a result of the analysis previously carried out, the proposed creativity model is based on the process of characterization and matching of the characteristics of real-life objects that biological neural networks perform during the creative act.

VII. Creative Artificial Intelligence

We have previously discussed a method that reproduces human creativity. We have seen some examples and we have found that there is a formal procedure.

This model has been embodied in an algorithm that ponders aspects such as curiosity and perseverance, having the ability to create new goals. These parameters end up determining restrictions on human beings when it comes to developing creative solutions to the problems they have to deal. Since you can be curious; but if the level of perseverance is not what high enough to cope with the creative process in question, it will not be possible to find the necessary creative solution.

Work is currently underway to determine the impact that these parameters have had on history of the development of some artifacts in antiquity and how the removal of such restrictions in an Artificial Intelligence they will be able to speed up the development of objects or the resolution of problems.

VIII. CONCLUSION

In this paper, a creative artificial intelligence model based on the neuroplasticity of the human brain is proposed.

The plasticity of the human brain allows relating objects and the proposed model focuses on this process.

The model is based on characterizing real-world objects and, through neuroplasticity, generating new neural interconnections to produce a new object.

It is important to highlight that the present work focuses on the process carried out by neural networks rather than on their topology.

The creative act is a formal process based in pairing characteristics from different objects.

The characteristics of the objects can be paired with or without necessity of their adaptation. The order of complexity of the creative act is determined based on the number of adaptations needed on each characteristic to achieve their pairing.

The realization of the creative act depends on the adequate characterization of the objects.

An adequate characterization of objects depends on several internal and external aspects of the human being.

The presented model seeks to emulate the creative process trying to explain it from the point of view of neuroplasticity.

The proposed model can be explained by different models of creativity with traditional approaches.

From the proposed model, the process of the creative act can be formalized and therefore it can be programmed by generating a code of a Creative Artificial Intelligence.

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