REVISTA CORDIS

CREATIVITY, KNOWLEDGE, AND ARTIFICIAL INTELLIGENCE: A POPPERIAN EPISTEMOLOGICAL PERSPECTIVE

CREATIVIDAD, CONOCIMIENTO E INTELIGENCIA ARTIFICIAL: UNA PERSPECTIVA EPISTEMOLÓGICA POPPERIANA

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ABSTRACT

This article examines the philosophical and epistemological framework developed by Karl R. Popper in order to assess its relevance as a cognitive approach to the study of creativity. The paper first outlines the philosophical foundations that inform Popper's conception of reality and knowledge, and then analyzes the epistemological scope and limits of his perspective. Particular attention is given to his methodological proposal and to the parallels he establishes between scientific inquiry and artistic creation. On this basis, the study relates several of Popper's epistemological categories to the field of creativity, exploring their potential as analytical tools for understanding creative processes and evaluating knowledge claims within this domain. The article also considers the prospective implications of this framework in the context of the rapidly expanding generative capacities of Artificial Intelligence, suggesting that Popper's epistemology may provide a useful conceptual lens for interpreting emerging transformations in contemporary creative practices.

KEYWORDS: Karl R. Popper, Philosophy of Science, Creativity Studies, Epistemology, Artificial Intelligence

RESUMEN

Este artículo examina el marco filosófico y epistemológico desarrollado por Karl R. Popper con el propósito de evaluar su pertinencia como enfoque cognitivo para el estudio de la creatividad. En primer lugar, el trabajo expone los fundamentos filosóficos que sustentan la concepción popperiana de la realidad y del conocimiento, y posteriormente analiza el alcance y los límites epistemológicos de su perspectiva. Se presta especial atención a su propuesta metodológica y a los paralelismos que

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establece entre la investigación científica y la creación artística. A partir de este análisis, el estudio vincula diversas categorías epistemológicas de Popper con el campo de la creatividad, explorando su potencial como herramientas analíticas para comprender los procesos creativos y evaluar las pretensiones de conocimiento en este ámbito. Finalmente, el artículo considera las implicaciones prospectivas de este marco en el contexto de la rápida expansión de las capacidades generativas de la Inteligencia Artificial, sugiriendo que la epistemología popperiana puede ofrecer una útil lente conceptual para interpretar las transformaciones emergentes en las prácticas creativas contemporáneas.

PALABRAS CLAVE: Karl R. Popper, Filosofía de la Ciencia, Estudios sobre Creatividad, Epistemología, Inteligencia Artificial.

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Introduction

Karl Raimund Popper (1904-1994), born in Austria, was one of the leading thinkers of our time. His contributions to the field of philosophy and his influence on the theory of knowledge have had a perceptible impact on the ways contemporary humans see the world and generate new knowledge. His inquiring spirit led him to question and scrutinize many of the traditional paradigms that governed science in the 20th century.

This analysis basically takes a reflective and explanatory approach. It is divided into two parts. In the first it follows the thread of the main ideas that formed the philosophical and epistemological foundation of Popper's thinking in the 20th century in order to appraise its transcendence in the field of creativity. It seeks to shed light on the deep reasons of Popper's focus, to appreciate the importance that his postulates have taken on in advanced scientific work, and to assess his impact among academics, with an eye to weighing the potential for his approach to be used as a critical framework for analyzing and interpreting artistic expressions and scientific innovations. Once the model is firmly established, the next part of the text looks into its validity when applied

to creativity, especially in the light of the dizzying advances made in the 20th and 21st centuries in the field of artificial intelligence.

First we will define the philosophical and epistemological aspects that form the basis of the scientific method as it is generally used today in the different sciences. Then we will analyze the epistemological categories known as Worlds One, Two and Three, which serve as the foundation of the critical framework, and apply them to the field of creativity. Finally, we present some of the conclusions that can be drawn from Popper's analogy between art and science and the challenges posed by the technological advances in artificial intelligence for the field of artistic creativity.

Philosophical Foundations

Popper is the thinker who subjected to philosophical reflection the disconcerting questions posed by the theory of relativity that Albert Einstein postulated in 1915 and that was promptly proven with the eclipse that occurred in 1919, questions that undermined the classic idea that science produced unassailable, firmly-grounded knowledge.

Popper started by weeding away the tired dichotomies that had grown up around reality (objectivism, subjectivism). His reasoning underscored scientists' nearsightedness over the centuries as they tried to pin down something as complex and elusive as nature with statements purporting to be hard facts. "Observations are important but not as an inductive foundation or bedrock of knowledge" (Karl Popper, 1976: 38). The core idea of Popper's thinking was a rejection of the ideal of positivism -the definitive justification of theories or models- and the assertion that the search for truth can never quench the human thirst for absolute certainty. Science should not aspire to discover totally infallible theories, but to discover, or more precisely to invent, theories that can be proven in every case. This means that "theories can be falsified, as can their verifications or their own falsifications" (Popper, 1969: 64).

What is, in the final analysis, a theory or a model? It would seem that the object I have in front of me is not the same as trying to make a model of it. A photograph, for example,

can be a model or it can also not be one. If we take a camera and set out to obtain a complete model of the human species by taking a picture of a man's back only, it will be easy to see that the task is impossible because the photograph will be missing the eyes, nose, mouth, ears, etc., parts that we consider indispensable for characterizing human beings. It would be absurd to take that photo as an integral reflection of the human species, because we are acquainted with that living model; we are sure of its physical appearance and its evolution. This is something that any person with common sense who sees the photo could easily invalidate. In this case, we all know that the representative Model of the human species projected in this photo cannot be verified, nor can it be representative of that reality.

This gives us a solid introduction, in simple terms, not only to the ontological dimension of Popper's object, but also to that of its probative intelligibility.

Critique of Models

Popper asked himself, Would a single viewpoint of reality also count as science? "Any attempt -starting with observations, experiments or statistical data, and going from there to general theories by way of induction, as well as the effort to transcend prejudices- rests on a misunderstanding, or even an illusion" (1976: 86). What is the point of this assertion? That all theories, as expressions of knowledge, are also models, be they simple or highly complex, that even though they are proposed to complement or rule out another model or models, will prove to be false, relative or limited in their origin because they come from a particular viewpoint, specific to a particular moment and particular circumstances.

This is precisely what happened with Newton's thinking with respect to the Models of the Universe when Einstein's ideas began to circulate in the early 20th century:

> The new theories of relativity and quantum mechanics showed that Newton's theory was at best an approximation, and that it actually yielded incorrect results in many circumstances, for example, for bodies moving at high speeds, for bodies with large gravitational masses and for the micro-world. The failure of such a prominent and oft-confirmed scientific theory gave new meaning to many thinkers' epistemological skepticism (Donald Gillies: 21).

What does this mean? That another common feature of these illusional or false models is their staticity, as if they were photographs, only able to reflect a partial, frozen reality, excluding both substantial elements that form part of said reality's very nature and the temporal conditions under which it plays out. For this reason Popper described deductive logic as "a tool (or *organon*) of critique. If a theory holds up under the most penetrating critique, that does not make it true or probably true. The methodology of falsification does not guarantee a given piece of knowledge because from the empirical viewpoint there are no conclusive proofs" (1969: 64).

What has all of this led to in the domain of science? It has enabled us to corroborate that the empirical foundation of objective science is anything but absolute. Thus, regardless of the debates that ensued in the philosophical-scientific arena trying to discredit Popper's position, he succeeded in declaring to the world that all models and theories are ultimately momentary viewpoints of reality. This would lead some of the most prominent theorists of the 20th century to acknowledge that the paradigms of science do not stand on bedrock (Vaclav Reznicek & Zdenek Smutny, 2020: 1042-1052). Popper himself wrote, "The bold structure of its theories seems to be built on a marsh. This is like erecting a building on pilings, which are driven from above into the marsh, but not into a given or known natural foundation. If we interrupt the action of driving, it is not because we have reached solid ground. We know that the pilings would sink in deeper. We stop simply because we are satisfied that the pilings are firm enough to hold up the structure for the time being" (1959: 111).

Popper would come to ask himself, What about art? And he would realize that there is an essential analogy: artists, like scientists, use the same trial-end-error method. A painter starts out by smearing some color on the canvas, then she stops, takes a step back to evaluate its effects, returns to the smear of paint to modify it or cover it up if it turns out that it does not solve the problem she is trying to portray. Now and again, the unexpected effect of an initial trial modifies the problem or generates a new related problem, just as in science.

Of course, the objectives of art are different from those of science; we know this. Science pursues truth, and art, perfection. Nevertheless, art can be considered or regarded as a place for solving problems too, for inquiring about new concepts, for confronting these concepts with others, for seeking multiple solutions to identical problems, etc.

> Naturally, in art, the problems and the ways of solving them are specific. There is an additional analogy, however: as with science, in the development of art, which runs its course from one problem to another, the critical analysis method used for problem-solving plays a key role… The application of critical analysis is the reason why the creator can move beyond his own potential and produce a work that transcends the limitations that characterize him (*Pfr*. Popper quoted by Elzbieta Pietruska-Madej, 2001: 37).

Popper contended that the trial-end-error method itself is what explains the evolution of models, artistic aims and value systems that are typical of all artistic fields or expressions. He believed that those who uphold a notion of art as a simple manifestation or expression of the artist's emotions tend to have a mechanical interpretation of the method and process of creation itself. Popper always resisted the expressionist theory of art that claims that its essence is the artist's personal expression of her personality, her inner world or her feelings.

Epistemic Categories

In order to further develop this analogy between art and science, and to situate it within the epistemological framework, Popper proceeds to develop the concepts of Worlds One, Two and Three, known in some academic circles as Popper's epistemic categories. World One is made up of purely physical media and objects with which artists and scientists must carry out their work, their experiment or their working hypothesis during the development process. World Two consists of those subjective or strictly human aspects involved in the process of creating any new work of advance of knowledge. And World Three comprises the objective content present in these created or generated works or contributions.

Popper focuses his interest on World Three, which he considers of prime importance. He defines it as the universe of objective content that makes up our vision of things, our world or cultural context. In World Three artistic expressions rub shoulders and interact with inventions, discoveries, scientific contributions and other human products that form an objective referential framework that is not necessarily to be understood in a restrictive or purely intellectual sense (Jessica Cabrera Cuevas, 2018: 113-126). Although the residents of this World Three may disagree among themselves, they share as something essential the result of a human activity that has been deemed objective.

This categorization of World Three allows Popper “to discuss art and science under a single gnoseological and procedural umbrella” (Pietruzka-Madej, 2001: 38). In both realms we find ourselves in the presence of an activity that cannot escape this World Three of objective content, a world that operates either as a theoretical referent or as tradition to be drawn on for setting norms and standards to be followed; this tradition then becomes for the creator an object of either critique or distancing (as in the case, for example, of literary tradition). In fact, the creative nature of an artwork or a scientific achievement can only be defined in reference to a prior artistic or scientific solution, i.e., to tradition. Tradition constitutes the natural background, consisting of the achievements made by predecessors in the artistic or scientific activity in question.

Once the contribution of knowledge or the artistic expression is created, it begins to take the reins of its own existence and gain independence from its creator, immersed once again in this World Three. This explains the transformation or cognitive advance that occurs in World Three over time. Once it establishes its presence in this world of objective knowledge, the contribution obviously has an epistemic impact back onto World Two of the human dimension, i.e., the world characterized by subjectivity.

General Schema
Creative process and epistemological categories

World One (materials to work with)
World Three ---------- ---------- ---------- ---------World Three

As objective referent World Two transformed by the contribution (of the human dimension, subjective aspects and emotions)

Evolution of the Field of Creativity

It was not until 1908 that the French scientist Henri Poincaré (illustrious member of the Circle of Vienna) differentiated the creative process from other cognitive processes by studying and recording his own psychic reactions to the need to find a solution for complex mathematical problems. Given Poincaré's prestige, the creative process would thereafter enjoy validation as an object of knowledge that warranted the attention of behavior scientists (Poincaré, 1908: 77-88; Ferdinand Verhulst, 2012). For example, Graham Wallas would wonder,

> At what stages in the association-process should the thinker bring the conscious effort of his art to bear? If we examine a single achievement of thought we can distinguish four stages – Preparation, Incubation, Illumination (and its accompaniments), and Verification. At the Preparation stage we can consciously accumulate knowledge, divide up by logical rules the field of inquiry, and adopt a definite "problem attitude." In Verification we can consciously follow out rules like those used in Preparation. At the Incubation stage we can consciously arrange, either to think on other subjects than the proposed problem, or to rest from any form of conscious thought. This second form of Incubation is often necessary for the severer types of intellectual production, which would be hindered either by interruption or by continuous passive reading. If we are consciously to control the Illumination stage we must include in it the "fringe-conscious" psychological events which precede and accompany the "flash" of Illumination, and which may be called Intimation. We can to some degree control Illumination by making ourselves conscious (as many poets are conscious) of Intimation; and by both encouraging the psychological processes which Intimation shows to be occurring, and protecting them from interruption (1926: 79).

Thus Poincaré's observations and the experimental evidence that Graham Wallas (1926), the first theorist of creativity, then brought to the discussion, led to the formalization of what would become the classic model in this new field of knowledge. Only later would Popper's contributions serve to broaden this cognitive domain and provide it with a philosophical underpinning:

> All creative processes involve four processes: one of preparation, which encompasses the preliminary analysis of a problem, its definition and framing. In other words, the conscious work that comes into play on the basis of the subject's educational experience, pertinent knowledge about the problem and analytical skills. Next comes the incubation phase, which does not imply

> conscious mental work on the problem: the subject deals consciously with other problems or simply rests, while the psyche unconsciously continues to work on the problem through associations. During this stage combinations of ideas emerge that the unconscious either holds on to or lays aside depending on their pertinency or futility.
>
> The third phase, illumination, takes place when the most promising ideas break through into consciousness. Illumination is usually preceded by an intuitive sense of certainty in the subject, that the idea is close at hand and could burst forth at any moment, like a wildfire. The fourth phase is called verification, because here what counts is the evaluation, refinement and development of the emerging idea or ideas (*pfr.* Andre B. Newberg and Eugene G.d'Aquili, 2000: 63-64).

It should be noted that many experimental scientists have made contributions to this model. Over the past 70 years their work has helped to identify different skills involved in human creativity, including sensitivity toward problems (Javier L. Cristiano, 2013: 305-327), the ability to produce many ideas and skills for modifying mental schemata (Carlos E. Acuña Escobar, 1986: 22-40), for reorganizing, for dealing with complexity and for evaluating (Mikel Ugalde and Valentín Zurbana, 2008; 129). Almost all of these skills and abilities are related to the phases of incubation and illumination mentioned above, i.e., to the subjective and inter-subjective dimension of the process. No decisive contributions to the development of the field can be found, on the other hand, when it comes to the stages of preparation, verification and results (i.e., the category of World Three that we analyzed earlier).

Scaffolding for the Creative Process

For explanatory and simplification purposes, the following schematic table condenses the four stages of creativity that evolved from Wallas's classic model and Popper's gnoseological substantiation that enriches it with his critical analysis apparatus (including the concepts of Worlds One, Two and Three):

Comprehensive scheme

Stage 1 Preparation	Stage 2 Incubation	Stage 3 Illumination	Stage 4 Verification	Result
Objective	Objective-subjective	Subjective-objective	Subjective-Objective	Objective
Reading of World Three by the subject exposed to it at the moment of defining the problem to be solved	Links between Worlds Two and Three made by subject by reviewing and considering the ideas that might express the problem and provide a comprehensive solution.	Experiences of World Two that the subject has upon detecting the core idea that guides the problem or provides a comprehensive solution in terms of expressivity and media	Procedure consisting of analysis and ongoing testing of steps (via trial-error-correction) that the subject engages in while manipulating the material (World One) during the execution and completion of the work.	Reinsertion of the work into World Three and its susceptibility to assessment as innovation or advance-ment (separa-tion of the work from its creator). Analysis of consequences .
Conception contribution	Interpretation	Conception of the work	Execution of the work	Final

* This same scheme is presented and analyzed by Humberto Ortega-Villaseñor (2003: 235-250).

Conceptual Observations

As the scheme suggests, in spite of Popper's interest in detaching gnoseology as an autonomous field of knowledge and his critique of *orthodox psychologism* as an instrument of knowledge, he did not rule out subjectivity when he made his critique of inductivists, or when he questioned the applicability of the traditional scientific method, or when he pondered the analogy between art and science. He simply handled it differently: he assigned subjectivity its own distinct role within the creative process.

Popper acknowledges artists' talent, inspiration, emotions and other subjective aspects, but they form part of the ongoing trail-and-error work that artists engage in as they execute their work and take it to its ultimate objective, perfection. The rejections, the imperfections, the projects left unfinished, etc., correspond to the method, to the verification stage (exemplified by incomplete literary notes, unfinished sketches and drawings, scribbles on musical staves, etc.).

These are also the efforts that, in Popper's view, link Worlds Two and Three, the sphere of inspiration and objective referents. Artistic creativity that within its expressive constraints cannot eliminate form. Constant swings of the pendulum between spontaneity and restrictions. For example, when writing a poem an artist might discover that in order to make the content fit a certain form, she has to wait for her imagination or bide her time until the flow brings the content she is looking for; some of the expressive forms are discarded while others are selected as she looks for the way to give the poem an expressive form that comes close to what she has in mind.

In another example, the most interesting thing about the emotions that composers of music feel is not that they need to express them in some kind of language but that these emotions and experiences can be used as a test. Artists' activity is accompanied by strong emotions: the emotion of creation and the reaction to the created work. These emotions play an ongoing role. If composers feel no emotional impact from their creative work as they are composing, they might consider it a failure. There is a kind of feedback loop between artists and their emerging work, e.g., between the piece of music that is taking shape and the person who is generating that music, or between the poetry being written and the poet, between the block of stone being sculpted and the sculptor. And it is through this feedback loop that artists test on themselves the consequences of their work over the whole process of creation. In this sense, the creators themselves serve as their own testing instrument.

Demonstrative Scope

What Popper achieves with his theory of knowledge is a comprehensive scaffolding for the critical function, with its own philosophical foundation and a methodical process consisting of concatenated steps linked with academic rigor. It is flexible in the sense that it can support studies of a complete process or of one or more of its parts. We now offer some reflections on the weight and applicability that this critical apparatus could have in specific cases.

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It can support studies that look at artistic creativity in general or at certain expressive media in particular to take advantage of the probative weight of the process (for example, the links between visual and literary creativity, which is the object of our research project). It can be accommodated to more ambitious analyses that focus on contexts, traditions or art history in general, or else on the consequences of creativity on expressive media or languages in different fields of human endeavor (taking into account the greater or lesser impact that the fruits of creativity have on the transformation or cognitive advance of World Three). The combinations could be very interesting and complex at the same time (Elsa María Beltrán-Luengas & Alejandro Villaneda Vásquez, 2020: 247).

The angle of the working hypotheses can be opened or closed to specific periods or movements; it can be circumscribed to specific creative careers, works, media or genres. Or on the contrary, the framing can be broadened to encompass a more ample disciplinary and interdisciplinary range and compare multiple hypotheses. The objects of study would be susceptible to interpretation from different perspectives and could be subjected to specialized methodologies as needed. (See for example Josué Vladimir Ramírez Tarazona, 2015: 67.)

Some members of the avant-garde of aesthetic creation have begun to recognize the importance of having a gnoseological foundation like the one we are considering here. They feel the need for an apparatus that can enable them to rigorously examine the concrete changes taking place in the field and to interpret them. For example, Alberto López Cuenca, a philosopher of art and language, states:

> There is one notable aspect to highlight in Goodman's position. In *Ways of Worldmaking*, art is assigned an epistemological value: artistic representation does not only provide pleasure or aesthetic enjoyment, it also affords different ways of knowing the world. There are obviously certain languages or modes of representation that are more widespread or understandable than others, but all languages impose a particular order on the world and therefore imply a way of knowing. The corollary to this is that art as a way of knowing is as valid as any other, that philosophy forms part of the theory of knowledge. A linear, progressive vision what happens in the artistic field is untenable today. This is due in part to the multiplicity of artistic creation strategies, which makes it well-nigh impossible to set them all along the same evolutionary path, but it is also due to the increase in the number of different explanatory theories of contemporary

> art and the discrepancies among them. There is no longer a single dominant reading of what is happening in the field of art. The opposite is true: the unprecedented development of art has compelled us to expand the conceptual framework for its analysis. An art that no longer turns out only objects but also installations and performances, interventions in architecture and media… calls for a theoretical approach that is as conceptually flexible as its object of study (López Cuenca, 2003: 30 & 32).

In the psychologistic current of thought it is surprising to find promising work like that of Ian C. Jarvie, who sees the transcendence of Popper's thinking in a positive light and points to its probative theoretical effects in other fields of science, by making more or less comprehensive use of its distinctions or categories, as follows:

> Works of art, like scientific theories, present a series of marks and signs etched on paper or daubs of color on a canvas. Both (work of art and theory) belong to World One. However, the artwork and the theory are associated with different psychic activities, intellectual states, emotions, that are fragments of World Two. What is most significant- the author goes on- are the objective contents of the theory and the objective dimension of the artwork, as well as the relationship in which that work -as a World Three object- lays out other objectivized artworks or theories that are co-creating that world. Is it not true that those relations are decisive for other fields due to the fact that something constitutes a theory, that this is a new theory, and that the given object is a work of art? The originality of a work ultimately depends on those relations as well. This is why the greatest importance must be linked to the analysis of World Three objects (1981: 120-121).

Prospective Scope

Then there is the prospective link between art and science. Although Popper recognized intrinsic differences, such as the artists' freedom vs the scientists' rigor in their reading of "objective standards," intuition vs rationality during verification, the wide-ranging media available to artists for expressing themselves vs the limited media available to scientists, etc., he insisted that the creative process inherent to scientists' work was analogous to that of artists' work. Both subjects make a reading of reality, both use an analogous testing process, both produce new objective knowledge. The difference, in any case, has to do with the cultural insertion or transcendence of the innovative contribution, and this skews in favor of artistic creativity inasmuch as the

work of art is recognized as having an crucial anticipatory impact when it comes to understanding the changes that science then proceeds to test.

López Cuenca himself alludes to this anticipatory effect in the aesthetic field, the social sciences and the humanities.

> What is relevant in the field of the arts is appreciating how changes are absorbed, neutralized or reflected from the level of symbolic representation. These processes and their results are often the experimental advance party of profound social changes. This is precisely what makes it difficult to understand certain contemporary artistic practices that, rather than affirming a society's identity (as the works of Francisco Goya might do in Spain, or those of Claude Monet in France, once they are assimilated), engage in an ongoing process of reformulating and problematizing that society, of experimenting with it (2003:40).

These ideas are not new. Marshall McLuhan (classic communication theorist) repeatedly insisted in all of his works on the potential that the study and systematization of this anticipatory link would have, not just for understanding or reorienting future changes in science and technology, but also for directly influencing the social body, by either diluting or foreseeing the pernicious effects of some of them.

> For some time now art has been recognized as having the power to foresee future social and technological innovations a generation or more in advance. In this century Pound called artists the "antennae of the race." Art, like radar, serves so to speak as an "early warning system" that lets us discover social and psychic targets in time for us to get ready to deal with them. This concept of the arts as prophetic contrasts with the idea that sees them as mere forms of self-expression. If art is an "early warning system," – to use a phrase from the Second World War, when radar was new—then it is closely related not just to media studies but also to the development of media control and to the prospect of global change (M. McLuhan, 1987: 17).

This would open up a rich vein for another level of inquiry into artistic creativity that could also draw on Popper's theoretical apparatus by accommodating, and equipping with a sturdy critical framework, systematic studies that would shed light on unknown dimensions on the horizons of science and give concrete answers to certain questions that the hard sciences, the social sciences and the humanities each pose separately about the future (e.g., Águeda Simó, 2016: 66-71). Uncertainty that floats in this World Three bristling with signs that nevertheless are at the heart of the concerns of different thinkers, scientists, technologists and educators today.

> Where is science headed? Art sees where science is headed –but far in advance. Woe to the middle-aged scientists, geometricians or mathematicians who begin to peer into Chaos Theory from the window of their contemporary systematization. Does the image perhaps allude to a precursor of the same “unborn” 50 or 60 years ago? If he had drawn on the cubism, the fiction, the treatments, interconnections and space-time leaps in the novels of James Joyce, the character would have emerged into the scientific world at a highly advanced level. The information was there for the taking, it already existed (although we know that the Chaos equation was not written in mathematical terms). What failed? If in all of its manifestations Art provides in advance all the elements that in everyday terms point to the modification of basic science, one has to wonder, what is missing from the individual’s formative and investigative ingredients?

Large Language Models as Catalysts of the Creative Process

We know that humans throughout time have endeavored to expand their capacities through science and technology, becoming artificers of innovations that have shaped the course of our evolution. Among these consequential inventions, the so-called digital age brought with it a change of paradigm that would revolutionize the way we communicate, learn and create. Thus, as *augmented* individuals, it is up to us to find the right synergy between collective knowledge and these disruptive tools, in order to pursue the common well-being.

As the culmination of a long process of research and development in the field of computing, artificial intelligence has emerged as a multidisciplinary field that seeks to endow machines with the capacity to learn, reason and make decisions autonomously. Its current state of the art serves as a catalyst for creative innovation, allowing for the generation of content, the exploration of new ideas, and the discovery of solutions to complex problems in a wide range of fields of knowledge.

Large Language Models (LLMs) have been developed precisely as an interdisciplinary innovation; they are trained using large amounts of information by a transformer—deep-learning architecture with a multiple-attention mechanism—that allows conceptual relationships to be explored on the basis of a probabilistic approach. This type of approach facilitates the discovery of new connections to

address different types of problems as long as they can be abstracted through language.

These models are inspired by the neurons of the human nervous system; abstraction works as basic unit of computing, which takes an input value and then produces some kind of output, establishing a connection between them, quantifying the force of each connection with a numerical weight that determines the degree to which the result of one neuron will influence the next as an input. Large Language Models (LLMs) are designed in particular to accept, process and generate sequential data like text.

The spectrum of applications for these technologies is auspicious, promising a revolution in the creative production of different disciplines such as literature, music and visual arts with a unique dimension. These tools lead to a democratization of these processes at little or no cost to the general public; they likewise lead to the development of new disciplines, such as Prompt Engineering, which seeks to systematize a coherent and effective paradigm for interacting with these models through instructions known as *prompts*.

Thanks to their self-referential nature, these systems are capable of operating in a wide range of knowledge fields, which fosters the discovery of new patterns and relations between pieces of interdisciplinary information governed by the rigor of a formal analysis in collaboration with human specialists to generate new knowledge. This type of emerging approach calls for the development of standards to evaluate the quality of the resulting products, which implies a series of challenges and opportunities.

Challenges and Opportunities

Generative artificial intelligence systems are ideal for producing and processing information in the form of text, making it possible for humans and computers to interact through conversation, which allows them to collaborate on a variety of tasks, especially those involving creativity. This association offers new ways to explore ideas and quickly

iterate concepts multimodally; for example image-generating models based on Stable Diffusion take a textual description among their parameters to operate in the latent space of images.

In an artistic context, this feedback cycle can be analogous to the role of a muse that guides and inspires the creative process; this role can be performed by the human element or the system (interspersed to favor the work flow). This type of approach empowers potential creators, enabling them to come up with ideas and generate solutions without being experts in the medium in question (which has sparked controversy in different industries regarding the legitimacy and integrity of the resulting work).

There is growing unease among professionals and industries about the impact of the content generated by these models. Their concern revolves around the need for a new perspective on the integrity and the intellectual property of the works used in the training process, since the approach taken by these systems could potentially be used to perpetuate harmful prejudices and stereotypes.

In the academic world, another of the persistent concerns has to do with the integrity of academic work. With AI algorithms capable of generating sophisticated content, the risk is that students and researchers could use these tools to commit plagiarism. This not only impacts the credibility of produced content, it also undermines the true value of education or research, blurring the line between original thinking and machine-generated content. These models are pre-trained by massive amounts of textual data with the option of focusing on specialized tasks. During their training, the models learn patterns and relations that exist in the textual data; these are then used to generate new text with similar style and content.

As we can see, the variants of AI have the potential to break new ground or open up new paths to creative expression, enabling people to focus on high-level tasks such as ideas and concepts. This process of *co-creation* capitalizes on the strengths of both parts, allowing the human participant to transcend physical and mental constraints and explore new horizons in the areas of art, science and technology. The challenges

associated with these new technologies include ethical considerations, loss of jobs, and the need for new ways to develop skills. With the right investment and education, we are convinced that AI algorithms can become valuable artifacts for increasing human creativity in the future.

AI systems are developing rapidly and people are using them in an enormous range of settings. For decades they sparked the imagination of countless writers and the public in general, feeding both rational and irrational fears. Unfortunately, as Kenneth R. Walsh affirms, “it is through this lens that the general public understands AI,” when “the public should see AI as a support for humanity and not as a competitor” (2021: 45). Such a perspective will prevent politicians from succumbing to the temptation to formulate policies that inhibit or block the acceptance of this technology and its optimal utilization for the common good.

Epistemic Challenges and Creative Potential in the 21st Century

Throughout this analysis we have seen that the creative process is complex and multifaceted; it has attracted the interest of researchers, who have examined a broad spectrum of possibilities. To understand and promote creativity, multiple working frameworks have been developed, each one focusing on different stages and aspects. One of these propositions is Wallas’s model, which, as we saw earlier, consists of four stages: preparation, incubation, illumination and verification.

The emergence of such artificial language models—particularly those based on the transformer architecture—promise to make powerful tools available for heightening the creative process by providing creators with new ways to generate ideas, explore creative territory and refine results. Artists will be able to explore the computing capabilities of these algorithms to generate original and innovative work.

Thanks to these technologies’ computing power, it is now possible to gather relevant information and knowledge about the problem or task at hand, which corresponds to the preparation staged proposed by Wallas’s model for creative processes. This serves to feed the work flow by providing new perspectives and ideas that can be explored in

subsequent stages. During the illumination stage, the implementation of these models can provoke moments of insight and full realization. Furthermore, by generating unexpected connections and associations, these tools can stimulate the creative process, enabling the artist to come up with new ideas and innovative solutions.

Finally, in the verification stage, these algorithms support the refinement and testing of creative products by effecting an iterative feedback loop, which serves to assess the product's feasibility and potential and to contribute to the creation of high-impact creations. While artificial language models revolutionize creativity, it is essential to consider the challenges and constraints that are inherent to these technologies, particularly the prejudices acquired during the training process, which can compromise the quality and truth of the resulting product.

One important challenge lies in these algorithms' capacity to produce a huge volume of information, which then takes time and attention to evaluate and categorize. In creative processes involving a high degree of subjective interpretation, the result must be given a value or its relevance must be assessed. On the other hand, the Large Language Models offer countless opportunities to enrich these processes by generating high-quality content, which implies proper curation.

The exponential growth of these technologies presents challenges in the form of adapting their implementation to our social structure, which inevitably sparks controversy in a wide range of industries; nonetheless, the technologies definitely broaden the production capabilities of individuals who lack technical proficiency or access to traditional resources by giving them the ability to produce new works, democratizing access to the field and incorporating novel perspectives that at present have no representation in the industry.

In Karl Popper's view, creativity is not a mystical or spontaneous process; it is rather a systematic and iterative approach to problem-solving. Three key stages can be identified: first the problem is identified and shaped, next a collection of ideas is generated to explore possible solutions, and finally a critical evaluation is made. In this last stage, rigorous testing is done to evaluate the results.

This perspective describes the cyclical nature of the creative process and its relation to science, in contrast to linear or sequential approaches. As a problem is explored, and as solutions are proposed and tested, new complications can emerge that require additional iterations. Development goes hand in hand with the knowledge and experience of individuals conditioned by external factors.

Conclusion

Popper's thinking, particularly in its philosophical, epistemological and instrumental aspects, is the foundation on which all disciplines are built today, along with their concrete approaches in their day-to-day application and evolution. In other words, it is the overall framework that holds up all fields of knowledge as such and that justifies all the focuses and interpretations of the sciences in their search for truth.
The construction of the epistemological categories of Worlds One, Two and Three, in which creativity is grounded as an autonomous field of knowledge, allows for the comprehensive and segmented study of all the processes that lead to the generation of new knowledge, scientific advances, discoveries, technological innovations and artistic expressions in all of the expressive languages and media.

Given its epistemological nature, the category of World Three serves as the foundation for focusing this study on the background, referential horizons or traditions against which the creative process pushes off to gain momentum, as well as on the consequences or impacts that the results of the process have. Because of the relation between the categories of Worlds Two and Three, as well as the purpose of the trial-and-error analysis method to test the results of the creative process in the verification stage, it is justified to study the links, forms of testing, reconstruction of steps and connections among expressive media and languages.

Finally, the overall critical proposal also serves as a basis for substantiating more complex systematization or research projects related to the future, given the anticipatory position that artistic creativity enjoys with respect to creativity in science and technology.

As we have seen, computing technology, especially in terms of the advances in Artificial Intelligence, plays a fundamental role in human development, science and art in both the present and the future because it enables humanity to reinvent itself and solve problems by overcoming constraints through the use of tools and systems. The road to progress calls for adaptations to meet the needs of an ever-changing society. By engaging in a feedback loop with the creative process in real time, artists have at their disposal an invaluable resource for considering a self-referential nature for creativity that allows them to subject their work to a process of evaluation.

In conclusion, the opportunities that these technologies afford are numerous, in spite of their inherent limitations. It is possible to address the challenges that creative processes pose by turning to effective strategies for dealing with the dizzying pace of the advances in these tools, which open up new paths, anticipate and build the road toward a promising age of creation.

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