NEW TECHNOLOGIES, ARTIFICIAL INTELLIGENCE, AND BIOETHICS: A NECESSARY DIALOGUE

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Abstract: This study explores the intersection and the need for a critical debate between technological advances, driven by artificial intelligence, and bioethics. Without any intention of exhausting the subject or providing definitive answers, it explores how these forces shape the future, demanding a thoughtful reflection that goes beyond responsibility, justice and human well-being on a global scale, given that artificial intelligence (AI) permeates multiple aspects, from virtual assistants to advanced medical diagnostics, raising complex ethical questions.

Keywords: new technologies; artificial intelligence; bioethics.

INTRODUCTION

Unlike human evolution, the evolution of machines advances at a far more rapid pace. Virtual reality, big data, and drones are just a few examples of new technologies that have already become part of everyday life and are embedded in human existence.

These emerging technologies are highly significant, with the potential to enhance and markedly improve quality of life across many domains, boosting efficiency, communication, and the democratization of knowledge, among other benefits.

Artificial intelligence (AI) is one of these technologies, enabling machines to learn and perform tasks that typically require human intelligence—such as speech recognition, computer vision, natural-language processing, and decision-making. One technical point is crucial: we remain far from achieving AGI (Artificial General Intelligence)—that is, an AI endowed with consciousness, critical sense, and the ability to solve any problem autonomously. What we do possess are systems that excel at *simulating* intelligence—highly effective at pattern prediction, large-scale data processing, and speeding up specific tasks.

This technology has been applied across diverse sectors—healthcare, finance, transportation, security, and retail—where it can automate repetitive tasks, generate insights, and raise efficiency and productivity. Consequently, AI is reshaping the world at breakneck speed, from virtual assistants on

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smartphones to complex algorithms driving medical research, penetrating and advancing multifaceted aspects of life.

However, as AI grows ever more sophisticated, new challenges emerge: the algorithmic universe is making increasingly consequential decisions that directly or indirectly affect human life, even though we do not fully understand their impacts, machine-learning cognitive biases, or how to develop AI ethically and sustainably.

Such ubiquity raises ethical questions, as biased algorithms can perpetuate discrimination while widespread automation threatens jobs and human dignity. Added to this are concerns over privacy and the security of personal data and information. Transparency and accountability in AI therefore become imperative to avert undesirable consequences.

This rapid technological evolution presents both opportunities and challenges. While it promises solutions to problems and productivity gains, it also raises significant ethical and social issues on a global scale. Reflecting on AI's impacts and the need for ethical and legal regulation requires acknowledging the topic's transnational nature and establishing at least a minimal common standard that aligns with global practices.

Within this context, bioethics—as applied ethics—plays a fundamental role, offering mechanisms that foster global integration and integrity, promoting systemic dialogue[1], and providing a paradigm for responsible intervention.

Global bioethics transcends the traditional boundaries of medical ethics and expands to address issues of social justice, equity, and sustainability within a complex[2], globalized environment. Intervention bioethics, in

[1] The present article uses the adjective *systemic* in the sense given by General Systems Theory, developed in biology by Ludwig von Bertalanffy in the 1960s. According to that theory, a *system* is any organism composed of inter-linked and inter-dependent parts. Its systemic virtue lies in the existence of a complex unity—a "whole" that cannot be reduced to the mere sum of its constituent parts—situated on a trans-disciplinary plane that simultaneously recognizes scientific unity and disciplinary differentiation. This shift in perspective entails, among other changes: (i) a movement from the parts to the whole, focusing no longer on each discipline's object but on the relations among disciplines; (ii) a move from mediation to mapping those relations; (iii) a turn from quantitative to qualitative data analysis; and (iv) a transition from merely objective knowledge to epistemological knowledge—*knowledge about knowledge*. Bertalanffy argued that studying systems as wholes is more effective than analyzing their parts in isolation, because it yields a broader, holistic understanding of the phenomena involved. His theory further holds that systems are *open*—constantly interacting with the external environment, receiving inputs and producing outputs—and emphasizes hierarchical organization in which different levels inter-connect and exert mutual influence. Bertalanffy, Ludwig von, and Alvaro Vieira Pinto, *Teoria geral dos sistemas: fundamentos, desenvolvimento e aplicações*, 3rd ed. (Petrópolis, RJ: Vozes, 2008).

[2] The term *complex* here derives from Edgar Morin's complexity theory. Etymologically—from the Latin *complexus*—it denotes that which "can be woven together."

particular, advocates proactive action to mitigate inequalities and promote human well-being, becoming essential to guide the development and application of disruptive technologies. It also operates in areas such as social justice and equitable access to technology, environmental sustainability and ecological responsibility, and global solidarity and international cooperation.

To ensure that AI contributes to a fairer and more sustainable future, it is essential to adopt a proactive and collaborative approach—unified rather than fragmented. This includes developing global ethical standards, fostering education and awareness about AI's impacts, strengthening governance and regulation, and encouraging responsible research and innovation.

Dialogue among new technologies, artificial intelligence, and global bioethics is an ongoing, dynamic process that demands the participation of all societal actors. By adopting a reflective, considered, and philosophical approach, we can strive to ensure that technological innovation is guided by solid ethical principles, promoting a fairer, more equitable, and sustainable future for generations to come.

I. NEW TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE: A SYMBIOSIS FOR INNOVATION

A new industrial revolution is looming on the horizon. The first occurred in the mid-18th century, marked by the use of steam as a source of energy. The second, at the turn of the 19th to the 20th century, is symbolized by electricity and the internal-combustion engine. The third unfolded in the final decades of the 20th century and culminated in the replacement of analogue technology by digital. Known as the Technological Revolution—or Digital Revolution—it enabled the widespread adoption of personal computers and smartphones and is epitomized by the Internet, connecting billions of people worldwide[3]. The fourth industrial revolution, now beginning to permeate our lives, combines Artificial Intelligence, biotechnology, and the expansion of the Internet, creating an interconnected ecosystem that links people, objects, and even pets in an Internet of Things and of senses.

Artificial Intelligence has come to play an ever-more important role in recent years. Machines are no longer limited to physical tasks; they now perform intellectual functions that require what we regard as intelligence.

The concept dates back to the 1950s, when the British mathematician

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As Morin notes, "Complexity is a problem-word, not a solution-word." Morin, Edgar. *Introdução ao pensamento complexo*, 5th ed., trans. Eliane Lisboa (Porto Alegre: Sulina, 2015), 13.

[3] Barroso, Luís Roberto. "Revolução tecnológica, crise da democracia e mudança climática," *Revista Estudos Institucionais* 5, no. 3 (2019): 1262–1300.

Alan Turing proposed the famous Turing Test[4] in his article "Computing Machinery and Intelligence."[5] A decisive milestone, however, came during the summer of 1956 with the Dartmouth College Conference, widely recognized as the beginning of AI as a field of study[6].

> At that conference, in addition to linking numerous studies to the organization of programmable machines, participants produced elements that began to shape the language of artificial intelligence—"natural algorithms" that science would later call genetic and evolutionary algorithms, "as they would become a fundamental piece for identifying common words in this new type of communication"[7].

The term *artificial intelligence* therefore refers to the performance, by computational devices, of intellectual processes characteristic of human beings—such as reasoning, discovering meanings, generalizing, or learning from experience[8]. According to Guitarrara, AI is a branch of computer-science research that seeks, through computational symbols, to build mechanisms and/or devices that simulate the human capacity to think and solve problems—that is, to be intelligent[9].

Through so-called *machine learning*, computers are programmed to learn in a manner similar to humans, and almost all machine learning is built on neural networks—computing systems with interconnected nodes that function like the neurons of the human brain. Using algorithms, they can recognize hidden patterns and correlations in raw data, group and classify

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[4] "*La prueba de Turing, formulada por Alan Turing (1950) publicado para la revista MIND titulado Computing machinery and intelligence, establece que: "las máquinas construidas por el hombre tienen —inteligencia—, motivación ejercida por los actores y por el lenguaje propio que se dinamiza dentro de las mismas" (1950, p. 434), esta —motivación— permite localizar en un escenario propio de la IA, a los interlocutores que en ella se relacionan (hombres-máquinas), cuya simbiosis o intercambio comunicacional, se convierte en un elemento conceptual fundamental en la historia de la IA, pues hoy es denominado en este campo "Sistemas Basados en Inteligencia Artificial —SBIA*". Villalba Gómez, Jairo Andrés. "Problemas bioéticos emergentes de la inteligencia artificial." *Diversitas: Perspectivas en Psicología* 12, no. 1 (2016): 137–47.

[5] Turing, Alan M. "Computing Machinery and Intelligence," *Mind* 59, no. 236 (1950): 433–60.

[6] Patel, Vimla L. et al., "The Coming of Age of Artificial Intelligence in Medicine," *Artificial Intelligence in Medicine* 46, no. 1 (2009): 5–17.

[7] Villalba Gómez, Jairo Andrés. "Problemas bioéticos emergentes de la inteligencia artificial." *Diversitas: Perspectivas en Psicología* 12, no. 1 (2016): 137–47.

[8] Bali, Jatinder, Rohit Garg, and Renu T. Bali, "Artificial Intelligence (AI) in Healthcare and Biomedical Research," *Indian Journal of Ophthalmology* 67, no. 1 (2019): 9–12.

[9] Guitarrara, Paloma. "Inteligência Artificial," *Brasil Escola*, 2008, https://brasilescola.uol.com.br/informatica/inteligencia-artificial.htm.

them, and—over time—learn and continuously improve[10].

In simple terms, AI consists of software programs that transfer human capabilities to computers in the form of data. These capabilities include cognitive tasks and decision-making—usually on the basis of the data, instructions, and goals with which they are fed. The "intelligence" found in today's apps and platforms is, in practice, a grand exercise in statistical guessing based on past data. They do not think; they calculate.

There is, however, no full consensus on the technical concept of AI or its scope. Entities and institutions such as the OECD[11] and UNESCO[12] seek to delineate its contours. Several common traits can be identified in these attempts: AI systems are capable of processing data and information in a manner akin to human intelligence, including learning, reasoning, perception, and language-based communication.

When asked, ChatGPT-4 offered the following definition:

> Artificial Intelligence (AI) is a branch of computer science dedicated to creating systems capable of performing tasks that traditionally require human intelligence. These tasks include learning (the ability to improve performance through experience), reasoning (the ability to solve problems through logical methods), perception (the ability to interpret sensory data to understand aspects of the world), and linguistic interaction (the ability to comprehend and produce natural language).

AI encompasses various stages or competencies, such as recognizing patterns and images, understanding written and spoken natural language, perceiving relationships and connections, following decision algorithms proposed by specialists, grasping concepts rather than merely processing data, acquiring "reasoning" through the capacity to integrate new experiences, and thereby self-improving, solving problems, or performing

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[10] SAS Institute, "Neural Networks: What They Are and Why They Matter," accessed January 23, 2025, https://www.sas.com/pt_br/insights/analytics/neural-networks.html.

[11] An AI system is a machine-based system that, for explicit or implicit objectives, infers—on the basis of the information it receives—how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptability once deployed. Stuart Russell, Karine Perset, and Marko Grobelnik, "Updates to the OECD's Definition of an AI System Explained," OECD AI Policy Observatory, November 29, 2023, https://oecd.ai/en/wonk/ai-system-definition-update.

[12]Accordingly, this Recommendation treats AI systems as systems capable of processing data and information in a manner that resembles intelligent behaviour and that typically includes aspects of reasoning, learning, perception, forecasting, planning, or control. UNESCO, *Recommendation on the Ethics of Artificial Intelligence* (Paris: UNESCO, 2021), https://unesdoc.unesco.org/ark:/48223/pf0000380455.

tasks[13].

Drawing on different studies, Gómez identifies four approaches to AI: (1) systems that think like humans; (2) systems that think rationally; (3) systems that act like humans; and (4) systems that act rationally. Robots fall into the category of intelligent computing systems capable of carrying out tasks without direct human instructions[14].

Initially, AI was applied mainly to real-world problem-solving by encoding experts' knowledge into computer programs. These programs—called expert systems or knowledge-based systems—were developed through interviews with specialists in specific fields.

Today there is great enthusiasm about AI's potential benefits: machines are learning to drive autonomous cars, and automatic translators are becoming increasingly accurate. AI is also present in everyday tasks such as reading e-mails, washing clothes, and recommending films on streaming platforms[15].

It is likewise gaining prominence in healthcare, radically transforming the field by offering more accurate diagnoses, personalized treatments, and easier access to care in remote areas. Yet the uneven distribution of these benefits may exacerbate existing disparities, creating a gulf between those with and those without access to technology.

AI research and development for health also raises specific ethical questions, such as informed consent in studies involving massive datasets, the validation and transparency of diagnostic algorithms, and liability in cases of errors or failures.

At present, AI has no self-awareness, discernment of right and wrong, emotions, feelings, morality, or even common sense. It is entirely dependent on human intelligence to feed it—including with ethical values.

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[13] Lobo, Luiz Carlos. "Inteligência artificial e medicina," *Revista Brasileira de Educação Médica* 41, no. 2 (2017): 185–93.

[14] "*En primera instancia los sistemas que piensan como humanos, corresponden a "máquinas que cuentan con información y la procesan con el propósito de comprender y predecir". En segunda instancia encontramos "sistemas que piensan racionalmente", que basado en el enfoque de las leyes del pensamiento aristotélico, "utilizan la lógica como una alternativa para hacer inferencias". Un tercer enfoque, corresponde al "sistema que actúa como humano", Kurzweil (1992) lo identifica como "máquinas con capacidad para ejecutar funciones que realizadas por humanos requieren de inteligencia". Finalmente, el cuarto enfoque, y el que más rápido evoluciona a través del tiempo, es el denominado "sistema que actúa racionalmente", este se enmarca bajo el escenario de lo hoy denominado "singularidad tecnológica", que en palabras de Kuzweill (2005), son "sistemas de automatización de una conducta inteligente". Villalba Gómez, Jairo Andrés. "Problemas bioéticos emergentes de la inteligencia artificial*." *Diversitas: Perspectivas en Psicología* 12, no. 1 (2016): 137–47, 99.

[15] Faceli, Katti et al., *Inteligência artificial: Uma abordagem de aprendizado de máquina* (Rio de Janeiro: LTC, 2021).

Thus, amid seemingly endless technological possibilities, only one bet is safe: values, which from ancient times have guided civilizational progress and the evolution of the human condition. They originate in Greece—the cradle of great philosophers and thinkers—pass through Buddha, Thomas Aquinas, Kant, and many others who built humanity's ethical heritage. Yet there is a point of tension: dizzying scientific progress has not been matched by a corresponding ethical evolution of the human condition. Goodness, genuine justice, and solidarity are often neglected in a world of extreme poverty in many regions, inequalities, wars, and a domestic and international order in which some win and so many others lose.

Perhaps no topic in the history of civilization has sparked such widespread reflection. In the media, in bars, at universities, at major international events, in gatherings of specialists, the subject is ubiquitous: artificial intelligence. There is no facet of its implications that is not being explored by the brightest minds and by ordinary citizens. Charting directions and limits is essential, given the complexity of these technologies' performance.

In Brazil—as elsewhere—the debate over algorithmic regulation is intensifying in light of AI's expanding use and development in every field, broadening discussions of ethical and legal aspects, including regulation itself. This scenario poses challenges: How can we ensure transparency, fairness, and safety in the use of algorithmic systems that directly impact our lives? How can we guarantee that AI will respect fundamental rights such as privacy, equality, and non-discrimination?

Bioethics therefore emerges as an important arena for such debates—not only regarding AI's application in healthcare, which might be the obvious focus, but in relation to all human and non-human life.

II. BIOETHICS: APPLIED GLOBAL ETHICS

Bioethics can be characterized as ethics applied to life. Although its exponential growth was triggered by the horrors of the Second World War—particularly the experiments and research conducted in concentration camps—its roots stretch back much further[16]. The very term *bioethics* signals an ethical commitment not only to human beings but to all living creatures[17].

[16] Fritz Jahr coined the bioethical imperative: "Respect, in principle, every living being as an end in itself and treat it as such whenever possible." Jahr, Fritz. "Bio-Ethik: Eine Übersicht über die ethischen Beziehungen des Menschen zu Tier und Pflanze," *Kosmos* 24 (1927): 2–13.

[17] Van Rensselaer Potter—the celebrated pioneer of bioethics—wrote: "I propose the term bioethics to emphasize the two most important components needed to achieve the new wisdom that is so desperately required: biological knowledge and human values." Potter, Van Rensselaer. *Bioethics: A Bridge to the Future* (Englewood Cliffs, NJ: Prentice-Hall,

Reflection on health- and environmental-related issues has broadened and deepened worldwide. Initially concerned with human research and the physician–patient relationship, bioethics has expanded over modernity to permeate virtually every field of knowledge—politics and public administration included.

In Europe, several distinctive approaches to health-care questions emerged[18]. In Australia[19], debates over the use of animals in research and even in food production gained widespread attention. In Latin America[20], discussions about access to health-care systems, poverty, and environmental preservation converged with global topics such as privacy, transplantation, assisted reproduction, euthanasia, and assisted suicide—giving rise to one of the major schools of bioethics: intervention bioethics[21].

Bioethics thus arises as a corollary of biological knowledge, engaging with systems of values. While it frequently addresses the ethical problems stemming from advances in the biological sciences—especially from the mid-twentieth century onward—it also concerns itself with the environment

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1971).

[18] As Christian Byk explains, bioethics is usually defined as a multidisciplinary and pluralistic approach to the ethical and social issues raised by biomedical progress. Law and jurists undoubtedly played a role in its birth and development. Yet, unlike the United States, bioethics in Europe opened new horizons for legal thought. First, it compelled the law to overcome its reluctance to confront scientific and medical debates and to extend its reflection to life-science questions—with the result that some believe the law ended up legitimizing dubious practices, while others see new norms as constraining medical and scientific freedom. Second, Europe is the only region in which biomedical techniques undergo legislative harmonization procedures that can lead to binding common rules. Indeed, the role law plays in shaping a European bioethics is comparable to its pioneering role in the construction of Europe itself. Byk, Christian. "Bioética, o direito e a construção européia," *Bio&Thikos* 7, no. 4 (2013): 418–25.

[19] Peter Albert David Singer—an acclaimed Australian philosopher, professor, and humanist—is renowned as a leading defender of animal rights and popularized bioethics across the continent.

[20] In Brazil, Professor Volnei Garrafa (University of Brasília) stands out as the leading voice of intervention bioethics; Professor José Roberto Goldim (Federal University of Rio Grande do Sul / HCPA) is a key figure in complex bioethics; and Professor Joaquim Clotet (PUC-RS) is prominent in principalist bioethics.

[21] Intervention bioethics lays out concepts that underpin concrete action: bioethics of emerging and persistent situations; core and peripheral countries; ethics and morality; equity and equality; empowerment, liberation, and emancipation; and moral imperialism. Its foundations include the concentration of power, globalization, the finitude of natural resources, corporeality, pleasure and pain, human rights, the "4 Ps" (prudence, prevention, precaution, and protection), critical solidarity, and responsibility. Intervention bioethics seeks to reduce social inequities through strong, "hard" interventionist practices. Cruz, Márcio, and Etelvino Trindade, "Bioética de intervenção: Uma proposta epistemológica e uma necessidade para sociedades com grupos sociais vulneráveis," *Revista Brasileira de Bioética* 2, no. 4 (2006).

and with policy and economics, inspiring terms like *ecoethics*[22], *ecopolitics*[23], and *biopolitics*[24].

The broader approach to bioethics—especially the strand that Van Rensselaer Potter later renamed "global bioethics" in opposition to biomedical principlism—became firmly established after UNESCO's 2005 *Universal Declaration on Bioethics and Human Rights*, which provided a normative and institutional framework for advancing the discipline in matters of human rights, global health, and international relations[25].

Potter's proposal embraces emerging ethical challenges such as global climate change, epidemics of infectious diseases, the digital revolution, the configuration of sustainable-development models, advances in biotechnology, and new reproductive technologies, among many other global-scale issues, positioning bioethics as an interdisciplinary meeting-point for scientific and moral knowledge.

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[22] Environmental ethics—now often called *ecoethics*—is a branch of environmental philosophy concerned with the ethical problems relating to non-human beings and nature. It gained particular prominence in the early 1970s, especially in 1973 with writings by philosophers such as Peter Singer, noted for his utilitarian ethics, and Arne Naess, who coined the term *deep ecology*. As Schramm observes, environmental ethics has functioned more as a "movement" than as an autonomous discipline, representing a renewal of applied ethics alongside the rise of business ethics and medical ethics. Schramm, Fermin Roland. "Niilismo tecnocientífico, holismo moral e a 'bioética global' de V. R. Potter," *História, Ciências, Saúde – Manguinhos* 4, no. 1 (1997): 95–115.

[23] Responsibility for the social and economic issues that affect human dignity—abundance and destitution alike—has generated ethical, political, and social dilemmas. In Brazil, the ecological movement also emerged in the 1970s, despite the military dictatorship and amid rapid industrial development, urbanization, expansion of the agricultural frontier in the north and center-west, and intense exploitation of natural resources. From the 1980s onward, especially after democratization, Brazil's ecological movement identified itself as ecopolitical and sought visibility in parliamentary arenas. Viola, Eduardo José. "O movimento ecológico no Brasil (1974–1986): Do ambientalismo à ecopolítica," *Revista Brasileira de Ciências Sociais* 1, no. 3 (1987): 1–22.

[24] In this study, biopolitics is used to mean the political application of bioethics, diverging from Michel Foucault's notion, which emphasizes a mode of governance that extends beyond territorial control to manage and shape human existence. In Discipline and Punish, Foucault views biopolitics not only as a search for social control and surveillance, but also as the promotion of policies that affect the biological and racial aspects of the population. Foucault, Michel. *Vigiar e punir: História da violência nas prisões*. Petrópolis, RJ: Vozes, 1987. Here, the term aligns with Volnei Garrafa's intervention bioethics, which criticizes principalist bioethics for neglecting public and collective dimensions, highlights persistent and emerging problems, and seeks to support political and social interventions on issues such as social exclusion, poverty, violence, morbidity, endemic disease, and drug trafficking—aiming at cosmopolitan citizenship and the promotion of horizontal dialogue and transparent, democratic structures. Garrafa, Volnei. "Ampliação e politização do conceito internacional de bioética," *Revista Bioética* 20, no. 1 (2012): 9–20.

[25] Cunha, Thiago Rocha da, and José Paranaguá Santana, "Construindo pontes interdisciplinares," *História, Ciências, Saúde – Manguinhos* 22, no. 1 (2015): 313–15.

Interventions in the political and socioeconomic realms through bioethical imperatives[26] are therefore necessary to change the course of planetary degradation and to reduce the injustices of a globalized world. Junges identifies Article 17 of UNESCO's *Universal Declaration*—which concerns the protection of the environment, the biosphere, and biodiversity—as a normative benchmark for environmental and intervention bioethics. The article's inclusion was a significant political victory for bioethicists from developing countries over delegates from central nations, who wanted the declaration to focus on the biomedical and biotechnological issues of traditional principlism[27].

To appreciate this fully, one must first understand that bioethics is a space of multi-, inter-, and trans-disciplinary[28] convergence and interaction devoted

[26] To help Member States and other stakeholders make sound decisions and implement effective policies for sustainable development, adapt to climate change, and mitigate its negative effects, UNESCO adopted a Declaration of Ethical Principles in relation to Climate Change in November 2017. The declaration rests on six ethical principles: *Prevention of Harm* – Better anticipate the consequences of climate change and implement responsible, effective policies to mitigate and adapt to it, including initiatives to reduce greenhouse-gas emissions and foster climate resilience. *Precautionary Approach* – Do not postpone measures to prevent or mitigate the adverse effects of climate change because definitive scientific evidence is lacking. *Equity and Justice* – Address climate change in ways that benefit everyone, in a spirit of justice and fairness. Ensure that those unjustly affected by climate change—whether through insufficient measures or inadequate policies—have access to judicial and administrative procedures, including reparations and remedies. *Sustainable Development* – Pursue new development pathways that sustainably preserve ecosystems while building a fairer, more responsible society that is more resilient to climate change. Particular attention should be paid to areas where the humanitarian consequences may be severe, such as food, energy, and water insecurity; oceans; desertification; land degradation; and natural disasters. *Solidarity* – Individually and collectively assist people and groups most vulnerable to climate change and natural disasters, especially in least-developed countries (LDCs) and Small Island Developing States (SIDS). Strengthen timely cooperative action in areas such as technology development and transfer, knowledge sharing, and capacity building. *Scientific Knowledge and Integrity in Decision-Making* – Reinforce the science–policy interface to optimize decision-making and the implementation of relevant long-term strategies, including risk forecasting. Promote scientific independence and widely disseminate scientific findings to as many people as possible for the benefit of all. Available at: https://www.unesco.org/pt/articles/os-principios-eticos-da-mudanca-climatica-0

[27] Junges, José Roque. "Bioética e meio ambiente num contexto de América Latina," *Revista Redbioética/UNESCO* 5, no. 9 (2014): 13–19.

[28] Garrafa, Volnei. "Multi-inter-transdisciplinaridade, complexidade e totalidade concreta em bioética," in *Estatuto epistemológico de la bioética*, ed. Volnei Garrafa, Miguel Kottow, and Alya Saada (Mexico City: UNAM/REDBIOÉTICA, 2005), 67–85. In his work, Professor Volnei Garrafa underscores that bioethics is inherently multi-, inter-, and trans-disciplinary. Multidisciplinarity involves several disciplines studying a single object simultaneously—each from its own viewpoint—so the result remains bounded by disciplinary frameworks. Interdisciplinarity entails transferring methods from one field to another: the disciplines "talk" to one another and enrich a topic through multiple lenses, yet

to reflecting on the ethical questions of *bios*—life. Yet it also matters to ask: *whose* life? The answer is unequivocal: absolutely all living beings, life on Earth.

Although bioethics is best known through its clinical branch—focused on human life and especially on medicine and clinical research (physician–patient relations and clinical trials)—it is not confined to that scope. Bioethics should—and must—be present in every discussion that involves life (human or non-human): from political to economic decisions (both national and transnational); from clinical research to transhumanism; from pandemics to water and food crises; from gene therapies to public-health policy; from artificial intelligence to biodiversity protection.

Bioethics therefore unites philosophy and science. Rejecting reductionism and fragmentation, it runs counter to Cartesian pragmatism and the paradigm of simplification that diminished communication between scientific knowledge and philosophical reflection. As a global and interventionist proposal, bioethics is anchored in complexity theory: it grasps phenomena through a multi-, inter-, and trans-disciplinary lens, abandons reductionism, and makes room for creativity and chaos. It works with notions of self-organization, fractality, and emergence, drawing on systems theory: parts are interdependent, interact, and transform one another, so the whole is defined not by the sum of its parts but by emergent properties. In this sense, the whole is more—and also less—than the sum of its parts, because emergent properties may inhibit certain qualities of the parts themselves.

A feedback-driven system is dynamic; by allowing space for chaos, disorder, and uncertainty, it addresses issues through non-linearity and the interconnectedness of phenomena. Bioethics thus tackles entanglement, the solidarity of phenomena among themselves, haze, uncertainty, and contradiction—particularly in the face of one of today's essential developments: the Digital Revolution.

From this perspective, the relevance of bioethics in debates on AI becomes apparent—not only regarding ethics in the strict sense, but also in its application to society, politics, and the economy. Scientific and ethical aspects of AI prompted a European expert meeting in Barcelona in March 2017, which produced the *Barcelona Declaration for the Proper Development and Use of Artificial Intelligence in Europe*[29]. The declaration

do not necessarily generate truly transformative knowledge. Transdisciplinarity goes further, dismantling the boundaries that separate disciplines while fostering active exchange among them. It is more than the mere sum of the parts; the fields not only converse but also create new knowledge. This is an advanced, dynamic notion that operates "between," "across," and "beyond" disciplinary lines.

[29] "Barcelona Declaration for the Proper Development and Use of Artificial Intelligence in Europe," Biocat, 2017, https://www.iiia.csic.es/barcelonadeclaration/.

sets out six principles:

- *Prudence* – Rapid advances in AI have been driven by maturing technologies, greater computing power and data storage, online delivery platforms, and a growing willingness among economic actors to experiment for themselves.

- *Reliability* – All artificial systems deployed in society must be tested to determine their reliability and safety.

- *Accountability* – When an AI system makes a decision, those affected must be able to obtain an explanation, understand the terms in which the decision was made, and challenge it with well-founded arguments.

- *Responsibility* – Rising concern surrounds AI chatbots and other automated messaging systems designed to manipulate political opinion, spread disinformation, extort, or engage in other malicious activities that endanger individuals and destabilize society.

- *Restricted Autonomy* – AI systems not only make decisions but, when embedded in physical systems such as autonomous cars, can act on those decisions in the real world—raising safety issues and the possibility that autonomous AI might one day surpass human intelligence.

- *Human Role* – Today's undeniable enthusiasm for AI sometimes creates the impression that human intelligence will no longer be needed, leading some firms to dismiss employees and replace them with AI systems. This is a grave mistake: all AI systems depend critically on human intelligence.

Beyond these established principles, other bioethical frameworks should be considered—such as the "4 P" scenario analysis proposed by Garrafa and Azambuja[30]: prudence toward the unknown, prevention of possible harm, precaution against indiscriminate use of new technologies, and protection of the socially excluded, most fragile, and vulnerable. The authors argue that incorporating these frameworks is essential to a bioethical practice committed to the vulnerable, to the *res publica*, and to environmental and planetary balance in the twenty-first century[31].

Technological evolution has transformed ethical issues from a purely

[30] Garrafa, Volnei, and Leo Azambuja, "Epistemología de la bioética," *Revista Colombiana de Bioética* 4, no. 1 (2009): 73–92, 82.

[31] Garrafa, Volnei, and Leo Azambuja, "Epistemología de la bioética," *Revista Colombiana de Bioética* 4, no. 1 (2009): 73–92, 82.

supra-structural concern into matters requiring direct participation in bioethical discussions aimed at humanity's well-being and future. One major emerging issue is the creation, use, and manipulation of technology evident in AI advances, which extend human capabilities and affect the mind, cognition, and development[32]. On another front, Linares highlights the need to build a technological philosophy in the face of holistically intertwined ethical elements:

> "In the technological world, the individual faces a paradox: on the one hand, personal freedom is enhanced by technology; on the other, social fragmentation and isolation, ecological and global political problems reveal a growing incapacity to act in solidarity, to establish universal criteria and values, and to overcome the relativism or moral scepticism that neutralizes ethical responsibility."[33]

Digital-age ethics can no longer be seen merely as a matter of private conscience. It now entails public responsibility and the interpretation of historical-social-environmental impacts, since the consequences affect all humanity—politically and economically—and the biosphere, given the high demand placed on finite natural resources to develop and maintain AI.

These considerations show the importance of bioethics as a tool within the widest variety of bioethics committees, commissions, and councils—hospital, institutional, care-related, public-administration, investigative—and in the broad spectrum of debates on artificial intelligence. Whether in narrowly focused action or in transnational and global impact assessments, knowledge of bioethics enables structured work grounded in coherent, consensual, and rational communication, argument, and dialogue. It employs

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[32] Within this spectrum, I venture to say that technological progress and artificial intelligence extend and expand human intellectual, physical, and psychological capacities, ultimately enhancing human intelligence by maximizing resources and boosting efficiency. The assistance of machines and the digital revolution reshapes humanity's relationship with its own nature and with self-organization, altering both subject and object. From the standpoint of self-organization theory, the subject emerges simultaneously with the world. Endowed with a capacity for self-organization—rooted in individuality, complexity, and uncertainty, and constantly exchanging with external processes and ecosystems—the subject arises in this inseparable relation. As algorithms not only guide but also transform the conditions under which we live, make decisions, and interact socially and politically—and as smartphones and apps become extensions of ourselves—there is a symbiosis that actively participates in, and intervenes in, human self-organization: Debrun, Maria. "A ideia de auto-organização." In *Auto-organização: Estudos interdisciplinares*, edited by Maria Debrun, María E. Q. Gonzales, and Osvaldo Pessoa Jr., 11–24. Coleção CLE 18. Campinas, SP: Unicamp, 1996; Debrun, Maria. "Dinâmica da auto-organização primária." In *Auto-organização: Estudos interdisciplinares*, edited by Maria Debrun, María E. Q. Gonzales, and Osvaldo Pessoa Jr., 25–59. Coleção CLE 18. Campinas, SP: Unicamp, 1996.

[33] Linares, Jorge Enrique. *Ética y mundo tecnológico* (Mexico City: FCE, 2008).

the complexity paradigm, which—as Sotolongo and Garrafa observe—characterizes bioethics itself:

> "The complexity paradigm reveals the emergent qualities of interactions among parts and their relations to the whole, projecting beyond the classical deterministic model by embracing notions of disorder, unpredictability, error, and chaos as drivers of evolution and transformation; it is an attempt to re-link contents and knowledge."[34]

It is therefore essential to place bioethics at the heart of the discussions prompted by the digital revolution and artificial intelligence, making it a concrete tool for transformative reflection on human rights and *bio-rights*—conceived here as the rights of the biosphere—far beyond the traditional intersection of bioethics and law.

CONCLUSION

A truly transformative AI—ethical, autonomous, and context-sensitive—that not only simulates aspects of human intelligence but also reshapes the conditions under which we live, make decisions, and interact socially and politically will require dialogue among bioethics, law, and computer science. Born in an interdisciplinary setting, artificial intelligence brings about not only a technical revolution in our lives but also a cultural, political, and philosophical mutation, demanding new forms of critical reflection and a renewed ethical responsibility. This hybrid character is one of AI's greatest strengths and, simultaneously, one of its foremost philosophical challenges.

Hannah Arendt warned in the twentieth century that science and technology would advance to the point of producing artificial life, severing the last bond that ties us to nature. Yet this leap, she argued, could not—and should not—be decided solely by scientists or technocrats, but by politics understood as the sphere of deliberation about the world[35].

The future Arendt described is already our present: we live immersed in a digital condition that not only transforms our tools but also reconfigures our human capacities, our subjectivity, and our way of being in the world. Juan Luis Suárez observes that "there is no longer a clear dividing line between information and reality: digitization not only represents reality, it constructs

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[34] Sotolongo, Pedro Luis. "O tema da complexidade no contexto da bioética," in *Bases conceituais da bioética*, ed. Volnei Garrafa, Miguel Kottow, and Alya Saada (São Paulo: Gaia/Redbioética UNESCO, 2006), 121–39.

[35] Arendt, Hannah. *A condição humana*, 13th ed. (São Paulo: Forense Universitária, 2016).

it. We are, in a sense, living information."[36]

Thus, the emergence of this debate calls for complex analysis. The evident growth of AI—driven by technological dynamics and coupled with the expansion and transformation of human capabilities—creates a field of study with high prospective impact for the future. Philosophy, and bioethics in particular (as applied ethics), plays a central role in the AI debate by constructing the conceptual and normative framework that must guide how we conceive, design, and deploy these technologies, providing the tools to evaluate not only what is possible with AI but what is desirable.

In this emerging scenario, critical analysis invites us to consider the moral, social, and political consequences of AI, which extend far beyond the legal realm. Defining an ethical scope for artificial intelligence is the task of bioethics, called upon to devise an ethical analysis that enables scientific and technological development while minimizing the impacts arising from their incorporation and adaptation.

Beyond setting limits, we must also imagine possibilities and solutions—paths toward emancipation, inclusion, new forms of care, and justice—using bioethics as an epistemological instrument to shape the kind of humanity we wish to build for the future.

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[36] Suárez, Juan Luís. *La condición digital* (Madrid: Trotta, 2023), 88.

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10.59224/bjlti.v3i1.70-86
ISSN: 2965-1549