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The Boundary Between Natural and Artificial: Challenges of Artificial Intelligence and Emerging Technologies

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Abstract

The rapid development of neuroscience and emerging technologies is opening new horizons where the distinction between the natural and the artificial becomes increasingly blurred. In this context, projects like Neuralink raise fundamental questions about our identity, human consciousness, and the potential social transformations. The idea of a direct interface between the human brain and technological devices not only opens extraordinary possibilities for treating neurological diseases but also raises important ethical and moral dilemmas. The fusion between human and machine could lead to a redefinition of the human condition itself, altering our relationship with the body, knowledge, and society. While the prospect of "enhancing" human cognitive abilities may seem appealing, the need to cautiously address the risks associated with these technologies—such as social control, surveillance, or economic inequalities—becomes apparent. Ultimately, the convergence between artificial intelligence and human biology could mark the beginning of a new era, one that demands a profound reflection on how we want humanity to evolve in an increasingly technological world.

Keywords: artificial intelligence, emerging technologies, human evolution, ethics, neuralink

1. Introduction

Today's society is structured as a constantly evolving entity, with its components in perpetual change (Battista, 2024). These alterations manifest in multiple aspects of daily existence, affecting lifestyles and individual behaviours across various social dimensions. Technological advances emerge as a key and inevitable element, significantly influencing the social fabric (Salzano et al., 2023), interpersonal relationships, and human identity. The current era is marked by technical progress that has initiated a profound alteration of the relationship between reality and the use of the Internet, a transformation that transcends basic internet usage to influence all aspects of social life. We live in a reality characterized by considerable technological deployment (Battista & Uva, 2023), where digital tools interact incessantly and pervasively with users. One of the most important innovations that has revolutionized civilization in recent years is undoubtedly the vigorous adoption of artificial intelligence (AI). This rapidly evolving technology has significantly influenced various social systems, including the economy, politics, science, and education, reshaping their structure and operations (Battista, 2024). Moreover, AI has opened new horizons in research fields like medicine, presenting sophisticated tools that are transforming conventional approaches to diagnosis and therapy. The field of neuroscience, particularly technology and computing, has benefited from these discoveries, leading to the emergence of innovative solutions like neurotechnology's. In this context, brain-computer interfaces (BCIs) have emerged as a highly promising component. The term BCI, coined for the first time by Jacques Vidal in 1973 in a seminal article (Vidal, 1973), refers to technologies that create a direct link between the nervous system, whether central or peripheral, and an electronic device capable of receiving, processing, and storing neural data (Shih et al., 2012). These tools facilitate new interactions between humans and machines, revealing unique possibilities in scientific research and medicine (Rajpurkar, 2022). Brain-computer interfaces (BCIs) help enhance understanding of brain functions and hold therapeutic and rehabilitative potential for people with motor and neurological disabilities. The first experiments in converting neural activity into commands to control external devices date back to the 1960s, particularly through research conducted on monkeys (Evarts, 1996). Currently, however, research on brain-computer interfaces constitutes one of the most interdisciplinary and engaging sectors of the scientific and technological arena. BCIs are highly promising for addressing sensory and motor disabilities (Daly, 2008), facilitating neuro-assisted communication, advancing exoskeleton technology, and evaluating cognitive states (Maksimenko et al., 2018). These technologies increase our understanding of the brain and offer new therapeutic and rehabilitative opportunities, transforming medicine and improving the outcomes of treating various neurological diseases, thanks to an unprecedented blend. This initiative represents a pioneering effort aimed at developing brain-computer interfaces capable of creating a direct connection between the human brain and electronic devices, enabling bidirectional communication between humans and machines. Through the implantation of neural chips, *Neuralink* not only aims to offer innovative solutions for treating neurological diseases but also to enhance cognitive abilities and, in the not-so-distant future, foster an increasingly deep hybridization between the mind and artificial intelligence. Neuralink, with its pioneering approach, represents a turning point in the convergence of neuroscience and advanced

technology. The idea of creating a direct interface between the human brain and electronic devices may seem futuristic, but its potential is already in concrete development. On one hand, brain-computer interfaces have the potential to revolutionize the treatment of neurological diseases and improve cognitive functions, while on the other hand, they raise significant ethical and social questions. The fear that the fusion between the human brain and artificial intelligence could generate new forms of inequality or increase control over individuals is not negligible. Moreover, the issue of privacy and the protection of neural data becomes crucial in a world where brain information could be used for purposes beyond disease treatment. Despite these risks, the innovation offered by Neuralink and similar technologies could, if managed responsibly, bring tremendous benefits, including the possibility of improving the quality of life for people with disabilities and pushing the boundaries of human knowledge. The main challenge will be finding a balance between technological progress and the protection of human rights (Battista, 2023), ensuring that these new frontiers do not threaten our autonomy and dignity, but instead enhance them.

2. Potential, Challenges and Impacts

The interpretation of artificial intelligence, since its inception, has captured the attention of scholars as well as the public, fuelling a debate that has transcended the boundaries of pure scientific speculation to become a fundamental subject of ethical, philosophical, and social reflection (Battista, 2024). The central element that has always guided this discussion is the competition between human ingenuity and that of machines. The dominant narrative has often revolved around this dialectic of confrontation, as if the progress of technology and the advancement of machine capabilities have the power to disrupt the existing hierarchies between humans and machines. Since the early studies on automated calculation, humans have sought to create tools capable of replicating, and sometimes surpassing, the cognitive abilities of the individual. The machine, over the centuries, has been conceived both as a tool to enhance human capabilities and as an entity capable of replacing humans in tasks requiring intelligence, and more recently, even creativity. Yet, the risk that such power could slip beyond human control has always been an integral part of the reflection, especially in the context of philosophical thought, which has always feared the power of technology and the invasiveness of its tools. In past eras, when reflection on artificial intelligence was not even a shadow of the present, philosophers pondered how the human mind could be emulated. The debate focused on ethical, epistemological, and ontological questions: is it possible for a machine to think? Can a machine feel emotions, be creative, or possess its own consciousness? These questions seem almost prophetic, anticipating the conflict that arises in modern times between humans and automatons. However, for a long time, the machine remained a simple extension of human efforts in a purely functional realm. Throughout the 20th century, the advent of computers and the evolution of computer technology dramatically accelerated the development of artificial intelligence. Over the years, what was once merely an academic curiosity has taken concrete form in algorithms capable of learning, improving autonomously, and even solving problems once considered exclusive to human intelligence. Thus, while humans continue to live under the aura of a cognitive power considered unique, the machine

does not remain merely an aid; it becomes increasingly complex, sophisticated, and capable of operating with results that even surprise scientists themselves. This scenario has inevitably fuelled the fear that machines, due to their superiority in computational capabilities, may one day reach or even surpass humans in all fields of knowledge, work, creativity, and ultimately, moral decision-making. The competition between humans and machines is no longer just a matter of computational speed, but extends to the ability to make decisions, to judge, to understand, and even to influence society. The existential questions that arise are of a delicate nature: what does it mean to be human in a world where machines seem increasingly capable of emulating human intellect? What place will humans occupy in a system increasingly dominated by technology? What emerges powerfully, beyond the pure competition between humans and automatons, is a reflection on how this technological evolution is radically changing our way of living, thinking, and interacting with the world. The machine, from a tool for enhancement, becomes a protagonist in a process of self-evolution that challenges the very boundaries of human nature, questioning the role of humans as the measure of all things. In this context, the competition between humans and machines also takes on a symbolic dimension, where it is no longer just a challenge between natural and artificial intelligence, but an invitation to reconsider our place in the technological universe we have helped to create. This representation has rooted ideas, stereotypes, and expectations about the threats and dangers that might arise from creating machines with intelligent behaviors. Influences such as the Turing Test, a measure used to assess a machine's ability to simulate human intelligence, have inspired this story. Artificial intelligence has provoked, and continues to provoke, contrasting reactions among scholars and thinkers worldwide, fueling a heated debate about its implications for the future of humanity. Some thinkers, like Bostrom (2014), have expressed concern that AI might not only change our society but even threaten our very existence. According to this view, the exponential growth of AI capabilities could lead to a situation in which machines, once achieving a certain autonomy and intelligence superior to human intelligence, could decide to act outside of human control, potentially harming humanity. The greatest risk in this perspective is that an artificial superintelligence, in the absence of adequate programming or supervision, might develop goals that conflict with those of humanity, leading to catastrophic consequences for our civilization. The idea of a "technological singularity," the point at which AI surpasses human intelligence in an irreversible manner, opens the door to dystopian scenarios where humans would no longer be the dominant decision-makers. On the other hand, there exists a diametrically opposed view, that of those who see artificial intelligence as an opportunity for progress, a driving force of innovation that could mark the beginning of a new era for humanity. According to these thinkers, as highlighted by Battista and Uva (2024), AI is not a threat, but rather a powerful tool to solve the most urgent challenges of our time. The ability of machines to process vast amounts of data, learn autonomously, and find innovative solutions could, for instance, revolutionize the healthcare sector, improve energy efficiency, optimize industrial production, and even help solve global issues like the fight against climate change. In this scenario, artificial intelligence is not seen as an entity challenging humans, but as a partner with which to collaborate for the collective improvement of society. AI, if used correctly, could lead to a radical transformation of our economic and social models, paving the way for a new era of

prosperity and well-being. The two views, though contrasting, reflect concerns and expectations responding to the same question: how to manage the unlimited potential of artificial intelligence. The fear of a technological dystopia, such as the one described by Bostrom, arises from the uncertainty about the moral and ethical boundaries of AI, the difficulty in predicting and regulating machine behavior as they acquire greater autonomy. The lack of clear answers to issues such as responsibility, algorithm transparency, and ensuring that machines act in humanity's best interest fuels concerns that AI could become an uncontrollable force, potentially harmful. On the contrary, those who view AI optimistically are more inclined to see technological progress as an opportunity for continuous growth and the realization of a more advanced, interconnected future. The positive perspective is, in fact, fuelled by the belief that humanity can guide AI development toward ethical and beneficial purposes. In this sense, AI could be integrated into our lives as a tool in the service of humans, capable of freeing up resources and increasing productivity across various sectors. In this debate, what emerges clearly is the need for continuous and deep reflection on how to approach the power of artificial intelligence responsibly. It is essential that AI research does not merely explore its technical potential but also considers its ethical, political, and social implications. Only with a balanced approach, centred on safeguarding human well-being and promoting harmonious coexistence between humans and machines, will it be possible to fully harness the opportunities offered by AI, while minimizing the risks associated with its uncontrolled development. There is no doubt that a myriad of sectors must confront a series of complex issues within informational and news ecosystems. The rapid growth of AI has brought a variety of perspectives and interesting issues related to increasingly interconnected worlds. We face problems such as source verification, information manipulation, equitable access to news, and the creation of a reliable information environment in this context. These findings require deep consideration of AI's ability to shape and influence certain debates and how effective strategies can be implemented to ensure a critical, informed, and transparent discourse in the AI era. The complex methodological and thematic challenges, including the impact on public opinion, have been addressed and analysed in a series of academic discussions (Siemens et al., 2022). However, it has been noted that technologies associated with artificial intelligence can enhance social dynamics and human understanding, but they can also introduce distortion, manipulation, and misinformation (Gallo et al. 2022). This duality in the impact of AI technologies on cognition and the social sphere is an important aspect to examine and understand in the context of contemporary challenges. However, it is undeniable that Artificial Intelligence (AI) is frequently perceived as a revolutionary technology capable of radically transforming every aspect of our daily lives. This sense of novelty and unprecedented change is fuelled, on one hand, by the continuous drive stemming from rapid technological developments, which seem to accelerate relentlessly, and, on the other, by the growing public interest, which becomes more and more engaged and fascinated by AI's potential. In fact, AI is often seen as the cornerstone of a new era, in which technology not only plays a supporting role but becomes an integral part of the very fabric of society. After all, in recent decades, the progress made in the field of artificial intelligence has been extraordinary. The ability of machines to learn autonomously, thanks to advanced techniques like deep learning and machine learning, has led to developments that, until

recently, were considered pure science fiction. From increasingly sophisticated virtual assistants to AI-based medical diagnosis systems, from automating complex industrial processes to creating autonomous vehicles, artificial intelligence has infiltrated every aspect of our lives, radically transforming the interaction between humans and technology. This revolutionary vision is not limited only to technological or industrial sectors, but also has a profound impact on society, even with artificial chips capable of integrating with the human brain. More generally, it has the potential to reform work dynamics, altering traditional occupational structures. Many professions are undergoing radical transformation or, in some cases, disappearing altogether, while new ones are emerging. This is not just a technological change, but it involves reflecting on how our societies will manage the adaptation to these changes from an economic, social, and ethical standpoint. Public interest plays a fundamental role in fueling this optimistic view of AI. Not only are experts and researchers involved in this development, but ordinary people are also fascinated by how technology is altering our daily lives. News about AI advancements is increasingly present in the media, with articles telling of its incredible capabilities and transformative potential. Social media and online platforms have contributed to spreading a culture of technological innovation, where artificial intelligence is no longer seen as a niche discipline, but as an integral part of our vision of the future. The matter in question is striking, especially considering that AI was initially studied as an academic discipline in the early 1950s, but for over fifty years it remained a field with limited practical interest and relative scientific obscurity (Haenlein & Kaplan, 2019). This period of stagnation was marked by several "AI winters," times when expectations for artificial intelligence were not met, and research saw significant slowdowns. During the 1970s, the first AI winter occurred due to the disappointment generated by technical difficulties and the inability of early AI technologies to solve complex problems. Later, in the 1980s and 1990s, the second AI winter emerged, when the scientific community recognized the limitations of traditional AI techniques, such as neural networks, which were unable to scale or tackle more complex tasks. These periods of stagnation had a lasting impact on the field, reducing funding and interest in the discipline. However, despite these setbacks, AI managed to recover due to new discoveries and approaches, such as the rise of deep neural networks and machine learning, which led to renewed interest and an explosion of practical applications in the 21st century.

3. Technology vs. Humanity and the Ambitious Goals of *Neuralink*

Neuralink is a company founded by Elon Musk, the visionary entrepreneur known for pioneering initiatives like Tesla, officially incorporated in 2016. For several years, the company remained enigmatic, until the publication of a white paper on July 16, 2019, outlining its goals and key initiatives (Dadia, 2019). The company's primary objective is to create a brain-machine interface (BCI) aimed at restoring motor and sensory functions in individuals with neurological diseases. While the idea is not entirely new—technologies like cochlear implants and other medical devices that stimulate the brain or nervous system have existed since the 1950s (Wilson & Dorman, 2008)—it stands out due to the scope of its aspirations. The articulated goals include "understanding and addressing brain disorders,"

"safeguarding and enhancing our cognitive functions," and "promoting a future in synergy with technology" (Kulshreshth et al., 2019). The company aspires to ambitious future goals, including helping individuals with various physical limitations by facilitating the connection of their brains to technological devices and promoting a symbiosis between humans and artificial intelligence (Battista & Petrone, 2024). Possible medical applications include enabling patients to control exoskeletons or robotic devices through mental commands, assisting communication for individuals with disabilities such as locked-in syndrome, restoring neural connections compromised by degenerative diseases like Alzheimer's, and evaluating and enhancing cognitive functions and psychophysiological conditions. Additionally, it could contribute to the prevention and management of drug-resistant epileptic seizures (Fourneret, 2020). Neuralink's uniqueness and controversial nature arise from Musk and the company's clear goal of transcending medical applications. Musk seeks to bridge the gap when artificial intelligence reaches the capability to fully replicate human brain functions, facilitating collaboration between the human brain and AI (Auriemma & Battista, 2023). The primary aim of this endeavor is to remedy and augment human capabilities, a vision that excites some with its ambitious aspirations, but at the same time raises significant apprehension and debate in others. Musk has articulated his philosophy as "The pursuit of a fantastic future," emphasizing the imaginative and simultaneously controversial essence of this venture, in line with his usual approach to design (Gertner, 2015). The brain implant represents an advanced technology for compensating and replacing lost abilities, with significant therapeutic potential, and aims to develop a brain implant that allows individuals to control various technological devices, such as computers and robotic prostheses, using only the electrical activity of neurons. This approach can be applied, for example, to enable a person to walk by controlling an exoskeleton or to communicate through a neuroprosthesis in patients with complete locked-in syndrome (LIS). Recent studies have shown that externally controlled devices, when decoded from intracortical activity, can become perfectly integrated as a natural extension of the body. The user is able to control these devices effortlessly, simply through thought (Collinger et al., 2013). It is not about acting with the force of physical movements, but rather using the electrical activity of the brain, a form of thought that lies halfway between the mental and the physical, referred to as "neural thinking" (Barfield & Williams, 2017). This concept refers to a thought that can be externally observed by scientists and their instruments, capturing neural signals and decoding them, thus delineating the correlation between mind and brain. For instance, an individual with LIS, a condition where the patient is conscious but unable to move or communicate verbally, could use a brain implant to control a computer and communicate. By capturing the neural activity associated with inner speech, also known as "hidden speech" or "verbal thinking" (Alderson-Day & Fernyhough, 2015), the implant transmits these signals to a computer that, through the processing of an artificial neural network, converts them into synthetic speech. This technological advancement not only promises to restore lost functions to those with severe disabilities but also opens new frontiers in the understanding and interaction between the brain and machines. With these functions, the goal is to improve neural function restoration through brain-computer interfaces (BCIs), surpassing previous technologies like deep brain stimulation. These claims were confirmed in 2024 when Neuralink's Link chip

was first implanted in a human as part of the first known experimental study, Prime. In 2016, Noland Arbaugh suffered a severe spinal cord injury during a dive in a lake, an event that radically changed his life. Paralyzed from the neck down after the accident, Arbaugh slowly managed to surface, only to realize the extent of his disability. At the time a college student, today, at 30, he lives with the aid of a wheelchair and controls an iPad mounted in front of him via a small joystick. In January 2024, Arbaugh took a historic step in medical technology, becoming the first patient to receive the experimental device Telepathy, developed by Neuralink. This device represents the first brain-computer interface (BCI) capable of interacting directly with the human nervous system. The system detects patterns of neural activation and translates them into specific instructions, which are then transmitted to a computer to execute the actions interpreted by the chip. A month after the device's installation, on February 20, 2024, Elon Musk announced on X that Arbaugh had successfully controlled a mouse pointer on a screen solely through brain activity, without any physical movement. In the following months, Neuralink reported that the device had presented slight structural defects: some wires had retracted from the brain tissue, significantly reducing the number of functioning electrodes. This issue was identified through continuous activity monitoring, as Arbaugh uses the device for 8-10 hours a day. After more than a hundred days since the chip's installation at the Barrow Neurological Institute, Arbaugh reported that he had noticed an improvement in the device's performance, and Musk described the experiment as a success. During this period, Arbaugh used the technology to perform various activities, including playing chess exclusively through mental control, thus demonstrating the potential of the brain-computer interface to expand human capabilities. After five months, he expressed satisfaction with the results obtained post-surgery, highlighting how the device had improved his independence. In an interview published by Wired, he stated that he felt less of a burden to those around him thanks to the Link chip. He also shared his thoughts on the possibilities and concerns related to Neuralink's technology: "I know that brain-computer interfaces currently only read neural signals, without adding information to the brain. However, I believe that adding new knowledge could be the next step. This perspective, though fascinating, could raise fears in many people. It is an aspect that requires deep reflection and a cautious approach, but it could open the door to an incredibly promising future." Despite the small size and discreet design of the chip, one of the main concerns is the idea of having a foreign device implanted in the brain, a prospect that causes widespread apprehension (Cooper, 1999). Alongside the medical and technological benefits, these innovations raise complex social issues, including ethical concerns related to inequalities, risks of hacking, and manipulation. These fears are amplified by the possibility that authoritarian governments or corporations may abuse the technology for control or profit, a hypothesis made even more unsettling by recent controversies surrounding data usage in social media (Wu et al., 2019). The proposed technology is thus at the centre of a debate that oscillates between the extraordinary promises of progress and the potential threats. A hundred days after the implant, the initial data presented by the company seem encouraging and hint at a future with significant applications. However, the revolutionary scope of these innovations also raises ethical and social concerns. This ambivalence stems from their potential to radically transform not only the individual experience but also the social structure and the foundations

of the human condition (Maynard & Scragg, 2019).

4. Conclusion

Neuralink undoubtedly presents itself as one of the most relevant emerging innovations, with the potential to radically transform key sectors of our society. This technology serves as a catalyst for a profound debate on the very definition of humanity, fostering the interconnection between artificial intelligence, technology, and the complexity of the human brain. Although initially conceived for medical purposes and to expand our understanding of brain functions, it is not necessarily implied that the goal is explicitly to enhance human cognitive abilities, though it lays the foundation for a potential future fusion between humans and technology. Neuralink has reinvigorated the debate on post-humanism, offering for the first time a technology that could directly impact human biology. While the chip is currently used to assist people with severe disabilities, such as paralysis, the continuous development of the technology could, in the future, significantly improve the device, paving the way for enhancements to brain capacities, as outlined by the company's own intentions. Despite initial successes in testing, many of the project's potentialities are accompanied by significant concerns, particularly regarding moral issues and safety. There are fears that such advanced technology could lead to forms of control or manipulation in the future. Elon Musk has demonstrated remarkable skill in transforming seemingly science-fiction ideas, such as the cyborgs in *Terminator*, into realizable prospects soon. However, uncertainties remain about the future, which could result in a true fusion between humanity and machine, enabling the control of technologies through the human brain, or it could simply prove to be a marketing strategy aimed at capitalizing on Musk's venture. The question for the future is whether Neuralink can become the company capable of radically transforming society, offering an innovative technology that can not only cure brain diseases but also enhance human cognitive abilities, fully integrating us into the interconnected digital network. Neuralink, with its proposal of advanced brain-computer interfaces, represents one of the boldest frontiers in artificial intelligence, with the potential to revolutionize our relationship with technology. In a future where AI becomes increasingly sophisticated, the combination of the human brain and intelligent systems could give rise to a new generation of cognitive experiences. For example, in 2021, demonstrated a pig using a brain implant to interact with computers through neural signals, and shortly after, a macaque playing video games using only its mind. Although these experiments are still in the early stages, they showcase the future potential of direct interaction with AI. Additionally, other research in neuroscience, such as AI applied to neuroimaging, is already helping to better understand how AI can be used to analyze and enhance brain functions. The integration between the human brain and AI could lead to "augmented cognition," where artificial intelligence not only improves mental abilities but also contributes to creating a new level of awareness and collective intelligence. However, this future also raises concerns: the possibility that AI could interpret and manipulate human intentions raises ethical and security questions. For instance, the case of DeepMind, an AI that learned to predict neurological diseases through brain scans, demonstrates how collaboration between AI and neuroscience can bring extraordinary benefits but also

significant risks related to privacy and surveillance. Ultimately, the implications of Neuralink and brain-computer interfaces raise fundamental questions about the future of human-technology interaction. While the potential of such innovations promises to revolutionize the treatment of neurological diseases and expand cognitive abilities, we cannot ignore the ethical, social, and philosophical challenges they present. The fusion between the human brain and artificial intelligence could lead to a new existential paradigm, where the lines between the biological and the technological blur, generating both opportunities and dangers. The prospect of "augmenting" human intelligence with AI, for example, could radically alter our perception of identity, creativity, and individual freedom. As with any major technological advancement, the risk of abuse and manipulation cannot be underestimated: governments and corporations could potentially use these technologies to exert unprecedented control over people. At the same time, however, the potential to improve the quality of human life is undeniable, with applications that could transform the lives of millions of people with disabilities. Ultimately, as we explore these new horizons, we will face the challenge of balancing innovation with caution, ensuring that the benefits are equitably distributed, and that humanity never loses sight of its dignity and autonomy.

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