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Review article

Medical ethics considerations on artificial intelligence

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ABSTRACT

Artificial intelligence (AI) is currently one of the mostly controversial matters of the world. This article discusses AI in terms of the medical ethics issues involved, both existing and potential.

Once artificial intelligence is fully developed within electronic systems, it will afford many useful applications in many sectors ranging from banking, agriculture, medical procedures to military operations, especially by decreasing the involvement of humans in critically dangerous activities.

Robots as well as computers themselves are embodiments of values inasmuch as they entail actions and choices, but their practical applications are modelled or programmed by the engineers building the systems. AI will need algorithmic procedures to ensure safety in the implementation of such systems. The AI algorithms written could naturally contain errors that may result in unforeseen consequences and unfair outcomes along economic and racial class lines.

It is crucial that measures be taken to monitor technological developments ensuring preventative and precautionary safeguards are in place to safeguard the rights of those involved against direct or indirect coercion. While it is the responsibility of AI researchers to ensure that the future impact is more positive than negative, ethicists and philosophers need to be deeply involved in the development of such technologies from the beginning.

1. Introduction

Science and technology are like the proverbial shining sun, as a constant source of light. After the recent advent of the internet, mobile telephones and robots, the time has come for artificial intelligence (AI). This article will the pros and cons of artificial intelligence in accordance with existing scientific research, how to integrate it with technology, and most importantly, how to take measures to protect ourselves in case the integration gets out of our control. However, it is anything but simple to focus on this matter at the moment since so many tests are still needed.

In 1950, Alan Turing published his masterpiece, "Computing Machinery and Intelligence", which paved the way for Artificial Intelligence [1]. Years later the community adopted the term Artificial Intelligence (AI), as coined by John McCarthy [2]. Turing, in his paper, asked, "Can machines think?" and proposed a simple method for assessing this, which later became known as the Turing Test. The Turing test takes a pragmatic approach, assuming that a computer that cannot be distinguished from an intelligent human actually has shown that machines can think [1]. Defining the scope of AI was more difficult than solving a small problem because advanced studies could have unpredictable results. Therefore, the growing and ever-evolving AI raised a lot of controversy and ethical complexity due to their presence in all fields and most importantly due to their intelligence and problem-solving skills that exceed even human skill**s**.

An artificial intelligence-based system including autonomous robotic systems and so on has become particularly acute in the context of military use and warfare. While some applications are still under development, the use of semi-automated drones and enhancement drugs in warfare is a documented fact [3]. This article discusses the ethical considerations related to AI, including existing and potential ethical problems.

2. Human or artificial intelligence?

Innovations and New developments have been increasing human capabilities and hasten our scientific progress. There are many reasons for ethicists to express misgivings about the future of AI and how to troubleshoot problems that could have catastrophic consequences due to the capabilities of such intelligence or even the consequences of current technologies and future nanotechnology.

The Turing Test provides some key points on which to base a definition of a thinking machine. It finds sufficient for the entity

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to be posed questions and made small talk with and for the entity to respond to the examiner with answers. In order for a computer to pass the Turing test, the examiner must be unable to tell if the answer was provided by a computer or a human, thereby emphasizing the lack of necessity of a physical nature and how a machine mimicking a human can be confused for one [4]. A positive result on the Turing test would mean that a sophisticated AI may have a consciousness. This could contradict with our definitions of humanness since we identify ourselves as thinking beings that operate on ethical codes, values and freedom derived from our experience and consciousness created by cerebral tissue [4].

3. Understanding artificial intelligence systems

Current AI algorithms with intelligence that is equal or superior to human intelligence are programmed to be confined only to a single area. For example; Deep Blue is an AI programmed only to play chess. However, human intelligence surpasses non-hominid intelligence: i.e., we are much better at some cognitive tasks [5].

Machine ethics can impose similar challenges leading to many other hardships for those involved in designing machines. However, new challenges arise when the cognitive operation of AI is implemented within social realms, in tasks that usually require a human touch [6].

However, advanced cognitive skills could enable AI to preform even better than humans. New applications of AI could open up exciting opportunities for more effective medical care, safer industries and services, and boost productivity on a massive scale [7].

4. Machine learning

Machine learning algorithms have proved to be efficient in identifying and analyzing patterns in large amounts of data, commonly referred to as "Big Data". Big Data is used to train learning algorithms to increase their identifying capacity and performance. Machine learning has already been utilized in various areas and productions. It is widely known that computer algorithms can track enormous amounts of data and categorize them into information and services, based on certain instructions and rules created by programmers. It is important to understand machine learning, which is generally a set of rules and instructions written in the form of algorithms for the machine to perform tasks on specific step-by-step patterns; however, the machine gradually gains the ability to be more flexible and work in different situations accordingly by using newly acquired data and writes new instructions and steps for performing new tasks that were not previously written manually by the programmer. An example of such can be seen in photo recognition applications [8].

However, this generates an increasing demand for data, encouraging data collection, and raises the risk of oversharing personal or public information at the expense of user privacy. Providing transparent data about the behaviors and the specific nature of such systems in their specific area is necessary for the assessment and implementation during the utilization of AI because clashes involving values and norms are inevitable during and after the evaluating process [9]. It is true that some algorithms are programmed with a set of values and choices but the more autonomous a system becomes, the more it will be engaged in conditions unanticipated by the designer, rendering crucial a decision making system that provides the best choice and course of actions [9].

The IEEE Global Initiative for Ethical Considerations stated, "*Recent breakthroughs in machine learning and perception will enable researchers to explore bottom-up approaches—in which the AI system learns about its context and about human values—similar to the manner in which a child slowly learns which forms of behavior are safe and acceptable.*" [10].

5. When an artificial intelligence system fails or is misused

It is important to program a specific good behavior in AI, such as 'a certain action (x) could lead to consequences that harm humans; therefore, (x) is wrong'. This is done by extrapolating the distant consequences of actions. This way, build AI with machine learning that could be utilized in areas requiring actions with many consequences would be safe [6].

A predictability feature in AI is important for legal issues because the main point for a justice system is to provide a supportive environment where citizens can thrive. Another important point is that AI needs to have robust prevention features against manipulations and unauthorized reprogramming [6].

AI algorithms might, by design, be subject to errors that can lead to consequences such as unfair outcomes based on race and socioeconomic class. One example is citizen profiling based on demographics arriving at the probability to commit crimes or default on financial obligations. Trustworthy AI systems should be built around the following principles [11]:

Transparency (operations visible to user)
Credibility (outcomes are acceptable)
Auditability (efficiency can be easily measured)
Reliability (AI systems perform as intended)
Recoverability (manual control can be assumed if required).

Contextual interpretation and vague ethical standards pose *a serious challenge* for the coding of AI systems.

Ensuring the compatibility of AI research with norms and ethics is necessary for all its applications. Scientists and researchers from fields such as biomedical science, psychology, ethics, economics, law and policy need to be involved in the development of AI to define the perception and notion of fairness, justice and equality norms and identify the acceptable and safe behavior for AI utilized in a given domain, thereby securing social acceptance which ensures predictable and easy to understand outcomes of AI actions. The looming threat is the misuse of medicolegal algorithms by hackers to develop autonomous techniques that jeopardize the security and safety of vital information. Machine learning journals are recently focusing on how an algorithm can surpass others while neglecting the criteria and consequences of replacing human judgments in social functions by AI [6].

6. Ethical consideration and its necessities

Ethical rules and moral values differ by region with ethnic groups, nations and countries holding different norms. However, all agree on honesty, truthfulness, transparency, benevolence, non-malevolence and respect for autonomy [12,13]. Several medical ethics theories described for human beings are being considered (consequentialist, deontological, virtue, etc.) as well as the implications of their use within a machine in order to identify the best way to describe and adapt values from humans to machines.

Our current moral systems are all based on how we are responsible for other humans. Therefore, problems arise when it is applied to a non-human being or a system: There are ethical issues involved when efforts are made to apply normative ethical principles on non-organic intelligence like AI or consciousness uploads (human brain being transformed into inorganic computers which can imitate the original brain personhood). When human consciousness is uploaded onto a fast computer, the principle of subjective rate of time, for example, could be incompatible with our

normative ethics [6]. The processor of that upload would be fast, therefore perceiving time more quickly than an actual human brain, leading to a slow subjective (the upload) perception of time. 1 s of objective time would be 17 min of upload subjective time. An example of the ethical impact of such a feature could be punishment for crime. For example, when uploading is a crime and with a 4 year prison sentence, the 4 years could be 1 day in subjective time perception. Should the duration of an experience be measured on subjective or objective time? We must recognize the extent of our normative precepts and adjust them according to empirical conditions and when applying them [6]. Moreover, in every area there are sets of rules and codes of ethics according to which each professional has to work. These ethical codes can be the basis for the ethics module of systems being utilized to help professionals.

7. Artificial Intelligence: Potential benefits and ethical considerations

The possibility of creating thinking machines raises a host of ethical issues. Currently we lack relevant policies and suggestions to deal with such issues that may come up in research being carried out. These questions relate both to ensuring that such machines do not harm humans, other morally relevant beings, and the moral status of the machines themselves. The process of creating AIs more intelligent than human must ensure that they use their advanced intelligence for good rather than ill [6].

8. Principles in medical ethics

The most fundamental ethics based on ethical principles that concern the medical practice and patient care and treatment [14] comprise non-maleficence, beneficence, respect for patient autonomy and justice.

8.1. Beneficence and non-maleficence

The moral obligation of doctors is to act in the patients' best interests and not to harm them. However, this does not include only the medical aspects regarding patients but their overall quality of life: It falls under the responsibility of doctors to ensure and maintain their well-being while respecting the patient's individual desires and values.

8.2. Respect for autonomy

The concept of autonomy is overarching, and thus has implications for other key ethical themes including responsibility, informed consent and privacy. However, it is also a central issue in and of itself, and comes up across clinical and ethical discussions. We note that the term is used differently by ethicists than by engineers and neuroscientists. For ethicists, autonomy refers to an individual's capacity to self-determine.

Among recent neurotechnical developments are "brain-computer interfaces" (BCI), which involve the communication between the brain and external devices such that brain signals are turned into commands for output devices to carry out desired actions, mostly to restore useful function for people disabled by neuromuscular disorders. Brain-computer interfaces (BCIs) acquire brain signals, analyze them, and translate them into commands that are relayed to output devices that carry out desired actions. BCIs do not use normal neuromuscular output pathways. The main goal of BCI is to replace or restore useful function to people disabled by neuromuscular disorders such as amyotrophic lateral sclerosis, cerebral palsy, stroke, or spinal cord injury. From initial demonstrations of electroencephalography-based spelling and single-neuron-based device control, researchers have gone on to use electroencephalographic, intracortical, electrocorticographic, and other brain signals for increasingly complex control of cursors, robotic arms, prostheses, wheelchairs, and other devices. Brain-computer interfaces may also prove useful for rehabilitation after stroke and for other disorders. In the future, they might augment the performance of surgeons or other medical professionals. Brain-computer interface technology is the focus of a rapidly growing research and development enterprise that is greatly exciting scientists, engineers, clinicians, and the public in general. Its future achievements will depend on advances in 3 crucial areas. Brain-computer interfaces need signal-acquisition hardware that is convenient, portable, safe, and able to function in all environments. Brain-computer interface systems need to be validated in long-term studies of real-world use by people with severe disabilities, and effective and viable models for their widespread dissemination must be implemented. Finally, the day-to-day and moment-to-moment reliability of BCI performance must be improved so that it approaches the reliability of natural muscle-based function.

Under the framework of the BCI (Brain-Computer Interface), Glannon states that "*nothing about the influence of neuromodulation on the brain and mind suggests that we should revise the concept of autonomy*" [15]. From an ethical perspective, however, he also questions whether an action that is produced mostly or solely by a device can truly be attributed to a human [15]. The difficulties related to making rational decisions that serve the need and rights of patients with respect for their autonomy lie in the fact that neurological interventions are accompanied by uncertainties regarding their probable outcomes and the nature of the risks involved. BCIs, like other neurotechnologies, should be developed and designed within a responsible, ethical framework [16] and in a user-centered manner to increase technology acceptance [3,17].

8.3. Justice

The entire process of the creation of AI, from early technological developments to distribution, is intertwined with justice-related issues. Some scholars assert that, as BCIs are being engineered, those most likely to be affected by the technology, including potential end users [18] and the general public, should be informed of the design process of the device and the conflicting requirements. These should be documented and signed by the intended individual/patient. According to the justice principle, doctors are **e**ntitled to offer procedures that best serve the patients' interests without harming them as well as assess the patients carefully to evaluate the benefits and risks. It should be noted that most BCI literature treats disability as a medical issue rather than a socio-cultural one, suggesting that the perspective of persons with disability may not have been considered [19].

8.4. The other rules of medical ethics

8.4.1. Trust

Systems working within the frameworks of ethics and social norms will establish trust between systems and users through the assurance of the protection of private data and the elimination of any potential for biases in the decision making process, as well as ensuring that the system works with existing legislation [20].

8.4.2. Human autonomy and privacy

Individuals' right to privacy is an essential human right not to be violated by governments or unlawful surveillance by authori-

ties. This basic human right is threatened by AI and Big Data, which features machine learning that requires the gathering and storage of data from the environment.

9. Concerns regarding policies in neuroethics

Neuroscience and neurotechnology are scientific areas that offer diverse applications in various fields including medicine, public health, education, law and security. The establishment of neuroethics was inevitable to address and solve ethical issues raised by neuroscience. Our knowledge of the biological function of the brain and its mental and psychological machinery are being expatiated by the field of neuroscience. Yet the research findings bring into question the ethical and philosophical challenges regarding the utilization of such findings [21,22].

In relation to neuroscience and to the related technologies, we need to be aware of the effect of proprietary intellectual property on the entire process of scientific discovery as well as access to the fruits of this process (The Manchester Manifesto, 2009) [23].

It been shown that current mechanisms related to the ownership of innovation may have adverse consequences for the progress of science. Not only do these mechanisms have a restrictive effect on the openness with which scientists feel they can communicate about their research, but commercialization and the existing balance of incentives for innovation may actually change the course of science itself (Nuffield Council on Bioethics, 2013) [24].

9.1. Ethical implications to preserve human dignity and identity

Mary Shelley, in her novel *Frankenstein,* set the ethical frame within which science and the search for knowledge should be based. She concluded that science can be a destructive force that need**s** ethical consideration before utilization in order to provide safety [25].

The use of advanced technologies does indeed carry the potential to interfere with fundamental rights and freedom of humankind. It has been 20 years since the Council of Europe expressed through the Convention on Human Rights and Biomedicine (the Oviedo Convention, 1997) its commitment to: "*... protect the dignity and identity of all human beings and guarantee everyone, without discrimination, respect for their integrity and other rights and fundamental freedoms with regard to the application of biology and medicine.*" [26], identifying the ethical questions that threaten human dignity within the context of emerging scientific developments. Better governance and surveillance over such technologies are needed to prevent any possible misuse that might violate human rights (Council of Europa expression, 2015).

10. Human enhancement

The technological promise of "human enhancement" is on the one hand as old as Bacon's *The New Atlantis*, and on the other hand, quite a recent concern in the ethics debate, especially after the development of recombinant DNA technologies suitable for genetic engineering. The directed and tailored modification of human genetic material in human individuals (germ line), pharmaceuticals and machines (prosthetic limbs and organs) that increase or improve physical, sensory and/or mental capabilities of humans, devices that establish a functional brain-computer interface, with bidirectional communication are only some examples [27].

We propose that ethical discussions on technologies of human enhancement (and indeed emerging technologies in general) should be made ethically more *specific.* These innovations are ethically associative because it must be assumed that the consequences for trial subjects cannot be fully controlled or assessed in advance.

11. Threat to human dignity and safety

AI systems have already begun to replace human beings in some industries. The replacement of humans in those sectors and positions related to human dignity and which are bound to ethics such as physicians, surgeons, judges, nurses, police officers and so on should be avoided.

AI systems that are self-improving could become so assertive than humans that could find it very hard to stop them from realizing their intentions, which may lead to undesirable consequences.

12. Discussion and suggestions

Taking into consideration the potential benefit of Artificial Intelligence and Autonomous Systems (AI/AS), we are in need of more digital strength or solution capabilities. It must be made sure that these technologies are compatible with human beings in terms of our ethical principles and moral values.

"The IEEE Global Initiative for Ethical Considerations in AI and Autonomous Systems" explains ethical consideration: "*...ethical issues can easily be rendered invisible or inappropriately reduced and simplified in the context of technical practice....Many engineering programs do not sufficiently integrate course work, training, or practical experience in applied ethics throughout their curricula;....Ethics education for engineering students should be meaningful, measurable, and incorporate best practices of STEM ethics education drawn from pertinent multidisciplinary resources. The aim of these recommendations is to prepare students for the technical training and engineering development methodologies that incorporate ethics as essential so that ethics and human rights become naturally part of the design process.*" [10].

12.1. Ethical considerations in deployment and design

"AI system designers and builders need to apply a user-centric approach to the technology. They need to consider their collective responsibility in building AI systems that will not pose security risks to the Internet and Internet users" should be the overarching principle [28].

Autonomous systems should be monitored while in operation, and updated or corrected as needed. Furthermore, AI systems must be data responsible. They should use only what they need and delete it when it is no longer needed "data minimization". They should encrypt data in transit and at rest, and restrict access to authorized persons "access control". AI systems should only collect, use, share and store data in accordance with privacy and personal data laws and best practices [9].

Innovation policies should require adherence to ethical standards as a pre-requisite. For instance, funded researchers in this field should be responsible for publishing any finding related to security vulnerabilities and defects in order to improve and repair the system without further damages. The principles and standards of ethical considerations in the design of artificial intelligence should guide researchers and industry going forward [9].

12.2. Ensure interpretability and safety of AI systems

AI decisions, especially those involved in public safety related actions have to be comprehensible. The ISOC states that, "*AI systems must be designed with the minimum requirement that the designer can account for an AI agent's behaviors. Some systems with potentially severe implications for public safety should also have the*

functionality to provide information in the event of an accident." [29]. Inclusiveness and transparency and collective responsibility are key principles that should form a basis for the AI decision-making process [30].

Preventing unexpected and unforeseeable actions by AI systems should be a concern for the developers and designers. Setting up boards to review resources and evaluate projects is essential for ensuring safety. In his book "Superintelligence", Bostrom proposes that we adopt a moral norm which he calls the common good principle: "*Superintelligence should be developed only for the benefit of all humanity and in the service of widely shared ethical ideals*" [31].

The way to ensure the safety of humankind against such risks in developing AI is to put restrictions and regulations and to work within an ethical framework. Furthermore, programming AI with rationality and human elements so that we may form a bond with and embrace our new civilization would mean depending even more on AI. It is necessary to develop new ethics, laws and a philosophy compatible with our new life.

According to Harari, we probably require a brand new package of religious beliefs and political institutions because liberalism is threatened not by the philosophical idea that there is no free will, but rather by concrete technologies [32]. We should abandon all our old definitions of what a human is since our philosophies depend on the idea of human uniqueness and that the world is centered on human beings (General Data Protection Regulation) [33]. One example is the very recently released USA federal policy on automated vehicles, which is already in effect [34]. The safe and broad spectrum utilization of these system**s** is the main aim of these policies.

Many luminaries ranging from Stephen Hawking and Steve Wozniak to the figureheads of AI at Facebook and Google, Yann LeCun and Demis Hassabis have signed a petition warning of a "*military artificial intelligence arms race*" and calling for a ban on "*offensive autonomous weapons*." [35].

Safety constraints and regulations essentially aim to ensure AI applications are fully beneficial and safe. An AI system that programmed according to our ethical principles and moral values would allow humans to interact with it safely. However, a lack of regulations could have disastrous outcomes harmful to society. However, excessive regulations would hinder us from taking full advantage of all the potential benefits that AI can offer [36].

In summary, the quest for systems utilizing artificial intelligence has the potential to bring unprecedented benefits to humanity, and it is therefore worthwhile to research how to maximize these benefits while avoiding potential pitfalls [37]. AI system development processes must take into account compatibility with human values and comply with specific behavioral principles. The importance of trust needs to be acknowledged in efforts to utilize AI as well as that of practices that can guide the safe and ethical development and management of AI such as assuring of the integrity of the data, algorithms and systems; and protection of privacy and personal information [37].

Perhaps an "objective" ethical code that every nation can agree on will never be possible. This could be resolved such that a free AI is created with common sense and which feel**s** the need to operate on certain ethical value**s** and that makes it as compatible with us as possible to reduce any alienation between us. Providing safety measures to prevent any direct or indirect coercion can only be possible through continuous ethical evaluations and monitoring technological development.

13. Compliance with ethical standards

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Appendix A. Supplementary data

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