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# Ethical issues of Artificial Biomedical Applications

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**Abstract.** While the plethora of artificial biomedical applications is enriched and combined with the possibilities of artificial intelligence, bioinformatics and nanotechnology, the variability in the ideological use of such concepts is associated with bioethical issues and several legal aspects. The convergence of bioethics and computer ethics, attempts to illustrate and approach problems, occurring by the fusion of human and machine or even through the replacement of human determination by super intelligence. Several issues concerning the effects of artificial biomedical applications will be discussed, considering the upcoming post humanism period.

**Keywords:** Bioethics, Artificial Intelligence in Biomedicine, Bioinformatics, Nanotechnology, Post humanism

## 1 Introduction

Aldo Leopold, states that ‘a thing is right when it tends to preserve the integrity, stability and beauty of the biotic community while it is wrong when it tends otherwise’ [1]. The converging of science and technology in several levels through their realizations is used to profit individuals, under the condition that humans serve always-high values and humanitarian ideal. The world of moral debt is, as it should be, the world of science, serving fields sensitive to the human biological identity and uniqueness. The basic characterization of an individual is to have freedom to make decisions, to have emotions and consciousness. Obviously this is not the consciousness of a super-intelligent machine or significant to the morality of Artificial Intelligence (AI). Additionally, nanotechnology is having a great impact on the fields of biology, biotechnology and medicine. This area of nanotechnology is generally referred to as nanomedicine, and sometimes widely called bio-nanotechnology [2]-[3]. Undoubtedly several issues are also related to advanced topics and applications of nanotechnology such as human immortality and democracy, artificial intelligence on nanomachines, therapeutic limitations etc.

Several authors have also argued that there is a substantial chance that super intelligence may be created within a few decades, perhaps as a result of growing hardware performance and increased ability to implement algorithms and architectures similar to those used by human brains [4]. While super intelligence is any intellect that is vastly outperforms the best human brains in practically every field, including scientific creativity, general wisdom, and social skills [5], we must be

very hesitant before we convict the artificial moral way of thinking. AI can adopt our culture, but it is not possible to identify and become a part of our evolution. Obviously super intelligence can produce new knowledge and solutions to hard or NP-complete problems. A smart nanomachine can recognize cancer cells using the tunnelling phenomenon. A machine learning algorithm could give right decisions in the forecast of neurodegenerative diseases like epilepsy.

Of course, it is not ethical to clone humans, but is it unethical to copy the products of artificial intelligence? While scientists are not allowed to 'duplicate' themselves, artificial products can easily be distributed in millions of copies. Emotional disturbance or motives are totally absent from the definitions of artificial intellects. Therefore it is important to control artificial process, but is it ethical any effort for the humanization of super-intelligence? In what way can we criticize or punished a serious error of an intelligent robot during a surgical process? There is no consciousness' risk on prognosis or medical treatment using AI, while the seriousness of illness or death is emotional absent in these cases.

## **2 Emerging Issues in Biomedicine**

While Bioinformatics deal with biotechnology, computer technology and also life sciences, the ethics emerging from this scientific field has to be an amalgam of the two major strands of applied ethics: computer ethic and bioethics [6]. On the other hand the parallel innovating structure of the so called 'convergent technologies', referring to the NBIC tools and including nanoscience and nanotechnology, biotechnology, biomedicine and genetic engineering, information technology and cognitive science, seems to remove any barrier in scientific and technological achievement [7]. The nanodevices which can repair cells, promise great improvements in longevity and quality of life, involving radical modifications of the human genome and leading to the old but diachronic issue of human immorality [8].

Biology itself provides a fully worked out example of a functioning nanotechnology, with its molecular machines and precise, molecule by molecule chemical syntheses. What is a bacterium if not a self-replicating, robot? Already, there are a few nanomedicine products on the market with numerous other potential applications under consideration and development [2],[3],[9]. In vivo disease detection and monitoring using micro-electromechanical systems (MEMS) also appears to be making applications for creating "lab-on-a-chip" devices to detect cells, fluids or even molecules that predict or indicate disease even more probable [10]. The use of MEMS chips and other devices for the purpose of diagnosing or monitoring healthy or diseased conditions is likely to raise grave questions about health information systems, privacy and confidentiality in our healthcare system [11]. The manufacturing of devices able to provide real time processing of several blood levels, leads to a strong cost benefit for people with chronic diseases or organ transplant. Artificial diagnosis could possible prevent illnesses or the impact of a disease and reduce the cost of drug discovery and development using nanodevices, unlike the traditional medicine.

Super intelligence therapeutics can be expected within the next decade for the specific delivery of drugs and genetic agents. This will provide a degree of specificity in the action of therapeutics that could prevent side-effects and improve efficacy [12]. Long-term therapeutic developments would include nanosystems that totally replace, repair, and regenerate diseased tissue. This could involve the correction of developmental defects or the resolution of problems from disease and trauma [13].

Let's assume a Case-Based Reasoning (CBR) system for decision making in reproductive technologies when having children. The system will have the ability to identify the best sperm-eggs, offering potential on individual choice and human rights. Therefore, we have to distinguish the ethics of the reproductive technologies as a human's risk, from the ethics concerning the scientific progress and the AI's progress. The use of AI techniques is totally separated from religious sentiments, human dignity or essential emotional states. But what about the pseudo-philosophical question for the upcoming era of the posthumans?

### **3 Substituting human consciousness with Artificial Intelligence**

Unlike mankind, AI applications can use and manipulate the storage knowledge through scientific or social networks in a more efficient way. Therefore one of the best ways to ensure that these super intelligent creations will have a beneficial impact on the world is to endow it with philanthropic values and friendliness [14]. Additionally, a super intelligence could give us indefinite lifespan, either by stopping and reversing the aging process through the use of nanomedicine [15]. Especially in the field of medical care and biomedicine, the convergence of nanotechnology and biotechnology with cognitive science began to produce new materials for improving human performance. Researchers looked toward biology as a guide to assemble nanostructures into functional devices, where only a small amount of subunits are required to produce a rich and diverse group of functional systems [16]. Bioinspired materials may create difficulties for biologic systems and ecosystems, as their small size allows them to be easily internalized in organisms. These materials can mimic biologic molecules and disrupt their function although toxic effects on cells and animals had been recognized [17].

In most of the cases, the relation of applied artificial intelligence with several environmental and social threats, where humans seems to 'play the God' with natural processes, cause questions of social and environmental nature to arise and wake up fears of the past about who patents and controls this new technology [18]. How immoral and harmful for the human freedom can be the effort to force biology to do a better job than nature has done?

The use of certain kinds of nanomaterials, nanomedicines or nanodevices also raises fundamental questions about human enhancement and human nature, about what are living and non-living and the definition of normal and human entity, against the possibility of post humanism. Nevertheless the extreme possibility of nanomachines going out of control by using their power of reconstruction and self-replication might more likely to happen in terms of a terrorist attack, despite than a machinery revolution. Of course these scenarios concerning the unethical cases of

advanced bio-terroring weapons are totally hypothetical against the applications on artificial biomedicine, genetics and human enhancement technologies.

#### **4 Ethical and Legal Aspects**

The prospect of post humanity is feared for at least two reasons. One is that the state of being post human might in itself be degrading, so that by becoming post human we might be harming ourselves. Another is that post humans might pose a threat to ordinary humans [19]. While the beneficial of technological progress seems to be subjective, homogenization, mediocrity, pacification, drug-induced contentment, debasement of taste, souls without loves and longings – these are the inevitable results of making the essence of human nature the last project of technical mastery [20].

The new species, or post human, will likely view the old “normal” humans as inferior, even savages, and fit for slavery or slaughter. The normal’s, on the other hand, may see the post humans as a threat and if they can, may engage in a preemptive strike by killing the post humans before they themselves are killed or enslaved by them. It is ultimately this predictable potential for genocide that makes species-altering experiments potential weapons of mass destruction, and makes the unaccountable genetic engineer a potential bioterrorist [21].

Is it possible to define the degree of influence of human conscience, dignity, rights and fundamental freedom by merging human and machine? Is it possible to achieve and control confidentiality and privacy on genetic data, without of course increasing tremendously the high quality treatment cost? Who can develop and participate in such scientific experiments, who will be the subject of the experiment and how can we make provision for individuals with special needs? It is important to note, that such social and ethical issues are not specific to nanotechnology alone; any modern technology is the product of a complex interplay between its designers and the larger society in which it develops [22]. The development of nanotechnology is moving very quickly, and without any clear public guidance or leadership as to the moral tenor of its purposes, directions and outcomes; where nanotechnology is leading and what impact it might have on humanity is anyone’s guess [23]. What appears to be missing at the present time is a clearly articulated prognosis of the potential global social benefits and harms that may develop from further scientific and technological advances in all of these areas [24].

According to Humanism, human beings have the right and responsibility to give meaning and shape to their own lives, building a more humane society through an ethic based on human and other natural values in the spirit of reason and free inquiry through human capabilities. The moral person guided from his evolving social behaviour, can easily comprehend and be committed to laws and principles that a scientific field, such as AI or Nanoscience set as a precondition, in order to improve the structural elements of man’s biological existence. What is mainly the problem therefore? Are there any laws and ethical aspects for the consequences of artificial implants in humans, or mainly the consequences from their non-application?

Super Intelligence should be comprehensible to the public, including activities that benefit society and environment, guided by the principles of free participation to all

decision-making processes; AI techniques in Biomedicine, should respect the right of access to information, having the best scientific standards and encouraging creativity, flexibility and innovation with accountability to all the possible social, environmental and human health impacts.

Another aspect of the applied research in biomedicine is the economical cost. The cost of care and also the expectations of citizens are increasing rapidly. Even if research is directed towards solutions economically accessible, the more effective solutions can possibly lead to the unequal distribution of medical care and prompting assurances companies to stop their attendance in the social health system [25].

It is obvious that these ethical codes differ from AI applications in Biomedicine to traditional medical applications due to the influence of other ethical frameworks and perspectives on their basic research and development. Novel Biomedicine methods will allow us to understand down to the atomic and single-cell level how our bodies are performing at any given moment. For some, this information could be helpful, empowering or enlightening and may enhance human health. For others, it is likely that such information could result in fear, anxiety and other mental health issues. Nevertheless, the development of novel therapies based on the convergent of AI, Bioinformatics and Nanotechnology will arise several ethics principles about human rights which have to be followed: moral, political and religious issues but also individual privacy, human dignity, justice, and fair access to the knowledge of the diseases but further more to any possible beneficial therapy. Therefore, it is ethically essential that researchers inform potential research subjects in clinical trials of all details pertaining to the study [26].

## 5 Conclusion

The new realizations of science put the modern person in front of dilemmas, as far as the moral and the legal, the socially acceptable and the pioneering dangerous, the naturally valorized and the technologically innovative [27].

The ethical considerations of innovating technologies have to be announced and explained to the social target groups. Therefore, it is ethically desirable to determine whether new artificial types of prognosis or treatment will be more effective and safe for humans when compared to conventional ones. Undoubtedly artificial biotechnologies will deliver a variety of improvements or a technological and healthcare revolution. The main problem is to study at early stage any social side effects.

## References

1. Leopold, A.: *A Sand County Almanac: And Sketches here and there*. Oxford University Press, New York (1987)
2. Vo-Dinh, T.: *Nanotechnology in Biology and Medicine: Methods, Devices, and Applications*. Boca Raton, FL: CRC Press (2007)
3. Niemeyer, C.M., Mirkin, C.A.: *Nanobiotechnology: Concepts, Applications and Perspectives*. Weinheim, Germany: Wiley-VCH (2004)

4. Bostrom, N.: Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards. *Journal of Evolution and Technology*. 9 (2002)
5. Bostrom N.: How Long Before Superintelligence?, *International Journal of Futures Studies*. 2 (1998)
6. Hongladarom, S.: Ethics of Bioinformatics: A convergence between Bioethics and Computer Ethics. *Asian Biotechnology and Development Review*. vol. 9, no.1, 37-44 (2006)
7. Roco, M.C., Bainbridge, W.S.: Converging technologies for improving human performance. *Journal of Nanoparticle Research*. 4, 281-295 (2002)
8. Drexler, E.: *Engines of Creation*. Bantam. New York (1986)
9. Kubik, T. et al.: Nanotechnology on duty in medical applications. *Current Pharmaceutical Biotechnology* 6: 17-33 (2005)
10. Craighead, H.: Future lab-on-a-chip technologies for interrogating individual molecules. *Nature* 442: 387-393 (2006)
11. Allhoff, F., P. Lin.: What's so special about nanotechnology and nanoethics? *International Journal of Applied Philosophy* 20.2: 179-190 (2006)
12. Patri, A., Majoros, I., Baker, Jr.: Dendritic polymer macromolecular carriers for drug delivery; using nanotechnology for drug development and delivery. *Current Opinion in Chemical Biology* 6(4): 466-471 (2003)
13. Bainbridge, W.S., Roco, M.C.: *Managing Nano-Bio-Info-Cogno Innovations. Converging Technologies in Society*, Springer, 119-132 (2006)
14. Kurzweil R. *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, Viking:New York, 1999
15. Moravec H. *Robot: Mere Machine to Transcendent Mind*. Oxford University press: New York, 1999
16. Mardiyani, S., Jiang, W., Lai, J., Zhang, J., Chan, C. W.: *Biological Nanostructures and Applications of Nanostructures in Biology*. Springer US (2004)
17. Oberdörster, G. et al.: Nanotoxicity: An emerging discipline evolving from studies of ultrafine particles. *Environmental Health Perspective* 113: 823-839 (2005)
18. Preston, C.J.: The Promise and Threat of Nanotechnology. *Can Environmental Ethics Guide US? International Journal for Philosophy of Chemistry*, vol. 11, No.1, 19-44 (2005)
19. Bostrom N.: In Defence of Posthuman Dignity, *Bioethics*, vol. 19, 3:202-214 (2005)
20. Kass, L.: *Life, Liberty, and Defense of Dignity: The Challenge for Bioethics*. San Francisco. Encounter Books: p. 48 (2002)
21. Annas, G., Andrews L., Isasi R.: Protecting the Endangered Human: Toward an International Treaty Prohibiting Cloning and Inheritable Alterations. *American Journal of Law and Medicine*. 28, 2&3: p. 162 (2002)
22. Pool, R.: How society shapes technology, in: Teich, A. H. (ed.), *Technology and the future* (9th edition), Wadsworth/Thomson Learning, Belmont, CA, pp. 13-22 (2003)
23. Berne, R.W.: Towards the conscientious development of ethical nanotechnology. *Science and Engineering Ethics*, 10: 627-638 (2004)
24. Sweeney, E.A.: Social and Ethical Dimensions of Nanoscale Research. *Science and Engineering Ethics*, Vol. 12, Issue 3, 435-464 (2006)
25. Solodoukhina, D.: Bioethics and legal aspects of potential health and environmental risks of nanotechnology. *Nanotechnology-Toxicological Issues and Environmental Safety*, Springer, 167-184 (2007)
26. Donaldson, K.: Resolving the nanoparticles paradox. *Nanomedicine* 1: 229-234 (2006)
27. Alexiou A, Vlamos P, *Ethics at the Crossroads of Bioinformatics and Nanotechnology*, 8th International Conference of Computer Ethics and Philosophical Enquiry (2009)