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Review Article

Current Trends of Artificial Intelligence in Nanosciences Application

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Abstract: Nanotechnologies are being spoken of as the driving force behind a new industrial revolution. Both private and public-sector spending are constantly increasing. In recent years the industries like Automobile, Medical, Space, Communication, Space and Military have realized tremendous benefits originating from discoveries made in the fields of Nanotechnology, Robotics and Artificial Intelligence (NRAI).During the last decade there has been increasing use of artificial intelligence tools in nanotechnology research. Artificial intelligence (AI) and nanotechnology are two fields that are instrumental in realizing the goal of precision medicine tailoring the best treatment for each cancer patient. Recent conversion between these two fields is enabling better patient data acquisition and improved design of nonmaterial's for precision cancer medicine. Diagnostic nonmaterial's are used to assemble a patient-specific disease profile, which is then leveraged, through a set of therapeutic nanotechnologies, to improve the treatment outcome. However, high intratumor and interpatient heterogeneities make the rational design of diagnostic and therapeutic platforms, and analysis of their output, extremely difficult. Integration of AI approaches can bridge this gap, using pattern analysis and classification algorithms for improved diagnostic and therapeutic accuracy. Nanomedicine design also benefits from the application of AI, by optimizing material properties according to predicted interactions with the target drug, biological fluids, immune system, vasculature, and cell membranes, all affecting therapeutic efficacy. Here, fundamental concepts in AI are described and the contributions and promise of nanotechnology coupled with AI to the future of precision cancer medicine are reviewed. Nanoscale applications working alone and in concert with AI will begin to move from the laboratories of the world into the theatres of war. Just as AI systems are now being wholly integrated into military decision making processes such as allowing satellites to deter attacks autonomously, in complimentary fashion, nanotechnology is providing the fabric for military space development.

Keywords: Artificial Intelligence, Nanosciences, Nanotechnology, Nonmaterial

1. Introduction

Innovations in the field of lithography and multi gate processing, such as double and tri gate transistor will also contribute to dramatic increases in processing speed and efficiency when compared to the traditional and increasingly more archaic silicon chip. Both independently and hand in hand with AI, recent discoveries in the field nanotechnology, specifically carbon nanotubes and nonmaterial's, are beginning to radically enhance not only traditional military space systems, but also the entire spectrum of miniaturized military technologies. New nonmaterial's with revolutionary abilities will provide thermal protection, structural integrity improvements, and power generation abilities to satellites and other critical space assets. Due to the inherent and unique properties of these materials, widespread application to the structural and electronic components of space systems is inevitable. Nanoscale applications working alone and in concert with AI will begin to move from the laboratories of the world into the theatres of war. Just as AI systems are now being wholly integrated into military decision making processes such as allowing satellites to deter attacks autonomously, in complimentary fashion, nanotechnology is providing the fabric for military space development [1].

Artificial Intelligence (AI) technology has been developing for many years now; not only as area of technology in and of itself, but also in the various spaces and industries where it can now be found. In the long run artificial intelligence and molecular nanotechnology are poised to shape our world like no technology that has come before [2]. In narrow ways, artificial intelligence has already achieved superhuman capabilities. Machines beat humans at computing prime numbers, charting itineraries, and steering vehicles, for example. While all of these achievements are impressive in isolation, the race in artificial general intelligence is less about breaking more and more records with carefully coded algorithms, and more about creating systems that can generalize to more tasks and to challenges that require qualities which we consider innately "human", such as creativity and intuition. The victory of the Alpha Go program against Lee Sedol, the best human in the game of Go, for instance, was considered significant precisely because Go, when played at the highest professional level, requires a deep intuition for the game as well as creativity. The level of complexity and the number of possible paths is so high that it cannot be solved algorithmically in the traditional sense. AI technologies such as Deep Learning, together with recent developments in computing hardware, offer a way to tackle this complexity. Ultimately, the arrival of artificial general intelligence, while holding promises and perils, is likely to be at least as revolutionary in its capacity to shape its environment as was previously the dawn of humanity. Even likelier, it will exceed our world-shaping capacity by orders of magnitude. The long-term prospects of nanotechnology are on a similarly impactful scale: In 1986 Foresight was founded on a vision of the emerging field of nanotechnology in which current capabilities in nanotechnology lead eventually to fabrication of complex products with atom-by-atom control of the manufacturing process. This ultimate development of nanotechnology, sometimes termed molecular manufacturing and now often termed APM (atomically precise manufacturing), was first described by Richard Feynman in 1959 in his visionary talk "There's Plenty of Room at the Bottom." The ability to manufacture with atomic precision promises a revolution in manufacturing, leading to a world of abundance. Medical nanodevices that cure diseases, can improve health and longevity, nano-enabled photovoltaic's that allow for abundant solar energy can heal the environment, and new materials a factor of 100 times stronger than steel can enable space exploration. For an overview of AI, nanotechnology, and possible roads to artificial general intelligence and molecular nanotechnology, please sees the background reading at the end of the white paper. On a less speculative and more immediate note, the workshop on AI for Scientific Progress arose from a need that became apparent during our workshop series on nanotechnology [3]. Many of the bottlenecks that participants repeatedly stressed during previous technical workshops appeared to be solvable with the help of AI. The design of molecular nanotechnology is a challenge with an unfathomably high level of complexity. Just like a generic computer cannot go through all possible steps in Go in order to beat the game, it cannot model all possible combinations of atoms to form useful molecules. This is where emergent AI technologies give us hope. Qua their computing power and fine-tuned algorithms, AI-tools are uniquely equipped to learn from the abundance of information at the Nanoscale, in ways humans are unable to do. Conversely, nanotechnology research can lead to progress in hardware that can tremendously advance computing power and boost progress in AI accelerating the mutually beneficial feedback loop between the two technologies. The value of this meta workshop, AI for Scientific Progress, was to propose and discuss the most promising routes for immediate collaboration between AI and nanotechnology experts [4].

2. Conceptual Review

2.1. Artificial Intelligence and Nanotechnology

Technology that operates on the nanometer scale often involves intricate systems that are not always suited to the various facets of AI. However, there are some growing areas where AI converges with nanotechnology. In addition to merging the two technologies, combined work in nanotechnology and AI can also boost study in each discipline, possibly leading to all kinds of new tools for gaining insights and communication technologies [5]. Artificial intelligence and nanotechnology have been named alongside nuclear war, ecological catastrophe and super volcano eruptions as "risks that threaten human civilization" in a report by the Global Challenges Foundation. In the case of AI, the report suggests that future machines and software with "human-level intelligence" could create new, dangerous challenges for humanity although they could also help to combat many of the other risks cited in the report. "Such extreme intelligences could not easily be controlled (either by the groups creating them, or by some international regulatory regime), and would probably act to boost their own intelligence and acquire maximal resources for almost all initial AI motivations," suggest authors Dennis Pamlin and Stuart Armstrong. Before understanding what Nanotechnology is, let's first look into the term "nano" (this might remind you of the text editor that is a favorite of many of us Linuxers in the FOSS community!). In both the cases, "nano" simply refers to a scale of measurement. For example, if we want to measure distance in nanometer (nm), a comparable value in meter would be [6]:

$$1 \text{ meter} = 1000{,}000{,}000 \text{ nanometers;}$$

That is, if you take 1 billionth of a meter, what you get is 1 nm. So, it is an extremely small scale of measurement. The video included in this section takes you to that small scale and explains Nanotechnology in a very simple manner. Nanotechnology is the implementation of different techniques using Science, Engineering and Technology in order to study phenomena at the Nanoscale. In general, such studies are carried out in the range of 1-100 nm. Nanotechnology is of immense significance due to its wide variety of applicability in diverse fields such as biology, physics, chemistry, material sciences and many others. As we already know that Nanotechnology works at the Nano scale, it means we can work at the molecular and subatomic level. Nanomedicine, for instance, has a created a revolution in the field of drug delivery because nanotechnology enables the therapeutic molecule (contained in the medicine) to lock on to the desired protein right on target after consumption. This is carried out with the help of Nanoparticles. It is due to Nanotechnology that chemotherapy can now be focused only on the disease affected area, ensuring the whole body need not go through the process of cancer treatment. Thus, the immune system is saved from getting destroyed as chemotherapy involves the use of toxic chemicals to get rid of cancerous regions [7].

2.2. Nanotechnology, Robotics and Artificial Intelligence

In recent years the industries like Automobile, Medical, Space, Communication, Space and Military have realized tremendous benefits originating from discoveries made in the fields of Nanotechnology, Robotics and Artificial Intelligence (NRAI). Advancements in space systems development have been enabled by these fields to their independent contributions, though as technological challenges present themselves, further progress will be achieved through each of these technologies going hand in hand. As researchers work to overcome tomorrow's commercial, industrial, social and military space challenges, the progressive convergence of these respective fields will make possible the future development of advanced space technology, and ultimately space warfare systems. Due to the interdisciplinary nature of NRAI technologies, advancements in future industrial and space systems will experience an exponential growth cycle similar to that observed in the human genome [8, 9].

Though there is tremendous potential for advances in civilian fields such as space exploration, communications and engineering through this convergence, such a process would also be the primary driver leading to advanced arms racing and evolved methods of space warfare. The convergence of nanotechnology, robotics, and artificial intelligence relative to space warfare systems as a function of time is outlined below [10]. In 1965 Moore's Law charted an exponential growth pattern in the complexity of integrated semiconductor circuits and data storage. The unprecedented explosion of computational potential, and in turn affordability, that Moore accurately predicted drove widespread discoveries in the field of computer science, such as the creation of the internet, complicated algorithms, and early Human Machine Interfacing (HMI).

In 2001 Kurzweil's Law of Accelerating Returns extended the growth pattern described in Moore's Law to transcend computers and reach into many other areas of science. Most remarkable is that this scientific and technological growth, which Kurzweil revealed, is not linear but exponential; and it is not limited to just the technology, as humanity accelerates its own potential as well. The way that one technology seems to reach its potential and then suddenly converges with another to become something greater was also observed with the marriage of early genetics research and advanced computer processors [11].

2.3. Nanotechnology Could Be the Key to Smarter Machines

The brain has been described as the most complex structure in the universe and the most mysterious. We know more about our own galaxy, sprawling for tens of thousands of light years, than we do about the 1,200 cubic centimeters of grey matter within our skulls. Though there are about half as many neurons in the brain as there are stars in the Milky Way, its workings arise from the teeming connections between those 100 billion cells a network whose staggering complexities we are only just starting to map. One of the most fascinating properties of the brain is what we call intelligence: the ability to acquire and apply knowledge and skills [12]. We still don't know how the brain does this how we remember things, how we learn, how we think. This is one reason the world has become fascinated by artificial intelligence [13].

AI shows us that it's possible to emulate certain aspects of intelligence simply by feeding data into a computer and using relatively simple algorithms to find patterns that can then be used to make predictions a process called machine learning. The most sophisticated AI algorithms use a machine-learning approach called "deep learning", with multiple layers of artificial neural networks mathematical models loosely based on how real neurons are connected. New applications are emerging every day, from detecting disease to crafting pick-up lines [14]. Yet AI is still no match for the human intellect when it comes to "human" things such as creativity and common sense. Even deep learning remains far from achieving the holy grail of artificial "general intelligence", defined as learning and reasoning abilities across multiple domains from medicine to politics, say and with broad autonomy. AI remains limited to specific tasks and relies on a lot of carefully curated data, as well as computer programming, to optimize how its algorithms execute the task at hand. So called neuromorphic computer architectures are designed to help curb AI's insatiable appetite for computer power, with chips that, like the brain, integrate memory and processing, and are less power-hungry than conventional chips [15].

Even so, AI struggles with meaning and context, and because its inner workings are hard-wired and tailored to narrow tasks, it's also easily fooled by ambiguity and so called black swan events unforeseen developments with drastic consequences. This is in stark contrast to the human brain, which has a seemingly unlimited capacity for learning all sorts of new things and for integrating and applying that knowledge in many different ways. The human brain continuously triages information "natural data" from its ever changing, noisy and unpredictable surroundings in real time, without any assistance. What I'm interested in is determining whether it's possible to replicate this sort of intelligence. To do so requires reproducing the brain's neural network in a "synthetic", rather than artificial, way: that is, creating a physical object whose structure resembles that of the brain, rather than software that mimics (some of) it's functioning [16].

2.4. The Opportunity for "Smart" Brain Machine and Brain Computer Interfaces

Brain machine and brain computer interfaces (we use these terms interchangeably here) represent technologies designed to communicate with the central nervous system: the brain, spinal cord, and neural sensory retina. Clinically, depending on the design and intent of the technology, the goal can be to record and interpret neural signals in order to execute an intended neural command through an external device, or to achieve neural stimulation, often to restore neural function following disease or trauma, or both. Some devices make use of feedback in an attempt to optimize performance, whether physiological or via patient specific intent and instructions. There is also a growing list of non-invasive brain machine interface technologies not meant for clinical use, primarily driven by innovative startup companies. These technologies are intended to augment the user experience and control interface for gaming and augmented (AR) and virtual reality (VR) applications. Although of course very different than technologies aimed at treating and restoring clinical function and quality of life to patients, this is a market that should not be ignored. Not the least of which because it could provide leveraging resources to the benefit of clinically related research. For example, advances in our understanding of the relevant neurophysiology, cognitive neuroscience, mathematical and engineering aspects of signal processing, and hardware, can significantly impact the gaming industry as well as clinical devices and neural prosthesis [17, 18].

As significant as these numbers are, these projections primarily reflect enabling technologies for interfacing between neural control and sensory experiences with machines. They do not reflect opportunities that go beyond what is currently possible with the existing state of the art. BMI that can learn and adapt reflect the cutting edge of what is technologically possible, due to a confluence of BMI technologies, in particular nanotechnologies, machine learning and AI, alongside a continued increasing understanding of the relevant neuroscience. AI can provide opportunities to create "smart" BMI that contextually learn and adapt to changing functional requirements and demands. This has the potential to produce personalized individual experiences in gaming and AR/VR, and allow for the changing requirements associated with patient specific disease progression and evolution in clinical applications. This latter point cannot be overestimated, because not only would it accommodate the differing clinical demands of different neurological disorders, it would allow for patient specific adaptation of BMI functionality to the needs of different patients. And it would allow the technology to continue to adapt as disease progression evolves in individuals over time. One of the significant limitations of current state of the art BMI and neural prosthesis is the assumption of one size fits all. In in other words, the assumption that a technology operating under a specific set or range of functionality will properly treat all patients. While we are not aware (yet) of a device or technology that reflects the actualized integration of machine learning and nanotechnology applied to BMI, we argue that the potential and impact of doing make the subject worth exploring. Each on their own, machine learning and nanotechnology, are already being used in the design and function of BMI and neural prosthesis in a number of ways that align with the vision we propose here [6].

2.5. Intelligent Systems and Nanosciences

The next generation of electronic technology will be smaller, faster and smarter than ever before. Our research into intelligent systems and nanoelectronics is driving this revolution. Much of our research links engineering with nature. Inspired by biological processes, we create electronic, robotic and computational systems with artificial intelligence and emergent behavior. We also develop and apply machine learning to characterize and understand medical signals, autonomous systems and fault tolerance. This systems-level research is underpinned by our fundamental studies into the next generation of innovative nanoelectronics materials and devices, including bimolecular electronic systems and spin-based electron devices [5].

3. Report on the Finding

Artificial intelligence and nanotechnology have been named alongside nuclear war, ecological catastrophe and super-volcano eruptions as "risks that threaten human civilization" in a report by the Global Challenges Foundation. The future of micro/nano sensor applications across multitudes of consumer-related industries in the world is vast. Researchers across the world are currently looking at different ways to integrate sensing devices for future applications such as enhancing the performance of energy generation and storage systems, improving the stability and accuracy of wearable devices to monitor human health constantly, advancing safety and security levels in homes, building, and factories, augmenting robotics capabilities by improving motion sensor-based position tracking, as well as integration of sensors and artificial intelligence techniques to create advanced ubiquitous cyber-physical sensing networks. Audio and other physical and chemical inputs. Many researchers worldwide are now developing novel sensing devices using MEMS and nano-fabrication techniques to advance their transduction capabilities. Without a doubt, the application of micro/nano sensing technologies will be proliferating in almost every aspect of our daily lives, including healthcare, virtual reality, autonomous, safety, and robotics products. For example, with the recent advancements in micro/nano sensing devices and micro/nano fluidics, biosensors are positioned to find useful applications in medicine as diagnostics tools, and as well as drug discovery and monitoring devices. On the other hand, when coupled with artificial intelligence, Smart Sensor Systems technology will revolutionize the world in the coming decades. By ensuring the integrity and reliability of the Smart Sensor Systems, this emerging technology will find applications in human-computer interaction devices, consumer electronics products, communication devices, home automation and monitoring, robotics, transportation, medicine, and military.AI could design and optimize nanotechnology development, accelerating nano-level manufacture of all kinds of substances [3].

We are very fortunate indeed to be living at a time where the speed of advances in medical technologies is such that we can expect to live increasingly healthier and longer lives; far beyond what would ever have been imagined as possible only a century ago. However, in contrast to our natural inalienable human rights to life, liberty, and the pursuit of happiness, our equally important right to good health (and by extension good health care), which is critical for all of us, is unfortunately either in disarray, dysfunctional, or completely neglected on a global scale. The field of nanotechnology, much like the rest of scientific research, has seen an exponential increase in the number of research papers available. Keeping up to date with the latest relevant research can present a challenge. One way to stay informed could be searching journals in the area of nanotechnology or signing up for email alerts [7].

4. Discussion on the Finding

Artificial intelligence (AI) and nanotechnology are two fields that are instrumental in realizing the goal of precision medicine tailoring the best treatment for each cancer patient. Recent conversion between these two fields is enabling better patient data acquisition and improved design of nonmaterial's for precision cancer medicine. Nanotechnology is evidently a very popular buzzword, comprising of several remarkable applicability's in Science and Technology. In this new article for Open Science and Artificial Intelligence, we will explore how both of them impact Nanotechnology research. In the case of nanotechnology, the report notes that "atomically precise manufacturing" could have a range of benefits for humans. It could help to tackle challenges including depletion of natural resources, pollution and climate change. But it foresees risks too. "It could create new products such as smart or extremely resilient materials and would allow many different groups or even individuals to manufacture a wide range of things," suggests the report. "This could lead to the easy construction of large arsenals of conventional or more novel weapons made possible by atomically precise manufacturing [16]."

The foundation was set up in 2011 with the aim of funding research into risks that could threaten humanity, and encouraging more collaboration between governments, scientists and companies to combat them. That is why its report presents worst-case scenarios for its 12 chosen risks, albeit alongside suggestions for avoiding them and acknowledgements of the positive potential for the technologies involved. In the case of artificial intelligence, though, Global Challenges Foundation's report is part of a wider debate about possible risks as AI gets more powerful in the future.

Artificial Intelligence (AI) has been an increasingly growing area for many years now; not just within itself, where the areas of machine learning, deep learning and artificial neural networks (ANNs) are now powerful methods in their own right, but also in the amount of areas and industries that they are now prevalent in. The adoption of artificial intelligence alongside the Internet of Things (IoT), industrial Internet of Things (IIoT), and the ever-developing industry 4.0, has already revolutionized many production and monitoring process across the chemical, mining and manufacturing-based industries, but it still continues to grow. So where does that leave nanotechnology and AI? It is true that the adoption of AI with nanotechnology has not been as widespread as other scientific industries, however, nanotechnology often requires more complex systems that are not always compatible with some aspects of AI (or it makes it harder to implement). That being said, there are some developing areas where AI converges with nanotechnology [6].

5. Conclusion

Nanotechnology combines the knowledge of physics, chemistry and engineering, AI has heavily relied on biological inspiration to develop some of its most effective paradigms such as neural networks or evolutionary algorithms. Bridging the link between current Nanosciences and AI can boost research in these disciplines and provide a new generation of information and communication technologies that will have a large impact in our society, probably providing the means so that technology and biology merge. Unsurprisingly, AI is also extremely useful with respect to the future of noncompeting, which is computing conducted through Nanoscale mechanisms. Currently, there are a lot of ways noncompeting devices can execute a function, and these can cover anything from the physical operations to computational methods. Due to a great deal of these devices depending on intricate physical systems to allow for intricate computational algorithms, machine learning procedures can be used to generate novel information representations for a broad range of uses.AI can also help with the future of noncompeting, that is, computation which is performed through Nanoscale devices. There are currently many ways that these devices can perform a function, and these range from the physical operations to computational approaches. Because of a lot of these devices rely on complex physical systems (e.g. plasmons) to enable complex computational algorithms to be performed; machine learning methods can be employed to provide novel data representations for a wide range of applications. Of course, there are always sensor networks that employ a wide range of AI methodologies. However, these are not strictly limited to nanosensors, because a sensor system that uses the same AI algorithms across its whole network will not strictly be limited to nanosensors, or nano-inspired sensors. As the arrival of strong AI. draws ever closer, along with it will come the realization that computing on such a scale and breadth is beyond our human ability to maintain and monitor even with the assistance of the machines themselves. We will begin to turn over the keys to the IT department to the computer within it, as non biological intelligence has the ability to drive its own evolutionary cycle, with human oversight existing from afar, at specific points in the data stream.

References

[1] C. Road, "Internet of Nano Things (IoNT): Next Organic Process Step in Technology," vol. 5, no. 3, pp. 1–10, 2018.

[2] R. Member, "Nanotechnology: The Future is Coming Sooner Than You Think," 2007.

[3] G. Katalagarianakis, "Shaping Europe â€TM s Future," 2020.

[4] F. Dressler and S. Fischer, "Connecting In-Body Nano Communication with Body Area Networks: Challenges and Opportunities of the Internet of Nano Things," vol. 6, pp. 29–38, 2015.

[5] G. A. Silva, "A New Frontier: The Convergence of Nanotechnology, Brain Machine Interfaces, and Artificial Intelligence," vol. 12, no. November, pp. 1–8, 2018.

[6] B. A. Bowser, M. Sloan, P. Michelucci, and E. Pauwels, "Artificial Intelligence: A Policy-Oriented Introduction," no. November, 2017.

[7] N. Subcommittee, N. Science, and T. Council, "THE NATIONAL NANOTECHNOLOGY INITIATIVE SUPPLEMENT TO THE PRESIDENT' S 2019 BUDGET," no. August 2018.

[8] "Nanoscience and nanotechnologies: opportunities and uncertainties," no. July, 2004.

[9] J. B. Lewis, "Artificial Intelligence for Nanoscale Design Artificial Intelligence for Nanoscale Design," 2018.

[10] T. Review, "Artificial intelligence in nanotechnology," 2013.

[11] "Structure prediction of hybrid nanoparticles via artificial intelligence (HNP-AI)," 2017.

[12] N. A. Ochekpe, P. O. Olorunfemi, and C. Ndidi, "Nanotechnology and Drug Delivery Part 1: Background and Applications," vol. 8, no. June, pp. 265–274, 2009.

[13] M. Ai, E. Systems, E. Ramedis, D. Warhouse, and E. Pathaligner, "Applications of Artificial Intelligence Bioinformatics," 2018.

[14] U. S. Epa and A. Osa, "Nanotechnology White Paper," no. February, 2007.

[15] W. S. Bainbridge and M. C. Roco, "Science and technology convergence: with emphasis for nanotechnology-inspired convergence," 2016.

[16] M. F. Aznar, "AI for Scientific Progress Workshop," 2016.

[17] S. Africa, S. African, and A. Manufacturing, "National Policies and Strategies (Draft Unedited Version, 3 May 2019)," no. May, pp. 1–11, 2019.

[18] O. International and F. Programme, "Opportunities and risks of Nanotechnologies."