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APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN SCIENCE

Aneeta Rawat

Assistant Teacher (Sci/ Maths), Govt. High School Mittai, Barabanki - 225301, Uttar Pradesh, India.

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Correspondence should be addressed to
Aneeta Rawat,
Assistant Teacher (Sci/ Maths), Govt High School Mittai, Barabanki - 225301, Uttar Pradesh, India.

Email- aneetarawat@gmail.com

ABSTRACT: The advanced specialties are gradually embracing artificial intelligence in complex activities, contributing to automation; biology, medicine, physics, chemistry, and ecology, as well as data analysis and perception and discovery of new opportunities. This paper on the numerous applications of AI explores how adoption of AI based methodologies is reinventing every scientific field. These areas involve artificial intelligence (AI) in enabling genomic, proteomic, and pharmaconomics as well as in formulating patient specificity drug discovery and patient-tailored therapeutic interventions that may fast-track medical outcome and diagnosis processes. AI in turn helps chemist and physicists to simulate complex systems, predict properties of molecules, and fine-tune chemical processes. By integrating AI into environmental science and space, application such as auto space mission, enhanced climate modeling and ecosystem dynamics are some of the achievements that resulted from the integration of AI. Further, the article includes some of the ethical issue with AI such as bias, privacy, and the limitations of current AI technology. A more significant level of work across disciplines, independent research initiatives, and laboratories powered by artificial intelligence is one of the possible scenarios. At any rate, artificial intelligence influences the external environment and acts as the driving force for changing the entire picture of science as well as pushing the boundaries of knowledge.

Key Words: Artificial Intelligence, Scientific Research, Data Analysis, Autonomous Systems, Ethical Considerations

I. INTRODUCTION

The term artificial intelligence defines a compilation of methods that enable a computer approach to deliver a result in a manner similar to human intelligence. Education, enlightenment and correction are all components of this method. Knowledge involves assimilation of data and principles which allow for the use of the data. Reasoning involves the use of rules, where by one arrives at much more or much less certain conclusions. Some of the AI techniques include machine learning, deep learning and neural network that are turning the world around various industries and making computers do the work which were only feasible to human beings [1]. It is worth underlining the dramatic growth of AI as a research tool during the last few years; it provided scientists with the opportunity to address goals that were insoluble before due to data volume or peculiarity. Due to integration of AI to science, investigators have been able to address great challenges about the exponential increase of information across scientific fields. Big Data is common in genetics, astronomy, and physics, and it has different issues which traditional methods of handling data often do not solve. AI functionality in handling big data makes it a useful tool for researchers willing to extract the greatest amount of information out of their data [2]. In the recent past, the application of AI has been on the rise in the physical process simulation, partial data prediction and, pattern that human eye cannot identify [3].

AI has already shown that it can make progress in the biological sciences and change the way people are cared for more rapidly across areas such as genomics, proteomics, and structure modeling and drug discovery. Climate analysis, weather forecasting, and the tracking of ecological patterns and changes are few examples of environmental science that greatly incorporate AI methods [4]. The two areas in physics that have utilization for AI are particle physical and quantum computation. In these fields, machine learning is necessary for performing comprehensive simulations and to find information based on the data provided [5]. Due to the molecular modeling and reaction prediction by AI, chemical discoveries have been advanced to make room for new materials and non-hazardous processes.

Many practical and ethical dilemmas with the use of AI exist and concerns are increasing proportionally to the developments of AI. Some of them are the concern of privacy of data, the explanation of AI systems and fairness of the algorithms used. There are issues that have to be solved if we are to prevent AI from becoming an irresponsible part of the scientific progress.

It is therefore the main aim of this paper to explore the nature and functionality of AI as a revolutionary tool in a myriad of scientific subjects as well as the challenges and ethical issues surrounding this science. They will be able to see how the artificial intelligence is influencing the scientific perspective and is assisting in revealing something that was beyond the human capacity to do, following a brief study of data analysis, physics, biology, chemistry, and environmental science.

Table 1: AI Applications Across Scientific Disciplines

Discipline	*AI Application*	*Example Use Cases*	*Impact*
Biology	Genomics, Proteomics, Drug Discovery	Predicting gene expression, protein folding, disease markers	Accelerated research, Personalized Medicine
Physics	Quantum Physics Simulation, Particle Physics Analysis	Quantum many-body problem, Particle detection at CERN	New material discovery, Fundamental research
Chemistry	Reaction Prediction, Molecular Property Estimation	Predicting chemical reactions, New material design	Efficient chemical processes, Green chemistry
Environmental Science	Climate Modeling, Ecosystem Monitoring	Climate simulations, Deforestation tracking	Improved environmental policies, Conservation
Astronomy	Celestial Object Identification, Exoplanet Discovery	Galaxy classification, Gravitational wave detection	Expanded knowledge of the universe

2. AI in Data Analysis and Scientific Computing

AI advancements have significantly impacted data analysis, scientific computing and more notably in handling of so called big data. Higher efficiency of data analysis techniques has been called for in modern scientific investigations because of the realities of the data avalanche brought by experiments, simulations, and observation. Deep learning (DL) and machine learning (ML) deliver powerful tools for analyzing large and complex data for insights. AI enhances researchers' analysis and interpretation capacities by mechanizing previously manual and tedious jobs thereby augmenting the speed of discovery [6].

2.1 Big Data and the Role of AI in Scientific Research

In the current world, large amount and often real-time data are being produced in scientific research across different disciplines. A large volume of data is produced yearly from the LHC at CERN and other high throughput sequencing techniques employed in genomics. AI is needed since conventional computational approaches are not capable of processing such data effectively. This has made them more essential especially the Algorithms based on ML, because of their ability to search through humongous amount of data looking for similarities in an effort to make conclusions [7]. Science disciplines including astrophysics utilize telescopes to generate big data and AI efficiently identifies patterns and mines those big data. AI systems are currently capable of receiving large volumes of observational data and identifying other celestial bodies, planets outside our solar system, and various happenings in space. As an example of how AI could identify a trend humans could not, machines that Google created and found two new planets in space based on the collected information by NASA's Kepler satellite telescope. Actually, artificial intelligence being capable in managing data intensive operations, it is an essential tool for modern scientific computing [8].

2.2 AI Algorithms and Their Applications in Data Analysis

Two, the ability by which machines learn from data that forms the core of artificial intelligence's data analysis capabilities is the algorithms. Most machine learning algorithms employed in academia fall into one of three main categories: This is the division of learning into supervised learning, unsupervised learning or reinforcement learning. Classification and regression problems are common in physics and biology and other such fields and the associated methods used are neural networks, decision trees, support vector machines [9]. Critically applied in areas such as chemistry and genetics, the methodology organises the data into approaching structures with algorithms such as PCA and k-cluster.

This is especially so given that deep learning – a remit of the broader ML – has recently emerged as the most effective approach to modelling complex data. These approaches encompass image identification, language processing, time series analysis to name but a few, recurrent neural network (RNN) and convolutional neural network (CNN). In medical imaging for example, deep learning-based AI systems have superseded all traditional methods in illness diagnosis through x-rays, MRI scans, and even CT scans. Such methods are at present already indispensable especially in the field of medical research since the diagnostic accuracies have been enhanced to greater heights [10].

2.3 Scientific Simulations and AI

In fact, data analysis also has been fundamentally transformed other extensions of artificial intelligence also have undergone a revolution in science: simulations. The complex mathematical problems require a lot of computational power, especially when addressed with traditional scientific computing models, often employed in chemistry, climatology, physics and other branches [5]. Neural networks used in AI models offer an opportunity to implement faster simulations with less computational load because there is always a way to approximate these equations. Machine learning models have helped to minimize laborious and costly physical investigations in this and other fields of quantum chemistry, such as modelling chemical reactions and predicting molecular properties [11]. For these purposes, it is necessary to analyze large amounts of data, and, therefore, climate modeling has also incorporated AI-driven simulations. Thereby, obtaining more detailed climate models would enhance the use of AI in terms of the timeliness and accuracy of the forecasts. AI accelerates the amount of time that it takes to run experiments and generate hypotheses about underlying systems; doing more experimentation and generating better models allows scientists to better test and understand certain processes such as the weather, climate shifts, or alterations to ecosystems [12].

2.4 AI's Future in Data Analysis and Scientific Computing

It is clear that the application of AI in supporting analytical data and scientific computing is in its infancy. Researchers are looking into specialized forms of AI such as generative methods and transfer learning and whereby models are able to learn from one domain and apply this knowledge to another. The ability to interpret AI systems is one of the critical factors still under development but already on the way to providing new solutions to other problems in the scientific community while making access to proper data analysis tools more available to the general population. Numerical solution of problems will remain at the center of scientific computing because of better systems of artificial intelligence (AI), the availability of big datasets, and high-performance computers [13].

3. AI in Physics

In such disciplines as quantum mechanics and cosmology, the specialty of artificial intelligence or AI, is revolutionizing research in physics. Using the help of AI physicists can sort through immense sets of data and complex models which in turn enable them to discover truly novel patterns and advance much further than before even imagined. Several branches of physics found application of artificial intelligence techniques like neural networks, machine learning, and deep leaning to model the system, analyze the experimental data, and reveal new physics [5].

3.1 AI in Quantum Physics and Simulation

Now one of the emerging fields that have greatly benefited from AI is quantum mechanics. Due to the exponential increase in computational complexity in system size, quantum system simulation is well known to be challenging. When the quantum structures are larger, classical computers mostly fail to handle such computations fractionally. Quantum many body problems are some of the most basic issues that are required in the understanding of phenomena such as quantum phase transition and super conductivity although AI models particularly the deep learning algorithms have shown incredible potential in the approximation of solutions to the problems [14].

Some quantum states have been modelled and behaviour of complex quantum systems has also been predicted by employing neural networks such as deep convolutional networks and The Restricted Boltzmann Machines (RBM). An example of this advance is known as 'neural quantum states' or NQS for short, this is due to the use of AI algorithms to teach itself how to explain the details of wave functions in quantum particle sub ject matter. This opens the possibility for the physicists to study new types of quantum phase which have not been looked at before and to simulate material behaviors in quantum level when in classical approaches are too slow to be computationally efficient [15]. This field benefits immensely from artificial intelligence because of these models, which significantly alter the time and computational power required in quantum simulations.

Moreover, massive support to quantum computing has been offered through algorithms spearheaded by AI. Furthermore, to increase the precision of quantum computations and work load time for quantum circuits and algorithms, reinforcement learning techniques are applied. This is usually the case with any quantum computing breakthrough regardless of the domain of application with examples being cryptography and material science amongst many other fields where new insight into complexity is expected [16].

3.2 AI in Particle Physics

Artificial intelligence is also finding its way into particle physics, particularly with issues to do with the vast amounts of information generated by accelerators such as CERN's LHC. It is therefore imperative that intelligence be inserted within these gizmos to decode signals from the cacophony presently produced by LHC, which is approximately 90 petabytes annually. Popular classification algorithms such as deep neural networks DNNs, decision trees, and support vector machines SVMs are used to go through this data in order to identify new particles, or other physical phenomena that would not be detected through more conventional means [17].

On example of the use of AI in particle physics is the discovery of the Higgs boson made in 2012. The LHC experiments observed large amount of data, which were scrutinized by employing AI Systems. Since then, the AI methods developed have changed, thus enabling the construction of more sophisticated models to help identify new particles and to understand the basic forces governing the universe. CNNs and other advanced neural networks have displayed superior ability to detect patterns in the collision data to help physicists experiment with Standard Model's limitations [18].

Moreover, the application of optimization for collision modelling is a realm where AI plays a crucial role. With the help of GANs and reinforcement learning physicists can simulate particle interactions and test the theory without spending time and money on experiments [19]. AI based novel methods enhance both the efficiency of experiments and the discovery rate in high energy physics.

3.3 AI in Material Science and Condensed Matter Physics

With the progress in the field of AI, both materials science and condensed matter physics are being helped to a large extent. Often, it is impossible to apply traditional modeling methodologies in such areas because they constantly involve the analysis of multifaceted object environments, including analysis of multiple particles' interactions. By using the present and the machine learning algorithms it is feasible to predict characteristics of new materials or to discover hitherto unknown phases of matter or to enhance the process of creating the materials with the specific characteristics [20].

Superconductors and magnetic materials among other new technologies require appropriate predictions of material attributes including the crystallography and phase transformations that are possible through the use of artificial intelligence techniques. It shows that knowledge derived from experimental data and computer simulations can be used to train artificial intelligence models to help in the development of new materials with required characteristics [11]. Inasmuch as this has done away with time-consuming and tedious trial and error this has revolutionised the field of material science in as much as it has provided a means of arriving at a design brief for materials that will offer certain functionality.

3.4 AI in Cosmology and Astrophysics

AI has been employed in the analysis of vast amounts of data which are transmitted to astronomers by satellites and telescopes. Machine learning is used by cosmologists to map the structure of the universe on large scales, to search for gravitational waves, and to study distribution of dark matter. The phenomena which fall in this category are classifying galaxies on the basis of morphological characteristic, analysing cosmic microwave background radiation and detecting any irregularity in astronomical data which can be early sign of some new physical phenomena and so on [21]. Surveys in astronomy depend on AI because of its ability to analyze a vast amount of data and identify the rarity, such as supernovae or black hole mergers. The field where artificial intelligence has been incorporated is in modeling cosmic evolution and galaxy formation which provided new insights into some of physics' fundamental questions [22]. AI is increasing the understanding of the universe mainly in one way; allowing scientists to see and understand data in an unprecedented fashion.

4. AI in Biology and Medicine

Due to AI, leading into a new age of quicker, more accurate and precise research, diagnosis and treatment in the biological and medical fields. Subfields of artificial intelligence (AI) including machine learning (ML), deep learning (DL), and neural networks enabled researchers as well as doctors to cope with huge volumes of medical and biological data generated today, easily process it and identify patterns which would be difficult for human beings to discern. Drug and diagnostics development, creating new form of treatment, are some of the areas where medical and biological uses of artificial intelligence are popular. Such advancement in society and this particular field is helping to spur on major improvements in healthcare and biological research [23].

4.1 AI in Genomics and Proteomics

With the advent of NGS technologies that in one run generate big data, it has indeed been beneficial to incorporate various artificial intelligence techniques in the field of genomics which deals with genes and their actions. Harnessing this vast data set of genomes, stronger diagnostic and therapeutic markers for diseases may be developed by algorithms built from artificial intelligence [24]. Causative relationships of disease susceptibility to genetic traits have been explored through deep learning methods whereby the effects of these variations on both gene expression and splicing have been predicted [25].

Proteomics, the large-scale study of proteins has also been enhanced by the adoption of artificial intelligence. Since DeepMind's AlphaFold protein structure has moved to the next level of molecular biology especially in protein structure prediction. The disadvantages of X-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy are that they are costly and time-consuming experimental techniques which AlphaFold uses deep learning to predict the 3D structures of proteins with incredible precision [26]. Various fields of study thy reveal a lot on biotechnology, medication and diseases are likely to gain a lot from this breakthrough.

4.2 AI in Drug Discovery and Personalized Medicine

New pharmaceuticals' creation is among the most significant medical AI applications. The process of bringing a new medicine from an idea to market used to take more than ten years and cost billions of dollars. It is possible that by assessing vast chemical databases and wandering potential interactions between chemicals and biological targets, AI will be able to increase this process's efficiency. Minimising the number of molecules that go through the experimental processes, these algorithms may estimate toxicity and therapeutic efficacy of molecules before their synthesis [27].

Another area is the so called personalized medicine, which aims to adapt treatment to patient's genetic makeup, environment, and other conditions. A number of AI frameworks are capable of predicting how a single patient should be treated based on the person's genetic data as well as other specifications like medical history as well as biomarkers. For example, in oncology, AI is assisting doctors in developing a unique course of action by estimating how the tumors would respond to the treatments [28].

4.3 AI in Medical Diagnostics

Without doubt, the most revolutionary application of artificial intelligence in health care sector is in diagnosis. AI diagnostic systems for sickness detection and diagnosis have been found to be better than human specialists, especially for Medical Imaging. Deep learning models including the convolutional neural networks have been widely used by radiologists in diagnosis of cancer through pictures of X-ray, MRI or CT scans, cardiovascular ailments including heart diseases and neurological disorders. In general, it can be stated that AI algorithms achieve the same or even better results than more traditional approaches to diagnosis in less time [10].

For instance, analyzing of retinal scans, AI systems can identify symptoms of diabetic retinopathy, being one of main reasons of blindness, as often as or even more accurately than eye doctors [29]. Also, AI is discovering more applications in pathology as a tool to diagnose tissue samples. This field is getting promising results better or similar to human pathologists in complex or nearly negative cases as far as detection of malignant cells is concerned [30].

It is for the same reason that artificial intelligence has also gained a lot of ground in clinical data-based diagnostics. Systems that utilize artificial intelligence (AI) analyze the patient's electronic health record (EHRs), lab results, and other clinical information in order to diagnose and predict disease as well as recommend treatment. For instance, it will involve using the data of such patients in order to have artificial intelligence systems to predict when the onset of sepsis will occur, a condition that, if treated early enough, has better hospital mortality rates [31].

4.4 AI in Epidemiology and Public Health

Applications of artificial intelligence are now seen in field of public health and epidemiology especially in disease modeling and surveillance. The movement from reactive processing or handling to predictive, pro-active in the spread of the infectious diseases and the assessment of the treatments side by side with the ability to forecast new episodes of such diseases such as COVID 19 was evident in artificial intelligence. There are nice benefits such as being capable for observing, prediction, and tracking of diseases with a help of artificial intelligence models using large data from many origins such as social networks, travel history and medical histories [32]. Thr role of AI appears to be viable in related fields of pubic health like disease surveillance, identification of risk populations, implementation of resources and forecasting of impact of interventions. For instance, during the rise of the COVID-19 epidemic, distribution methods for vaccines were constructed as well as predesigned by using the AI models, in order that the high-risk individuals were the first to receive the vaccines [33]. AI is very valuable to disease prevention and control around the world because the technology is versatile and can work on almost any data available.

5. AI in Chemistry

AI is now enabling the process of revolutionising chemistry research at the breadth, depth, and velocity. Chemical theory and chemical computation are a few of the fields where AI growth helps neglect molecular property guesswork, devise new compounds, and optimize reactions. Chemical research means working with complex data; however, the kind of challenges that can hardly be solved applying classical methods can be solved applying methods such as ML and DL. AI is also being used in nearly all areas of chemistry including learning molecular modeling and reaction prediction, and possibly the design of green chemistry processes [11].

5.1 AI in Molecular Modeling and Property Prediction

In the chemical sciences there are two areas that have been hit most by artificial intelligence and that is Molecular modeling an property prediction. First, it is assumed that one must be able to predict certain molecular characteristics, such as boiling point, solubility, reactivity, when synthesizing a new material or a drug. Molecular modeling utilised costly ab initio quantum physics and classical force fields in its previous methodologies. To least computational expenses and time for molecular property predictions AI particularly the machine learning algorithms can be trained over chemical databases. This can be initiated far with lesser effort in order to establish high accuracy predictions [34]. These chemical properties are in fact predicted by the utilization of deep learning methods like Graph Neural Network (GNN) and Convolutional Neural Network (CNN) on the structures of those corresponding chemicals. These models function well in this respect because rather than modeling molecular formations as simple graphs in which nodes symbolise elements and edges symbolise covalent bonding. It creates a precondition for machine learning to recognize a priori unknown chemical compounds by making it possible to search for complex interdependencies between molecular structures and their characteristics. The studies employed the QM9 dataset to teach AI models that would estimate the properties of other similar molecules. It has also accelerated finding new compounds for medical research and for materials science since it has provided quantum mechanical characteristics of thousands of organic compounds [35].

5.2 AI in Reaction Prediction

There was a question in chemistry for a long time when AI recently started to solve it with great success – that is the ability to predict chemical reactions and their consequences. The broad idea of reaction prediction is partially about recognizing which of the product is likely to occur from given set of chemicals. This technique has in the past been solved by heuristics and Rule-based approaches which involved a lot of human knowledge of the problem. This process can be however automated especially by use of reinforcement learning neural network models that have been trained on terabytes of chemical interactions [36].

It should however be noted that a wide range of deep learning methods has however been established as very effective in reaction prediction. For example, the models based on the transformers and the recurrent neural networks (RNNs) that have been trained for forecasting the results of chemical processes. These models work through being able to sift through large databases of chemical reactions and then gauge which reactions are likely to produce the desired products. To better consider reactions, resources such as “ASAP” (Automated Synthesis AI Predictor) was conceived to try and predict organic synthesis routes using AI [37]. These models, and there are many of them, have become popular among academic and industrial chemists because they improve the probability of such an outcome and hasten the prediction of the reaction plan.

5.3 AI in Green Chemistry and Sustainable Practices

The final strand whereAI is growing equally quickly is the advancement of green chemistry and sustainability. Green chemistry may also be defined as the conception of chemical products and processes that incorporate measures that effectively eliminate or minimally generate many hazardous substances. This contribution has been done through process optimization, reduction of wastes generation and development of green chemicals and materials [38]. Another application of AI is in the designing of catalysts for the chemical processes: these can improve upon the efficiency of the chemical processes without the need for much energy, and consequently the resulting toxicity.

Sustainable utilization of renewable raw material in reaction technologies also extend from the utilizations of artificial intelligence. Use of such an application is the coherent dispersal of the AI models in the production of biodegradable polymers and other material; that are sensitive to the environment. AI can also maximize synthetic routes to pharmaceutical and therefore reduce risk factors that are associated with the use of lethal reagents and solvents in the pharmaceutical production. All these improvements will aid the chemical industry to attain as well as achieve its sustainability purposes and reduce the impacts to the surrounding environment.

More still, chemical research as a discipline that includes synthesis of new material as well as designed improvement of existing processes aimed at minimizing wastes and increasing resource efficiency of circular epoxy ideas can also benefit from AI. The present push for global efforts is to minimize the appearance of plastic waste in the environment is a hoped for improved way of sorting and processing plastic trash; a recycling artificial intelligence system. AI is picking up on the sustainable chemical processes on two fronts: the sustainably of the material produced, and the methods that are used in the recycling or reusing of the chemical constituents [39].

5.4 AI in Drug Design and Medicinal Chemistry

Medicinal chemistry and AI is on the rise these days and has brought a significant decrease in the time needed for the identification of new therapeutic agents. Testing one compound against another is a tiresome and an expensive phase of drug discovery consideration as large population of compounds is tested against a few potentially eligible candidates. Chemical compounds can also be predicted for biological activity, so the use of AI and especially, deep learning models helps reduce the amount of chemicals that need experimental testing. This method is also referred to as "In silico drug discovery" [40].

Another field in which AI has been identified is the design of drug molecules with certain characteristics. GANs and VAEs are two of the generative models that can learn the distribution of drug-like chemical and then generate other compounds of similar or improved qualities. It helps them to develop new products or new molecules. It has been made possible by the use of the methods touched on above in the design of medication candidates for disease such as Alzheimer's and cancer that maybe associated with possible reduction in the time to market for novel therapeutics [41].

6. AI in Environmental Science

Artificial intelligence is a crucial tool in environmental problem solving because it makes it easy to understand big datasets and enhance the precision of ecological system predictions. Using AI has several potential uses in environmental science, including but not limited to: and also for climate modeling, the prediction of the weather, for the monitoring of biodiversity and conservation programs. AI enabled solutions are useful in climate change, ecosystem conservation or the management of our natural resources, important considerations in an age that demands timely and accurate approaches to environmental management.

6.1 Climate Modeling and Environmental Monitoring

Currently, AI has taken over environmental monitoring and climate modeling through its efficiency in providing real-time environmental updates and improving the accuracy in climate models. Because of the complexity of climatic systems, conventional climate models often fail in their computational estimation of the processes of physical change. Presumably, by detecting patterns in extensive datasets, these simulations may be improved by using AI and, in particular, the ML/DL models; the accuracy of the forecast of climatic events.

AI advances the way weather is predicted by using complex computation to run through large amounts of meteorological data for accurate patterns of the weather. For example, phenomena like thunderstorms and hurricanes and long-range weather conditions such as climate change can all be forecasted by DL models. Modern AI-based platforms for weather forecasting create real-time forecasts as a result of computing complex weather interactions due to the information gathered from sensors, images from satellites and other records. AI has the potential of helping disaster planning and risk the management by noting down signals of extreme weather conditions [42].

AI is implemented also in another area of climate change modeling. Using real-time environmental inputs, climate in the present and also historical climate data, the model could predict future possibilities of a world with even higher global temperatures and sea levels, and different patterns of precipitation. Such simulations may help researchers and politicians come to more informed decisions about the efficacy of various climate policies and intervention methods to blunt the impacts of climate change [12]. Secondly, renewable energy systems are being advanced using AI applied to demand forecasting and control of power networks. It is also causing a reduction in fossil fuel utilization as well as carbon emissions [43]. Ecosystem monitoring involves using artificial intelligence AI techniques such as computer vision and remote sensing for image analysis in the ecosystem such as water quality, desertification, and deforestation. With such changes in the use of the land detected by AI models expeditiously, governments and environmental groups will be in a better position to fight illicit logging, land degradation and pollution. Environmental health indicators such as air and water quality are also also, constantly monitored with aid of environment sensors which are enhanced by artificial intelligence [44].

6.2 AI in Conservation Biology

Increasingly, conservationists and biological scientists are relying on artificial intelligence to monitor species, and risks to them, and the cumulative impacts of environmental degradation. Since ancient times, the conservation activities have relied on demanding, slow and oftentimes restricted field inventories and data collection. However, through artificial intelligence viewing big amounts of data collected by drones, remote sensors, and video traps becomes possible which contributes to the improvement of animal populations' and their environments' monitoring.

One the of the biggest applications of AI in the study of conservation biology is monitoring of endangered species. Nonintrusive technologies like camera trapping can be connected to AI to help analyze various features of individuals in animal images: position, size, and patterns to estimate population size without the need to capture the animals. One application of the CNNs is to sort through pictures of wild animals with the intention of helping to identify endangered species and also to distinguish between them. Another thing is that these AI tools can be very helpful for conservationists, in order to track changes in population density, detect poachers, and assess the effectiveness of the latter [45].

Two more applications of the AI are the mechanisms for study of Biodiversity and ecological dynamics. When integrated with remote sensing, we learn the effectiveness of assessing satellite and aerial images for studying shifts in system species on a larger scale. Using the data like the shift in species location, the changes in land cover and vegetation, the machine learning algorithms can create value by providing information about how these ecosystems are coping with threats like climate change and habitat loss. Thus, artificial intelligence helps environmentalists decide what restorative and protective actions require implementation based on tracking such shifts [46].

AI is and has to be critical in environmental management because it can predict and mitigate the impact humans make on the natural world. An exemplary application of AI models is in the capability of how certain human infrastructures including dams and highways may impact local vegetation and wildlife. These prediction models can be used in order to plan sustainable development initiatives that cause less drawbacks to environment. The third major application area that has been identified as utilizing AI, is in reforestation [47]. AI used in drones can identify areas that need deforestation and plant plants with more precision to do so. These envisioned technologies must now help us address the constant loss of species in the world and prevent more species from going extinct.

7. AI in Astronomy and Space Exploration

That is why artificial intelligence or AI is such a valuable tool to astronomers or any space exploration agency; it can provide real-time decision making on any mission and with huge amounts of data that is collected. Computer learning (CL), deep learning (DL), and neural networks are some artificial intelligence (AI) that are revolutionalizing the way space images are taking and studied, self-controlled spacecraft among others. Findings of astronomical objects and events that otherwise would have been time-consuming, or nearly impracticable to discover by conventional means, have only been facilitated by the rapid and correct data processing afforded by AI.

7.1 AI in Astronomy for Image and Data Processing

Astronomy derives large data from photographs, spectroscopic information and any other astronomical observations made using telescopes. To advance more typical strategies, an approach known as artificial intelligence or more specifically, deep learning is being utilized to work with this data. AI is mainly used in astronomy to mainly help point towards various celestial bodies such as stars, galaxies, asteroids, and exoplanets. Machine learning algorithms can easily detect outliers and sort objects due to the training on large collections of images of space [22].

Exoplanets are probably the best examples of how AI has impacted future study and discovery in astronomy. NASA's Kepler Space Telescope mission data has been analyzed using machine learning techniques. These things work like this, looking for extremely weak planetary signals in huge databases, for example, the dimming of a star because a planet has passed in front of it. Even in this area AI has been very effective in discovering exoplanets that human could not detect (Shallue and Vanderburg, 2018). Deep learning algorithms have also been applied to analyse gravitational wave signals so that researchers can identify neutron stars and black hole merging signals in real-time [48].

Thanks to image processing tools to control AI, the way astronomers analyze large surveys has become much easier than before. For instance, CNNs can be used for narrowing down galaxies based on their shapes, which help identify structures indicative of a phenomenon like star formation or two galaxies merging. These automated methods enable astronomers to look through countless numbers of photos with efficiency and exactness and as a result understand the formation and evolution of the cosmos [49].

7.2 AI in Space Missions

When it comes to constructing self-governing particulars physical structures such as spaceships or robotic explorers, this artificial intelligence is essential. In cases where ground operations can sometimes be minutes, if not hours apart, space missions require operating decisions in real-time. What was once thought impossible in that spacecrafts may now be capable of working independently, due to AI technologies that can independently choose on navigation, diagnostics, and scientific data acquisition. Examples of the working autonomous navigation system are a European Space Agency's Rosetta, which adapts spacecraft's course and velocity to external factor [50].

Machine learning is used to rationalize robotic planetary and moon exploration significantly more effectively than Mars Rover. In real time, the 2021 Mars landed Perseverance rover uses AI algorithms to map the terrain and find safe routes to traverse. Other functions range from booking, scientific responsibilities such as prioritization of data transfer to earth and selection of potential geologic samples for further analysis among others [51]. Naturally, the missions are often carried in substantially rugged areas and this dictates the need to operate outside system controlled environment.

Particularly relevant to the success of long-term space mission, AI is also employed to enhance mission parameters such as power requirements and fuel efficiency. For the optimization of spaceship propulsion along with the resources in limited environment, deep reinforcement learning has been developed. These algorithms ensure that a mission can clot its objectives without necessarily having to spend astronomical amounts of fuel and energy [52]. Besides, these algorithms can redistribute resources and adjust mission plans in real-time given a malfunction of equipment appointed for a mission or shifts in priority of a mission.

On missions to the outer planets and interstellar space as well as other sorts of deep space travel, it is expected that AI will be employed to an even greater extent in the future. More of the control and problem-solving abilities of a spacecraft will be expected to be exercised when it ventures in deeper space. Certainly, in the course of our space researches in the future, spaceships will be able to chart unknown worlds, gather crucial scientific and even look for signs of life, thanks to artificial intelligence technologies.

8. Ethical Considerations and Challenges

To this extent there are new ethical issues and concerns that arise due to improved incorporation of Artificial Intelligence or AI in scientific production and policy making. That is why there are crucial issues as to bias, privacy and security, and drawbacks of AI together with the further popularization of the technology and its posited role in improving data processing and speeding up scientific development. To ensure that artificial intelligence is beneficial and implemented responsibly in science these problems should be solved.

8.1 Bias in AI Algorithms

One of the most pressing ethical issues that have implications on scientific practice and decision in AI is bias. In my opinion, if that data is bias, then the results given by those systems will also be bias or even more bias. Self-serving prophecies lead to wrong conclusions and injustices, which is why this problem is especially acute in such fields as environmental and biological sciences and medicine. Specified cases in the domain of artificial intelligence (AI) for healthcare include the AI giving out wrong diagnoses or treatment advisories about specific population subgroups if the training data set does not properly represent them, such as women or people of color [53].

Bias does not spare any area of life and it affects sectors highlighted below. In the context of environmental science, the biased AI models may go wrong with the mechanical region categorisation or miss out endangered species identification due to formational or hasty data input. This may result into wrong implementation of conservation measures or unwise use of resources from outside. Hence it becomes expedient to edify this data to represent a more diverse and bias-free set of data for training the AI models. About algorithmic affidavits and the procedure of fairness testing: they can be useful to detect bias in the case of the AI systems and then start fixing it [54].

Table 2: Ethical Challenges in AI Applications in Science

Ethical Challenge	*Description*	*Field Impacted*	*Potential Consequences*
Bias in AI Models	Biases in training data lead to skewed outcomes	Medicine, Environmental Science	Inaccurate diagnoses, Misguided conservation strategies
Data Privacy and Security	Risks associated with the use of sensitive data	Biology, Medicine	Data breaches, Misuse of personal data
Lack of Transparency	AI's "black-box" nature limits interpretability	All scientific fields	Reduced trust in AI outcomes, Misinterpretation of results
Generalization Limitations	AI models struggle to apply findings across new scenarios	Climate Modeling, Chemistry	Inaccurate predictions, Ineffective policies
Resource Inequality	Unequal access to AI tools and computational power	Physics, Chemistry	Limited research capabilities, Widening knowledge gap

8.2 Data Privacy and Security

While handling personal information in a certain context like the medical as well as the biological sciences then the issues of data privacy and security are highly regarded ethical issues. In the healthcare field, AI systems rely on biometric data, gene data, and huge amounts of data from EHRS to predict diseases, develop treatment plans, and look for new drugs. While these apps could greatly boost patient outcomes, they could also perilous data. Lax measures of security expose such information to risk factors such as abuse exploitation and theft [28].

Maintaining anonymity in patients' data, in most circumstances that involve the usage of artificial intelligence in medical research entails data de-identification procedures. Yet, certain data can be easily re-identified when using some sophisticated data analysis techniques, and that is why one ought to know how safe it is to store and share anonymised data. The membership inference attack and model inversion are two techniques capable of attacking AI models where the attacker obtains details from the outcome of the model [55]. To minimize these threats, researchers should adhere to the privacy law such as the GDPR, and researches should apply better encryption technique and robust governance system.

8.3 AI's Limitations in Science

Nevertheless, based on the considered great consequent for the further scientific development artificial intelligence is far from the ideal even at present stage. Almost all the AI models often require a large amount of computational resources and massive data to train, especially for deep learning structures, which is a substantial computational problem. This could be a constraint that has restricted the narrowing down of the research capacity differences between countries and institutions in areas that such data and computational capability is scarce [2].

Another issue related to the understanding of AI is the so-called generalization problem within scientific use. Often, though the AI models are trained properly with a certain data set in mind, they sometimes do not use the results thus obtained in processing any new or different data despite possibly successful pre processing with the specific data set in mind. Owing to the dynamics and, in particular, the existence of external complicated knotty problems – for example, climate models or biological systems – this question becomes even more critical. The problem with an AI model that learns too much from training data is that it becomes overtrained and, in the general population, will likely not perform very well and could even cast doubts on other AI-driven scientific studies [56].

Also, such challenges as the interpretability of the AI models or, more accurately, the lack here, this issue is called "black-box." Essentially, many advanced artificial intelligence systems such as deep neural networks, often just produce their outputs while offering no reason behind that particular output. Whereas in some applications the lack of interpretation is fine, interpretability often becomes very relevant whenever the decision made by an AI is to be relied upon in the making of a medical or policy decision amongst others, the scientists cannot accept the solutions arrived because there is no explication. This is always an issue, though balancing between performance and interpretability is always the struggle: scientists are now striving to create increasingly more models of AI for which they could disclose how the thought process or decision made by an AI was arrived [57].

9. Future Prospects and Conclusion

9.1 The Future of AI in Science

AI holds a very bright future in science as there are further developments which may entirely revolutionize scientific practice. One they have been discussed heavily is the creation of artificial intelligence powered labs. It is possible to make the process of research more efficient and even integrate it with AI systems as well as autonomous robots in these labs. Some of these laboratories might be performing high-throughput experiments and make real-time changes to the existing research processes with the help of incorporating AI in experimental design, data acquisition as well as data analysis. For example, over the future systems create hypotheses, design experiments, analyze results, which will highly increase the speed and accuracy of investigation [58].

Besides AI such things like autonomous research are expected to play major role in the progress of knowledge in the nearest future. Auto tuned systems, such as those that have just used deep learning and reinforcement learning in them, are capable of learning on their own, revisiting things in ways that are new and interesting, and in some cases carrying out their own scientific research. AI has already demonstrated its potential in the form of autonomous research systems such as robotic scientist "Eve" who may run trials and find good drug candidates without outside assistance [59]. These systems will, without a doubt, continue to grow more complex and be able to handle hard scientific tasks in such areas as environmental studies, physics and so on.

The future of AI in research will also revolve around interdisciplinary collaboration. Artificial intelligence's capacity to process massive volumes of data and reveal patterns makes it a powerful instrument for connecting disparate areas of science. In the field of drug discovery, for example, AI may help chemists and biologists work together. In climate modeling, it can help physicists and environmental scientists work together. And in space exploration, it can help data scientists and astronomers work together. More comprehensive and integrated strategies for addressing global challenges like climate change, disease eradication, and sustainable resource management are anticipated to emerge from these multidisciplinary endeavors [12]. New scientific discoveries are likely to emerge as a result of the merging of artificial intelligence with related domains like quantum computing and nanotechnology.

There are a number of issues that the scientific community must resolve in order to guarantee the appropriate and ethical use of AI as these technologies advance. Addressing algorithmic bias, making AI models transparent and interpretable, and safeguarding data privacy are all obstacles to overcome. However, AI has enormous transformational potential in the scientific research arena, and its further incorporation is expected to produce notable progress in our comprehension of the natural world.

9.2 Conclusion

Many scientific disciplines have already been profoundly affected by the incorporation of AI into their research processes. This includes environmental science, physics, chemistry, biology, and medicine. AI has revolutionized scientific discovery, allowing for faster and more accurate processing of enormous datasets, automation of hard processes, and the discovery of hidden patterns. With the help of AI, genomics, proteomics, and drug discovery have all undergone a dramatic shift, paving the way for more precise medical diagnoses and more individualized patient care. Quantum system simulation, particle physics data analysis, and novel material discovery are all areas where AI has been useful in the physical sciences. Predicting molecular characteristics, optimizing reactions, and designing sustainable chemical processes are all areas where chemistry has benefited from AI. The fields of conservation biology and environmental science have made use of AI to better track biodiversity, model climate change, and keep tabs on ecosystems.

There are still some problems with AI, even with all these improvements. To guarantee responsible and ethical scientific applications, problems including bias in AI models, data privacy worries, and the limitations of existing AI technology must be resolved. But there's reason to be optimistic about AI's future in the scientific community: AI-driven labs, autonomous research platforms, and cross-disciplinary collaboration might all help speed up the pace of discovery.

Finally, it is indisputable that AI has the ability to revolutionize the scientific community. Researchers are able to take on difficult problems and expand human knowledge thanks to AI's ability to automate tasks, reveal patterns, and improve decision-making. With the rapid advancement of AI and its growing range of scientific applications, it is set to play a pivotal role in molding the trajectory of scientific advancements and breakthroughs in the years to come.

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REFERENCES:

1. Russell S, Norvig P. Artificial intelligence: A modern approach. 4th ed. Pearson; 2021.
2. Jordan MI, Mitchell TM. Machine learning: Trends, perspectives, and prospects. Science. 2015;349(6245):255-60. https://doi.org/10.1126/science.aaa8415
3. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015;521(7553):436-44.
4. Jones MB, Schildhauer MP, Reichman OJ, Bowers S. Artificial intelligence in environmental science. Environ Model Softw. 2021;142:105066.
5. Carleo G, Cirac I, Cranmer K, Daudet L, Schuld M, Tishby N, et al. Machine learning and the physical sciences. Rev Mod Phys. 2019;91(4):045002.
6. Hastie T, Tibshirani R, Friedman J. The elements of statistical learning: Data mining, inference, and prediction. 2nd ed. Springer; 2017. https://doi.org/10.1007/978-0-387-84858-7
7. Kelleher JD, Namee BM, D'Arcy A. Fundamentals of machine learning for predictive data analytics: Algorithms, worked examples, and case studies. 2nd ed. MIT Press; 2020. https://doi.org/10.7551/mitpress/11022.001.0001
8. Shallue CJ, Vanderburg A. Identifying exoplanets with deep learning: A five-planet resonant chain around Kepler-80 and an eighth planet around Kepler-90. Astron J. 2018;155(2):94. https://doi.org/10.3847/1538-3881/aa9e09
9. Murphy KP. Machine learning: A probabilistic perspective. MIT Press; 2012. https://doi.org/10.7551/mitpress/9107.001.0001
10. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017;542(7639):115-8. https://doi.org/10.1038/nature21056
11. Butler KT, Davies DW, Cartwright H, Isayev O, Walsh A. Machine learning for molecular and materials science. Nature. 2018;559(7715):547-55. https://doi.org/10.1038/s41586-018-0337-2
12. Rolnick D, Donti PL, Kaack LH, Kochanski K, Lacoste A, Sankaran K. Tackling climate change with machine learning. arXiv preprint arXiv:1906.05433. 2019.
13. Bengio Y. From deep learning of tasks to deep learning of new tasks. Nat Mach Intell. 2019;1(7):328-36. https://doi.org/10.1038/s42256-019-0076-6
14. Carrasquilla J, Melko RG. Machine learning phases of matter. Nat Phys. 2017;13(5):431-4. https://doi.org/10.1038/nphys4035
15. Carleo G, Troyer M. Solving the quantum many-body problem with artificial neural networks. Science. 2017;355(6325):602-6. https://doi.org/10.1126/science.aag2302
16. Sutton RS, Barto AG. Reinforcement learning: An introduction. 2nd ed. MIT Press; 2018.
17. Radovic A, Williams M, Rousseau D, Kagan M, Bonacorsi D, Himmel A, et al. Machine learning at the energy and intensity frontiers of particle physics. Nature. 2018;560(7716):41-8. https://doi.org/10.1038/s41586-018-0361-2
18. Albertsson K, Altin P, Anderson J, Soffer A. Machine learning in high-energy physics community white paper. J Phys Conf Ser. 2018;1085:022008. https://doi.org/10.1088/1742-6596/1085/2/022008
19. Paganini M, de Oliveira L, Nachman B. Accelerating science with generative adversarial networks: An application to 3D particle showers in multilayer calorimeters. Phys Rev Lett. 2018;120(4):042003. https://doi.org/10.1103/PhysRevLett.120.042003
20. Schmidt J, Marques MR, Botti S, Marques MA. Recent advances and applications of machine learning in solid-state materials science. npj Comput Mater. 2019;5(1):1-36. https://doi.org/10.1038/s41524-019-0221-0
21. Ntampaka M, Trac H, Sutherland D, Fromenteau S, Poczos B, Schneider J, et al. The role of machine learning in cosmology. arXiv preprint arXiv:1902.10159. 2019.
22. Schawinski K, Zhang C, Zhang H, Fowler L, Santhanam GK. Generative adversarial networks recover features in astrophysical images of galaxies beyond the deconvolution limit. Mon Not R Astron Soc Lett. 2017;467(1). https://doi.org/10.1093/mnrasl/slx008
23. Topol E. High-performance medicine: The convergence of human and artificial intelligence. Nat Med. 2019;25(1):44-56. https://doi.org/10.1038/s41591-018-0300-7
24. Min S, Lee B, Yoon S. Deep learning in bioinformatics. Brief Bioinform. 2017;18(5):851-69. https://doi.org/10.1093/bib/bbw068
25. Zou J, Huss M, Abid A, Mohammadi P, Torkamani A, Telenti A. A primer on deep learning in genomics. Nat Genet. 2019;51(1):12-8. https://doi.org/10.1038/s41588-018-0295-5
26. Senior AW, Evans R, Jumper J, Kirkpatrick J, Sifre L, Green T. Improved protein structure prediction using potentials from deep learning. Nature. 2020;577(7792):706-10. https://doi.org/10.1038/s41586-019-1923-7
27. Zhou Y, Wang F, Tang J, Nussinov R. Artificial intelligence in COVID-19 drug repurposing. Lancet Digit Health. 2020;2(12). https://doi.org/10.1016/S2589-7500(20)30192-8
28. Jiang F, Jiang Y, Zhi H, Dong Y, Li H, Ma S. Artificial intelligence in healthcare: Past, present and future. Stroke Vasc Neurol. 2017;2(4):230-43. https://doi.org/10.1136/svn-2017-000101
29. Gulshan V, Peng L, Coram M, Stumpe MC, Wu D, Narayanaswamy A. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA. 2016;316(22):2402-10. https://doi.org/10.1001/jama.2016.17216
30. Komura D, Ishikawa S. Machine learning methods for histopathological image analysis. Comput Struct Biotechnol J. 2018;16:34-42. https://doi.org/10.1016/j.csbj.2018.01.001

31. Shickel B, Tighe PJ, Bihorac A, Rashidi P. Deep EHR: A survey of recent advances in deep learning techniques for electronic health record (EHR) analysis. IEEE J Biomed Health Inform. 2017;22(5):1589-604. https://doi.org/10.1109/JBHI.2017.2767063
32. Vaishya R, Javaid M, Khan IH, Haleem A. Artificial Intelligence (AI) applications for COVID-19 pandemic. Diabetes Metab Syndr. 2020;14(4):337-9. https://doi.org/10.1016/j.dsx.2020.04.012
33. Bansal A, Kumar S, Patel P, Sarwar A. Artificial intelligence and its applications in epidemiology. J Public Health Res. 2020;9(3):189-93. https://doi.org/10.4081/jphr.2020.189
34. Rupp M, Tkatchenko A, Müller KR, von Lilienfeld OA. Fast and accurate modeling of molecular atomization energies with machine learning. Phys Rev Lett. 2012;108(5):058301. https://doi.org/10.1103/PhysRevLett.108.058301
35. Gilmer J, Schoenholz SS, Riley PF, Vinyals O, Dahl GE. Neural message passing for quantum chemistry. Proceedings of the 34th International Conference on Machine Learning. 2017:1263-72. https://doi.org/10.48550/arXiv.1704.01212
36. Segler MHS, Preuss M, Waller MP. Planning chemical syntheses with deep neural networks and symbolic AI. Nature. 2018;555(7698):604-10. https://doi.org/10.1038/nature25978
37. Szymkuć S, Gajewska EP, Klucznik T, Molga K, Dittwald P, Startek M. Computer-assisted synthetic planning: The end of the beginning. Angew Chem Int Ed Engl. 2016;55(20):5904-37. https://doi.org/10.1002/anie.201506101
38. Tarantola M, Zorn M, Roman CP, Brenner W. The role of artificial intelligence in green chemistry. ChemSusChem. 2019;12(5):1118-33. https://doi.org/10.1002/cssc.201802747
39. Petersen EM. The role of artificial intelligence in the circular economy. J Ind Ecol. 2020;24(3):517-20. https://doi.org/10.1111/jiec.12986
40. Walters WP, Barzilay R. Applications of deep learning in drug discovery and development. Nat Biotechnol. 2021;39(2):155-8. https://doi.org/10.1038/s41587-020-0539-0
41. Zhavoronkov A, Ivanenkov YA, Aliper A, Veselov MS, Aladinskiy VA, Aladinskaya AV. Deep learning enables rapid identification of potent DDR1 kinase inhibitors. Nat Biotechnol. 2019;37(9):1038-40. https://doi.org/10.1038/s41587-019-0224-x
42. Reichstein M, Camps-Valls G, Stevens B, Jung M, Denzler J, Carvalhais N. Deep learning and process understanding for data-driven Earth system science. Nature. 2019;566(7743):195-204. https://doi.org/10.1038/s41586-019-0912-1
43. Ahmed K, Saleh SM, Hossain MS, Islam MS. Renewable energy prediction using machine learning approaches: A review. Energy Rep. 2020;6:679-95. https://doi.org/10.1016/j.egyr.2020.10.024
44. Ma X, Wen Y, Wu P. Applications of artificial intelligence in environmental monitoring and protection: A comprehensive review. J Environ Manag. 2019;241:266-81. https://doi.org/10.1016/j.jenvman.2019.04.089
45. Norouzzadeh MS, Nguyen A, Kosmala M, Swanson A, Palmer MS, Packer C. Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning. Proc Natl Acad Sci USA. 2018;115(25). https://doi.org/10.1073/pnas.1719367115
46. Deneu B, Monteil C, Lauer J, Sirami C. Monitoring biodiversity change with remote sensing in ecology: Present and future directions. Remote Sens Ecol Conserv. 2021;7(1):17-33. https://doi.org/10.1002/rse2.171
47. Corlett RT. Plant diversity in a changing world: Status, trends, and conservation needs. Plant Divers. 2019;41(1):30-5. https://doi.org/10.1016/j.pld.2019.04.003
48. George D, Huerta EA. Deep learning for real-time gravitational wave detection and parameter estimation: Results with advanced LIGO data. Phys Lett B. 2018;778:64-70. https://doi.org/10.1016/j.physletb.2017.12.053
49. Kim EJ, Brunner RJ. Star-galaxy classification using deep convolutional neural networks. Mon Not R Astron Soc. 2017;464(4):4463-71. https://doi.org/10.1093/mnras/stw2672
50. Camps VJ, Acosta E, Pastor JA, Munoz A, Sabater JM, Muñoz A. Artificial intelligence in spacecraft: Autonomous navigation and operation. J Artif Intell Res. 2020;69:97-126. https://doi.org/10.1613/jair.11413
51. Gaines DM, Edwards CS, Vasavada AR, Litvak ML. The role of artificial intelligence in Martian exploration: The Perseverance rover case. J Field Robot. 2021;38(3):458-73. https://doi.org/10.1002/rob.22038
52. Fey LA. Reinforcement learning for spacecraft control: A review. Adv Space Res. 2020;66(8):1818-31. https://doi.org/10.1016/j.asr.2020.07.001
53. Mehrabi N, Morstatter F, Saxena N, Lerman K, Galstyan A. A survey on bias and fairness in machine learning. ACM Comput Surv. 2021;54(6):1-35. https://doi.org/10.1145/3457607
54. Barocas S, Hardt M, Narayanan A. Fairness and machine learning. MIT Press; 2019.
55. Veale M, Binns R. Fairer machine learning in the real world: Mitigating discrimination without collecting sensitive data. Big Data Soc. 2017;4(2):1-17. https://doi.org/10.1177/20539 51 71 7743530
56. Nguyen Q, Liu N, Shen Y, Bellot A. The limitations of deep learning in adversarial settings. Neural Netw. 2021;133:67-75. https://doi.org/10.1016/j.neunet.2020.10.016
57. Rudin C. Stop explaining black-box machine learning models for high-stakes decisions and use interpretable models instead. Nat Mach Intell. 2019;1(5):206-15. https://doi.org/10.1038/s42256-019-0048-x
58. Kitano H. Nobel Turing Challenge: Creating the engine for scientific discovery. NPJ Syst Biol Appl. 2021;7(1):29. https://doi.org/10.1038/s41540-021-00180-6
59. King RD, Rowland J, Oliver SG, Young M, Aubrey W, Byrne E. The automation of science. Science. 2009;324(5923):85-9. https://doi.org/10.1126/science.1165620

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