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Mathematics and its Appliance in Artificial Intelligence

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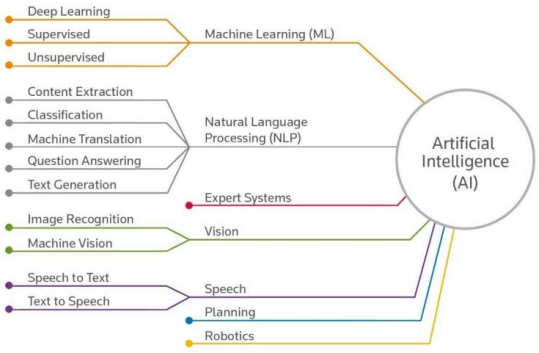
Abstract: The concept of artificial intelligence has, from the beginning, been one that piques the interest of people all around the globe. The term "artificial intelligence" (AI) refers to the capability of machines to perform cognitive tasks such as thinking, perceiving, learning, problem solving, and decision making. It was inspired by the ways in which people use their brains to perceive, learn, reason out, and decide the action to take. The artificial intelligence (AI) software that powers the Fourth Industrial Revolution is the engine that propels the revolution itself. Its influence can already be felt in people's homes, places of business, and the political system. Soon, it will be embodied in the shape of robots that are capable of driving automobiles, filling warehouses, and providing care for children and old people. It offers obstacles such as incomprehensible "black box" algorithms, unethical use of data, and the possible displacement of jobs, but it also holds the possibility of resolving some of the most important problems that society is now experiencing. As rapid advancements in machine learning (ML) increase the scope and scale of artificial intelligence's deployment across all aspects of day-to-day life, and as the technology itself can learn and change on its own, multi-stakeholder collaboration is required in order to optimize accountability, transparency, privacy, and impartiality in order to build trust. However, for the sake of this study, we shall steer clear of such intricate technical details and instead show the dentition that is considered the most typical.

Keywords: Artificial Intelligence, Machine Learning (ML), Deep Learning, Automated Simulation

I. Introduction

AI is not a well-defined technology and no universally agreed definition exists. It is rather a cover term for techniques associated with data analysis and pattern recognition. AI is not a new technology, having existed since the 1950s. While some markets, sectors and individual businesses are more advanced than others, AI is still at a relatively early stage of development, so that the range of potential applications, and the quality of most existing applications, have ample margins left for further development and improvement.



A careful study of the above graph would lead us to believe that many of the technologies and the underlying principles that each of these follows, have a strong correlation with the teaching learning processes at school as well as college levels. Hence it is necessary that AI should not only be introduced as a subject in the school curricula, but also should become a link to teach other subjects at all the levels. Many of the AI based applications are now available to facilitate a learner to learn in his own unique way and at his own pace.

II. Background

Patel et al. (2022), AI works proficiently to emulate human intellect. It may also play an important role in understanding and recommending the creation of a COVID-19 vaccine. This outcome-driven technology is utilized for effective screening, assessing, forecasting, and tracking of present and potential future patients. Traditional network designs are unable to cope calmly with the impact of COVID-19 due to massive network data traffic and resource optimization requirements. As indicated by the growing amount of restorative clinical data, artificial intelligence (AI) has the potential to successfully boost the upper limit of the medical

and health network. They discuss the primary uses of artificial intelligence technology in the process of suppressing the coronavirus from three main perspectives: prediction, symptom detection, and development, based on an extensive literature study. Furthermore, the advancement of next-generation network (NGN) technologies based on machine learning (ML) has given limitless opportunities for the formation of novel medical approaches. Wehave also discussed the challenges related to AI technologies in combatting COVID-19. The devastating epidemic of the Novel Coronavirus (Covid-19) has highlighted the importance of accurate prediction mathematical models. They have also discussed different mathematical models, their predictive capabilities, drawbacks, and practical validity.

Maduabuchi (2022), The rising levels of global warming in the environment owing to emissions from fossil-fuel-based engines has increased the search for efficient clean energy systems. Thermoelectric generators (TEGs) standout as a promising energy conversion device which can directly convert heat to electricity. Several optimization studies have been carried out on these devices to improve their power generation rate and efficiencies while guaranteeing long lifespan. However, the limitations of finite element methods (FEMs) in easily providing optimization guidelines at a fast rate has hindered the manufacture of TEGs with high thermo-mechanical performance. This is why this paper presents the first ever artificial intelligence enabled optimization of a TEG conducted via deep neural networks (DNNs). Previous research on this topic completely neglected the mechanical performance and consequently, the service lifetime of the TEG when exposed to thermal operating conditions. To fill this gap, the effects of strategic parameters on the power output, efficiency and thermal stress performances of the TEG are investigated. These parameters are the hot and cold junction temperatures/heat transfer coefficients, incident heat flux, external load resistance, TE leg height, area, and area ratio. The DNN is fed with verified three-dimensional FEM simulations carried out on the ANSYS Workbench platform. The FEM results exhibit almost perfect correlation with experimental data which establishes the precision of the model. Results are that the DNN model is able to provide the necessary optimization guidelines for maximum thermo-mechanical performance in just 8 seconds compared to the 8 hours required by the FEM. The TEGs that were modelled using the DNN optimization guidelines improved the power, efficiency and mechanical performance of the unoptimized TEG by 11.94%, 14.17%, and 91%, respectively. These results are sufficient to provide useful guidelines at a fast rate for the fabrication of high-efficiency TEGs that will operate for a long time.

Shafiq et al. (2022), In recent years, statisticians have become more and more interested in the study of mixture models, especially in the last decade, without adequately considering the difficulty of modeling the reliability measures of mixture models using artificial neural networks. In this study, in which artificial neural networks and mixed model reliability criteria are analyzed, various reliability parameters are calculated considering different scenarios. In order to estimate the obtained numerical reliability parameters, a multilayer artificial neural network model has been developed. Seven different reliability parameter values have been obtained from the artificial neural network model designed with four input parameters. The prediction values obtained from the artificial neural network model developed with five neurons in the hidden layer have been compared with numerical data, and the performance of the model has been analyzed comprehensively. The mean squared error (MSE) value for the network model has been calculated as 1.98E-08 and the R value as 0.99991. The results clearly revealed that the artificial neural network model developed using data from the appropriate statistical model is an excellent tool that can

He et al. (2022), Artificial intelligence, an emerging technology, widely exists in the field of engineering science and technology. Due to its high efficiency and precision, artificial intelligence is increasingly used in the optimal control of water treatment and seawater desalination. Generally, the design of a desalination system includes four processes: site selection, energy prediction, desalination technology selection and systematic parameter optimization. To a large extent, these choices depend on the experience and relevant criteria of researchers and experts. However, facing the scientific and technological progress and growing expectations, it is impossible to solve such complex nonlinear problems by simple experience and mathematical models, but artificial intelligence is good at this. In this paper, they synthetically analyzed and summarized the application of artificial intelligence in the field of seawater desalination with renewable energy. Artificial intelligence application in desalination is mainly divided into four aspects: expert decision-making, optimization, prediction and control by sequence. The features of artificial intelligence employed in the design of desalination systems not only realize the maximum of efficiency and minimum of cost, but release the human resources. After analyzing the four processes of desalination, it is found that artificial neural network and genetic algorithm are more widespread and mature than other algorithms in dealing with multi-objective nonlinear problems. This paper overviewed the application of artificial intelligence technologies in decision-making, optimization, prediction and control throughout the four processes of desalination designs. Finally, the application and future development prospect of artificial intelligence in the field of seawater desalination are summarized.

Manoharan et al. (2021), This article highlights the importance of implementing intelligent monitoring devices with the internet of things (IoT) for observing the number of charges on different appliances in each household. In India, it has been observed that 20% of power is wasted due to commercial appliances where the amount of charge flow is much excess to corresponding appliances. Therefore, to perceive information about the flow of charges, it is necessary to implement an intelligent device, and it is possible to obtain exact information on the flow of charges with the help of wireless sensor networks (WSN). Even most of the researchers have developed an intelligent device for monitoring the amount of charges but delay, energy consumption, and cost of implementation are much higher. It is always necessary to extract precise information at corresponding time periods for reducing the delay in packet transmission of a specific network. To excerpt such real-time data in the network layer, an active procedure should be followed by integrating dissimilar network areas inside a single cluster, and binary coded artificial neural network (BCANN) is introduced to acquire information about hidden layers. To prove the effect of such integration process, several tests have been prepared using online and offline analyses where simulation results prove to be much effective in case of all different scenarios to an extent of 52.4% when compared to existing methods.

Rabbat et al. (2021), The bridge of artificial intelligence to cardiovascular medicine has opened up new avenues for novel diagnostics that may significantly enhance the cardiology care pathway. Cardiac phase space analysis is a noninvasive diagnostic platform that combines advanced disciplines of mathematics and physics with machine learning. Thoracic orthogonal voltage gradient (OVG) signals from an individual are evaluated by cardiac phase space analysis to quantify physiological and mathematical

features associated with coronary stenosis. The analysis is performed at the point of care without the need for a change in physiologic status or radiation. This review will highlight some of the scientific principles behind the technology, provide a description of the system and device, and discuss the study procedure, clinical data, and potential future applications.

van der Niet & Bleakley (2021), Technologies, such as deep learning artificial intelligence (AI), promise benign solutions to thorny, complex problems; but this view is misguided. Though AI has revolutionized aspects of technical medicine, it has brought in its wake practical, conceptual, pedagogical and ethical conundrums. For example, widespread adoption of technologies threatens to shift emphasis from 'hands-on' embodied clinical work to disembodied 'technology enhanced' fuzzy scenarios muddying ethical responsibilities. Where AI can offer a powerful sharpening of diagnostic accuracy and treatment options, 'cold' technologies and 'warm' hands-on medicine need to walk hand-in-hand. This presents a pedagogical challenge grounded in historical precedent: in the wake of Vesalian anatomy introducing the dominant metaphor of 'body as machine,' a medicine of qualities was devalued through the rise of instrumental scientific medicine. The AI age in medicine promises to redouble the machine metaphor, reducing complex patient experiences to linear problem-solving interventions promising 'solutionism.' As an instrumental intervention, AI can objectify patients, frustrating the benefits of dialogue, as patients' complex and often unpredictable fleshly experiences of illness are recalculated in solution-focused computational terms.

Sun et al. (2021), Artificial intelligence education (AIEd) is defined in the field of education as the utilization of artificial intelligence. There are currently many AIEd-driven applications in schools and universities. This paper applies an artificial intelligence module combined with the knowledge recommendation to the system and develops an online English teaching system in comparison with the common teaching auxiliary system. The method of English teaching is useful in investigating the potential internal connections between evaluation outcomes and various factors. This article develops deep learning-assisted online intelligent English teaching system that utilizes to create a modern tool platform to help students improve their English language teaching efficiency in line with their mastery of knowledge and personality. The decision tree algorithm and neural networks have been used and to generate an English teaching assessment implementation model based on decision tree technologies. It provides valuable data from extensive information, summarizes rules and data, and helps teachers to improve their education and the English scores of students. This system reflects the thinking of the artificial intelligence expert system. Test application demonstrates that the system can help students improve their learning efficiency and will make learning content more relevant. Besides, the system provides an example model with similar methods and has a referential definition.

Ali (2021), Artificial intelligence (AI) is trending in the military and safety-critical application sectors. Currently, the private sector is helping the government sector to implement new advanced techniques to bring a revolution for different government and public sector management. It also helps to provide sustainable accountability in the accounting field; at present, AI is bringing a revolution in concept building. It is bringing potential revolutions by using novel approaches in such directions. This paper is a novel approach in the same direction; our research aim of this paper is to emphasize the AI in the militaries, what are the latest trend and usages recently worldwide used for AI applications in militaries. In this paper, they not only discuss the usage of AI applications in the military but also in the civil defense and health industry. They review and discuss that AI has potential benefits in military applications, HRMS, decision making, disaster prevention and response, GIS, service personalization, interoperability, extensive data analysis, anomaly and pattern recognition, intrusion detection, and new solution discovery using the highly configurable system and real-time simulation.

Bhbosale et al. (2020), AI is the technology which is very helpful for human being. By using this technology, the hard work of human can be escape. The artificial intelligence can be use in healthcare, education, in electronics, software development, pharmacies, games, engineering, communication and development. AI is based on science and technology on discipline like information technology, biology, phycology, mathematics etc. The main advantage of artificial intelligence is , the work will be accurate and the time can be save.

Obaid & Sharma (2020), The utility of Artificial Intelligence (AI) to design is mainly concerned with trying to make systems smarter through getting to know how to enable them to represent and control the real global understanding. It is likewise about contemplating studying how designers observe human intelligence to design, and with looking to make computer aids to design greater knowledgeable. Presently the principal topics inside the utility of Artificial Intelligence are to discover the formal illustration of the layout information, and additionally to expand strategies for reasoning with or applying this expertise. Computers have historically been capable of cope with the application of the legal guidelines of science, expressed in mathematical techniques. Artificial Intelligence (AI) mainly permits illustration of heuristic (or rule based) understanding this is less effortless or simple to explicit the use of mathematical methods. This, a part of artificial intelligence is in particular concerned with the development of such representations is called professional structures or more typically information based totally systems. This paper covers the various steps and ideas involved in adding synthetic Intelligence to the layout of mechanical structures. In this paper, a broad audit with respect to the uses of the Artificial Intelligence, in conjunction with its connection between the mechanical building for the method of mechanical imperfections identification and design layout configuration is proposed. This paper accommodates the précis or synopsis related to the precise utilizations of Artificial Intelligence in the field of mechanical Eng. Several applications, like errors identification, Analytic indicative Framework machine, mechanical shape and structure investigation, and mechanical layout plan are notably inspected. This study uncovers that the Artificial Intelligence based smart system is broadly utilized generally in the total mechanical Engineering designing area. This paper likewise presumes that the Mechanical Engineering and designing field can be effectively combined with different other Artificial Intelligence based innovation era to make it progressively successful to improve in the mechanical framework.

Chowdhary (2020), Fundamentals of Artificial Intelligence introduces the foundations of present-day AI and provides coverage to recent developments in AI such as Constraint Satisfaction Problems, Adversarial Search and Game Theory, Statistical Learning Theory, Automated Planning, Intelligent Agents, Information Retrieval, Natural Language & Speech Processing, and Machine

Vision. The book features a wealth of examples and illustrations, and practical approaches along with the theoretical concepts. It covers all major areas of AI in the domain of recent developments. The book is intended primarily for students who major in computer science at undergraduate and graduate level but will also be of interest as a foundation to researchers in the area of AI.

Asan et al. (2020), Artificial intelligence (AI) can transform health care practices with its increasing ability to translate the uncertainty and complexity in data into actionable—though imperfect—clinical decisions or suggestions. In the evolving relationship between humans and AI, trust is the one mechanism that shapes clinicians' use and adoption of AI. Trust is a psychological mechanism to deal with the uncertainty between what is known and unknown. Several research studies have highlighted the need for improving AI-based systems and enhancing their capabilities to help clinicians. In this paper, they focus on clinicians as the primary users of AI systems in health care and present factors shaping trust between clinicians and AI. They highlight critical challenges related to trust that should be considered during the development of any AI system for clinical use.

Taghinezhad et al. (2020), In the study, drying process of quince fruit was accomplished in a microwave-convective dryer (MCD). The experiments were carried out at microwave power levels of 100, 200, and 300 W, air temperatures of 40, 55, and 70°C, and air velocities of 0.5, 1, and 1.5 m/s. Nevertheless, three artificial intelligence techniques consisted of artificial neural networks (ANNs), particle swarm optimizer (PSO), and grey wolf optimizer (GWO) were evaluated to predict the parameters of D_{eff}, SEC, ΔE, and S_b. In the evaluation the data by ANNs, input parameters of networks consisted the values of air temperature, microwave power, and air velocity. According to the results, the maximum values of effective moisture diffusivity (D_{eff}) and specific energy consumption (SEC) were 1.71×10^{-9} m^2/s and 126.07 kWh/kg, respectively. In addition, minimum values of total change in color (ΔE) and shrinkage (Sb) of quince achieved 10.85 and 33.85%, respectively. For predicting all parameters, three models used in the study represented good predictive capability with $R^2 > 0.97$. The obtained results showed that the GWO model had better predictive performance than the ANN and PSO models.

III. Mathematical Analysis of AI and Derived Deep Neural Networks

The core building blocks are, as said, artificial neurons. For their definition, let us recall the structure and functionality of a neuron in the human brain. The basic elements of such a neuron are dendrites, through which signals are transmitted to its soma while being scaled/amplified due to the structural properties of the respective dendrites. In the soma of the neuron, those incoming signals are accumulated, and a decision is reached whether to fire to other neurons or not, and also with which strength. This forms the basis for a mathematical definition of an artificial neuron

3.1 Definition

An artificial neuron with weights w1, ..., wn∈R, bias b∈R, and activation function ρ:R→R
is defined as the function f: Rn→R given by
f(x1, ..., xn) = ρ n
X
i=1
xiwi−b! =ρ(hx, wi − b),
where w= (w1, ..., wn) and x= (x1, ..., xn).
By now, there exists a zoo of activation functions with the most well-known ones being as follows:
(1) Heaviside function ρ(x) = (1, x > 0,
0, x ≤0.
(2) Sigmoid function ρ(x) = 1
1+e−x.
Rectifiable Linear Unit (ReLU) ρ(x) = max {0, x}.

We remark that of these examples, the by far most extensively used activation function is the ReLU due to its simple piecewise linear structure, which is advantageous in the training process and still allows superior performance. Similar to the structure of a human brain, these artificial neurons are now being concatenated and arranged in layers, leading to an (artificial feed-forward) neural network. Due to the particular structure of artificial neurons, such a neural network consists of compositions of affine linear maps and activation functions. Traditionally, a deep neural network is then defined as the resulting function. From a mathematical standpoint, this bears the difficulty that different arrangements lead to the same function. Therefore, sometimes a distinction is made between the architecture of a neural network and the corresponding realization function.

3.2 AI is an approximation of a mapping

In mathematical terms, AI is essentially about a function from a domain to a codomain. Just like the function f (x) = sin (x) maps all real numbers x for the range [−1,1]. In weak AI, these mappings are usually much more complex and not defined in any straightforward way. For this reason, AI must be considered an approximation of a true description. For example, artificial neural network models consist of several composite mappings, so they may include millions of adjustable factors. In the late 1980s, it was shown that a mapping meeting certain preconditions can be approximated with this kind of a neural network. Because AI applications are taught with certain source data, their capability to generalise the outcome is strongly dependent on the source data. How extensive is it? How high quality is it? How many elements are there?

3.3 Taking advantage of the benefits of modelling

Collecting data in order to teach AI applications is essential. In many applications, the collection process is slow, time-consuming and expensive. From the perspective of large-scale use of even a weak AI, it would be worthwhile to find solutions to this problem. In certain settings, computational science and mathematical modelling offer us tools for solving this issue. In such a case, a computer

can produce a large set of data, all parameters of which we know. For instance, we can first model the travel of light on a single leaf of a tree, then in a tree and a forest, and how light scatters outwards from there. Training AI to approximate the inverse mapping of this simulation, we can determine from an image some biophysical and biochemical parameters of the leaf. Drawing on this knowledge, we can simulate new training data based on already collected images. Alternatively, inverse description can be used in explaining why an AI algorithm works the way it works. This may concern, for example, recognition of different tree species, the health of trees, or even skin cancer. Traditional mathematical modelling combined with AI research can provide new dimensions for many fields of science as well as for society. Although AI research is now fashionable, there is also reason to appreciate more traditional computational science, which encompasses themes ranging from mathematical modelling and simulation to scientific computing.

3.4 Method for automated simulation using AI

The problem of performing automated simulation for a particular engineering system is then of finding the "best" set of parameter values BP for the mathematical model. Here is where AI methodology comes to be very useful. The main idea in AI is that we can use certain techniques to simulate human experts in a particular domain of application. In this case then, we use heuristics extracted from experts in this domain and statistical calculations to limit the search space for the computer program. The algorithm for selecting the "best" set of parameter values can be stated as follows:

Step 1 Read the mathematical model M.

Step 2 Analyze the model M to "understand" its complexity.

Step 3 Generate a set of admissible parameters AP using the initial "understanding" of the model. This set is generated using heuristics (expressed as rules in the knowledge base) and solving some mathematical relations that will be defined later.

Step 4 Perform a selection of the "best" set of parameter values BP. This set is generated using heuristics (expressed as rules in the knowledge base).

Step 5 Perform the simulations by solving numerically the equations of the mathematical model. At this time the different types of dynamical behaviors are identified.

3.5 Implementation of the method for automated modelling

The implementation of the method for AMM as a computer program was done using the PROLOG programming language. The choice of PROLOG is because of its symbolic manipulation features and also because it is an excellent language for developing Prototypes, the computer program was developed using an architecture very similar to that of an intelligent system (knowledge base, inference engine and user interface) with the addition of a numerical module for parameter estimation. We will focus our description of implementation details only to the knowledge base of the intelligent system. In the computer program, the knowledge base is the part that simulates the process of model discovery described by step 1 to 4 in the algorithm of section 2. Accordingly, the knowledge base consists of three Expert Modules: Time Series Analysis, Expert Selection and Best Model Selection.

IV. Conclusion and Future work

The effects of this are already being seen in households, organizations, and government. Cars soon be driven by robots, warehouses stocked by robots, and the old and children cared for by robots. It has the ability to address some of society's most serious problems, but it also poses risks in the form of opaque "black box" algorithms, unethical data collection and usage, and the elimination of jobs. Multi-stakeholder collaboration is essential to optimize accountability, transparency, privacy, and impartiality in order to create trust in AI as rapid advancements in ML expand the breadth and scale of AI's deployment across all aspects of daily life and the technology can learn and change on its own.

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