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The role of artificial neural network and machine learning in utilizing spatial information

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Abstract In this age of the fourth industrial revolution 4.0, the digital world has a plethora of data, including the internet of things, mobile, cybersecurity, social media, forecasts, health data, and so on. The expertise of machine learning and artificial intelligence (AI) is required to soundly evaluate the data and develop related smart and automated applications, These fields use a variety of machine learning techniques including supervised, unsupervised, and reinforcement learning. The objective of the study is to present the role of artificial neural networks and machine learning in utilizing spatial information. Machine learning and AI play an increasingly important role in disaster risk reduction from hazard mapping and forecasting severe occurrences to real-time event detection, situational awareness, and decision assistance. Some of the applications employed in the study to analyze the various ANN domains included weather forecasting, medical diagnosis, aerospace, facial recognition, stock market, social media, signature verification, forensics, robotics, electronics hardware, defense, and seismic data gathering. Machine learning determines the many prediction models for problems involving classification, regression, and clustering using known variables and locations from the training dataset, spatial data that is based on tabular data creates different observations that are geographically related to one another for unknown factors and places. The study presents that the Recurrent neural network and convolutional neural network are the best method in spatial information processing, healthcare, and weather forecasting with greater than 90% accuracy.

Keywords Machine learning · Artificial neural networks · Satellite communication · Deep learning · Spatial information · Multimedia applications

1 Introduction

The human brain structure consists of the biological neurons that form the ANN. ANN is formed by the different layers of the neurons in the human brain which are associated together. These neurons are called nodes. ANN is a kind of artificial intelligence [1] that pursues reproducing the network of neurons to make up the human brain so that processers may recognize the brain signals and make decisions like a human being in the computing system. The neurons are programmed using computers to act like interrelated brain cells to generate an ANN. The human brain contains approximately 1000 billion neurons. Individually neuron has several association points ranging from 1,000 to 100,000. The associated data is stored in the human brain in such a way that it may be spread, and we can pull multiple sections of this data from our memory at the same time based on the need and capability. Scientifically, the human brain is made up of incredible parallel processors.

Neurons are the building blocks of the brain, central nervous system [2], spinal cord, and peripheral nervous system ganglia. A typical neuron has all of the components found in every cell, as well as a few unique structures: soma/cell group of the body, axons, dendrites, and synaptic terminals. The anatomy of neurons has the soma or cell body which is the utmost essential part of the cell. It houses the nucleus, which houses chromosomes, which contain genetic material.

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Dendrites are a sort of extension lead that can be seen on neurons. They look like branches or spikes which are projected from the cell body. Other neurons provide chemical messages to the surfaces of the dendrites [3]. A protracted operation that usually involves other sections of the nervous system extends to other parts of the neurological system. The axon is the neuron's principal conducting entity that is proficient in conveying electrical signals through large spaces extending from 0.1 to 2 m. Axons are absent in many neurons. Synaptic terminals are found where axons terminate and contain vesicles containing neurotransmitters. A space also separates them from the next neuron (synapse). The cytoplasm [4] and nucleus make up the cell body. Before terminating at nerve terminals, the axon extends from the cell body and provides steady growth to minor outlets or branches. Dendrites cover the cell body of the neuron and receive messages from other neurons. Synapses, which connect one dendrite to another dendritic or one axon to another axon, are the fundamental contact areas for communication between neurons.

ANN has an extensive variety of applications in science and technology, including biology, physics, and chemistry. ANNs are working in chemical kinetics, industrial reactor behavior prediction, drug release modeling kinetics, electrophoretic technique optimization, categorization of agricultural yields such as onion variabilities, and even species resilience [5]. In principle, data as disparate as biological item classification, and kinetic data for chemical, and clinical restrictions can be controlled really in a similar way. Innovative computational approaches, such as ANNs, use a variety of input data that is applied in the background of preceding training past on a given sample record to provide a therapeutically meaningful output, such as the possibility of a specific pathology or biomedical item grouping. ANNs are suitable for the examination of diabetic patients' urine and blood samples, tuberculosis diagnosis, leukemia classification [6], analysis of composite outpouring samples, and image analysis of radiographs or even existing tissue in arrears to the significant smoothness of input data.

The originality of the research article presents in terms of the study of the significant role of the different machine learning and AI methods [7, 8] for utilizing spatial information in serval domains. AIML has been extensively used for analyzing geospatial data or geographic information [9] directly or indirectly about a particular place or region. It has played a very important role in disaster management and quick response. The researchers discovered that disaster relief organizations could more quickly understand the causes, timing, location, and effects of floods by connecting data from disaster response organizations, the Global Flood Detection System (GFDS) satellite flood signal, and flood-related Twitter activity. In reality, with the massive amount of data on Twitter, anyone attempting to exploit it will encounter a lot of challenges (350,000 tweets each minute). To resolve this issue, some projects are initiated that utilize machine learning and AI. In the early stages of the coronavirus pandemic, scientists examined the web, social media, and news sources to track the progress of the disease. This is one of the more contemporary occasions of the application of AI and machine learning in disaster response, in the cases of pandemic response. Researchers might identify emerging hotspots and early signs that younger patients were more resistant to the illness by searching for posts that described symptoms unique to Covid. Indeed, the users of social media and on-the-ground support workers often produce some of the most essential data gathered during a crisis. For instance, images and remarks from Facebook, Twitter, Youtube, and Instagram can aid specialists in their initial damage evaluations. Additionally, by locating and planning new disaster locations in requirement of assistance, this information can assist rescue personnel in finding disaster victims more rapidly. Finally, combining information from seismometers, social media comments with location tags, and satellite imagery data can assist aid organizations in providing early warnings and real-time report verification [10]. Geographic Information Systems (GIS) frequently employ machine learning for the study of spatial data [11]. Time series, tabular, text, and image data are used in machine learning applications and competitions. The GIS information covers data gathering, manipulation, management, visualization, and systemic analysis of spatial data. The spatial information has spatial features for each observation, in contrast to tabular data. Spatial data comes in two different forms: raster and vector. Shapes for vector data include lines, points, and polygons. Raster data is a collection of pixels assembled into an image [12]. Conventional machine learning methods such as Support Vector Machine, linear regression, and tree-based regression, are used to predict target variables according to the dependent variables, but cannot analyze that target variables in closer to the distance tend to have more similar values. Empirical Bayesian Kriging, least square regression, areal interpolation, and spatially weighted regression (SWR) [13] are the machine learning regression techniques used for spatial analysis. The classification techniques include decision trees, SVM, random forests, and maximum likelihood [14]. The many clustering techniques include multivariate clustering, hot spot analysis, image segmentation, density-based clustering, space-time pattern mining, and spatially constrained multivariate clustering[15]. The extensive use of CNN and RNN is used for forecasting meteorological droughts for remote sensing and long-range.

2 Methods

Most machine learning today is Artificial Neural Networks. Because of the recent rise in computing power, these Neural Networks have turn into tremendously popular, and they are presently found practically everywhere. The neural networks provide the intellectual edge that retains us involved in each application in the real world. The learning of computer processes that can acquire and evolve on their own given experience and data is known as machine learning (ML). It is deliberated to be a constituent of artificial intelligence. Machine learning is also identified as analytical learning when it is applied to explore business contests. Machine learning enables systems to make decisions on their own, without the need for external assistance. These decisions are completed when the machine is ready to learn from the data and recognize the essential patterns within it. They then return the results, which can be a classification or a forecast, after pattern matching and further processing.

ML algorithms are separated into three approaches [16]: Supervised learning, unsupervised learning, and reinforcement learning. Supervised learning is the most frequent paradigm for performing machine-learning operations. It is frequently utilized for data with a closefitting between input variables and output data. In this scenario, the dataset is labeled, which means that the algorithm recognizes the features explicitly and makes predictions or classifications based on them [17]. The procedure can control the links between the two logical variables as the training time continues, agreeing for us to expect the new outcome. Linear regression, gradient boosting, random forest, logistic regression, support vector machine, and artificial neural networks [18] are examples of supervised learning. An unsupervised learning system does not have labeled data since the data is not implicitly classified into distinct groups. The prediction model learns the data by detecting implicit patterns, the model can learn from the data. The unsupervised data are recognized based on their structures, densities, associated fragments, and other similar properties. Clustering, anomaly detection, autoencoders, principle component analysis, and deep belief networks are examples of unsupervised learning. Reinforcement learning [19] is a machine learning training approach that promotes good behavior while punishing undesirable ones. In general, a reinforcement-learning agent may observe and grasp its environment, perform, and acquire using trial and error methods. A reinforcement-learning agent can perceive and comprehend its surroundings, act, and learn through trial and error in general. Reinforcement learning is the process of training machine learning models [20] to make chains of decisions. In an uncertain, theoretically composite environment, the agent works to achieve the objectives. Artificial intelligence encounters a game-like incident in reinforcement learning. To achieve the clarifications in the objectives, the processor works on trial and error to get the output. Artificial intelligence is assumed to either be rewarded or penalized for the performances it earnings to acquires based on the user requirements and accomplishments. The main motive is to enhance the total price as much as can be accomplished.

3 Major applications of ANN

Artificial neural networks are effective problem-solving models. Handwriting recognition, social media, medical diagnosis, image compression, aerospace, defense, electronics, hardware accelerators, traveling salesman problem, robotics dynamics, stock Exchange prediction, facial recognition, and weather forecasting, to name a few, have all seen a surge in interest in the last few years.

3.1 Medical diagnosis and health care

Artificial intelligence (AI) is changing the healthcare system [5] at a fast pace. Researchers have commenced progressing on different tools to provide better outcomes in the process of clinical care, escalation of medical research, and progress efficiency, driven by the combining of the approach of big data and resilient machine learning algorithms. These technologies rely on algorithms, which are computer programs that can generate predictions or suggestions based on healthcare data. The algorithms themselves, on the other hand, are frequently too sophisticated for their rationale to be grasped, let alone articulated openly.

AI technology is likely to continue to advance, bringing new advances to health care in the future. Machine learning is the branch of AI and the learning of computer algorithms [21] that improve themselves over time by employing mathematical techniques. The subclasses of machine learning, and deep learning, describe the procedures that are studied by handling data using ANN and imitating neurons in the biological brain. The extensive use and progress of digital data, the enlargement of computing power driven by different hardware design and system technologies such as graphics processing units (GPUs), and fast expansions in machine learning methods, widely realized using deep learning techniques, and all parting an ineffaceable mark in the domain of healthcare. AI and ML are applicable for clinical data, radiology imaging, image processing, and digital pathology.

In the current era, people are leveraging the assistance of expertise and technology in healthcare. In the healthcare industry, Convolutional neural networks (CNN) [22] are used for CT scans, MRI, X-ray detection, ECG, EEG, and ultrasound. The medical images and supporting data received from the aforesaid tests are evaluated and measured using neural network models, as CNN [23] is used in image processing. Recurrent neural networks (RNNs) have been widely adopted for learning and realizing voice recognition systems. These days, voice recognition systems are employed to maintain track of patients' information.

Generative neural networks are also being used in medication development [24]. Matching diverse kinds of medications is a difficult undertaking, but generative neural networks [25] have simplified the process. They are utilized to combine various ingredients, which is the basis for medicine development.

3.2 Facial recognition

One of the greatest effective and relevant usages of biometric and image processing systems is face recognition. Due to the great diversity of face looks, complexity, and illumination effect of the image background, face recognition from real data, arresting images, database images, and sensor images is a challenging task. Facial recognition systems (FRS) [24] are reliable surveillance systems. The human face is matched and compared to computer photos using recognition systems. They are used in offices for discriminating records [26]. As a consequence, the technologies validate a human face by relating it to a database of IDs. CNN has been used extensively for image processing and facial identification at different orientations. The database reference images are applied to the neural network for training purposes and the photos are processed in advance to the computer values. The accurate assessments of CNN are done based on the sampling. The models are fine-tuned for pinpoint accuracy in recognition.

Principle component analysis (PCA) is the ANN methodology, which recognizes the features of face image retrieval using this technique. The PCA is a dimensionality reduction method that keeps the bulk of the data set inputs variability. It follows the information to encrypt the facial photos by determining the value of the variances according to the dataset. It estimates the feature vectors for several face points and generates a column matrix according to the same dataset. After completing the computation of the feature vector, it calculates the mean of the face, then normalizes each input face image by deducting the mean values of the face, then computes the covariance matrix for it. It determines the eigenvalues based on the covariance matrix, and maintains only the maximum eigenvalues, then computes the values of the eigenvector to complete the covariance matrix to calculate the eigenface for the covariance matrix using that matrix. The PCA methodology analyses the major variations in the dataset by translating it from high to low picture dimensional space. These extended projections of face images are formerly sent to ANN for testing and training. PCA recovers the differences in the feature selection of face pictures that comprise the maximum information with decomposed dimensions. The differences in the features of different face images that comprise the maximum information with decomposed dimensions are also retrieved. The eigenfaces are generated based on the extracted features, which are then given to Artificial Neural Networks for training purposes. The eigenface of the tested image is fed into the accomplished neural networks for testing, and it determines the best matching components while taking into account based on the threshold value to reject non-human and unidentified face images. The input facial photos are trained using a propagation feed-forward ANN. The neural networks are fed the computed eigenfaces of the input face images.

3.3 Social media

The behavior of social media users [4] is studied using ANN. For competitive analysis, data shared daily via virtual interactions are stacked up and examined. The actions of social media users are replicated by neural networks. The associated data is linked to people's outlay patterns after examination of their behavior via social media networks. Data from social media applications [27] is mined using Multilayer Perceptron (MLP) ANN. The MLP uses several training methods such as Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Squared Error (MSE) to forecast social media trends (MSE). MLP considers a variety of parameters, including the user's favorite Instagram pages, bookmarked options, and so on [23]. These variables are used as inputs in the MLP model's training.

ANN can surely effort as the most appropriate and adequate model for data analysis in the ever-changing discussions of social media apps. ANN analysis has been used to detect both linear and nonlinear interactions in the study model that comprises novelty hurdles and confidentiality concerns using data acquired from moveable social media users who had no understanding of mobile community business. People are virtually connected as the use of the internet grows, using other social media platforms such as Facebook, text messages, Twitter, and other similar platforms. This has resulted in a rise in the distribution of spam, or unsolicited messages, which are used for marketing, data collection, or simply to offend people. As a result, having a powerful spam recognition architecture that can block these styles of messages is critical. Due to the short script and great diversity in the language used in social media, spam detection on noisy platforms like Twitter remains a challenge [28]. For social media, a revolutionary deep learning-based design on CNN [29] and long short-term neural networks (LSTM) are utilized.

3.4 Stock market

The forecasting stock market [8] is a very important issue that is gaining traction. The risk involved is too much and completely depends on the market. In the extremely unstable market, and essentially incredible to predict imminent changes. The continuously varying bullish and bearish stages were random before neural networks. A multilayer perceptron MLP [30] is used to develop an effective real-time stock prediction. MLP is formed using different layers of nodes in which each layer is fully connected. The MLP model is configured using past stock performance, yearly returns, and nonprofit relations. To follow typical linear and nonlinear methods for the stock market [9], different neural networks and hybrid models have been offered in existing years for procuring dependable prediction outcomes. Multi-layer perceptron (MLP), hybrid neural networks, and dynamic artificial neural network (DAN2) use generalized autoregressive conditional heteroscedasticity (GARCH) to extract extra input variables which are used to expect stock market estimates [10]. The Mean Absolute Deviate (MAD) and Mean Square Error (MSE) of the individual model are associated using real exchange regular rate standards of the NASDAQ standard interchange index. Bayesian standardized artificial neural network [16] is a distinctive technique for estimating financial market behavior. Financial procedural indicators and daily market values are used for contributions to predicting specific stock closing return one day in the future [31]. The prediction of stock amount movement is regularly observed as a difficult and important task in financial time series investigation.

3.5 Aerospace

The applications of a neural network allow for the evaluation of the interrelationships between various landscape features. The neural networks have the advantages that all modules can operate in parallel, thereby boosting proficiency in problem-solving, particularly in the field of image processing. The approach of developing ANN with back-propagation error within the context of this research has been proposed as a solution to the challenge of creating decoding indicators based on the superposition of spatial and spectral properties of images from the Landsat TM satellite [17]. Artificial immune systems (AIS) integrate a priori knowledge with biological immune systems [18] adaptive characteristics to provide a potent alternative to currently available pattern recognition, modeling, design, and control techniques. Immunology is the study of the built-in defense systems that all living things have to defend themselves from external threats. A biological immune system can be viewed as a resilient, adaptable system that can cope with a wide range of disruptions and uncertainties. To achieve this adaptiveness, biological immune systems require a finite number of discrete "building pieces." These construction blocks are similar to jigsaw pieces that must be assembled in a certain order to neutralize, remove, or destroy each disturbance that the system encounters. Neural networks have been used to optimize the design of aircraft structural components. The prediction of optimal designs by neural networks is satisfactory, for the majority of the output design constraints.

Aerospace engineering is a broad phrase that encompasses spacecraft [19] and aircraft development. Neural networks have taken over in areas such as fault detection, autopiloting with high performance, securing aircraft control systems, and modeling crucial dynamic simulations. Delay in time for modeling nonlinear temporal dynamic systems, neural networks can be used. Delay in Time For feature recognition that is not dependent on position, neural networks are used. Pattern recognition is possible with the technique, which is based on time-delay neural networks. Because passenger safety is paramount in an airplane, algorithms based on neural network systems ensure that the autopilot system is accurate. Because the majority of the autopilot operations are automated, it's critical to ensure that they feel maximized security. ANNs have been used to model the quality of the surface alloys for aerospace applications which are based on the wire electrical discharge machining (WEDM) process [32] and structural components [25].

3.6 Defense

In the interpretation of data from high-data-rate sensors, electronic intelligence collection, sonar array processing, battlefield surveillance, aircraft identification, both radar and infrared, and multisensory fusion, neural networks have the capability and prospective applications. Artificial intelligence is giving the defense industry the much-needed boost it needs to scale up its technology. CNN is used for perceiving the existence of underwater mines. Underwater mines are a type of underpass that serves as a prohibited cross-border exchange route. Unmanned Airborne Vehicles (UAVs) and Unmanned Undersea Vehicles (UUVs) are self-directed sea vehicles that interpret images using CNN. Convolutional Neural Networks are built on the foundation of convolutional layers. These layers utilize various filters to distinguish between photos. Layers also have larger filters for picture extraction than filter channels. Artificial Immune Systems (AIS) and ANNs have exploded to enable the creation of an intelligent cyber defense system. Artificial intelligence has applications in cyber defense (CD), as well as the prospects for improving cyber defense capabilities by expanding defensive system intelligence. Artificial neural networks are being used to investigate and simulate protective fabrics for military purposes. The botnets acquire extra-large size, the manner of the attack shows a range of features, and application-level attacks have become the most common attack method. All of these methods have a major influence on internet security. On the other hand, traditional software defense detection approaches, suffer from a low accuracy rate, an outdated detection method, an unduly passive detection method, and a time-consuming defense system implementation.

3.7 Signature verification and forensic

Signature authentication has been one of the foremost investigated domains in the area of image and computer vision [20]. Signature verification is used by many legal and financial organizations as a form of authentication and access control. Signature photos do not contain a lot of texture, but they do have a lot of important geometrical information.

In forensics [33], handwriting analysis is extremely important. The approach is often used to assess the differences between two manuscripts. In behavioral analysis, the spilling words on a blank sheet method is also employed. CNN is used for handwriting examination and verification. Signature verification is used in banking operations, and other financial bodies to double-check an individual identity. The signatures are usually examined using signature verification software. Signature authentication is an essential feature that aims to closely analyze the legitimacy of signed booklets, as occurrences of forgery are rather widespread in financial organizations. The signatures are verified using ANNs to distinguish between genuine and fake signatures. ANNs can be used to verify signatures in both the offline and online worlds. Various datasets are fed into the database to train an ANN model. The data given in this way aids the ANN model in differentiating. For feature extraction, the ANN model uses image processing. To identify persons in organizations or finance divisions, biometric techniques such as signature verification are extremely viable.

3.8 Robotics and dynamics

Single-layer feedback neural networks, multilayer feed-forward networks, and competitive learning networks are among the neural networks studied for all three stages of robotic handling [34] applications, path design, task scheduling, and path control. Knowledge-based training of ANN for dynamic autonomous robots applies real-time network design and training methodologies. ANN is used to govern the reactive movement of an autonomous robot in a busy real-world unidentified environment, ensuring that it meets the defined objectives while avoiding static and dynamic impediments. Right, left, and front obstacle distances to their positions, as well as the goal approach between a robot and a defined target collected by a group of sensors, are the inputs to the suggested neural controller. The neural controller was designed and developed using a four-layer MLP to handle the track and phase optimization issues of mobile robots, which involves intellectual activities like learning, adaption, generalization, and optimization. The network is trained using the back-propagation approach.

The MLP feed-forward network is used to construct an intelligent controller for an autonomous mobile robot, allowing the robot to direct in real-world dynamic conditions. The neural controller inputs are the distance between the left, right, and front obstacles about their target angle and position. The steering angle is the output of the neural network. The time and route and optimization issues of mobile robots have been solved using a four-layer neural network, which contracts with cognitive actions such as learning, adaption, optimization, and generalization. The network is trained using a backpropagation approach. Inverse kinematics of robotic arms are also solved using an artificial neural network approach.

3.9 Weather forecasting

Weather forecasting is generally used to predict the weather conditions that will occur in the future. Before the implementation of artificial intelligence, the meteorological department's forecasts were never correct [35]. The capacity of ANNs to predict an undefined nonlinear relationship between load and meteorological factors [61] makes them particularly intriguing. Weather forecasts are now also utilized to anticipate the likelihood of natural disasters in the modern day. Wavelet transformations, forward backpropagation, and regression neural networks are used for the daily precipitations [36] predictions. Neural networks are being used to predict hourly mean surface temperatures. Backpropagation and a batch learning strategy are used to train this neural network offline. The accomplished neural network has been successfully tested on temperatures that are not the same as those utilized in the training. To estimate the temperature for the same hour the next day, it only needs one temperature [37] value as input. The anticipated hourly temperature readings are related to the actual measured temperatures.

MLP, CNN, and Recurrent Neural Networks (RNN) have been utilized for weather forecasting. Traditional multilayer ANN models can be utilized to forecast weather 15 days ahead of time. To anticipate air temperatures, a hybrid of multiple neural network designs can be utilized [38]. For training neural network-based models, several inputs such as relative humidity, air temperature, wind, speed, and sun contaminations were taken into account. In the case of weather, combination models (MLP + CNN), and (CNN + RNN) are generally used for better predictions.

3.10 Electronics hardware & accelerators

Artificial intelligence (AI) capabilities such as fuzzy logic, expert systems, and neural networks are examples of artificial intelligence (AI) capabilities that will be available to consumers in the coming decades in power electronics and motion control. Although these technologies have advanced significantly, have a wide range of applications, and power electronics and machine drives have been unaffected. In the fields of motion control and power electronics, AI technologies and their applications play a critical role. Deep neural networks (DNNs) have become an important tool in artificial intelligence, with applications ranging from computer vision to robotics, medical diagnosis, autonomous vehicles, and security. The complexity of DNN models rises in tandem with the complexity of the application, and deploying complex DNN models necessitates a lot of computing resources. Complex DNNs cannot be processed by general-purpose processors with the required latency, throughput, and power budget. Domain-specific hardware accelerators are thus required to deliver great computational resources while maintaining great throughput, and energy efficiency in a compact very-large-scale integration (VLSI) chip area. A novel paradigm of field-programmable gate array (FPGA) integrated computational intelligence has developed from an assessment of the deployment of DNN accelerators. AI is in high demand for semiconductor design and verification, which are now the most demanding tasks.

FPGA is used to create the chip architecture and hardware synthesis & implementation of multilayer feed-forward (MFF) neural networks (NN) [39]. Despite advances in FPGA thickness, the network size that can be realized on FPGA hardware is limited by multiple multipliers in ANN. It will render NN applications commercially unviable. The proposed solution is intended to reduce resource requirements without interfering too much with system performance, allowing a larger NN to be comprehended on a single chip at a low cost. The new architectures have digital neurons in a single layer that can be reused several times with variable weight coefficient vectors in the direction of a substantial decrease in the essential silicon area. Machine learning, which is a subset of artificial intelligence (AI), has evolved into a disruptive technology that is now widely used across a variety of industries. One of the greatest important developments made possible by machine learning is in the domain of VLSI [40]. In the foreseeable future, more growth and advances in this field are expected. The production of thousands of transistors in VLSI is complex and time-consuming, and needs the design process to be automated, which led to the development of CAD tools and technologies. Machine learning techniques are used at various levels of abstraction in VLSI CAD and the incorporation of machine learning into VLSI will help the design engineers to predict the hardware resources before manufacturing.

4 Results & discussions

Table 1 lists the uses of ANN for healthcare informatics and different diseases. ANN has been used with accuracy for Coronary heart disease diagnosis (64–94%), sleep apnea using ECG (99%), MIT-BIH arrhythmia dataset of ECG data (95.12%), and seizure detection using EEG (98.86%). Hybrid ANN is applied for predicting the use of social media, dissemination of scientific papers on social media, customer behavior, gender detection, and stock market forecast. The backpropagation ANN and principal component analysis are

Table 1 ANN and hybrid ANN for healthcare and other spatial information

Description	Accuracy	AIML	Application
Atkov et al. [41]	64–94%	Artificial neural network	Coronary heart disease diagnosis
Salari et al. [42]	99%	The residual neural network algorithm	Sleep apnea using ECG
Sowmya et al. [21]	95.12%	ANN deep learning	MIT-BIH arrhythmia dataset of ECG data
Abdulla et al. [43]	98.86%	Ada-boost back-propagation neural network (AB-BP-NN)	Seizure detection using EEG
Leong et al. [27]	86.67%	Hybrid ANN with structural equation modeling (SEM) and	Predicting the use of social media
Ma et al. [28]	78.05%	ANN with simultaneous equation model (3SLS)	Predicting the dissemination of scientific papers on social media
Zheng et al. [44]	93.13%, 54.00%	ANN (93.13%,) and SVM (54.00%) with a sigmoid kernel function	Prediction of customer's behavior
Safara et al. [29]	98.00%	ANN with whale optimization algorithm (WOA)	Author gender detection (AGD) in email, messenger, and social network communication
Jabin et al. [31]	100%	Feed-forward ANN	Stock market forecast
Kara et al. [45]	75.74%, 71.52%	ANN (75.74%), and Support vector machine (71.52%)	Predicting the direction of stock price index movement in Istanbul
Liu et al. [46]	99.60%	Backpropagation ANN and Principal Component Analysis	Prediction of manufacturing supply chain digital transformation risks

used for the prediction of manufacturing supply chain digital transformation risks with 99.60%.

To generate a workable design, a lot of rendering and testing is required, especially with the rise of open-source architectures like reduced instruction set computer (RISC)-V and different computer-aided design (CAD) software tools available for the design and verification. Machine learning, artificial neural networks (ANN), and deep learning are used to predict system performance and accuracy. Table 2 list the RNN and CNN deep learning-based applications for spatial forecasting and different diseases. RNN with accuracy is used for mental depression from EEG data (96.50%), multi-face detection and identification of prisoners in jail (87.00%), and Fake news identification and classification (99.00%). The CNN has been utilized for interactive labeling (92.00%), X-rays of the adolescent pelvis for forensic bone age estimation with twos stage CNN (88.00%), smart glass security and authentication (98.5%), health assistant for perceptive symptoms of common diseases (97.37%), vision-based spacecraft (92.53%), and aircraft engine feature selection (90.00%) using the data-driven prognostic model. Table 3 lists the applications of machine learning using SVM.

Machine learning and ANN have been used for GIS data, solar panel performance prediction, electrical load forecasts for commercial buildings, and analysis of electricity load forecasts for a single building on a university campus. Machine learning has been proven a boon in the medical field that the machine learning algorithm system often computes picture features that are deemed important in creating the prediction or diagnostic of interest. After that, the system of machine learning algorithm decides the best arrangement of these image aspects for classifying the image or generating a metric for the specified image region. ANN has been applied for cancer detection,breast cancers, mouth ulcer, kidney stone, lung diseases, heart rate, arrhythmia detection, Parkinson's diseases, epilepsy disorders, and many more [37]. It has been used for the study of equipment, and machinery for biomedical applications such as ECG, EEG, EMG, etc. ANN and machine learning can be

Table 2 CNN and RNN for multi applications

Description	Accuracy (%)	AIML	Application
Sarkar et al. [22]	96.50	RNN with the integration of the LSTM Model	Mental depression from EEG data
Dan et al. [47]	92.00	Convolutional Neural Network and U-Net	Interactive labeling for the Patched Asphalt Pavement Images
Peng et al. [23]	88.00	Two-stage CNN	X-rays of the adolescent pelvis for forensic bone age estimation
Almabdy et al. [24]	94–100	CNN with multi-class SVM	Face recognition from facial images
Khan et al. [26]	98.5	Deep CNN	Facial Recognition from smart glass for authentication and security
Diyasa et al. [48]	87.00	Convolutional Neural Network	Multi-face detection and identification of Prisoners in Jail
Jadhav et al. [30]	99.00	Recurrent Neural Network Classifier	Fake news identification and classification
Phisannupawong et al. [32]	92.53	Deep CNN	Non-cooperative docking process for vision-based spacecraft and pose prediction
Rai et al. [25]	97.37	CNN	Intelligent health assistant for Knowing symptoms of common diseases
Khumprom et al.[49]	90.00	Deep CNN	Aircraft engine feature selection for a data-driven prognostic model

Table 3 Applications of machine learning using SVM

Description	Accuracy (%)	AIML	Application
Chaudhary et al. [50]	94.6	Support vector machine	Brain tumor and MRI
Zheng et al. [44]	93.13, 54.00	SVM (54.00%) with a sigmoid kernel function	Prediction of the customers behavior
Yuan et al. [51]	97.17	Support vector machine	For exact internet traffic classification
Prashanth et al. [52]	96.40	Naïve Bayes, and Support vector machine	Early detection of Parkinson's disease using multimodal features
Shi et al. [53]	80.00	Support vector machine	Forecasting the power output of photovoltaic systems based on weather classification

applied in electronics hardware, semiconductor industries, textiles, software applications, food packing, and most real-time applications [54]. aneAI has played a very important role in the education sector. The advancement of AI and natural science has provided a new era of computer-assisted learning. The computer system with human intelligence could serve as an intelligent tool, tutor, or tutee, as well as support educational decision-making [54]. The combination of AI and education will open up new opportunities for drastically increasing learning and teaching and quality. Teachers can use intelligent technology to assist them with tests, data collection, devising new strategies, and increasing learning progress. The outcome of the student's knowledge can be enhanced through asynchronous learning and knowledgeable professors. Given the growing interest in artificial intelligence in education (AIEd) and the dearth of thorough reviews, the work's goal is to provide an exhaustive and methodical evaluation of significant AIEd studies. A mobile learning technique based on formative assessment will assist AI to increase student learning attitudes and achievements.

5 Conclusion

Machine learning is a branch of artificial intelligence that use a variety of probabilistic, statistical, and optimization techniques to permit computers to "learn" from past examples and detect hard-to-observe patterns in vast, noisy, or complex data sets. Medical applications, especially those that rely on complex proteomic and genomic measurements, are a good example of this, which will benefit greatly from this capability. Artificial intelligence (AI) refers to the creation of computer-based systems that can perform activities that are comparable to human intelligence. Artificial intelligence, in reality, encompasses the entire learning scale and is not restricted to machine learning. Learning representation, natural language processing, and deep learning are examples of AI (NLP). Computational programs that replicate and simulate human intelligence in learning and problem-solving are referred to as AI. Artificial intelligence in medicine employs computer algorithms to extract information from raw data to make accurate and right medical decisions. Machine learning can be applied n any domain to solve real-world applications and predict possible outcomes. Machine learning is altering businesses in a variety of industries, from huge corporations to small firms. As machine learning pervades various businesses, everyone starts to leave a data trail. Each individual generates and shares data. Machine learning (ML) has the potential to make self-optimizing design tools possible. After deployment, AI-enhanced tools can learn and improve in (local) design contexts. Organizations will benefit from a greater understanding of their customers in the future by providing better, more tailored experiences.

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Declarations

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