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A REVIEW REPORT ON CONVERGENCE OF ARTIFICIAL INTELLIGENCE AND BLOCK CHAIN AND APPLICATIONS

[1]Dr.Y.Sowjanya Kumari,[2]R.Radha Kumari,[3]Dr.D.N.V.Syam Kumar
[1]Associate Professor, [2]Associate Professor, [3]Associate Professor
, Department of CSE, St.Ann's College of Engineering & Technology,
Chirala, Andhra Pradesh,INDIA,

Abstract:

In recent days, Artificial Intelligence and BlockChain have become popular and groundbreaking technologies. AI algorithms are used for Learning, Planning, Autonomic Computing, Optimization, Knowledge Discovery Perception, Search and Reasoning. On the other hand, Blockchain is a distributed point-to-point system that provides a safe and verifiable mechanism for decentralised transaction validation. In this article, we take a more detailed and four look at the intersection of blockchain and artificial intelligence. We begin by discussing the areas of AI, as well as the concept, characteristics, and essential technologies of blockchain, before examining the viability of integrating the two technologies. The study on the convergence of blockchain and AI is then outlined. The integration of AI with blockchain might have a significant impact on disciplines such as the IoT, identification, financial markets, civic governance, smart cities, local communities, supply chains, personalised medicine, and other fields, resulting in many people benefiting.

***Index Terms*: Artificial Intelligence; Blockchain;Machine Learning;Deep Learning; Internet of things**

I. Introduction

To learn, infer, and make final conclusions, AI algorithms rely on data or information. Blockchain is a distributed ledger that allows data to be stored and exchanged in a cryptographically signed, vetted, and agreed-upon manner by all mining nodes. When smart contracts are utilised to make judgments and do analytics using machine learning algorithms, the results may be trusted and unquestioned. When AI and blockchain are combined, they can build a safe, immutable, decentralised system for the very sensitive data that AI-driven systems must acquire, store, and use. This approach leads to major data and information security advances in a variety of industries, including medical, personal, banking and financial, trading, and legal data. "It is difficult for conventional AI architectures to screen data effectively and/or track malicious data providers. Conventional centralized AI architectures may also lead to privacy disclosure and data abuse. Hence, a recent trend is to move away from centralized AI approaches to decentralized AI approaches [5]." Decentralized AI applications and algorithms can be constructed using AI and blockchain technologies, with access to an identical view of a secure, trusted, shared platform of data, logs, knowledge, and choices. A trusted trail of all recordings taken by AI algorithms before, during, and after the learning and decision-making process can also be stored on such a platform. Decentralized AI allows for the processing and decision-making of verified, digitally signed, and secures shared data that has been transacted and kept on the blockchain in a distributed and decentralised manner, without relying on a central authority. Decentralized AI allows for distributed and decentralised processing and decision-making on trusted, digitally signed, and secure shared data that has been transacted and kept on the blockchain, without the use of Trusted Third Parties or intermediaries. AI is recognised for working with large amounts of data, and blockchain has been identified as a secure platform for storing this information. There has been some research towards combining blockchain and AI. In [6] the authors explained how combining blockchain with AI can create a new ecosystem for a decentralised economy in terms of decentralised data storage and administration, infrastructure, and AI applications. However, there isn't much discussion about how Your privacy is safeguarded. Blockchain technology has been proposed as a viable solution for storing healthcare data for the purposes of sharing, exchanging, and analysis among various providers. Decentralization, increased data security and privacy, medical data held by patients, data verifiability, transparency, and trust are some of the advantages of Blockchain for cancer applications. By integrating ML and BlockChain technologies data security and transparency are increased.[8]. "Recent market research predicts that AI market will grow up to 13 trillion US dollars by the year 2030"[6]. In this work, we review the existing research on blockchain's applicability in AI. We specifically looked for works published in English between 2019 and 2021 using

keywords like (blockchain and AI) in major academic databases (e.g., IEEE Xplore, ScienceDirect, ACM Digital Library, and SpringerLink). We found over 150 articles, excluding those that were not immediately related. In the end, we decided to include 44 papers in this document for debate. This paper's main contributions can be summed up as follows:

- We include an orientation to AI's fundamentals, main components, and applications.
- We provide a summary of Blockchain's attributes.
- We discuss how AI is powered by blockchain and how blockchain is powered by AI
- We look at how combining AI and blockchain can aid in a variety of real-time applications. We also go through the primary advantages that this integration provides.

We provide a review of blockchain fundamentals, important features, and how to use AI with these characteristics. The remainder of the essay is structured as follows. The history of AI and its characteristics are covered in Section 2, and Section 3 describes blockchain technologies . Section 4 discusses how AI is powered by Blockchain and how blockchain is powered by AI. Section 5 describes Blockchain and AI applications for one another. Section 6 Completes the paper.

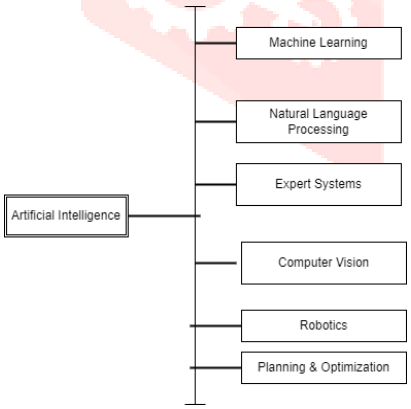
II. Background

This review presents a summary of AI, blockchain and discusses the key features of AI a blockchain technologies.

2.1. Artificial intelligence (AI)

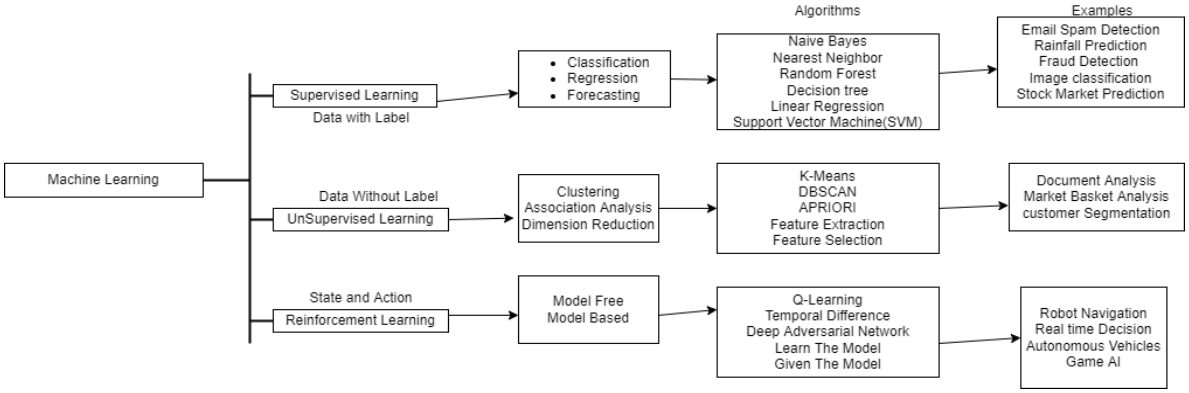
Artificial intelligence(AI) is an automatic machine that can do numerous functions such as learning, perceiving, reasoning, and solving problems automatically. “Artificial Intelligence (AI) has great potential in diverse real-time mission-critical applications and one such application is telesurgery or robotic surgery [23]”. AI planning and Computer vision for example are at the heart of the video game enterprise, which has expanded to include a more significant entertainment sector. Speech recognition is now possible on our phones and in our kitchens due to DL, a sort of ML centered on neural networks, which are layered representations of variables. Deep learning techniques can also be applied to a variety of applications utilizing pattern recognition. In comparable specialised applications, we may anticipate a significant increase in the usage of AI technology in the future, including additional healthcare diagnostics, self-driving cars, physical help for elder care, and tailored therapies.Businesses around the world will employ AI and robotics to attract younger workers, including those in farming, food & beverages, fulfilment centres, and factories.To distribute online orders, they'll deploy flying drones, autonomous trucks, or robots that can ascend steps to the front door. “AI is frequently utilised in marketing campaigns where quickness is critical. AI systems know how to better engage with customers based on information and client data, then give them customized communications at the ideal moment without any need for advertising staff involvement, ensuring optimal productivity. Artificial intelligence allows firms to better control their internet brand and secure existing presence online. It accomplishes this by allowing brand and service executives to undertake comprehensive review and study on web pages, social networking sites, and other venues [22].”

Artificial Intelligence(AI) is the branch of Computer Science, AI is the study of how to make machines to think, behave intelligently like humans. Artificial Intelligence is a superset of various technologies that encompasses Machine Learning (ML), Computer Vision (CV), Robotics, Expert Systems, Natural Language Processing (NLP),



2.1.1. Machine Learning (ML)

The investigation of algorithms and analytical algorithms that computer systems use to complete tasks without being explicitly instructed is known as machine learning (ML). The term ML, is defined as a "computer's ability to learn without being explicitly programmed." ML is a subfield of artificial intelligence(AI).Supervised Learning, Unsupervised Learning, Semi-Supervised Learning, Reinforcement Learning, Ensemble Learning, Multitask Learning, Neural Networks, and Instance Based Learning are the different categories for ML approaches, ML applications are image text mining, spam detection, video recommendation, and multimedia concept retrieval etc [9]. ML is broadly divided into Supervised Learning, Unsupervised Learning, and Reinforcement Learning



- *Supervised Learning:* Supervised automates the process through using labelled datasets to train algorithms that pinpoint data or forecast outcomes. The weights in the model are adjusted as more data is added until the model is well fitted. Regression, classification, and forecasting are the three types of supervised learning. supervised learning approaches include the following algorithms nave bayes, linear regression, random forest, logistic regression, Decision Trees, Nearest Neighbor and support vector machine (SVM), among others. Businesses can employ supervised learning to scale up the solutions to a wide range of real-world issues, including classifying spam in a distinct folder from your email.
- *Unsupervised machine learning* Unlabeled datasets are analysed and clustered using machine learning approach. These algorithms discover additional patterns or data groupings without any need for human intervention. Dimensionality reduction , Association and Clustering are the three types of unsupervised learning algorithms. singular value decomposition(SVD) and Principal component analysis(PCA) are two popular techniques for lowering the number of features in a model through the wavelet transform process. Probabilistic clustering approaches, k-means clustering, Neural networks, and other algorithms are employed in unsupervised learning . It is a nice alternative for cross-selling initiatives, exploratory data analysis, consumer segmentation, and visual and pattern analysis due to its ability to recognize similarities and contrasts in data.
- *Reinforcement machine Learning* Although reinforcement machine learning does not employ sample data to train the algorithm, it is a cognitive machine learning paradigm similar to supervised learning. This model gains knowledge as it goes via trial and error. A string of prosperous outcomes will be reinforced in order to determine the best proposition or approach for a particular circumstance. Examples for Reinforcement algorithms are: Q-Learning, Deep Adversarial Networks and Temporal Difference (TD). The Algorithmic Warfare Cross-Functional Team (AWCFT) programme uses machine learning to scan drone-produced digital images and videos as well as hazy cancerous tumours on x-rays and skin blemishes,The job at hand is to recognise objects in the static and moving images, like autos. Drones carry so much video that human analysts are unable to process it all,Paul Scharre, a US security expert, agrees that integrating artificial intelligence applications into weapon systems is not difficult and does not need significant changes to military operations [35].

2.1.2. Deep Learning (DL)

Deep learning is a subset of ML that teaches a computers to complete tasks akin to those performed by a person including speech, picture, and prediction recognition. DL establishes critical information parameters and teaches the computer to learn on its own by identifying patterns utilising multiple processing layers. as opposed to organising data to run through predefined equations. Computational models with multiple deep architectures can learn data representations with different levels of abstraction thanks to deep learning. The back propagation approach is used by deep learning to illustrate how a machine ought to alter internal variables that are required to generate the represent at every level from the representation in the preceding layer, showing complex structure in huge data sets. DL is a descendant of a traditional NN, but it significantly superior to what came before. DL techniques are divided into the following categories: Deep reinforcement learning, Deep supervised learning, Deep unsupervised learning [11]. DL applications are Health care, Self driving cars, Fraud detection, Deep Dreaming, Language translations, Visual Recognition, Automatic Handwriting generation, Detection of growth delays in children, speech recognition and many other domains such as genomics and drug discovery. DL Algorithms have demonstrated tremendous promise in the automated processing of medical data and imaging in a range of medical fields. DL algorithms have been utilised in ophthalmology to diagnose severe eye illnesses such as diabetic retinopathy and glaucoma.

2.1.3. Artificial neural network

ANNs imitate human NNs in order for computers to develop and learn judgments in a similar manner to humans. Conventional computers are programmed as though they were linked brain cells to build ANNs. The ANN tool's artificial brain function is far more trendy than typical computer linear logic. In general, DL NNs strive to perform in a hierarchical fashion, with input, hidden, and output layers, similar to biological NNs. Output and Input weighted edges connect the nodes(neurons) in each layer of NN. The covert layer axons compute summation of weighted input layer values neurons and output nonlinear outcomes via activation functions. During each training step, the weights of NNs are modified to examine the low-dimension attributes of extremely complex inputdata. The weighs are assigned at random in the beginning. A sequence of NN procedures results in the output layer being used to determine the learning outcome. Artificial Neural Networks have applications in Social Media, Marketing & Sales, and Healthcare and personal assistance. Types of ANN are FNN(Feed forward Neural Networks) used to perform basic pattern and image recognition, RNN(Recurrent NeuralNetwork) used in Natural Language Processing(NLP) and speech synthesis, CNN(Convolution Neural Network) used in object recognition and video analysis.Tools used for AI,ML and Deep Learning are: TensorFlow, IBM Watson, Caffe, DeepLearning4j, Torch, Scikit Learn, PyTorch, Weka, KNIME, Apache Mahout,Keras etc.

2.1.4.Natural Processing(NLP)

NLP is an area of AI that gives computers the ability to decipher human language. Its objective is to develop text-understanding computer programmes that can carry out automatic tasks like translation, spell checking, and topic classification. It focuses on understanding unstructured data. Text mining, readability analysis and manual text analysis are a few examples of NLP. It is utilised to uncover the case for developing strategies based on the marketplace and communication between customers. In contrast to conventional internal audits. Unstructured text data can be automatically scanned using NLP technology, retrieve and examine the important points of review systematically and automatically, freeing internal auditors from heavy reading and review effort. NLP systems can now "learn" as they go by using deep learning models and learning strategies based on CNNs and recurrent neural networks RNNs, which assist them to extract meaning from large amounts of unstructured, unlabeled text and voice input with ever-higher accuracy. By deconstructing human text and speech input, several NLP techniques assist the computer in comprehending what it is taking in. They are: Verbal sense disambiguation, Voice recognition and text categorization recognition, Part of speech tagging, Natural language generation, Co-reference resolution, Sentiment analysis.The following are use cases of NLP used in Text Extraction, Language Translation, Sentiment Analysis, Chat bots. The real world applications of NLP are: Siri and Alexa, chatbots, streamlining the recruiting process on sites like LinkedIn ,Tools like Grammarly .

GNMT is a system that increases fluency and accuracy across languages by employing a massive artificial neural network. Rather than translating individual words, GNMT tries to interpret entire phrases. GNMT uses greater context to derive the best applicable translation because it scours millions of examples,it looks for commonalities among various languages.

2.1.5.Computer Vision (CV)

CV is a subfield of AI that enables computers and machines to see and interpret the world around them. DL, a kind of ML that use algorithms to extract information from data, is at the heart of current computer vision. Motion analysis, recognition, image restoration, scene reconstruction, object categorization, object identification, and object tracking are examples of conventional computer vision tasks.The real-world Applications of Computer vision are , Autonomous vehicles, Tactile Feedback ,Medicine, Machine Vision, Military .

2.1.6. Robotics

Robotics is a branch of AI, Robotics is the design of robots that can do activities without human assistance. Robotic Applications that Use AI: Customer Service, Assembly, Packaging. Robotic process automation is a machine-learning-based, repeatable, and automated process. It can mimic email sending, human behaviour, record Afterward enter data again for a variety of activities and fill out spreadsheets. It operates according to predetermined routines and is unable to detect changes in situations, like the surroundings outside. The Big Four accounting firms have now introduced their own financial robots that can create financial reports, enter invoices, and recognise data automatically; these financial robots are probably going to replace simple accounting clerks, enabling business managers without any accounting education to make wise business decisions based on simple accounting data [29].

2.2 AI applications

1. Transportation: An application of AI transportation will be autonomous transportation. In "autopilot" mode, an autonomous vehicle can use a self-driving vehicle to travel from one location to another and uses variety of in-vehicle technologies and sensors, including anti-lock hydraulic systems (brake by cables), adaptive cruise control, energetic steering (steer by wire), Global positioning technology, and warn drivers when making lane changes of anything in their blind areas.. Pre-collision systems were developed using vision and radar technology, allowing cars to brake autonomously when a collision risk is recognised. DL has also been used to increase the ability of autos to detect and recognise things in the environment. “Google’s autonomous vehicles and Tesla’s semi-autonomous cars are driving on city streets today. Google’s selfdriving cars, which have logged more than 1,500,000 miles (300,000 miles without an accident),33 are completely autonomous”[2] . Apple has been developing Project Titan, an all-electric self-driving vehicle. Ai systems will certainly encompass trucks, flying vehicles, and personal robots in addition to cars.

2.Home/Service Robots: The first commercial house robot was a vacuum cleaner. Roomba is an iRobot vacuum cleaner robot. The robots were able to develop a 3-dimensional image of a home as they cleaned, and grow more powerful at covering the cleaning spectrum, thanks to Twenty years of artificial intelligence technologies. Robots will deliver products, clean offices, and improve security in a number of locations.AI-based domestic robots that are presently primarily focused on social interaction. The assistance and communications provided by robots in the future will be enhanced through advancements in voice understanding and cloud-based machine learning.

3. Healthcare : automated clinical management, counselling and monitoring of patients equipment to aid in surgery or patient care, and healthcare system administration are all popular applications in healthcare. Recent accomplishments, such as using social media to infer potential health risks, ML to diagnose at-risk patients, and robotics to assist with surgery, have set a new standard AI for healthcare.

4. Education: Students can interact with automated interactive tutors in language, science, math and other courses via Intelligent Tutoring Systems (ITS).Natural Language Processing has increased internet schooling allowed for teachers to quadruple particularly when coupled with machine intelligence and crowdsourcing, their classrooms' size while concurrently addressing each student's needs for learning and preferences. “Ozobot is a robot that teaches children to code and reason deductively while configuring it to dance or play based on color-coded patterns. Cubelets help teach children logical thinking through assembling robot blocks to think, act, or sense, depending upon the function of the different blocks. Wonder Workshop’s Dash and Dot span a range of programming capabilities. PLEO rb is a robot pet that helps children learn biology by teaching the robot to react to different aspects of the environment.”[2]

5. Low-resource Communities: AI has been utilised to construct prediction models for assisting government organisations solve challenges such as preventing lead toxicity in children at risk and distributing food effectively, for example, using data mining and machine learning. More could be done, based on these early initiatives, especially if organisations can interact and create confidence in these communities. “The Illinois Department of Human Services (IDHS) uses predictive models to identify pregnant women at risk for adverse birth outcomes in order to maximize the impact of prenatal care [2].”

6.*Public Safety and Security :*Improved surveillance drones and cameras,Financial fraud detection algorithms crime, and predictive policing are examples for public security and safety.

7. *Employment and Workplace :* In near future, Tasks will likely be replaced by AI as opposed to employment, and it will also generate new types of professions . ex ML Engineers, Data scientists, Data Engineers, Architects,BI developers, Product Managers, Software Engineers, etc.

8.. Entertainment : Using methods from Crowdsourcing, NLP, image processing, crowdsourcing, machine learning, social networks, and other platforms for sharing and viewing blogs, videos, and other online content photographs have changed entertainment.“ Even the lay user can exercise his or her creativity on platforms such as WordsEye, which automatically generates 3D scenes from natural language text [2].”

9. Agriculture: The best outcomes in the field of agriculture come from a combination of resources, including time, money, and effort. These days, agriculture is becoming increasingly automated, and AI is gaining ground. Agro uses AI in a variety of ways, incorporating solid and crop agriculture robotics monitoring, and predictive analysis. The use of AI in agriculture has the potential to be very lucrative for farmers.

10. Astronomy: The analysis of astronomical data, including the discovery of new stars, distant planets, and even dark matter, can be aided by artificial intelligence (AI) machines.

11.E-commerce: Shoppers can use AI to find related products in their preferred size, colour, or brand.

2.3. auxiliary technologies in ai : The effective fusion of machine learning and big data technologies to understand the past and predict the future using huge volumes of data has resulted in AI.

- Fyle : Fyle is a PC, Android, and iOS spending tracking app powered by artificial intelligence. Fyle, a leading provider of smart expense accounting, has announced direct integration with Google G Suite and Microsoft Office 365.
- Socratic: Socratic is AI-powered software that assists children with math and other projects. Students will take photos with their phones, and Socratic will utilise its AI techniques to generate visual illustrations for the principles they must master. Socratic is a text and voice processing tool that can help kids understand disciplines including physics, arithmetic, art, and social sciences.
- Naunce: “The Nuance security suite filters every call and compares voice characteristics, including tone, rhythm and accent, to a voice digital library associated with bank fraud. The software can quickly flag suspicious calls and alert agents in call centres to a possible fraudulent attempt” [29].
- Elsa Speak: SELSA Speak is a popular artificial intelligence-assisted English language learning programme. Users can use this programme to practise pronouncing English and chatting in it in brief spurts.
- DataBot: This app uses voice to respond to your queries and discuss the topics that matter to you. DataBot provides digital platforms that convey images, information, and interactive presentations on your chosen topic.
- Clarifai : Utilizing item recognition and identification, Clarifai is used in conjunction with a camera system to calculate how many items are still on the shelf and to more accurately predict the rate at which commodities are selling.
- Alexa is The user's workspace and programmes can be managed with voice commands by Amazon's personal AI assistant. Additionally, voice communications with the service are possible for visitors. Banks and Amazon have partnered to offer voice access to bank accounts.
- Kensho : Kensho offers investment professionals the next generation of analytics platforms through the utilisation of massively parallel statistical computing, intuitive visual user interfaces, and cutting-edge technology in predictive analytics [29].
- “ Skymind uses AI technology to automatically adapt to new behaviour, using untapped data sources to detect fraud cases. Skymind builds and trains a neural network that uses historical transaction data to score new transactions based on their likelihood of fraud. Human analysts are used to review risky trades, and the results are fed back to the neural network to improve detection efficiency” [29].
- IBM Watson was developed to improve the field of open domain question answering by the application of advanced NLP, IR, KR, automated reasoning, and machine learning. "Over 100 distinct approaches are utilised to evaluate natural language, identify sources, uncover and produce hypotheses, find and score evidence, and integrate and rank hypotheses," according to IBM.

2.4. AI research trends:. As per[2] the hot areas of AI are discussed as Large-scale ML, DL, RL, Robotics, CV, Crowdsourcing, collaborative systems, NLP, and human computation Internet of Things (IoT), neuromorphic computing, and computational social decision in games with algorithms. Scaling up current algorithms to operate with exceedingly enormous sets of data is a key focus of contemporary ML studies. However, the introduction of DL has given RL a boost. “The success of AlphaGo, a computer program developed by Google Deepmind that beat the human Go champion in a five-game match, was due in large part to reinforcement learning.” [2].In Computer Vision, current research is mostly focused on automatic picture and captions for video. In NLP, research is now transitioning toward constructing polished and capable systems that can interact with humans through dialogue rather than simply responding to styled demands. Research on human computation and crowdsourcing looks into ways to supplement computer systems by employing human intelligence to address problems that computers can't answer well on their own. The goal of crowdsourcing is to come up with new ways to harness human intelligence. Current research is looking into the best work divisions for humans and machines depending on their capabilities and prices.The IoT research is focused on the notion that a broad range of items, such as buildings, appliances, automobiles, and cameras, can be connected to assemble and exchange the vast amounts of sensory data for use in vicious applications. Research on collaborative systems looks into models and procedures that can aid in the development of independent systems that can collaborate with additional systems and people. Computational mechanism design, computational social choice, incentive aligned information elicitation, and algorithmic game theory are current studies in algorithmic social choice and game theory.

III. Blockchain:

Decentralized, autonomous, persistent, verifiable, fault-tolerant, integrity,confidentiality, traceability, and transparency are all desired characteristics of blockchain technology. "As blockchain technology evolves and our exploration of its uses expands, it joins other disruptive technologies such as big data, the Internet of Things, intelligent assistants, and autonomous vehicles in creating major opportunities as well as having potential unintended social consequences".[12]. To track the transfer of digital "tokens" or "coins" like Bitcoin and other cryptocurrencies, blockchain was first developed as a ledger system. These coins and tokens needed a means to track who owned them. Blockchain arose from the necessity to create a digital ownership record. In many respects, blockchain aims to complement the current internet of information with the internet of value that we are creating for the future [13]. Some cryptocurrencies are Bitcoin ,Ethereum ,Dash ,Litecoin ,Zcash ,Zcoin ,Ripple ,Blackcoin ,Qtum ,BitConnect ,Komodo ,Dogecoin ,Ark ,Byteball ,Naivecoin ,RScoin. "NATO's C4ISR and the US Department of Defense (DARPA – DoD) have already launched their own blockchain programs, developing a secure, decentralized messaging application for the military under the name SBIR 2016.2[35]." Numerous stakeholders from various industries, including healthcare, finance, real estate, utilities, and government, have expressed interest in blockchain technology. Several projects are currently in the works that will interfere with how health care data is managed, even our online identities, supply chains, and property titles.The authors spot five upcoming research streams that blockchain used in marketing: BC and Marketing, BC and Electronic Commerce, BC and Data, BC and Data Analytics and ,BC Privacy and Security [7]. A BC is a decentralized distributed system that fulfills the dual functions of recording and preserving transaction records. The data on this blockchain is stored in a system of connected laptops known as 'nodes,' with no core authority. Each node in the blockchain has its own distributed ledger for keeping transaction history. A signed data package containing a message sent from one externally owned account to another account on the blockchain is in reference as a transaction. A chain of data in blocks is connected by a hash function. Since every block in the blockchain technology network is connected to the one before it, no malevolent system can hijack the transaction. BC is a group of blocks, where each block contains four components: timestamp, transaction information, present-block hash value, and previous-block hash value [1]. A network of people or organisations can utilise blockchain to keep track of their transactions (activities). The group's members can generally regard recently stored transactions, but nobody has the power to edit or remove any of them. Blockchain thereby maintains an immutable record of the organization's activities. Without the need for a regulatory authority, BC allows a collection of entities to agree on a specific undertaking and record that agreement. BC can be used to secure, record, and distribute their agreed-upon activity. A monetary transfer between members, a purchase, a vote, or the entry of a patient's lab test results are a few instances of agreed-upon tasks. multi-party cooperation on a certain task, contractual agreements and logistics of the supply chain are only a few examples of such operations [15]. Each user on the blockchain has complete control over their own data, accounts, and privacy.There are two types of blockchain. Permission less blockchains where all parties can view all the records ,permissioned blockchains where there is the maintenance of privacy, that is only selected parties can view information and also be nameless and present[14].Because anybody can engage in their BC networks, which are also known as permissionless BC, Ethereum and Bitcoin are public Blockchains. Because users must be authenticated before entering the network, the various Hyper ledger Blockchain networks are private Blockchains, also known as permissioned Blockchains [3].

BC technology consists of various components that work together they are Ledger, Cryptography, Peer-to-Peer Network, Assets, Merkle Trees, Consensus Algorithms [13].

- Ledger: Blockchain is a digital ledger or immutable record. Asset ownership is frequently tracked and managed via the ledger. However, BC can be used as a simple data storage device for a variety of purposes.
- Cryptography: Cryptography is used in blockchain technology to safeguard confidentiality, provide ledger immutability, and ensure non-repudiation on the blockchain. To connect the data in a block together, a procedure known as a "cryptographic hash" is applied to each piece of information. Cryptographic hashes produce a distinct output or identity for each input. As a result, each block's hash will always be unique dependent on the inputs. Changing the content in a block produces a hash or ID that differs from the original value noted on the chain's subsequent block. Hash functions are used to detect tampering. Blockchain employs the following cryptographic fundamentals: Digital signatures and encryption are done using public key cryptography, Hash Functions [3].
- Peer-to-Peer Network: Blockchain relies heavily on existing the use of computer networking, particularly peer-to-peer network designs. Blockchain is built on the same technology that powers our modern internet. P2P network architecture provides increased reliability and fault tolerance through eliminating single points of failure that are ubiquitous in typical architectures of client/server networks. "Blockchain as a technology combines the advantages of both peer-to-peer networks and cryptographic algorithms to ensure the validity of the conducted agreements. None of the participating entities can change an approved and registered activity without involving the other participating entities."[15]
- Asset: anything that calls for an ownership history qualifies as an asset this can be financial or non-financial., or simply information, such as medical records, event tickets, a car title, or a patent.
- Merkle Trees: Merkle trees are used in blockchain to validate data quickly and efficiently. Merkle trees create a root hash of the complete collection of data in a block to summarise it. The root hash is discovered through repeated pair hashing of data nodes until only one remains. The Merkle root is the last remaining child node. Merkle tree allows proof of membership.
- Consensus Algorithms: A consensus is a contract that is ratified by all of the network's nodes. There are many different types of consensus protocols that are used to reach agreements across nodes, and popular ones include Proof-of-Work(PoW), Proof-of-Stake(PoS), and Delegated Proof-of-Stake(DPoS), Proof-of-Publication(PoP), Proof-of-Burn(PoB),Proof of Elapsed Time(PoET). Practical Byzantine Fault Tolerant (PBFT) Directed Acyclic Graph (DAG),Ripple, Tendermint [3]. A consensus mechanism is used in a Blockchain system to develop trust and accurately store transactions on blocks. As a result, consensus algorithms are at the heart of all Blockchain transactions.
- Smart Contract: Smart Contract is a protocol for authorising devices and ensuring that they do not operate outside of their capabilities. It establishes a safe channel of communication for dispersed networks and smart devices.

- One of the key benefits of blockchain allows without involving a third party like a government agency or authorisation institution, two or more entities can safely record an agreement of specific acts using a public network like the Internet. As a result, once the agreement is added to the chain, it cannot be changed, cancelled, or disputed by any of the parties involved. To ensure the authenticity and consistency of the completed agreements attached to the chain, a technique known as "mining" is used [15]. In a blockchain network, there are two sorts of nodes: miner nodes and normal nodes. Miner nodes are unique nodes that are picked based on a set of rules and policies. These are used in the network to authenticate, verify, authorise, and validate transaction blocks. For doing these actions, they are paid in bitcoins (or some other cryptocurrency/'gas'). Normal nodes are nodes that have the complete blockchain information in their ledger. They coordinate and collaborate on transactions that are authenticated by the network's miner nodes [4]. In [3] the authors discussed the Hazards and Real Threats on Blockchain Systems some of the attacks are Core Software Bug, Attacks Related to Cryptocurrency Exchange Platforms , Endpoint Attacks, Bugs and Attacks on Smart Contracts, Attacks with Wallets , Network Attacks, Attacks with IOTA.

IV. Integration of AI And Blockchain:

Integration of BC and AI is the convergence of two most advanced technologies, with the capacity to present a variety of possibilities. An autonomous cars, and a smart transportation in cities are all using artificially intelligent blockchain. The combination of blockchain and AI can boost ML and provide financial products to AI. The blockchain provides a secure authentication system [22]. “On one hand, blockchain suffers from weaknesses such as security, scalability, and efficiency. On the other, AI has its fair share of issues with trustworthiness, explainability, and privacy. blockchain will bring trustlessness, privacy, and explainability to AI; in turn, AI can help build a machine learning system on blockchain for better security, scalability, and more effective personalization and governance[10].” Blockchain thinking could lead to new consensus models like The application of demurrage principles to transfer brain currencies like ideas and potentiate intellect, as well as self-mining ecologies and intelligence proof [16].

4.1.Blockchain forAI:

AI judgments will becoming more trustworthy, comprehensible, and transparent thanks to blockchain. Because all data on the BC is public, AI is essential for ensuring users' security and privacy. This is exactly what blockchain can achieve, monitoring every step of the data processing and decision-making process. We get a better knowledge of and confidence in the judgments made by AI-based systems by studying their behaviours across various data input and application scenarios.

Data sharing, explainable AI, artificial trust, security, and privacy are just a few of the difficulties that AI faces. Many academics have employed different blockchain technologies to address these issues, including Deep chain, distributed ledger, and G-coin, innovative cryptocurrency scheme, legacy access control, and others. In [6] the authors discussed various applications of AI are Planning, maximising, managing knowledge, perceiving, learning, searching, and reasoning are all aspects of autonomous computing. The evolution of fully decentralised autonomous systems is driven by interactions between people, data, applications, devices, and systems. By analysing highly relevant data, decentralised optimization leads to better system performance. Decentralized AI planning methodologies can be used to create vital, Mission-critical applications and systems require immutable plans. Decentralized perception techniques are advantageous because they eliminate the requirement for apps and systems to acquire data streams. Modern AI systems can benefit from the development systems of extremely dispersed, autonomous learning enable perfectly synchronised worldwide local intelligence domains. Decentralization based on blockchain allows for the tracking of perception trajectories, safe data transport, and immutable data storage. Successful search traces and traversal paths should be permanently and securely stored using blockchains and decentralised infrastructure, which could enable ideal searching solutions for same type operations in the future.Decentralized distributedreasoning on blockchain based on smart contracts provides the accessibility to memorable reasoning processes that may aid in the execution of similar reasoning methods in the future.In [1] The author talked about how blockchain is driving AI for IoT to maintain qualities like explainable AI, which offers AI techniques that are trusted and simple for IoT, AI effectiveness, which offers users in IoT applications predictive methods, data sharing, which enables users to easily share data resources from one machine to another, and artificial trust, which offers solutions for issues.

4.2. AI FOR BLOCKCHAIN :

Thousands of variables and trade-offs between performance and security, decentralisation, and other factors go into the creation and operation of a blockchain. Artificial intelligence (AI) can help with these decisions, as well as automate and optimise BC for better governance and performance. Furthermore, because data on the BC is public, AI take part in a critical role in ensuring users' security and privacy. Blockchain has problems with scalability, energy use, security & privacy, efficiency, and more. Many academics offer AI tools including genetic algorithms, federated learning, spark ML, and multidirectional RNN to help reduce these problems.If the harm is inevitable, the AI might at the at the very least, protect the remainder of the blockchain platform by separating the attacked component. The blockchain may be governed by a comparable AI, making it more scalable and robust. In[1] In order to preserve attributes like energy consumption, scalability, security, efficiency, and a lack of talent, the author addressed how the blockchain is driven by AI for IoT. The author identifies knowledge-based ability and employs an intelligent system based on the concept of ML.

By reviewing various papers we can identify that the convergence of AI and Blockchain results in the following benefits of improved data security, increased confidence in robotic judgement, high efficiency, and decentralised intelligence, Collective Decision Making. Many real-time applications have become prominent of the convergence of two incredible technologies.

V.Applications related to Integration of AI and BC

In [20] For residential dwellings, the authors developed a safe energy trading system based on blockchain, They created a novel PoCC consensus protocol for selecting miners and forming blocks, They also proposed using an improved sparse neural network (ISNN) to reduce the system’s overall processing cost. Furthermore, BC technology is used to secure the security of prosumers, and security study demonstrates that the system is resistant to the Sybil attack. ISNN was proposed, and it consists of two key components:SNN(Sparse Neural Network) and the Jaya optimization method, The error convergence rate is accelerated while the number of connections between distinct layers of neurons is reduced using the Jaya optimization technique[20]. In [21],[45] The

authors Proposed to run ML algorithms on BC, they described that Data hashes may be used in blockchain data verification to confirm information access under the grant of client authorisation, This means that none of the clients can get client access without the clients' permission, They used consensus node to implement consensus algorithm, key verifier to verify the identities of the users, a membership service participants (MSP) to identify the client registration and certification process to the various participants and two types of blockchains, namely DataChain used for a data access control and BehaviorChain forms an immutable data access to obtain the level of perceptibility,To validate the prediction model, they used the dataset obtaining from an insurance company[21]. To validate the client requests as fraud or non- fraud they applied classifier techniques,To monitor the methods including gradient boosting, ridge, elasticNet, and XGBoost, as well as regression performance were used, They measured performance for fraudulent module, risk assessment module against the classifiers like decision tree, Nearest Neighbor, Naïve Bayes and has shown that their proposed method PPSC-BCAI achieved a better result, They also discussed security evaluation using the features like security, privacy, scalability [21]. The writers addressed how BT is important in a variety of corporate applications. While preserving accountability, it improves safety and speeds information sharing. Blockchain technology is bolstering its influence in the business world in order to assist businesses in gaining more clients, To improve business operations and preserve secure interactions among numerous clients, the authors proposed BI-AIBT, They looked at the ratios of demand prediction, product quality, business development, consumer behaviour analysis, and customer satisfaction,they found that employing the suggested BI-AIBT, the results enhance the demand forecast ratio, Consumer satisfaction, product quality, business development, and customer behaviour analysis ratios [22]. In [23] The authors proposed BATS, a self-managing, secure, transparent, and trustable system with huge Ultra-Reliable Low-Latency Communication, as a 6G telesurgery system powered by blockchain and AI (mURLLC),BATS classifies diseases with a criticality score ranging from 0 to 1 using AI methods such as XGBoost. To preserve security and trust among the different players engaged in telesurgery procedures, A public BC was preferred by BATS, namely Ethereum, By assessing the patient's fundamental symptoms and past health records and communicating the results via the blockchain network, to doctors and patients, AI can assist forecast the type of sickness and operation that will be required, Utilizing prediction models, network matrices, and blockchain metrics, the performance of the BATS is evaluated (blockchain mining profit and data storage cost). According to their research, the suggested BATS scheme beats the InterPlanetary File System (IPFS) in terms of prediction precision, throughput when user numbers increase, extraordinarily low packet loss ratio, low storage cost, high mining profit, and low bandwidth usage [23]. In [24], The authors presented an integrated solution for various parts of BC and NLP to identify false new and improved anticipate bogus posts and user accounts using machine learning approaches. The blockchain used to detect Based on PoA, bogus news and has a high rate of transactions. This is the system's most powerful feature for detecting false user information and accounts. Using NLP for deep text analysis based on shared contents, designing a false news prevention system. Using the Reinforcement Learning technique to forecast the system's learning rate and detect bogus accounts. To avoid spreading fake news, find the relationship between items and extract the similar meaning and structure of the shared material. In [25] The authors presented " A comprehensive intelligence and secure data analytics framework for 5G networks based on the convergence of Blockchain and AI named Block5GIntell''. Homomorphic encryption enables blockchain to organise and classify 5G-produced data into categories, securely store it in a real-time shared ledger, and maintain data anonymity without disclosing sensitive information like identify or location. Decentralized AI apps running on the 5G network will be able to function independently and perform network planning, network optimization, user behaviours, and network traffic learning and knowledge management techniques. All without the involvement of a third party, resulting in significantly improved network performance, tightened security, and cost savings for both network operators and providers They presented an energy-saving case study for AI-enabled 5G using Blockchain, with the simulation resulting in a reduction in energy consumption at the RAN level [25]. This study used machine vision techniques and blockchain to find an efficient method for recording parking utilisation, To ensure that the suggested solution was useful and consistent with the established hypothesis, the research examined the many components, It can be determined that such a solution can accommodate fully level 5 autonomous cars based on the analysis of the findings generated by the many tests that tested the various components of the proposed system ,A new transaction is added to the blockchain when the vehicle enters a parking space.This is done using computer vision algorithms, which also identify the vehicle and record the entry time. Three primary categories will be used to evaluate this research: identifying automobiles [26]. The paper gives a thorough and in-depth examination of AI-based solutions for the ECM system, including the use of BC technology,The Authors suggested a decentralised and secure AI-integrated BC-based ECM architecture, which they tested using a P2P energy trading case study, In the P2P energy trading platform, AI and BC enable the growth of interconnected microgrids to handle energy production directly from renewable energy sources and sell excess to neighbours in a more transparent, secure, and distributed manner. It aids in the reduction of energy bills, the promotion of green energy, the reduction of energy costs (due to lower demand for energy from SG), and the provision of incentives to prosumers for involvement in energy trading,Using AI approaches, this peer-to-peer energy trading system detects frequent sellers and buyers as well as illicit transactions on the network , An entire P2P energy trading system can be harmed by a malicious node or block, An AI-based system can assist in identifying fraudulent transactions and network threats,The study demonstrates superior system performance when compared to alternative state-of-the-art systems, resulting in lower carbon emissions and energy bills [27]. The writers talked about Six human experts were used to compare the performance of the deep learning algorithms for the identification of myopic macular degeneration and high myopia (using SE criterion) (five retinal specialists and one ophthalmologist), In order to compare the performance of deep learning algorithms with that of human specialists, They demonstrated how deep learning algorithms may be combined with blockchain technology to improve confidentiality, transparency, and auditability in AI-based medical investigations. They calculated AUC, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and error rate (1 - accuracy) in the small randomly selected test datasets [28]. In [29] The writers talked about As a result of the accounting industry's deep integration of cutting-edge technologies like big data, machine learning, artificial intelligence, and blockchain, accounting procedures have been reengineered, accounting information errors and distortions have been reduced, accounting efficiency has increased, and accounting career structures have changed, They also talked about how prominent accounting firms like PRICEWATERHOUSECOOPERS, DELOITTE, KLYNVELD PEAT MARWICK GOERDELE and ERNST & YOUNG, are using these technology into their work. "The authors Proved that the factors of industrial and manufacturing engineering have an important role in increase of quality of digital legal proceedings' services, ensuring a new level of quality of these services based

on Big Data, blockchain, and AI. In developing countries, management of these factors should be the main measure of increasing the quality of digital legal proceedings' services, and in developed countries – an additional measure. In countries of the both categories, management of other significant factors of quality of digital legal proceedings' services is required. Focus on the factors of industrial and manufacturing engineering is a limitation of the performed research, as it ignores other factors, of which many could be rather significant, especially in developed countries of the Asia-Pacific region . They used correlation analysis, Simplex method for determining the optimal influence of the factors of industrial and manufacturing engineering on quality of legal proceedings in countries of the Asia-Pacific region[30]." The authors explored the numerous obstacles in several elements of sustainable smart cities in this study, illustrating the range of security problems and obstacles that prevent the use of BC with AI,The authors gave aspects of intelligent infrastructure for environmentally friendly smart city settings using AI-Blockchain integration, as well as certain technical and commercial obstacles in the BC-AI industry,They also explored Solutions for BC security in smart city transportation, as well as concerns like as longevity and presence in blockchain-AI life cycle studies, as well as some of the technology's future possibilities [31].In [32] The authors described that Data transparency and AI ethics are inextricably linked. They proposed,using smart contracts of Blockchain how the data transparency that is related to AI ethics is ensured. They proposed various research directions that focus on challenging issues in Blockchain based transparency. In[33] The authors talked about how AI-driven cryptocurrency would operate with the blockchain network and how that will affect it. Artificial intelligence-driven cryptocurrencies are cryptocurrencies developed by artificial intelligence without the need for human participation, using the standard human cryptocurrency development methodology. The process of producing a new coin can be replicated by a programmed AI computer. Here, the AI system collects data from many sources to create a framework for hosting the cryptocurrency. An AI might construct a cryptocurrency without the help of humans by using deep and many layers to extract and place encrypted data in the blockchain network. Cryptocurrency, for example, can improve transaction security and anonymity, among other things. AI can also find patterns and optimise results via machine learning. The authors addressed how blockchain will be used to run AI-driven cryptocurrency. The AI-Chain, which combines deep learning and blockchain, is a proposed block chain energised edge intelligence for B5G networks,The AI-Chain is a distributed and immutable record of learning results that may be used to create a new sharing foundation amongst edges, In the AI-Chain, The authors examined a novel learning-based consensus mechanism known as proof of learning (PoL),PoL considers the training process as a functional puzzle, rather than the meaningless hashing in a proof of work protocol, in response to the massive computer power waste PoL, on the other hand, fully realises the potential for transferring more complex intelligence between edges, They use the AI-Chain to address a joint resource allocation problem in B5G networks in order to demonstrate its usefulness [34]. The AI-Chain outperforms the current popular approach in experiments. Simulating two schemes: classical DRL and collaborative reinforcement learning using the AI-Chain, the performance is compared,They use lightweight edges to train neural networks and blockchain to communicate learning results in a transparent and permanent way The learning edge that reduces the loss function by the least amount is the winner. As a result, processing power waste is dramatically decreased, and the lightweight edge node's learning ability is significantly boosted thanks to the learning skills of other edges [34]. The AI-Chain is then used to address a shared resource allocation problem for B5G networks. The effectiveness of their proposed strategy is demonstrated by experimental findings. In [35] The author advised that the Central Defense Management Authorities establish organic competence in blockchain technology by discussing various topics in AI, Machine vision, and Blockchain. DLT (Distributed General Ledger) technology can take advantage of emerging innovations like AI and CV, A digital data store known as a distributed general ledger that is disseminated (decentralised) and shared among many different countries, regions, or institutions,The prospective utilisation of DNN learning skills on such an universal ledger raises a variety of military science difficulties, and as a result, emerging new venues for cyber operations,The use of computer vision and automated picture analysis in the military could save money. Computer vision is used to generate 3D models from photos or videos. A path planning method based on a combination of A* and the artificial potential field approach is provided,The decentralised characteristics of blockchain are fully utilised by the smart contract-based public key certificate issuance scheme described in this work, which also addresses the issue of certificate issuing agencies being easily exploited during the conventional public key certificate issuance process. An improved potential field ant colony algorithm is suggested in order to address the path planning problems of ant colony algorithms. In this study, existing techniques are improved such that the robot may navigate in static and dynamic surroundings, partially resolving the path planning issue in real-world applications [36]. In [37] The authors show how a swarm of robots can reach consensus using blockchain technology even in the presence of Byzantine robots,The authors compare their method to existing consensus protocols and utilise a robot swarm simulator to show it in a collective sensing scenario where robots in a swarm are controlled by blockchain-based smart contracts (decentralised protocols implemented via blockchain technology), Each robot maintains a local copy of the blockchain; if robots are physically close to one another, they share blockchain data,They illustrate the ARGoS-blockchain interface, which enables researchers to test and develop the scenarios given on various platforms. They provide a framework for safe robot swarm cooperation using smart contracts built on the blockchain as "meta-controllers" with the created ARGoS-blockchain interface, Blockchains avoid Sybil assaults by limiting the number of transactions a robot can send with their scarce coin. Furthermore, the blockchain can be used to safely store key occurrences. This decentralised log can then be used to assess experiment quality and identify anomalies. They have demonstrated in this research that smart contracts based on the blockchain are a potential and versatile method for addressing security challenges in swarm robotics [37]. Using distributed ledgers and integrity proofs, the authors examined how to make log records unchangeable with a focus on mobile and public service robot deployments,To ensure the immutability of continuous event data recordings, they created a secure logging system for robots using distributed ledgers and connected integrity proofs, Checkpoint proofs and smart contracts, which take into consideration the nature of mutually distrusting parties and impose a contractual symbiosis between regulators, robots, and users, are used to establish authenticity and non-repudiation, BBR is a distributed ledger implementation that uses open source robotic middleware and satisfies with the in-vehicle data recording, storage, and access management requirements, It may also be adapted to generic autonomous AI applications [38]. "In a connected vehicle application, the driver heavily depends on the messages, such as accident notification, collision warning, brake warning, etc., generated by the vehicle. These messages, which are generated by On-Board Units (OBU) can be used by an attacker to distract the driver or change the driving behavior to fulfill the attacker's intentions. These generations of false messages are termed under illusion attacks. These types of attacks can be deterred by using blockchain-based architecture, which requires consensus to validate the generated messages [39]". By selecting good nodes and

excluding bad nodes from the system, ALICIA is proposed to detect and validate accidents as well as raise malicious node tolerance in the system, ALICIA has been shown to be more secure and dependable than any traditional implementation of a VANET system or a blockchain-based VANET system that does not include MNS [39]. In [40] The authors proposed The risk mitigation strategies for Securitization of assets are explored in order to improve the security of Securitization of assets and minimize investment risk. The BC technology is being utilised to lower the likelihood of these dangers and increase the security of investments. The artificial bee colony(ABC) method is used to improve the portfolio of BC investments. Because the earlier ABC method can address single-objective planning problems, a different population is created to help it improve. The findings show that the modified ABCalgorithm can maximise many aspects in an investment portfolio at the same time, reduce investor decision-making error, and balance investment returns and risks more effectively.Simultaneously, after evaluating the method, it is discovered that the accuracy and practicality have been increased to some amount. The enhanced ABC algorithm outperforms the competition in terms of risk asset return maximum value, lowest value, and mean value.The mean value of the revised ABC algorithm is not the best among the skewness optimization outcomes, but the algorithm's calculation result is near to the best value. It denotes that the algorithm is the most stable and resilient. The resilience and stability of the revised ABC algorithm must be increased further. In [41] The suggested study's subject is A revolutionary step toward enabling trusted decentralised artificial intelligence in the construction industry is to build a blockchain-based AI system,This paper proposes a modular infrastructure for data collection and decentralised inference to serve as a repository for general blockchain AI-models, The system is designed to guarantee safe data exchange, the validation of AI conclusions, the updating of AI models, and ownership traceability. To help construction businesses decide on bids and financing choices, the proposed method employs a four-step approach to estimate the cost of building roads.The first stage is to use NeuroSolution Software Version 5.92 to create a machine learning model as a multi-buffer perceptron ANN with the Levenberg Marquardt algorithm as a Dynamic nonlinear learning under supervision,The model is then written in a chaincode template using JavaScript as the second step, The next step is to use IBM BaaS to configure the blockchain networkThe fourth stage is to use IBM Cloud Functions to create a access and interaction with the blockchain network through the frontend interface. Moreover, the system's performance was assessed using the computational delay of 50 consecutive invocations, the scaling of important actors, and the submission of incomplete data. In [42] The proposed solution showed a self-driving car that had been trained to handle supply chain management. Supply chain management employs AI and ML algorithms to train autonomous vehicles using BC technology. In this research, the authors propose RLIH for self-driving cars employing BC and combine the benefits of reinforcement learning with heuristic search approaches. The authors implemented supply chain management using a decentralised application (DApp). A Dapp is a decentralised application that enables experts to communicate directly with users. Results reveal that the suggested method surpasses the current heuristic search method in terms of service time and data traffic. RLIH was developed with the use of a Decentralized software. The authors of [43] suggested a method for combating the coronavirus (COVID-19) epidemic using blockchain and AI technologies,They've talked about how blockchain can help solve the pandemic through five major solutions: outbreak tracking, day-to-day operations, user privacy protection, donation tracking and secure medical supply chain, Additionally, through five application domains—epidemic estimation, coronavirus detection, coronavirus analytics, vaccine/drug development, and prediction of future coronavirus-like outbreaks—the potential of AI in addressing the COVID-19 challenge has been examined. A case study that follows the most important use cases and initiatives of blockchain and AI to tackle COVID-19 has also been highlighted.In [44] The goal of this proposed research project is to detect bogus news and reduce its propagation. In the proposed study, a machine learning approach is employed in conjunction with a blockchain architecture to detect bogus news. The model uses supervised Machine Learning (ML) methods to recognise both reporter-generated and malicious bot-generated fake news. The blockchain system, on the other hand, revokes the destructive action of disseminating bogus news. Mining, smart contracts, and Proof of Work (PoW) consensus are used to establish a blockchain environment,The performance of the system was evaluated using a traditional blockchain framework once it was partially implemented. In an experiment, it was discovered that bespoke blockchain takes the least amount of time to compute throughout the module execution via a case study.

Ref.	Year	Use Case/Domain	Technologies		Contributions
			Blockchain	AI	
[20]	2022	Energy Trading	PoCC consensus protocol	Improved sparse Neural Networks	A bockchain-based secure energy trading system for private houses was proposed, employing ISNN to reduce the overall computing cost.
[21]	2021	Business (Insurance data)	Smart Contract, Practical Byzantine Fault Tolerance	Machine Learning ,extreme gradient boosting (XGBoost) decision tree	Proposed, a privacy-preserving in smart contracts for cyber risk measurements using blockchain and AI(PPSC-BCAI).
[22]	2022	Business	Smart contract	AI algorithms	Blockchain technology and artificial intelligence-based business innovation proposed to enhance business operations and maintain safe consumer loyalty.

[23]	2021	Health Care	Etherium Smart Contract	extreme gradient boosting (XGBoost)	Proposed BATS, a conscience, safe, transparent, and trustworthy telesurgery system with huge ultra-reliable low-latency communication that is powered by blockchain and AI (mURLLC).
[24]	2021	Social media	Proof-of-Authority (PoA), Hyperledger Composer in smart contract	Reinforcement Learning technique, NLP, Markov Decision Process (MDP)	Machine learning techniques were applied to various parts of blockchain and natural language processing (NLP) to better forecast false user accounts and posts and to detect fake news.
[25]	2020	Energy saving using AI enabled 5G	Improved Practical Byzantine Fault-Tolerance (PBFT) algorithm, Consortium Blockchain	Unsupervised algoritms, Supervised algorithms, Learning modules	Presented "Block5Gintell," a platform for intelligent and secure data analytics for 5G networks built on the fusion of blockchain and AI.
[26]	2021	Autonomous vehicles.	Etherium Smart Contract	Computer Vision,	Presented a method for automating car park management for autonomous vehicles using blockchain and computer vision.
[27]	2020	Energy Cloud System	Eherium Network.	DL based LSTM model	Outlined a decentralised, secure, BC-based ECM architecture for managing energy clouds.
[28]	2021	Health Care	Hyperledger Fabric	Deep learning algorithm	Proposed deep learning algorithms for myopia correction based on retinal photographs and a blockchain infrastructure to support medical AI research.
[29]	2020	Business	Distributed Ledger	NLP,ML,DL,AI	Presented applications of artificial intelligence and blockchain technology in the field of accounting
[30]	2021	Digital legal proceedings in Industrial and manufacturing engineering	Blockchain	AI	Suggested that Using Big Data, Blockchain, and AI to analyse how industrial and manufacturing engineering aspects affect the calibre of services offered in digital legal procedures in the Asia-Pacific area.
[31]	2020	Smart City	Smart contracts	AI techniques	Blockchain and artificial intelligence coming together in an IoT network to create a sustainable smart city
[32]	2019	Data Tranperency	Smart contracts	AI algorithms.	Discussed the AI ethics driven transparency and detailed how to leverage blockchain technology as a transparency infrastructure.

[33]	2020	Cryptocurrency	Cryptocurrencies.	ML,DL	Proposed a frame work for Artificial intelligence-driven cryptocurrencies.
[34]	2020	Beyond 5G networks	proof of learning (PoL) Consensus Protocol.	Deep reinforcement learning (DRL),DNN	Proposed Blockchain-powered edge intelligence for networks beyond 5G.
[35]	2020	Defence System	Distributed General Ledger Technology	Computer vision, DNN algorithms	Proposed Applications of decentralisation in defence management employing blockchain technology, computer vision, and artificial intelligence.
[36]	2022	Robot	Proof of Work	Path Planning algorithm based on A*, Genetic algorirthms, Ant colony algorithm	Proposed an algorithm for researching how intelligent robots plan their routes and using blockchain technology.
[37]	2020	Robot	Linear Consensus Protocol ,W-MSR algorithm ARGOS-BLOCKCHAIN INTERFAce, Etherium Network	Byzantine Robots	Proposed a method that have Shown how using blockchain technology, a swarm of robots can come to an agreement even in the presence of Byzantine robots.
[38]	2019	Robot	smart contract, DLT network	Robots	Proposed Blockchain-based immutable black box logging for robots
[39]	2021	Vehicular Network	Hyperledger Fabric, Practical Byzantine Fault Tolerance (PBFT)	Artificial Neural Network	proposed ALICIA (Applied Intelligence in BlockChain vAnet) offered Accident detection and validation system to choose when and which node to exclude during the consensus process.
[40]	2021	Business (Investments)	Digital Signatures	Improved Artificial Bee colony algorithm(ABC), MOABC	Proposed a method to bolster asset securitization security and lower investment risk using BC and AI
[41]	2022	Construction Industry	Hyperledger Fabric, BBN	multi-buffer perceptron artificial	Proposed AI applications using blockchain technology for Decentralizing construction.

				neural network	
[42]	2020	Self driving Vehicles	Decentral application(DAPP),Public Ledger, Smart contract.	Reinforcement learning integrated heuristic search method (RLIH)	Supply chain management using the proposed Reinforcement Learning Integrated Heuristic Search Method (RLIH) for self-driving vehicles
[43]	2021	Healthcare.	Distributed Ledgers	Convolution Neural Networks	Proposed methods to tackle epidemics similar to the coronavirus (COVID-19) using Blockchain and AI.
[44]	2021	Social Media	Proo of Work, Smart contract	Supervised Algorithms	Proposed work to detect fake news and minimize spreading of the fake news.

Table 1 Applications that integrates AI and BC

ABC	Artificial Bee Colony
AI	Artificial Intelligence
ALICIA	AppLied Intelligence in bloCkchain vAnet
ANN	Artificial Neural Network
AUC	Area Under ROC curve.
BATS	A Blockchain and AI-Empowered Telesurgery System
BBR	Black Block Recorder
BC	BlockChain
BI-AIBT	Business Innovation based on artificial intelligence and Blockchain technology
CPP	critical peak pricing
DApp	Decentral application
DLT	Distributed General Ledger Technology
DRL	Deep reinforcement learning
ECM	Energy cloud management
EDR	Event Data Recorder.
HF	Hyperledger Fabric
IPFS	InterPlanetary File System
ISNN	improved sparse neural network
MSP	membership service participants
MNS	Miner Node Selection
mURLLC	massive Ultra-Reliable Low-Latency Communication
NLP	Natural Language Processing
OBU	On-Board Units
PoA	Proof-of-Authority
PoCC	Proof-of-computational-closeness
PoL	Proof of Learning
PoW	Proof of Work
PPV	positive predictive value
PPSC-BCAI	privacy-preserving in smart contracts using blockchain and artificial intelligence
NPV	negative predictive value
RAN	Radio Access Network
RLIH	Reinforcement learning integrated heuristic search method
RTP	real-time pricing
SNN	Sparse Neural Network
ToU	time of use
P2P	Peer to peer
VANET	vehicular network

VI. Conclusion

In this study, we reviewed and carried out a survey on the most recent developments in the application of regarding the use of blockchain technology for AI and AI features for BC. We gave a description of AI, its subfields , its applications and discussed how AI drives BC, then we discussed overview of blockchain and its implementations, consensus protocols, in and Blockchain driven AI. Additionally, a summary of several AI characteristics for blockchain applications is provided.Our assessment of the literature reveals that the adoption of integrating BC technology and artificial intelligence (AI) for applications are still in their development and that there are numerous research difficulties.

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Dr. Y.Sowjanya Kumari working as Associate Professor in SACET (Affiliated to JNT University, Kakinada), Chirala, India and she has 18 years of teaching experience. She has received her Ph.D. in JNT University, Kakinada,She has received M.Tech. in Computer Science & Engineering from JNTU, Kakinada A.P and B.Tech in Computer Science & Engineering from N.B.K.R.I.S.T, Vidyanagar, Nellore(dt) A.P.She has Published 11 research papers in various International Journals. Her research interest includes Image Processing, Machine Learning, IOT,AI.

R.Radha Kumari working as Associate Professor in SACET (Affiliated to JNT University, Kakinada), Chirala, India, and she has 17 years of teaching experience. She has received M.Tech. Degree in VLSI Design from Sathyabama university , Chennai and B.Tech in Electronics & Communication Engineering from N.B.K.R.I.S.T, Vidyanagar, Nellore(dt) A.P. Her areas of interest includes VLSI Design , Digital image processing and Artificial Intelligence, Machine Learning.

Dr.D.N.V.Syma Kumar, Presently working as an Associate Professor in the department of Computer Science & Engineering at St. Anns College of Engineering &Technology, Chirala, Andhra Pradesh, India. He had received his Ph.d. degree from Krishna University in the stream of Computer Science & Engineering in 2017.He had published more number of international publications in Scopus and various reputed journals. His research interests are Software Engineering, Data Mining, Artificial Intelligence and Machine learning.